A CONTRIBUTION TO A GENERIC REVISION OF *SIMOCHROMIS* AND *TROPHEUS* (PISCES: CICHLIDAE) - FROM LAKE TANGANYIKA, WITH SPECIAL REFERENCE TO THE PHARYNGEAL APOPHYSIS AND ITS TAXONOMIC IMPORTANCE

by

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ABSTRACT

The purpose of this thesis is to investigate the taxonomic status of Simochromis and Tropheus. Material for the study was collected during three visits to Lake Tanganyika in 1976-1977. Tropheus polli G.S. Axelrod 1977, was found and described, and a new species of Simochromis was found and will be described in a forthcoming paper. Nine colour varieties of Tropheus moorii and three colour varieties of Tropheus duboisi were found and described. A diagnosis and description, with colour photographs, is given using morphometrics and meristics of the five species of Simochromis and four species of Tropheus. A dissection and cleaning technique for the pharyngeal apophysis and lower pharyngeal bone is explained, together with a method for the interpretation of relative bone composition of the pharyngeal apophysis. Photographs are included. The dentition is examined, evaluated and figured.

Doubt has been cast upon the taxonomic validity of the composition of the pharyngeal apophysis as an indicator of affinity at the subfamilial level. This is shown by its seeming lack of functional relationship, apparent arbitrary variation, interspecific variability in Simochromis and Tropheus, and intraspecific variability in S. diagramma and T. duboisi. Thus, the apophysis cannot be considered a reliable cichlid taxonomic characteristic at any level of classification, unless its validity is substantiated in each instance. Furthermore, it is considered very probable that the Tropheus-Simochromis species complex is a monophyletic assemblage at the genus level, on the basis of similar dentition and mouth form, which is unique in Lake Tanganyika. It is proposed on phyletic grounds that Simochromis and Tropheus be united into the one genus Tropheus, and that Tropheus be divided into the subgenera, Tropheus (Tropheus) and Tropheus (Simochromis), along the lines of its previous division in two separate genera. Characteristics supporting this division include differences in the anal and dorsal fin meristic counts noted in the original descriptions of the genera. In addition, two modifications of the dentition were found during the course of this study which are not mentioned in any previous literature. It is considered probable, that Tropheus (Tropheus) and Tropheus (Simochromis) are monophyletic sister groups within the Tropheus complex. Pseudosimochromis Nelissen 1977 is not considered to be a taxonomically valid genus on either phyletic or gradistic grounds, and is included within Tropheus (Simochromis). The lower pharyngeal bone of T. (S.) diagramma is considered to be plesiomorphic in tooth arrangement, size and shape. A preliminary working hypothesis is established on the basis of the conjectures made and other available information which supports the phyletic relationship suggested by Fryer and Iles (1972). An illustration is given.

INTRODUCTION

Darwin's (1859) observations on the Finches of the Galapagos Islands offered the first example of explosive speciation to be recognised as such and studied in depth (Greenwood, 1964). Since that time many other striking cases of this phenomenon have been uncovered and examined. Perhaps the most significant example of explosive speciation can be found in the Great Lakes of Africa. Here the fish faunas are dominated by one large family, Cichlidae. The cichlids have evolved within the individual lakes to a point where hundreds of endemic species now exploit almost every conceivable way of life. Lake habitats successfully colonised by cichlids include rocky shores, sandy shores, pelagic regions and bathypelagic regions. Lake Tanganyika cichlids offer the most outstanding example of intralacustrine speciation and species diversification (Ferno, 1973; Fryer, 1969; Greenwood, 1964). To date 40 genera have been described, of which 34 are considered endemic (App. 1). Furthermore, all of the lake's (approximately) 140 known species are considered endemic.

At present, Tanganyikan cichlid taxonomy is in a state of flux. Fryer and Iles (1972) maintain that there are many examples of taxonomic incongruity, which has been caused by a vast number of newly discovered species and by some relatively recent changes in taxonomic philosophical reasoning. They specifically mention the genera *Simochromis* Boulenger 1898, *Tropheus* Boulenger 1898 and *Petrochromis* Boulenger 1898. These three genera were long regarded as having a *Tilapia* Smith 1840 related ancestory, due to the composition of their pharyngeal apophyses.

Wickler (1963) noted striking similarities in the reproductive behaviour of Tropheus moorii Boulenger 1898 and a species of Haplochromis Hilgendorf 1888, and suggested that T. moorii was a haplochromine derivative. In addition to examining the Haplochromis-Tropheus relationships, Wickler compared the features of Petrochromis, Petrotilapia Trewavas 1935 (related to Haplochromis) from Lake Malawi, and various Haplochromis species. His examination was mainly ethological in nature (except for his anatomical examination of the ovarian tubes), and one of his aspects of comparison was coloration. He examined the egg-spots of the anal fin, "which only make sense if the fishes behave in a Haplochromis-like manner" (Fryer and Iles, 1972, page 503). Wickler stated that the only way Petrochromis could be related to Tilapia would be if it exhibited convergence with Petrotilapia to an extent presently unknown in the animal kingdom. These observations and deductions led to the re-examination of the pharyngeal apophyses of the genera concerned. That of Tropheus moorii was re-examined by Trewavas and quoted in Buchard and Wickler (1965), and found to be of the Haplochromis type, substantiating Wickler's behavioural work. Thus, Wickler's Petrochromis-Haplochromis comparisons, along with the long-standing postulate of a close relationship between Tropheus, Simochromis and Petrochromis (Regan, 1920), would lead one to expect all three genera to have a Haplochromis type pharyngeal apophysis. According to Fryer and Iles (1972, page 503), re-examination by Dr P.H. Greenwood showed, however, that Petrochromis and Simochromis have a Tilapia type pharyngeal apophysis, thus creating a theoretical taxonomic contradiction. Hence, a review of the Simochromis-Tropheus-Petrochromis relationship and an investigation into the taxonomic value of the pharyngeal apophysis is necessary in order to resolve the problem.

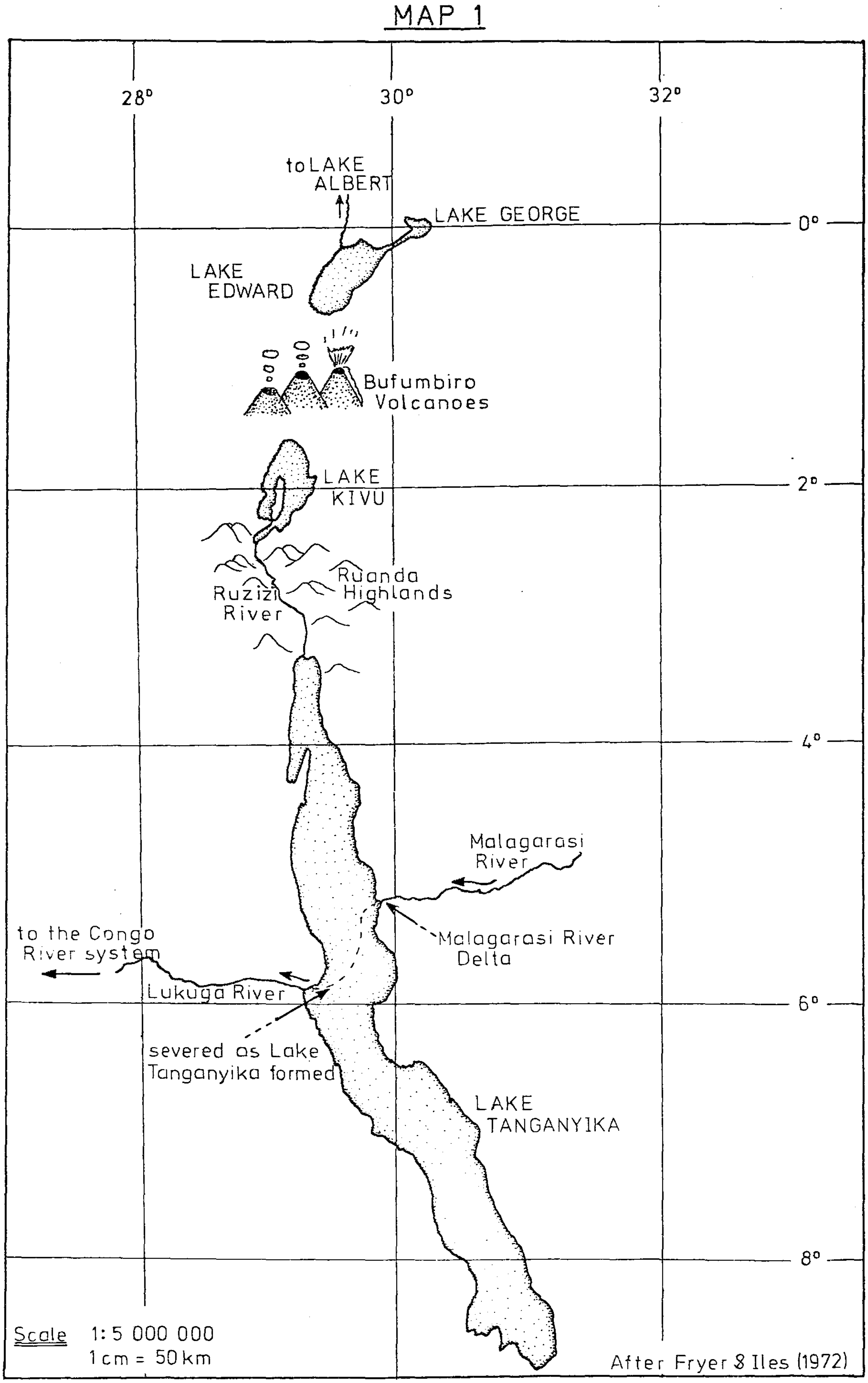
The purpose of this thesis is to investigate the taxonomic status of *Simochromis* and *Tropheus*, making a contribution to the resolution of the previously mentioned problem. The scope of the research has been confined to a gradistic analysis of the genera, based upon their original descriptions, with some preliminary cladistic comments and an investigation into the value of the pharyngeal apophysis as a character of taxonomic importance within this group. The results of this research have led to a working hypothesis of some phyletic interrelationships of the *Simochromis*-*Tropheus* complex as a monophyletic assemblage.

CHAPTER 1

THE GEOGRAPHICAL FORMATION AND BIOLOGICAL ISOLATION OF LAKE TANGANYIKA.

Lakes Tanganyika and Malawi were formed as a result of tremendous tectonic earth movements. The Great Rift valleys which contain the lakes began to develop in Miocene times and were completed during the Pliocene. The eastern Malawi rift valley and the western Tanganyikan rift valley were never connected. Lake Tanganyika consists of two continuous troughs, which significantly altered the drainage system of the area as they began to form. The Malgarasi River was cut in two by the Tanganyikan Rift, and the upper reaches of the river (to the lake's east) drained directly into the huge crevice. The lower portion of the river (to the lake's west) which is probably represented today by the Lukuga River, was cut off from supply. According to Brooks (1950), this internal drainage sink could have lasted as long as six million years.

Lake Tanganyika was isolated for some 10 000 000 years until Pleistocene times. As recently as 100 000 years ago, the lake gained its outlet to the Congo River system (as reviewed by Fryer and Iles, 1972). This event was stimulated by topographical changes due to volcanic activity that occured north of the lake (as illustrated in Map 1). Prior to this activity, Lake Edward and the Nile River system served as the receptacle for drainage from the Ruanda Highlands. During late Pleistocene times, however, the Bufumbiro Volcanoes formed across the northern part of the rift valley and impeded the drainage to Lake Edward; Lake Kivu formed against these



Map 1: The geographic formation of Lake Tanganyika. (details in the text).

volcanoes, eventually spilling over to the south. This overflow formed the Ruzizi River which flowed through the Ruanda Highlands and into the north of Lake Tanganyika. The Panzi Falls separated the fauna of Lakes Kivu and Tanganyika. Lake Tanganyika itself began to rise. It eventually overflowed through the old western portion of the Malagarasi River, which is now called the Lukuga River, thus ending Lake Tanganyika's long period of isolation.

Today, Lake Tanganyika is 650 km long and approximately 50 km wide, and lies at an altitude of 773 metres (as reviewed by Beadle, 1974). The main inflows into Lake Tanganyika are the Ruzizi and the Malagarasi Rivers. The main outflow is the Lukuga River, which is occasionally blocked by accumulated swamp vegetation. According to Beauchamp (1946), evaporation accounts for 95% of the total water loss from the lake. Nevertheless, the salt concentration, although higher than in the rivers, is only 420 parts per million, a surprisingly low figure considering the great age of the lake. The lake is the second deepest in the world after Lake Baikal in the U.S.S.R. A depth of 704 m has been recorded for the northern basin (lat. 5°S) and a depth of 1470 m has been recorded for the southern basin (lat. 7°S). Because of deoxygenation and the retention of hydrogen sulphide at greater depths, the ichthyofauna is contained in the uppermost 100 m (Beauchamp, 1946). This oxy-chemocline ranges between depths of 40 and 100 m. Its existence is due to the stable climatic conditions of the region, since temperature stability in the lake prevents thermo-currents that would otherwise create a circulation. This circulation would oxygenate the deep water and pass the hydrogen sulphide into the atmosphere. Since this is not the case, only a relatively thin surface layer of water sustains aerobic life in Lake Tanganyika (Worthington, 1954).

The results of Böhm's 1883 expedition to Lake Tanganyika led to the first theory of the lake's origin. It was postulated that, during the Jurassic Period, the lake was connected to the Atlantic Ocean across the Congo River Basin. This theory was biological and based upon fauna that appeared to be of marine origin. It was formulated as a result of Böhm's discovery of Limnocnida tanganyicae, the medusoid coelenterate. It was further supported by the presence of marine-like prosobranch gastropod molluscs and potomonid crabs, collectively called "thalassoid" forms according to Beadle (1974). This theory gained wide support among prominent biologists, notably Günther (1898) and Moore (1903). The "thalassoid" forms are now known to be related to other African freshwater fauna. Cunnington (1920) discredited the "sea theory" and no geological evidence has been found to support it.

The transection of the Malagarasi River has been supported by the presence of several species of fish which are not found in the lake, but occur in the Malagarasi and Congo River Basin. Brooks (1950) cited two examples of this, Labeo weeksii and Barbus eutaenia, while Poll (1946) cited four more examples, Polypterus ornatipinnis, P. congicus, Distichodus maculatus, and Tetraodon mbu. These fish are assumed to represent early Pliocene riverine forms which were geographically separated into two groups during the lake's formation (Poll, 1946). Although they did not enter the lake, other fishes from the Malagarasi River did. Beadle (1974) concludes that most of the Tanganyikan fauna has been derived from Miocene riverine forms. These fish once inhabited a water system draining the flatlands south of the (today's) Victoria Basin, and passing into the Congo River System. Later additions to the lacustrine fauna, however, have not been ruled out.

CHAPTER 2

ASPECTS OF THE FAUNAL COLONIZATION, ADAPTIVE RADIATION AND SPECIATION WITHIN LAKE TANGANYIKA.

Little is known about African freshwaters before Miocene times. It seems, however, that most genera acquired a Pan-African distribution (Beadle, 1974). The invasion of Lake Tanganyika by fish from the Malagarasi River is assumed to have immediately followed the initial formation of the Rift Valley (during Miocene times). The lake's dominant fish family, Cichlidae, is assumed to have arisen from the ancestors of the generalized riverine forms of *Tilapia* Smith 1840 and *Haplochromis* Hilgendorf 1888. Cichlids in Lake Tanganyika can thus be divided into two generalized species flocks of diphyletic origin. All members of a given species flock (or species complex) are more closely related to each other than to any fish outside the flock. The *Tilapia* species complex, including the genera *Tilapia*, *Sarotherodon* Rüppell 1893, and related fish, have often been referred to as tilapiine fishes; and the *Haplochromis* species complex, including the genus *Haplochromis* and related fish, have often been referred to as haplochromine fishes (Hoedeman, 1947, 1954). (Doubt has been cast on this assemblage by Wickler, 1963. This will be discussed in the later chapters.) According to Trewavas (1949, p. 1)

> "the *Tilapia* cannot have been very different from the population of *T. mossambica* now existing in the Tana River; the *Haplochromis* resembled *H. wingatii* of the Upper Nile and *H. bloyeti* of the Tanganyikan Territory."

H. bloyeti has the characteristics one would expect from riverine ancestors. It has a generalised anatomy, is relatively small (usually less than 14 cm in standard length), omnivorous, leaning toward a largely unspecialized carnivorous diet, and can tolerate a variety of conditions. H. wingatii, however, has been re-defined by Greenwood (1971) and little can be said about its phylogenetic relationships, with the exception that it may not be a generalized Haplochromis (it has specialized oral dentition and an unusual pectoral scale pattern).

It is a widely recognised biological postulate that, in order for animals to survive, they must be adapted to the environment in which they live. Adaptations in a changing environment are always inseparably coupled with function, and particularly in the present case, are largely structural or habitual modifications. Adaptive radiation refers to the territorial advancement of an animal which will then adapt to the changing environments it encounters. It involves behaviour, habits, and physiology, as well as morphology. The invading riverine fish entered the lacustrine habitat which is composed of three basic regions. The littoral region comprises the bottom reaches of the lake, and the water above these bottom reaches where it is clear enough and shallow enough to allow photosynthetic rooted flora to exist. In Lake Tanganyika, this region is found only along the shoreline, due to the steep gradient of descent. The region is composed of rocky outcrops and sandy shores, and contains the majority of Lake Tanganyika's faunal diversification. The benthic region is the area of the lake bed below the littoral region and bounded in its lower limit by the oxy-chemocline. The pelagic region is that area of water over the benthic region and the oxy-chemocline, and bounded by the littoral region.

According to Corbet (1961), African fishes must have passed through certain stages of evolution before they could adapt to the lacustrine environment. The initial primitive condition is a complete river existence which entails feeding and breeding only in rivers. As the fish begin to evolve toward a lacustrine existence, they feed in the lakes and rivers but breed only in the rivers. The height of generalization comes in the third stage, where the fish feed and breed in both the lakes and rivers. Finally, in the fourth and last stage, the fish become specialized lacustrine inhabitants by feeding and breeding only in the lakes. Today, almost all of the cichlid fishes within Lake Tanganyika and the other African Great Lakes are confined to their particular body of water and barred from riverine life due to their specializations. Over the course of time, geographical changes in Lake Tanganyika have resulted from such events as changes in the lake level, rock slides, silting from inflowing rivers, and erosion of rock surfaces. One result of these changes has been to create new barriers and remove old ones. Wright (1943) has mathematically postulated that the linear continuity of distribution within an animal system is more likely to differentiate than assimilate. This was applied to the African Great Lakes by Fryer and Iles (1972). Microgeographic isolation in Lake Tanganyika is an essential element of the lake's speciation story. Brooks (1950) developed the argument of intralacustrine speciation, where a lake is composed of many micro-habitats allowing allopatric speciation through geographic separation.

According to Kosswig (1963, p. 238),

> "the lapse of time and degree of isolation in the course of such changes in water level in Lake Tanganyika was sufficient to ensure the development of sexual barriers only as a by-product of diversification by micro-geographic isolation."

Prior to this theory, sympatric speciation was widely thought to have provided the only possible answer to the extreme diversification of Africa's Great Lakes, as geographic isolation could not have accounted for the entire occurrence. According to Worthington (1954, p. 1067), many scientists assumed incorrectly that

> "a single lake, even a big one, is one geographical unit and that a species-pair or a species-flock, if proved to have evolved within that lake, is evidence of sympatric speciation."

As time passed, the theory of sympatric speciation continued to lose support. Mayr (1963) regarded speciation of sympatrically distributed organisms as feasible and defined the phenomenon as

> "the origin of isolating mechanisms within the dispersal area of the offspring of a single deme."

Later, however, (1970) he changed his opinion and was convinced that sympatric speciation did not occur.

The example of Tropheus moorii:

Tropheus moorii is an example of an endemic cichlid widely distributed in Lake Tanganyika which is undergoing speciation through microgeographic isolation. Matthes (1962) and Marlier (1959) have extensively studied the distribution of this fish in the northern part of the lake. Records of T. moorii's distribution on the western shores of the lake are imprecise aquarist records and are not cited here. In three visits during 1976 and 1977, I examined the distribution of T. moorii in the eastern central part of the lake. Like the northern portion, this part consists of rocky outcrops separated by long stretches of sandy beach. T. moorii is a rock-dwelling fish that is rigorously restricted to its habitat of rocky outcrops and reefs along the littoral zone. According to Marlier (1959), it never moves more than one metre away from the rocks it inhabits. Thus, the sandy beaches act as geographical barriers. There are many known colour morphs of this fish, as can be seen from Map 2 and its accompanying Table 1. The morphometrics of these fish are virtually the same, but different colour varieties might be regarded as subspecies, as they are reproductively isolated (geographically) and there are no colour intermediates. Here is an excellent example of differentiation in its early stages. The different populations are isolated from one another and are morphologically diverging (assuming colour to be a morphological characteristic). They can still interbreed, however, and this is illustrated by the Kashikezi population which appears to be intermediate between the Luhanga and Bemba groups. Although many of these populations may never reach species status, one probably already has. Tropheus duboisi seems to have been a colour morph of T. moorii which has diverged to the point where it may be regarded as a distinct species (Fryer, 1969). It co-exists with the orange form of T. moorii but is reproductively isolated.

The wide diversification of fish in Lake Tanganyika, which shows more faunal diversification than any other African lake, is probably a result of the lake's greater period of isolation. (This assumes that the described genera are co-ordinate with other cichlid genera from the other lakes. If they are not, this point may be a human rather than a natural condition.) Cunnington (1920) cited geographical isolation as the major factor for the endemic diversity in Lake Tanganyika. Intralacustrine speciation has occurred to a much greater extent in cichlids than in all of the other lake fish families (13) combined. This phenomenon is repeated in almost all of the African tropical lakes. Lake Tanganyika contains approximately 140 cichlid species as compared with a total of 67 non-cichlids. According to Fryer (1969), we can only speculate as to the reasons involved. Fryer postulates that the answers lie largely in two areas of cichlid organization: their morphology and their elaborate breeding habits.

It was essential for the fish to overcome the problem of lacustrine colonization before adaptive radiation was possible. Spawning was one of the most difficult problems to overcome as it was often closely associated with running water. Cichlids evolved the ability to generate their own supply of running water by fanning their eggs with their fins or, in the case of mouth-brooders, by their opercular movements. This, coupled with increased spawning precision and territoriality, was vital to the success of radiation throughout the lake.

The elaborate breeding rituals of the cichlids present many opportunities for divergence and, hence, for speciation. According to Fryer (1969), slight behavioural changes in the spawning ritual can lead to incompatibility and ethological reproductive isolation.

Table 1 (refer to Map 2)

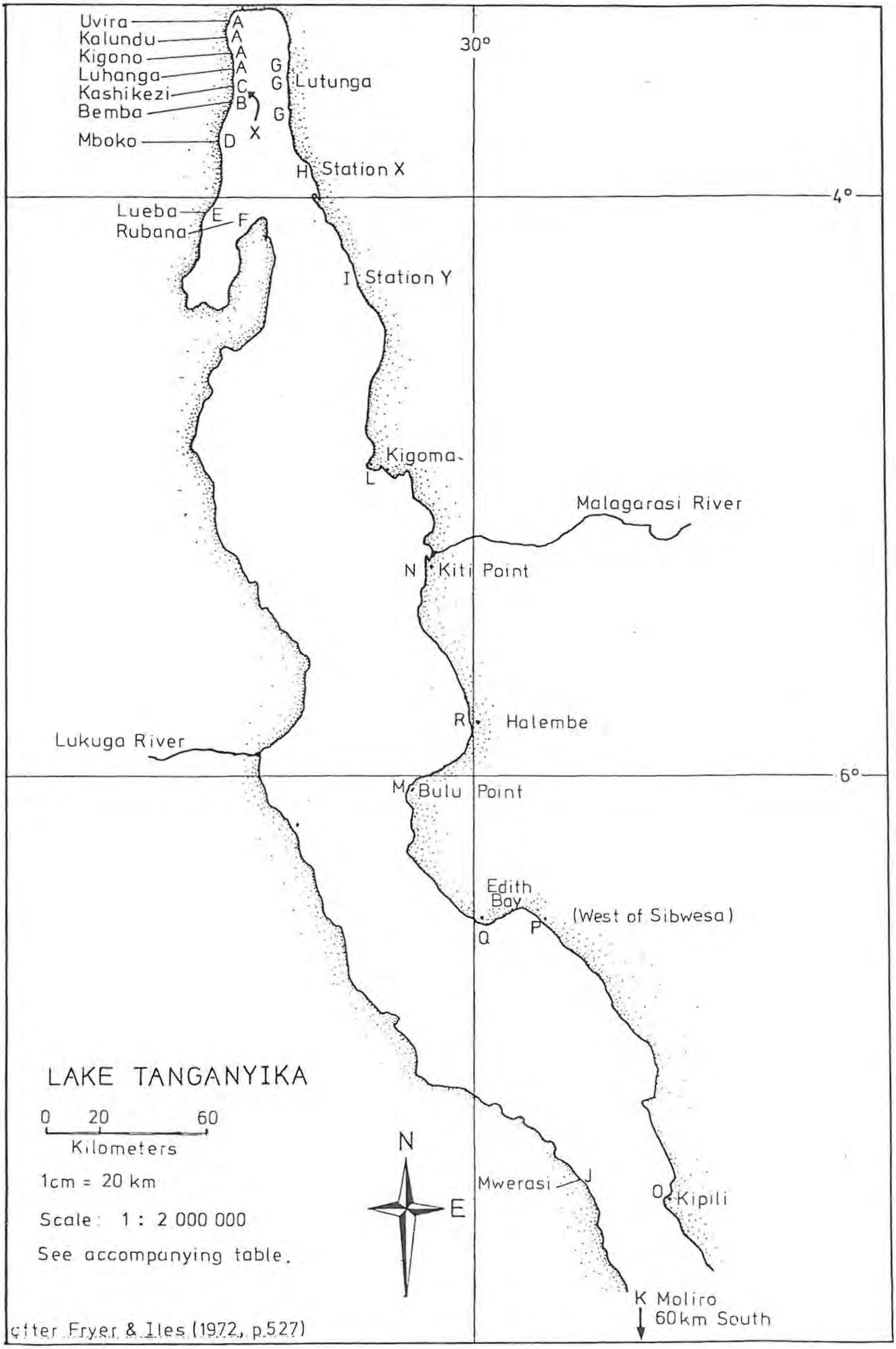
Some of the morphs of *Tropheus*.

Species[x]	Morph	Location	Map 2 Letter Code
T.m.	Black '	Uvira, Kalundu, Kigono, Luhanga	A
T.m.	Orange 1	Bemba	B
T.m.	Black + Orange 1 (intermediate) '	Kashikezi	C
T.m.	Golden '	Mboko	D
T.m.	Blue-Black '	Lueba	E
T.m.	Orange 2 '	Rubana	F
T.m.	Red-Yellow '	Lutunga	G
T.m.	Brown-Yellow '	Station X	H
T.m.	Brown-Green '	Station Y	I
T.m.	Olive-Yellow '	Mwerasi	J
T.m.	Red-blotched '	Moliro	K
T.m.	Brown ♀, Yellow-Olive ♂	Kigoma	L
T.m.	Red	Bulu Point	M
T.m.	Green	Kiti Point	N
T.m.	Yellow-finned	Kipili Bay	O
T.m.	Rainbow	west of Sibwesa	P
T.m.	Red-Orange-spotted	Edith Bay	Q
T.d.	White-banded '	Kashikezi & Bemba	X
T.d.	Narrow Yellow-banded	Kiti Point	N
T.d.	Wide Yellow-banded	Halembe	R
T.p.	-	Bulu Point	M

x *T.m.* = *Tropheus moorii*, *T.d.* = *Tropheus duboisi*, *T.p.* = *Tropheus polli*.

' as in Fryer and Iles (1972, p. 527).

MAP 2



Map 2: Some of the known Tropheus collection locations. (refer to Table 2).

Kosswig (1947, 1963) suggests that parental care and pair formation of most cichlids would generate micro-communities of inbreeding. These cell communities would tend to impede gene flow and stimulate speciation. The cyprinid and clariid fishes from Lake Tanganyika (to name but two families) lack these breeding rituals and specializations. Their reproduction is communal in nature and involves an inefficient method to achieve fertilization. Thus, their mass spawning , creating a lesser degree of genetic mixing, reduces the chance of speciation as compared to the cichlids.

According to Fryer (1969, p. 316)

> "Cichlid morphology is potentially capable of allowing mechanical specialization such as are denied, for example, to the cyprinids and clariids, both of which show some intralacustrine speciation in African lakes."

This includes many of the more specialized cichlid trophic modifications of the dentition, oral cavity, pharyngeal bones, and digestive physiology. Cyprinids are especially restricted as they lack teeth. Regan (1920) stressed that the large number of endemic cichlids (in Africa's Great Lakes) was mainly due to adaptive radiation towards different trophic specializations. Greenwood (1964, p. 260) emphasized this.

> "It is in their feeding habits that the Haplochromis have run riot, producing adaptations in dentition, skull and jaw form, and in digestive physiology. As a consequence, the species are able to use almost every food source in the lake. This multivarious adaptive radiation is one of the outstanding characteristics not only of the genus Haplochromis but of the entire family Cichlidae."

Greenwood (1974) again stressed the adaptability of the cichlid trophic morphology as the key factor in the family's remarkable success at diversification. According to Liem (1973), the cichlid ability to colonise and diversify within the lacustrine environment (in spite of strong competition and predation pressure) is unequalled in its extent by any other vertebrate family. Liem (p. 425) points out a

> "unique morphological key innovation of maximum versatility"

within the cichlid pharyngeal jaw apparatus that can be attributed to this phenomenon, along with the availability of a wide range of potential "adaptive zones." The flexibility of the pharyngeal complex with its ability to manipulate and prepare food, has freed the oral dentition from this constraint and has allowed a wide range of specializations for food collection. Cichlid trophic specializations include mollusc crushing, sand sifting to collect small crustaceans and chironomid larvae, the cropping of higher plants, algae scraping, insect collecting from algal covered surfaces, zooplankton feeding, extracting gastropods from shells, scale snatching from other fish, eating other fish, and extracting eggs and embryos from the mouths of other cichlids.

Due to the extreme cichlid morphological differentiation, specializations have been developed which exceed the limits ordinarily found within a family. Myers (1960) referred to these specializations as "supralimital." The leaf-like teeth of Perissodus is an excellent example of the extreme specializations found in certain cichlid genera. Another example would be the specializations of the pelvic fin found in the bottom-dwelling Asprotilapia and

Xenotilapia. Due to extreme radiative divergence and convergence in different families, some Tanganyikan cichlids closely resemble members of other percomorph families (Myers, 1960) such as Girellidae (Tropheus), Blennidae (Telmatochromis), and Percidae (Asprotilapia).

The rates of population transformation (speed of speciation) are regulated by the genetic stability of the population in question and the selection pressures placed on the population. As we have seen, the genetic stability of the cichlids is very "plastic" since modifications are frequent. Selection pressures include the climatic environment, the availability of food, population size, and predation. Population size is usually dictated by the other three selection pressures. Most cichlids are, however, territorial. This also influences population size as territoriality is a moderating factor on population density. Lake Tanganyika has had a relatively stable climatic environment which has been conducive to speciation (Poll, 1950 & Fryer, 1969). A comparison might be made between the isolated portion of the Malagarasi River and Lake Tanganyika. Few endemic species have evolved within the Malagarasi, and Poll (1956(b)) suggests that this is largely due to the river's climatic environment. The alternating periods of drought and flood, to which the Malagarasi has been particularly susceptible, create an unstable environment that is not conducive to specialized forms living in narrow niches. These drastic climatic changes, however, have had less of an effect on the lake, due largely to its enormous depth. During periods of long drought, the water level in the lake dropped, splitting it into two bodies of water. The fish fauna receded with the water level. This can be correlated with the distribution of

Haplochromis species, which are restricted to either one basin of the lake or the other (Mayr, 1952). Thus, the more specialized forms of life within the lake were able to survive. The Malagarasi River environment was more favourable to generalized forms (Matthes, 1960). Under stable conditions, food of particular kinds is in plentiful supply. Specialists may evolve which can utilize these particular resources in a more efficient manner than can the generalized forms of life. Harsh climatic conditions, however, may place limitations on the quantity of these various foods. The generalized fish will have the ability to utilize available food of several kinds. The specialized fish will probably perish, as it is either restricted to a particular food which is in intermittent short supply, or cannot adequately compete with other fish for the available food. Thus, stable environments are conducive to specialization, while unstable environments will more successfully sustain generalized life forms.

The pathways of evolution from the ancestral stock (or stocks) of Lake Tanganyika to the present day fish fauna remain unclear. This is due, in part, to the fact that the fishes have undergone many generations of adaptive radiation. Applying Hennig's (1966) philosophy of classification, all of the Tanganyikan cichlid ancestors have most probably become extinct. The present day fish have evolved to the point where their physical and habitual specializations are far different from their ancestors'. Several mechanisms such as parallel and convergent evolution, complicate phyletic studies as convergent evolution often leads to incorrect phyletic interpretations of evidence.

Boulenger (1906-1916) was the first to arrange taxonomically the entire known Tanganyikan fish fauna and place his conclusions within one volume. Since that time, much work has been done in an attempt to elucidate the ancestral relationships of the formulated species. Since evolution is an historical process, a fossil series containing both specialized and primitive representatives is important in deciphering the pathways of physical change of any group of organisms. Such a series, however, is not (in present case) available. Analysis of the situation has been almost solely based on external morphology, trophic specializations and, recently, behavioural characteristics. Deductions from evidence on these modes of analysis have led to many conflicting hypotheses. It may, therefore, be assumed either that some of these investigative criteria are invalid for evolutionary analysis, or that conclusions based upon valid criteria have been erroneous. It is clear, therefore, that considerably more research is needed in this area to help clarify many of these problems and contradictions.

The purpose of this thesis is to investigate the taxonomic status of two Lake Tanganyikan genera, *Simochromis* and *Tropheus*, and to make a contribution toward the clarification of their classification and intrarelationships. The scope of this research has been confined to a gradistic analysis of the problem, although some preliminary phylogenetic comments are put forth. Additionally, mention is made of the pharyngeal apophysis and its taxonomic use in cichlid classification.

PLATE 1: Monofilament net used during collections.

CHAPTER 3

METHODS AND MATERIALS.

PART A: FIELD TECHNIQUES.

Collection of Material:

All specimen material was collected using a single netting technique. A 10 mm bar mesh transparent monofilament net, 1.5 m in height (depth) and 10 m in length (Pl.1), was placed in an upright position across the rocks on the lake bed. Lead weights and styrofoam floats were fitted along the net's lower and upper lengths respectively. This ensured the net's vertical positioning. The fish were chased into the long transparent net and then scooped into hand nets. The hand nets had a circular opening approximately 30 cm in diameter with a 60 cm long, 7.4 mm bar mesh cotton net attached. The fish were forced from the hand nets into weighted 200 liter plastic drums. The drums were fitted with 7.5 mm bar mesh elastically self-closing net tops and had 5 mm perforations on their upper halves to ensure adequate water circulation. Self-contained underwater breathing apparatus (SCUBA) was used in all collections except those south of the Malagarasi River, where snorkel diving was done. The plastic drums were floated just below the water for the snorkel diving. The fish were kept alive within weighted plastic drums which were submerged in the lake in approximately 3 m of water until they were photographed.

Underwater Photography:

Many of the collected fish were photographed underwater. This was done to record their live colouration and habitat. A Nikkormat FTn 35 mm SLR camera with a Micro-Nikkor-P Auto 1:3.5 (F-55 mm) macro-lens was used for all underwater photography, and was placed within an Ikelite underwater camera housing. A Honeywell Strobonar 710 electronic flash was used for lighting and was also placed within an Ikelite housing. Kodak high speed (ASA 160) Ektachrome daylight 35 mm slide film was used.

Phototank Photography:

The specimens were removed from the submerged plastic drums (see "Field Techniques - Collection of Material") and placed in 200 liter storage barrels. They were then photographed using a "phototank technique" (H.R. Axelrod, 1972). The following are deviations from - or further explanations for - that technique:

According to H.R. Axelrod (1977, page 65) the fish are placed in a solution of MS-222 (tricane methanesulfonate) "to bring out their colours and put them to sleep." The effects of MS-222, a fish anaesthetic, vary with fish of different species and different sizes, with different temperatures, and at different concentrations. Its use in the field almost invariably kills all specimens. Any that might survive, however, will be killed during the rest of "Axelrod's phototank technique" procedure, which includes pinning out the fins of the fish and fixing them into position with formalin (conc. used). MS-222, is reputed to relax the chromatophores of a fish, thereby "bringing out its colours" (Axelrod, pers. comm.). Death, however, also does this. The fish loses complete control over the regulation of its complexion. After a period of time (varying with species, temperature, and fish size) the colour of the fish will no longer match its natural live coloration. This problem manifests itself in the case of Cichlasoma axelrodi, the South American "black" cichlid (formerly Chuco axelrodi). In its original description (Fernandez-Yepez, 1971) the adult was pictured and described as solid black, while an immature specimen was pictured as brown. In fact, its adult coloration is brown as in the juvenile (H.R. Axelrod, 1977). The original adult photograph was of a dead specimen, while the original juvenile photograph was of a live specimen. The incorrect description of coloration confused several scientists who sought to collect the fish.

MS-222 has its advantages. It seems to kill the fish with a minimal amount of trauma, thus minimizing the specimen damage which occurs with convulsing fish (personal observation). Furthermore, accurate live colour reproductions can be made if one shortens the time between the actual death of the specimen and the taking of the photograph. For the purpose of this thesis, the final product was compared to the underwater photographs and observations, and to aquarium specimens. Thus, if the potential colour problems can be controlled, the phototank technique seems to offer the optimal specimen positioning for scientific examination and comparison.

Preservation and Transportation of Specimens:

All specimens were preserved in 4-5% formaldehyde, diluted from a 37% (conc.) aqueous solution of the gas. Four percent was normally used, but 5% was used for large specimens (over 100 mm s.l.), whose body fluids were considered as a dilution factor. The body cavities of these specimens were made more accessible to the fixative with a 2-4 cm incision which ran diagonally on the fish's right side originating at the anus. The fish were fixed for one (for small fish) to two (for large fish) weeks, washed in water for 1 day and then placed into 70% propanol. This technique was used in both the field and laboratory.

The fixed fish were transported from Lake Tanganyika to South Africa wrapped in alcohol moistened paper and placed in airtight plastic bags.

PART B: LABORATORY TECHNIQUES.

Drawing Methods:

A Wild camera lucida, mounted on a Wild M5 dissecting microscope, was used for drawing the *Tropheus polli* specimen. Maps were redrawn from British Ministry of Defence maps (1964) which were purchased in Tanzania.

Dissections:

In order to examine the pharyngeal apophysis, the base of the neurocranium was exposed. This involved the dissection of the head from the body of a specimen. An incision was made just posterior to the supra-occipital crest and the vertebral column was severed. The supracleithrum of the pectoral girdle was separated from the posttemporal. All ligamentous and cartilaginous attachments from the branchial basket (with the upper pharyngeal bone) and hyoid arch to the neurocranium and exocranium were severed. This freed the neurocranium and exocranium from the branchial basket, hyoid arch and body of the specimen.

The upper pharyngeal bone was then removed from the branchial basket so that the lower pharyngeal bone could be extracted more easily. Incisions were made behind the lower pharyngeal, along its sides, above the horns and into the central cartilage of the branchial basket to free the bone. Care was taken so that the paired fitting rostral tips and the keel of the bone would not break. To ensure this, paired lateral slits were made in the central cartilage of the branchial basket down to the 3rd copula blade. The extracted lower pharyngeal was then cleaned of flesh, a delicate process which often removes teeth. This must be done manually, as chemical flesh clearing also loosens most teeth to the point where they fall out (Greenwood, pers. comm.; pers. obs.). The most effective flesh removal method employed (for this thesis) involved freeing the flesh from the fossa ledge and fitting rostral tips, and then pulling the flesh as one unit - from the anterior fitting rostral tips towards the posterior of the bone. Any remaining flesh was removed using fine tweezers. During this process, the bone was clamped into a fine foam mat, held by 3 thin spring steel wires across the 2 horns and fitting rostral shaft.

The pharyngeal apophysis and surrounding area were cleaned of flesh so as to clearly expose all suture lines. The cartilaginous pad covering the apophysis (which articulates with the dorsal side upper pharyngeal bone) was left intact for a photograph and then removed.

The dentary (mandible) and premaxilla were often cleaned of flesh so that the teeth could be more easily counted and/or photographed.

An incision was made into the lateral right body wall, originating at the anus, in order to sex the fish. A gonad sample was removed from each specimen. A Wild stereoscopic microscope model M5 was used for all dissections.

Clearing and Staining:

All skulls were cleared and stained (alizarin red S) using the "enzyme method of clearing and staining small vertebrates" (Taylor, 1967). Clearing only took several days as the dissection removed most flesh. The lower pharyngeal bones were stained but not cleared.

Electron Microphotography:

Scanning electron micrographs were taken of a pharyngeal bone of *Tropheus polli* and several pharyngeal apophyses of other fish. The advantage of the electron microphotography over the light microphotography is the greater depth of field obtainable from "light" of a shorter wave length. L. Vleggaar of the Rhodes University Electron Microscope Unit took some of the pictures, and instructed the author in taking the others. The individual shots were arranged together as composite photographs, re-photographed and reduced.

Light Macrophotography:

Photographs were taken of the pharyngeal apophysis, dentition and lower pharyngeal bone of most specimens. The pharyngeal apophysis was photographed from the sides and from directly above (fixing the apophysis parallel to the plane of the film). The latter photograph was used in the calculation of the relative bone contribution to the apophysis, and if the articular surface were tilted, a distorted perspective would have resulted (so far as relative bone contribution is concerned). The apophysis was levelled under a Nikon model SBR-T binocular microscope under 50X magnification. A combination of a 10X objective and 5X eyepiece gave a depth of focus equal to 16 microns. Thus, levelling was assured within an acceptable range.

Two Nikon SB-1 electronic strobe flashes were used for lighting from above, while a Honeywell Strobonar 710 electronic strobe flash (reflecting off a white card) was used for lighting from below. A Nikkormat EL 35 mm SLR camera with Vivitar bellows and micro-Nikkor-P Auto 1:3.5 (f=55 mm) macro-lens was used for all macrophotography. An Izumar XI green filter was used to enhance the contrast with the red stained material. Kodak Panatomic-X (ASA 32) black and white film was used and developed (by R.E. Stobbs) with Kodak D-11 fine grain developer. (All photos by the author)

X-Ray Photography:

X-rays (by R.E. Stobbs) were taken of the specimens in order to make vertebral counts. Caudal fin rays, dorsal fin soft rays and spines, and anal fin soft rays and spines were also counted. These compared favourably with counts taken manually.

Evaluation of the Pharyngeal Apophysis:

It is often extremely difficult to evaluate the border of the pharyngeal apophysis, as the surrounding bones often initially slope gradually away from the articulary surface. It was found that the cartilaginous covering over the apophysis in *Tropheus* and *Simochromis* was cup-shaped to receive the analagous articulary surface from the upper pharyngeal bones. This cup-shaped cartilaginous covering was assumed to allude to the area of articulation, and thus delineated the boundary of the apophysis. The apophyses were photographed with and without the cartilage intact. The articulary border was noted on the "cleaned" photo, and the suture lines of the contributing bones were also marked. A planimeter was used to calculate the unit area of each bone's contribution to the articulary surface, and these data were in turn divided into the total unit area to find each bone's relative percentage participation.

Histological Sex Determination:

The sex of each fish was checked histologically. After dissection, each tissue sample was dehydrated in an American Optical histokinette (70%, 80%, 90%, 3X absolute ethanol; 2X xylol -

2 hours for each step) and then impregnated with paraffin. Tissue samples were then embedded into paraffin blocks (Merk Paraffin Blockform, m.p. 57-60°C) and sectioned in 8 micron slices with a Lipshaw 45 Rotary Microtome. The slices of embedded tissue were placed on slides and hydrated (2X xylene - to remove wax; absolute ethanol, 90%, 80%, 70%: H_2O - 10 mins for each step). The hydrated tissue was stained with haematoxylin and eosin (haematozylin - variable time 30 secs - 3 mins ; H_2O wash; eosin - variable time 10 secs - 3 mins). The stained tissue was re-dehydrated (70% - 5 secs, 90% - 5 secs, 2X absolute ethanol - 10 mins; 2X xylene - 10 mins) and mounted permanently under a cover slip with Canada balsam. The slides were dried for 2 days at 50-60°C. The finished slides were viewed under a Nikon compound microscope and analysed for oocytes or spermatocytes.

Statistical Analysis, Morphometric Measurements and Meristic Counts:

A Texas Instrument SR-52 calculator with a PC-100A printer was used to calculate all statistical results. The statistical evaluations and symbols used in this thesis can be found fully explained in Sokal and Rohlf (1969). $\bar{x}$ represents the mean value of counts and/or measurements. This value is followed by the standard deviation (SD, by the n-1 method). CV is the coefficient of variation ($CV=SD/\bar{x}$ X 100%). It should be noted that the SD and CV values are only valid to one decimal place, but are expressed to two decimal places. The second figure after the decimal carries no statistical weight other than approximation.

Below are the equations used for the "t"-test.

n = the number of specimens.

t = the absolute value of the student's t-distribution where the particular characteristic for the species is compared against that same characteristic of *T. polli*.

DF = degrees of freedom, sometimes expressed as v.

%t = the percent probability of rejection of the null hypothesis. The null hypothesis states that there is no statistical difference between the two mean values for a characteristic.

$$t = \frac{\bar{x} - \bar{y} - \triangle}{\left(\frac{1}{n_x} + \frac{1}{n_y}\right)^{\frac{1}{2}} \left(\frac{\sum x_i^2 - n_x\bar{x}^2 + \sum y_i^2 - n_y\bar{y}^2}{n_x + n_y - 2}\right)^{\frac{1}{2}}}$$

$$= \frac{(n_x + n_y - 2)\,(\bar{x} - \bar{y} - \triangle)}{\left(\frac{1}{n_x} + \frac{1}{n_y}\right)^{\frac{1}{2}} \left(\sum x_i^2 - n_x\bar{x}^2 + \sum y_i^2 - n_y\bar{y}^2\right)^{\frac{1}{2}}}$$

Since $SD_x = \sqrt{\frac{\sum x^2 - n_x\bar{x}^2}{n_x - 1}}$, $SD_x^2\,(n_x - 1) = \sum x_i^2 - n_x\bar{x}^2$

$$\text{thus } t^1 = \frac{(n_x + n_y - 2)^{\frac{1}{2}}(\bar{x} - \bar{y} - \triangle)}{\left(\frac{1}{n_x} + \frac{1}{n_y}\right)^{\frac{1}{2}} \left(SD_x^2\,(n_x - 1) + SD_y^2(n_y - 1)\right)}$$

Since testing is for the null hypothesis, $\triangle = 0$.
t formula was used to evaluate *T. m. moorii*, and t^1 formula was used to evaluate *T. duboisi*, *T. brichardi* and *T. m. kasabae*.

TABLE 2

The following counts and measurements were made to help evaluate the taxonomic status of Simochromis and Tropheus. Most methods are identical to those used by Trewavas (1935) and Hubbs and Lagler (1947).

Count/Measurement	T[1]	H[2]	No. on Ill. 1	Comments
total length	T	H	1	-
fork length			2	snout tip to the posterior tip of shortest mid-caudal rays
standard length	T	H	3	-
head length	T	H	4	-
body length			5	standard length minus head length
body depth		H	6	taken at body's widest point
caudal peduncle depth			7	narrowest portion of the caudal peduncle
head width		H	-	-
interorbital width	T	H	8	-
preorbital depth	T		9	least depth across the preorbital (from the orbital circumference to the bone)
head depth			10	depth of the head at the posterior border of the preoperculum
snout length	T	H	11	measured as a projection
postocular portion of head		H	12	-
eye diameter		H	13	-
mouth width			15	distance between opposite ascending processes of the dentary
mouth length			16	axial projection from the most anterior portion of the dentary's median teeth to the ascending process of the dentary
cheek depth		H	14	-
dorsal fin:				
spine count		H	-	-
branched ray count		H	-	except the last ray is counted if it is separated at the base of the fin
length at base		H	17	-
longest spine		H	-	-
longest branched ray		H	-	-
distance from snout		H	18	-

Table 2 (continued)

Count/Measurement	T[1]	H[2]	No. on Ill. 1	Comments
anal fin:				
spine count		H	-	-
branched ray count		H	-	except the last ray is counted if it is separated at the base of the fin
length at base		H	19	-
longest spine		H	-	-
longest branch ray		H	-	-
distance from snout			20	diagonal from insertion of the first anal spine to the tip of snout
pectoral fin:				
branched ray count		H	-	-
longest soft ray		H	-	-
distance from snout			21	axial projection to the tip of the snout
pelvic fin:				
ray count		H	-	-
longest branched ray		H	-	-
distance from snout			22	diagonal from insertion of the pelvic spine to the tip of the snout
caudal fin:				
principal rays		H	-	-
longest ray			23	total length minus standard length
scales:				
lateral line count	T		-	-
around the caudal peduncle		H	-	-
above the lateral line		H	-	-
below the lateral line		H	-	-
cheek scale rows		H	-	-

1 as described in Trewavas (1935).

2 as described in Hubbs and Lagler (1947).

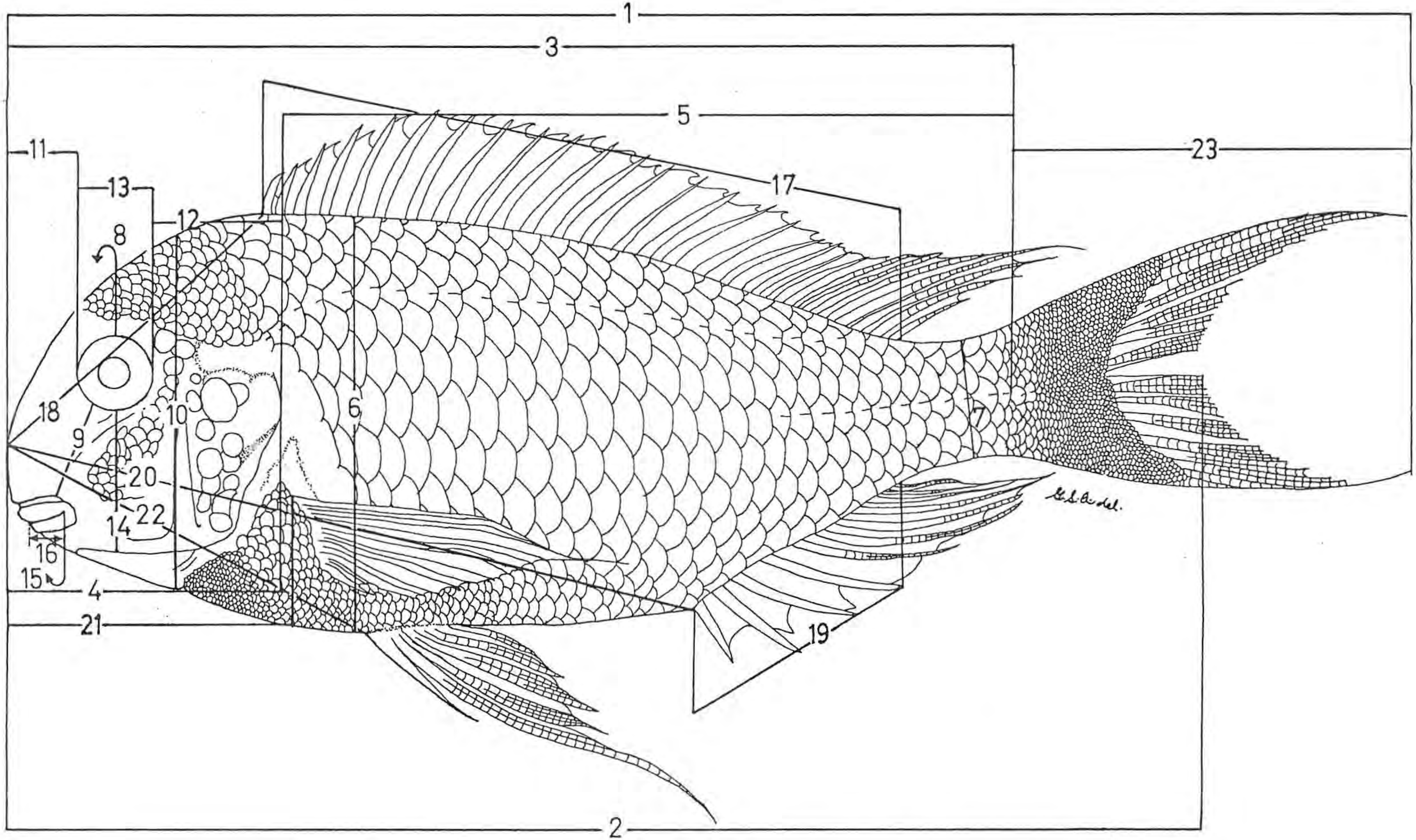


Illustration 1 : Methods of morphometric measurement. (refer to Table 2).

In addition to the previous, several other counts and measurements were made. The pharyngeal bone was cleaned for observation and its length and width were measured. The width is the distance between the most lateral portions of the bone's horns (terminology as in Barel *et al* 1976). The length is the distance between the most anterior portion of the keel, measured along a parallel to the keel itself, and the point midway between the most posterior portions of the horns.

Vertebral counts were made from X-rays of the specimens. The total number of vertebrae was counted from the atlas at the base of the neurocranium to the ultimate vertebra preceeding the hypurals. The total number was subdivided into caudal and pre-caudal vertebrae. The first caudal vertebra occurs with the fusion of the transverse process, which is detected as a light "hot spot" of bone concentration on an X-ray.

It should be noted that all measurements were made after preservation of the specimens. Some dental counts were made before preservation.

PART C: MATERIAL EXAMINED.

Specimens examined were either collected by the author (GSA), donated by or examined at the Koninklijk Museum voor Midden-Africa, Tervuren (KMMA), or examined at the British Museum (Natural History), London (BM(NH)).

Specimens were collected at the following locations on the eastern shore of Lake Tanganyika:

Nyanza, Burundi - 4°21'S. 29°36'E., collection by P. Brichard (Nelissen & Thys, 1975).

Kigoma (Harbour area), Tanzania - 4°52'S. 29°37'E., collection by G.S. Axelrod (refer to Map 3).

Kigoma (Kitwe Point), Tanzania - 4°55'S. 29°37'E., collection by G.S. Axelrod (refer to Map 3).

Kiti Point, Tanzania 5°17'S. 29°47'E., collection by G.S. Axelrod (refer to Map 4).

Halembe, Tanzania - 5°44'S. 29°55'E., collection by G.S. Axelrod (refer to Map 5).

Bulu Point, Tanzania - 6°01'S. 29°43'E., collection by G.S. Axelrod (refer to Map 6).

Edith Bay, Tanzania - 6°28'S. 29°55'E., collection by G.S. Axelrod (refer to Map 2).

Kipili Bay, Tanzania - 7°30'S. 30°39'E., collection by G.S. Axelrod (refer to Map 2).

West of Sibwesa, Tanzania - 6°35'S. 30°15'E, collection by G.S. Axelrod (refer to Map 2).

Field catalogue numbers are prefixed with GSA and not J.L.B. Smith Institute numbers. All measurements given are standard lengths.

Simochromis sp.A: ♀♀ GSA-SS604, 606 (76.9 & 63.2 mm resp.). The 2 specimens were collected in Kigoma Harbour (Map 3) at 2-6 m depth in 9/76. Both specimens were used for external morphometric measurements, external meristic counts, dentition counts and vertebral counts. GSA-SS606's lower pharyngeal bone was examined and measured; in neither specimen was the neurocranium extracted nor the pharyngeal apophysis examined.

Simochromis babaulti: ♂♂ GSA-SB404, 8 (62.5 & 60.5 mm resp.), ♀♀ GSA-SB402, 403 (62.8 & 53.4 mm resp.). The 4 specimens were collected in Kigoma Harbour (Map 3) at 2-6 m depth in 9/76. All specimens were used for external morphometric measurements, external meristic counts, vertebral counts and lower pharyngeal bone measurements. Three specimens were used for dentition counts, as some of the teeth were damaged in GSA-SB8. Three specimens were used for pharyngeal apophysis examination, and one specimen, GSA-SB402, was kept intact.

Simochromis curvifrons: ♂ GSA-SC300 (78.5 mm), ♀ GSA-SC5 (65.2 mm). These 2 specimens were collected in Kigoma Harbour (Map 3) at 2-6 m depth in 9/76. ♂ KMMA-129651 (89.9 mm). This specimen was collected by Matthes in Lake Tanganyika (location unknown) in 1960. All specimens were used for external morphometric measurements, external meristic counts, dentition counts, vertebral counts, lower pharyngeal bone measurements, and pharyngeal apophysis examination.

Simochromis diagramma: ♂♂ GSA-SD500-503, 508, 9 (127.9, 144.4, 108.2, 120.4, 123.7 & 122.1 mm resp.), ♀♀ GSA-SD504-507, 509-512 (75.6, 74.5, 76.3, 54.3, 95.2, 62.3, 65.2 & 60.8 mm resp.). The

14 specimens were collected in Kigoma Harbour (Map 3) at 2-8 m depth, GSA-SD500-507, 9 were collected in 9/76 and GSA-SD508-512 in 6/77. External maristic counts and morphometric measurements were made on all specimens, except when damage (e.g. a torn fin) prevented such. The 10 largest specimens were used for dentition counts. GSA-SD500-509, 9 were used for lower pharyngeal bone measurements and pharyngeal apophysis examination. Vertebral counts were made on GSA-SD500-507.

Simochromis marginatus: ♂♂ GSA-SM600-603, 605, 10 (93.7, 90.3, 89.5, 89.6, 84.9 & 86.9 mm resps.), ♀♀ GSA-SM400-401 (83.3 & 83.0 mm resps.). These 8 specimens were collected in Kigoma Harbour (Map 3) at 2-6 m depth in 9/76. External meristic counts and morphometric measurements, dentition counts and vertebral counts were performed on all specimens, except when damage prevented count or measurement of a particular characteristic. The lower pharyngeal bone was measured in all specimens except GSA-SM401. The pharyngeal apophysis was examined in all specimens except GSA-SM401 & 605.

Tropheus brichardi: ♀♀ KMMA-P76-9-P-40 & 41 (74.2 & 63.2 mm resp.). These 2 specimens were collected by P. Brichard in Nyanza, Burundi in 1974 (Nelissen & Thys, 1975). All specimens were used for external morphometric measurements, external meristic counts, dentition counts, vertebral counts, lower pharyngeal bone measurements and pharyngeal apophysis examination.

Tropheus duboisi: ♂♂ & ♀♀ GSA-TD61-104, 4 (68.2-96.1 mm), with little difference between the s.l. ranges of the different sexes. Twenty-one specimens, GSA-TD61-80, 3 were collected at Kitwe Point

(Map 3), Kigoma at 12-14 m depth in 5/76. Two specimens, GSA-TD81, 82, were collected at Kiti Point (Map 4) in 9/76 and are yellow banded, as opposed to all of the other T. duboisi collected which are white banded. Eighteen specimens, GSA-TD83-100, were collected at Bulu point (Map 6) at 10-15 m depth in 9/76. Four specimens, GSA-TD101-104, were collected at Halembe (Map 5) at 10-12 m depth in 9/76. External meristic counts and morphometric measurements were performed on all specimens, except when damage prevented such. Eleven specimens, ♂♂ GSA-TD61, 63, 64, 4 (91.3, 89.2, 88.8 & 59.0 mm resp.) and ♀♀ GSA-TD62, 65-70 (91.8, 96.1, 79.1, 84.2, 79.7, 82.4 & 81.7 mm resp.), were used for vertebral counts, lower pharyngeal bone measurements, and pharyngeal apophysis examination. Of these, all but two, GSA-TD70, 4, were used for dentition counts.

Tropheus moorii: ♂♂ & ♀♀ GSA-TM1-64 (50.4-90.1 mm) with little difference between the s.l. ranges of the different sexes. Eleven specimens, GSA-TM1-11 were collected at Kitwe Point (Map 3), Kigoma at 2-6 m depth in 5/76. Ten specimens, GSA-TM12-21, were collected at the same location and depth in 9/76. Twenty-one specimens, GSA-TM22-42, were collected at Kiti Point (Map 4) at 3-6 m depth in 9/76. Eighteen specimens, GSA-TM43-60, were collected at Bulu Point (Map 6) at 4-8 m depth in 9/76. External meristic counts and morphometric measurements were performed on GSA-TM1-60, except when damage prevented such. Eleven specimens, ♂♂ GSA-TM6, 7, 13, 16 (79.0, 75.6, 82.6 & 75.1 mm resp.) & ♀♀ GSA-TM1-5, 10, 14 (79.6, 84.0, 82.3, 86.5, 84.6, 68.9 & 77.3 mm resp.), were used for vertebral counts, lower pharyngeal bone measurements and pharyngeal apophysis examination. Of these, all but two, GSA-TD14, 16, were used for dentition counts.

GSA-TM61-64 were photographed as examples of chromatic differentiation within the species. GSA-TM61 (79.7 mm) was collected at Kipili Bay at 4-5 m depth (Map 2), GSA-TM62 (80.9 mm) was collected at Edith Bay at 5-6 m depth (Map 2). GSA-TM63-4 (84.2 & 83.1 mm, resp.), was not collected by the author, and comes from an unknown location north of Kigoma.

Tropheus polli: The relevent information is contained in the new species description bound with this thesis.

Type material for several species of Tropheus and Simochromis was examined at the BM(NH) in 6/77 and at the KMMA in 1/77.

Simochromis curvifrons: KMMA holotype (t.l. 120 mm), collected by A. Lestrade from Lake Tanganyika at Nyanza, Burundi in 1937, (Poll, 1942).

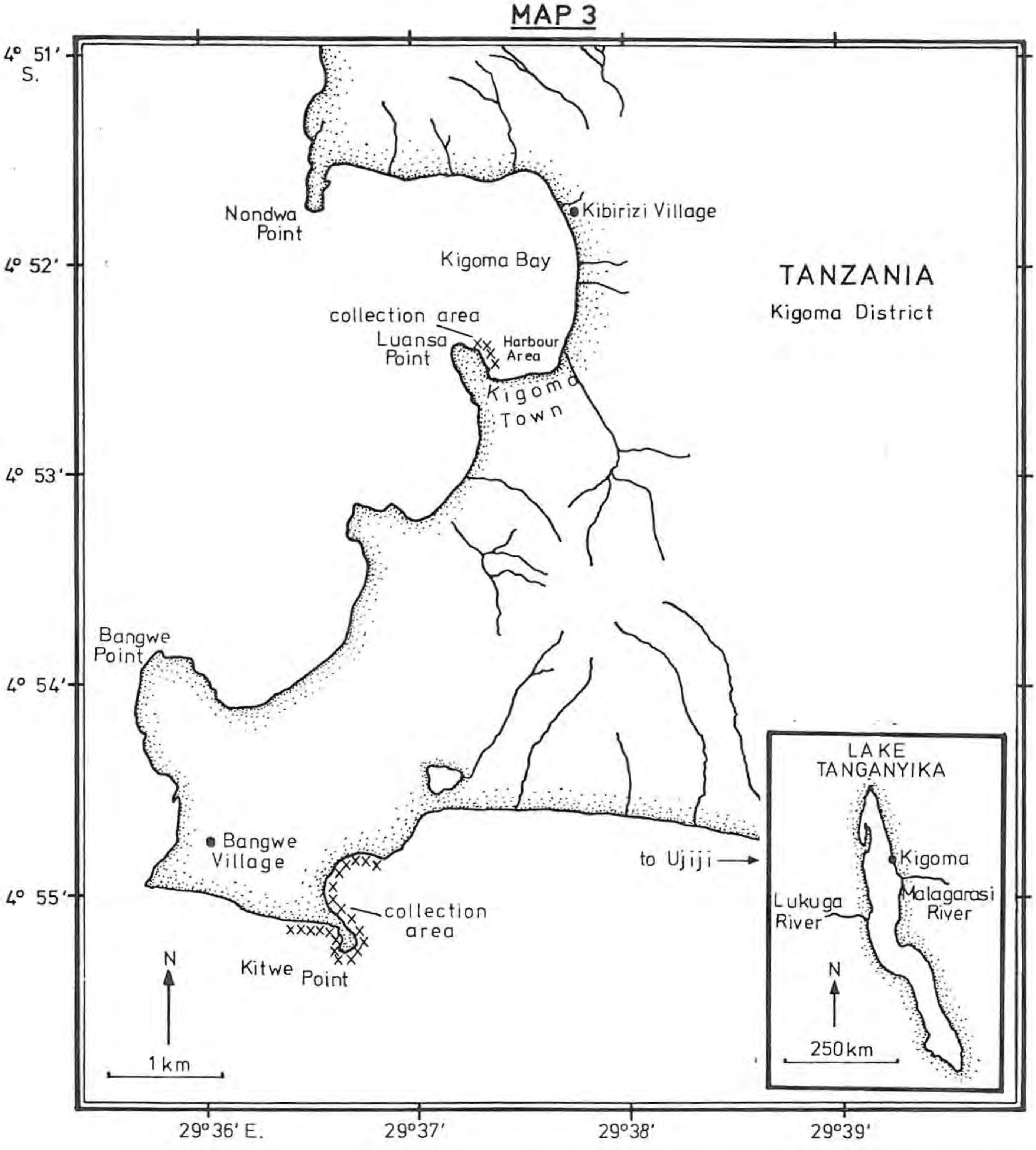
Simochromis marginatus: KMMA holotype (t.l. 89 mm), collected by M. Poll from Lake Tanganyika at Manga, Zaire on 17/4/47. (Poll, 1956).

Tropheus brichardi: KMMA holotype (t.l. 84.8 mm), collected by P. Brichard from Lake Tanganyika at Nyanza, Burundi on 5/9/74. (Nelissen & Thys, 1975).

Tropheus duboisi: KMMA holotype (s.l. 103.8 mm), collected by J. Dubois from Lake Tanganyika at Bemba, Zaire in 1957. (Marlier, 1959).

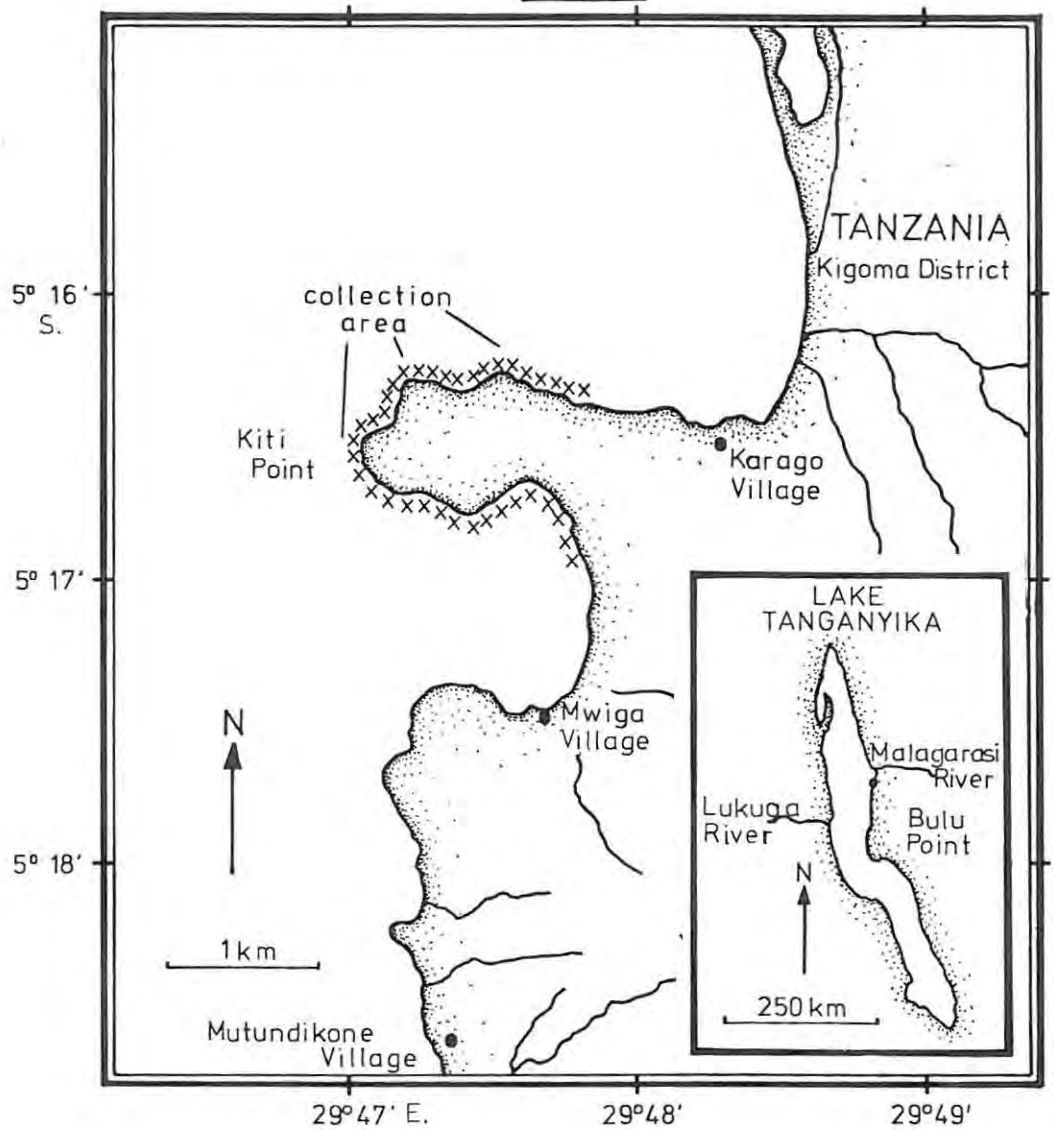
Tropheus moorii: BM(NH) co-type (t.l. 110 mm), collected by J.E.S. Moore from Lake Tganganyika at Kinyamkolo (=Niamkolo), Zambia in 1895-6. (Boulenger, 1898).

<u>Tropheus annectens:</u> BM(NH) co-type (t.l. 80 mm), collected by Capt. Hecq from Lake Tanganyika at Albertville, Zaire in 1900 (?). (Boulenger, 1900).



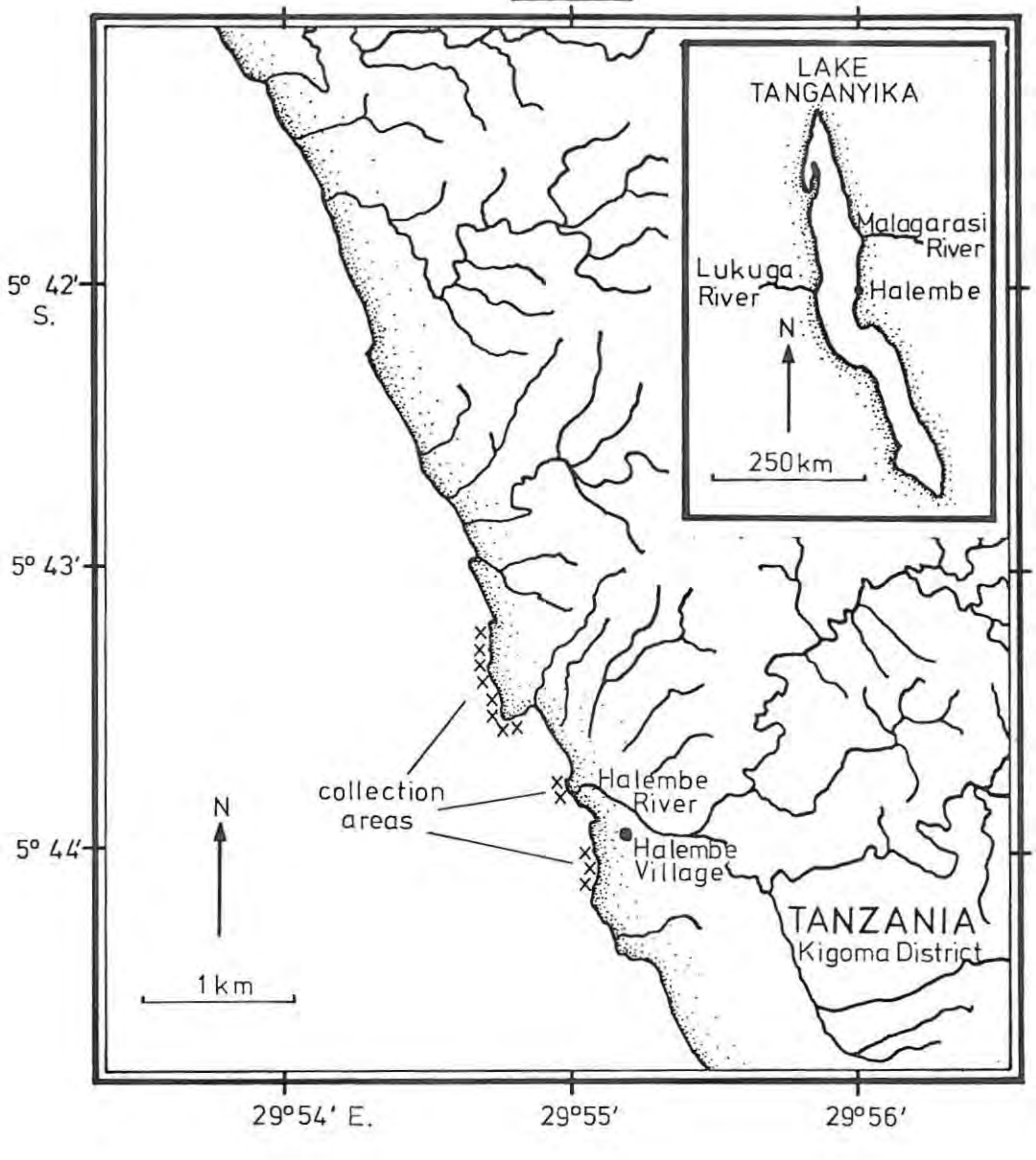
Map 3 : Kigoma collection area. Adapted from the Survey Division, Ministry of Lands and Surveys, Tanganyika, map (1959), series Y742, T.S.D. second edition.

MAP 4

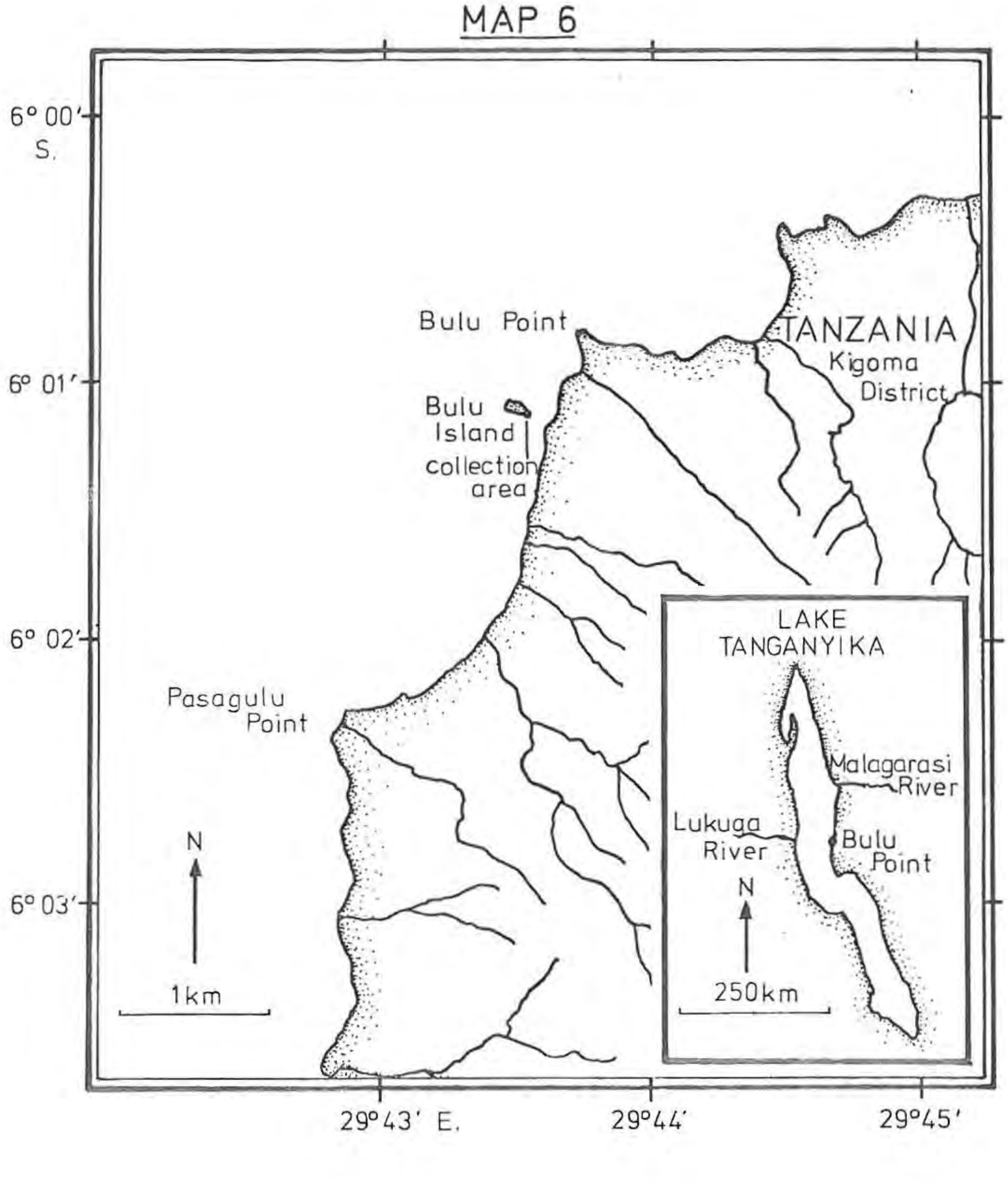


Map 4 : Kiti collection area. Adapted from the United Kingdom Ministry of Defence map (1964), series Y742, sheet 112/IV, edition 2-GSGS.

MAP 5



Map 5 : Halembe collection area. Adapted from the United Kingdom Defence Ministry map (1964), series Y742, sheet 131/II, edition 2-GSGS.



Map 6 : Bulu collection area. Adapted from the United Kingdom Directorate of Colonial Surveys map (1955), D.C.S. 22, first edition.

CHAPTER 4

DIAGNOSES AND DESCRIPTIONS OF THE SPECIES IN THE GENERA SIMOCHROMIS AND TROPHEUS.

The four species of Tropheus (T. brichardi Nelissen & Thys 1975, T. duboisi Marlier 1959, T. moorii Boulenger 1898, T. polli G.S. Axelrod 1977) and five species of Simochromis (Simochromis sp. A = undescribed species, S. babaulti Pellegrin 1927, S. curvifrons Poll 1942, S. diagramma (Günther 1893), S. marginatus(Poll 1956) are described below. A diagnosis is given for each species where its morphometrics and meristics are compared to the other species in Simochromis and Tropheus. This is followed by a selected description of each species' morphology, meristics and habitat. There are eleven comparative morphometric/meristic tables (Tables 31-41) at the end of this chapter that are cited in the text. The purpose of this chapter is two-fold: (1) to help to define the parameters of each species so that they can easily be separated from one another and (2) to gather morphometric and meristic information at a specific level so that it can be consolidated at the generic level (Chapters 5 & 6) for a taxonomic comparison of Simochromis and Tropheus.

Due to the limited time available for this thesis, it was impossible to collect a sufficient quantity of specimen material to validate all of the statistical morphometric comparisons made in this chapter. I regret having to subject a population of only two fish (i.e., Simochromis sp. A and Tropheus brichardi) to statistical analysis, and apology is made for this transgression on true mathematical validity. It was decided, however, that a standard means of comparison using the sample mean, standard deviation and *t*-test would be preferable to no comparison at all. Thus, when n is small (less than 5), care must be taken to note that the differences expressed in Tables 38-41 are not as reliable as they would be for a larger number of specimens.

Tropheus moorii kasabae Nelissen 1977 is not discussed or evaluated in this thesis as specimens have not been available for examination and I am not, at the present, fully convinced of the taxonomic validity of this subspecies. Furthermore, *Pseudosimochromis* Nelissen 1977, is not recognized as a valid genus and the reasons for this are discussed in Chapter 6.

As a helpful guide, all Plates, Tables, figures and Maps are referred to page numbers in a Table of contents at the beginning of the thesis. Most of the Plates and Tables are in close proximity to their citation, with the exception of the extended pharyngeal bone Plates and specimen colour photograph Plates bound into the rear of the thesis. All abreviations are listed appendix 2.

N.B. There is a slight (approx. 5%) and unavoidable enlargement of the transparent overlays, on the pharyngeal apophysis plates, by the transparency copying machine. Thus, although the suture lines drawn on the transparent overlays indicate the pattern on the photographs, the alinement may be noticeably inaccurate in some cases.

Simochromis sp. A

During the examination of the genus Simochromis, a new species was found amongst the S. marginatus. It was inadvertantly placed there during a preliminary separation of the Simochromis species due to its almost identical coloration. Furthermore, Poll's (1956) key for the genus cannot adequately separate it from S. marginatus. For this thesis, the fish has been referred to as Simochromis sp. A. Below is a diagnosis and description of Simochromis sp. A, which will be fully described in more detail (with specimen drawing) as a new species in the near future.

Diagnosis:

Morphometric characteristics -

Simochromis sp. A morphometrically differs[1] (Tables 38-41) from all other Simochromis species and Tropheus species in the caudal peduncle depth (as % s.l., 14.2 cf 10.6-12.3; as % b.l., 20.6 cf 15.3-17.4), interorbital width (as % s.l., 9.3 cf 7.0-8.3 & 10.1-12.4), preorbital depth (as % s.l., 5.6 cf 6.3-9.5; as % h.l. 17.8 cf 20.8-32.1), mouth width (as % h.l., 31.7 cf 35.1-47.6) and longest branched pectoral ray (as % s.l., 26.1 cf 29.9-35.7; as % b.l., 38.0 cf 43.2-51.7). Additionally, Simochromis sp. A differs[2] from all other Simochromis species in the eye diameter

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1. The numeral sequence respectively compares each parameter of the unidentified Simochromis sp. A and all of the other Simochromis species and all of the Tropheus species.

2. The numeral sequence respectively compares each parameter of the unidentified Simochromis sp. A and all of the other Simochromis species.

(as % h.l., 32.2 cf 27.2-31.0) and longest anal spine (as % s.l., 16.9 cf 13.8-15.4; as % b.l., 24.5 cf 19.6-22.4), and differs[1] from all Tropheus species in the eye diameter (as % s.l., 10.1 cf 7.3-8.9), mouth width (as % s.l., 9.9 cf 12.3-13.8), cheek depth (as % s.l., 9.2 cf 11.3-12.4), interorbital width (as % h.l., 29.9 cf 35.7-41.8), head depth (as % h.l., 97.7 cf 112.0-116.7), length of the dorsal fin base (as % s.l., 59.7 cf 61.7-63.0) and length of the anal fin base (as % s.l., 18.8 cf 20.0-22.8). Simochromis sp. A further differs[2] from S. marginatus in the following characteristics: postocular head (as % s.l., 12.6 cf 11.3; as % h.l., 40.2 cf 37.4), eye diameter (as % s.l., 10.1 cf 9.0; as % h.l., 32.2 cf 30.0), mouth width (as % s.l., 9.9 cf 12.0), snout length (as % h.l., 27.5 cf 32.6), mouth length (as % m.w., 41.1 cf 32.8), longest branched dorsal ray (as % s.l., 19.7 cf 17.4; as % b.l., 28.7 cf 24.8), longest branched anal ray (as % s.l., 19.6 cf 17.8; as % b.l., 28.5 cf 25.4), length of the dorsal fin base (as % b.l., 86.9 cf 83.5), longest dorsal spine (as % b.l., 19.5 cf 18.1), length of the anal fin base (as % b.l., 27.4 cf 25.5), longest caudal ray (as % b.l., 34.6 cf 32.2).

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1. The numeral sequence respectively compares each parameter of the unidentified Simochromis sp. A and all of the Tropheus species.

2. The numeral sequence respectively compares each parameter of the unidentified Simochromis sp. A and S. marginatus.

Meristic characteristics -

The dorsal fin of Simochromis sp. A has 17 spines and 9-10 branched rays, as compared with all Tropheus species which have 20-22 spines and 5-8 branched rays (Table 31). The anal fin of Simochromis sp. A has 3 spines and 8 branched rays, as compared with S. marginatus which has 3 spines and 7 branched rays, and all Tropheus species which have 4-6 spines and 5-8 branched rays (Table 32). Simochromis sp. A has 7 gill rakers below the articulation on the outer gill arch as compared with 5-6 gill rakers for S. marginatus and 10-12 gill rakers for all Tropheus species S. curvifrons and S. diagramma (Table 33). Simochromis sp. A has a mean value of 37 bicuspid teeth in the outer row of the upper jaw as compared with 27-32 & 43-45 for all other Simochromis species, and has a mean value of 29 bicuspid teeth in the outer row of lower jaw as compared with 34-49 for all Tropheus species (Table 35, Table 38).

Description:

All methods of count, measurement and statistical analysis are explained in Chapter 3 - "Laboratory Techniques." Tables 3 and 4 list the selected morphometric characteristics of the head, body and fins of Simochromis sp. A. Statistical comparisons of the selected morphometrics of all known Simochromis and Tropheus species are shown on Tables 38-41. Both specimens are sexually mature females. Specimen field numbers, sizes, collection locations and collection dates are found in Chapter 3 -"Material Examined."

The fin formulae for Simochromis sp. A are listed on Tables 31 and 32, and are compared with the other Simochromis species and with the Tropheus species.

Dorsal Fin Formula: $\frac{XVII,9}{1}$ $\frac{XVII,10}{1}$

Anal Fin Formula: $\frac{III,8}{2}$

Pectoral Fin Formula: $\frac{16}{2}$

Pelvic Fin Formula: $\frac{I,5}{2}$

Caudal Fin Formula: 16 principle rays, I-14-I.

The gill raker counts for Simochromis sp. A are listed on Table 33 and compared with the other Simochromis species and with the Tropheus species. The gill rakers are conical in shape.

Gill Raker Count - number above, on and below the articulation: 2-1-7 (F.1), 3-1-7 (F.1).

The selected scale meristics for Simochromis sp. A are listed on Table 34 and are compared with the other Simochromis species and with the Tropheus species.

Lateral Line Count: 29+2 (F.1), 30+2 (F.1).

Cheek Scale Rows: 4 (F.2).

The dentition counts for Simochromis sp. A are listed on Table 35 and are compared with the other Simochromis species and with the Tropheus species. The pattern of the dentition is explained in the description of S. curvifrons.

Upper Jaw: 4-5 rows of tricuspid teeth, mode = 5 rows.
36-38 bicuspid teeth in the outer row, mean = 37 teeth.
4-6 conical teeth at each corner of the mouth, mode = 6 teeth.

Lower Jaw: 5 rows of tricuspid teeth.
28-30 bicuspid teeth in the outer row, mean = 29 teeth.

The lateral portion of the lower jaw was not examined as of yet. The specimen will be X-rayed to check for lateral conical teeth in the lower jaw, eliminating the need for dissection.

The lower pharyngeal bone of Simochromis sp. A is triangular in shape with a median indentation on its posterior border (Pl.23 fig. 5). There are 42 enlarged teeth on the posterior border of the bone which are anteriorly slanting unicusps with a poorly defined shoulder. There is a second row of similar teeth parallel to the previous row, but these teeth are not as enlarged as the former. All of the other teeth are very slender unicusps which slant posteriorly. There are 10-11 teeth parallel to the midline of the above. The lower pharyngeal bone length (as % h.l.) and width (as % bone length) are listed on Table 36.

Total length of the bone: 30.3% of the h.l.

Total width of the bone: 100.0% of the bone length.

The pharyngeal apophysis of Simochromis sp. A was not examined.

The vertebral counts of Simochromis sp. A are listed on Table 37 and are compared with all of the other Simochromis species and with the Tropheus species. There are 30 vertebrae in total, 14 precaudal and 16 caudal.

The coloration of Simochromis sp. A (Pl.2 fig.1) is indistinguishable from that of Simochromis marginatus (Pl.2 fig.2; Pl.21 fig.1). Furthermore, the habitat is the same (so far as is known) and both species are found together in Kigoma Harbour (see "Material Examined" - Chapter 3) at 2-6 m depth. They seem to be restricted to the littoral zone, and have been amongst the weeds and rocks.

PLATE 2

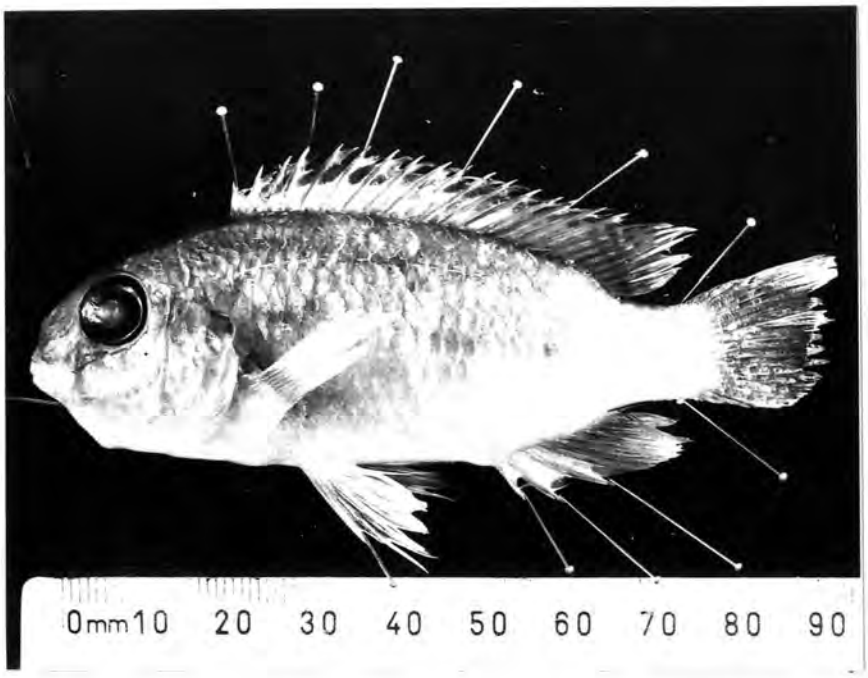

Fig. 1: Simochromis sp. A female (GSA-SS604)

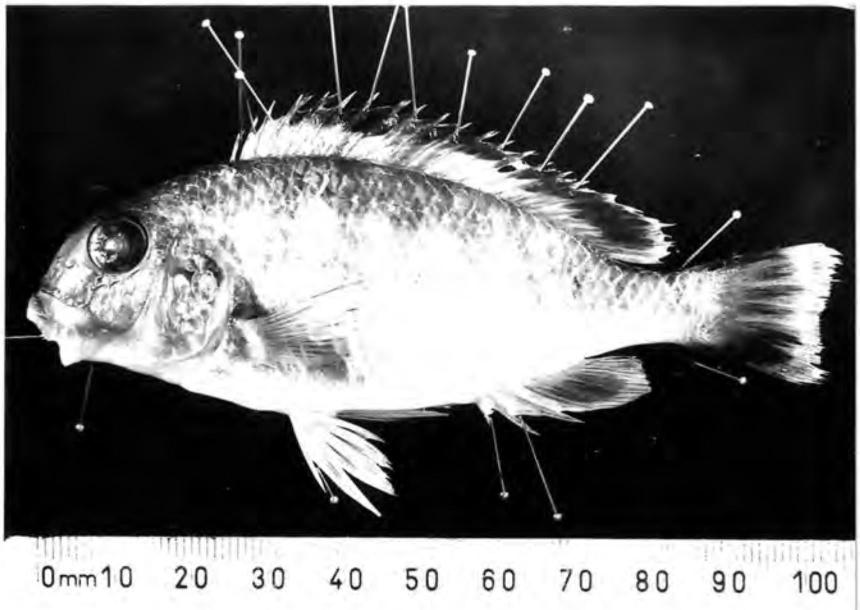

Fig. 2: Simochromis marginatus male(GSA-SM605)

PLATE 3

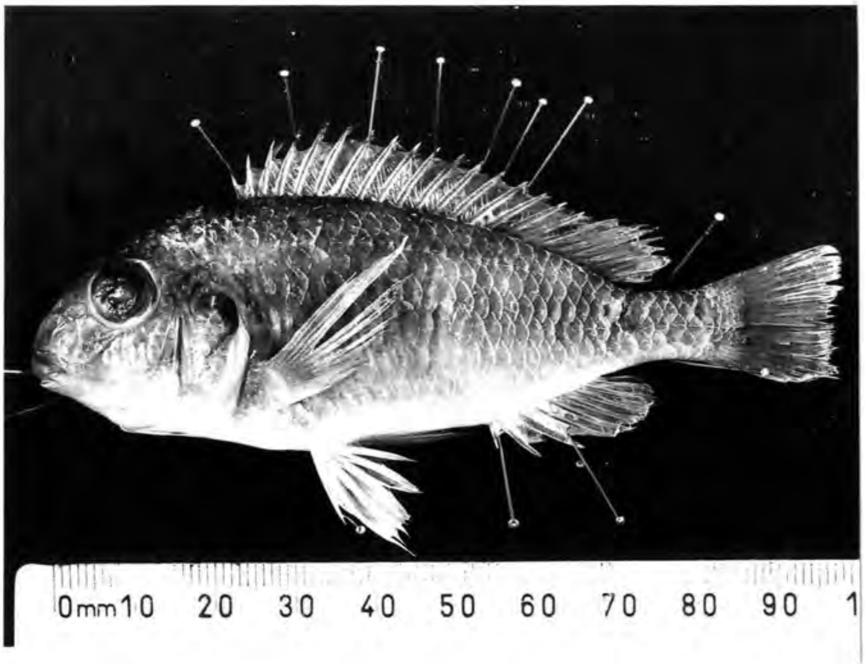

Fig. 1: Simochromis marginatus female (GSA-SM401)

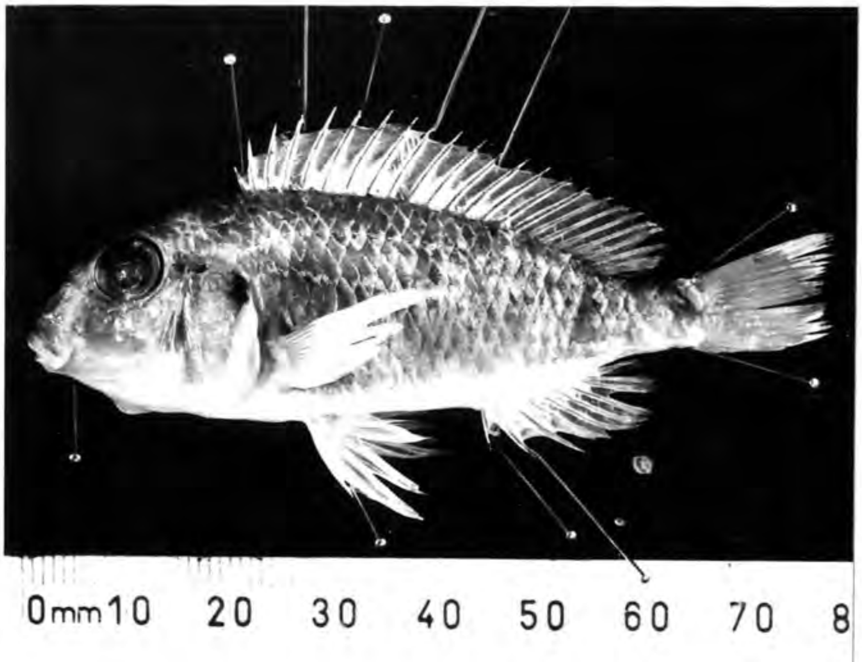

Fig. 2: Simochromis babaulti female (GSA-SB402)

TABLE 3

Simochromis sp. (♀ only) : General Characteristics of the Head and Body

characteristic	relative standard length data					relative body length data					relative head length data				
	%s.l.	SD	CV	range	n	%b.l.	SD	CV	range	n	%h.l.	SD	CV	range	n
standard length	-	-	-	-	-	145.5	0.18	0.12	145.4-145.6	2	319.8	0.87	0.27	319.2-320.4	2
head length	31.3	0.08	0.27	31.2-31.3	2	45.5	0.18	0.39	45.4-45.6	2	-	-	-	-	-
body length	68.7	0.08	0.12	68.7-68.8	2	-	-	-	-	-	219.8	0.87	0.39	219.2-220.4	2
body depth	37.1	0.52	1.42	36.7-37.5	2	53.9	0.70	1.29	53.5-54.4	2	-	-	-	-	-
caudal peduncle depth ..	14.2	0.36	2.54	13.9-14.4	2	20.6	0.50	2.42	20.3-21.0	2	-	-	-	-	-
interorbital width	9.3	0.22	2.39	9.2-9.5	2	-	-	-	-	-	29.9	0.79	2.66	29.3-30.4	2
preorbital depth	5.6	0.04	0.68	5.5-5.6	2	-	-	-	-	-	17.8	0.17	0.95	17.7-17.9	2
head depth	30.6	0.92	3.02	29.9-31.2	2	-	-	-	-	-	97.7	3.21	3.29	95.5-100.0	2
snout length	8.6	0.53	6.12	8.2-9.0	2	-	-	-	-	-	27.5	1.76	6.39	26.3-28.8	2
postocular head	12.6	0.33	2.60	12.4-12.8	2	-	-	-	-	-	40.2	0.94	2.33	39.6-40.9	2
eye diameter	10.1	0.28	2.82	9.9-10.3	2	-	-	-	-	-	32.2	0.82	2.55	31.7-32.8	2
mouth width	9.9	0.14	1.45	9.8-10.0	2	-	-	-	-	-	31.7	0.54	1.72	31.3-32.1	2
mouth length	4.1	0.06	1.44	4.0-4.1	2	-	-	-	-	-	13.0	0.15	1.17	12.9-13.1	2
cheek depth	9.2	0.04	0.43	9.2	2	-	-	-	-	-	29.4	0.21	0.70	29.3-29.6	2
% mouth length/m.w. ...	41.1	1.18	2.88	40.3-41.9	2										

standard length range: 63.2-76.9 mm

body length range : 43.4-52.9 mm

head length range : 19.8-24.0 mm

TABLE 4

Simochromis sp. (♀ only) : General Characteristics of the Fins

characteristic	relative standard length data					relative body length data					relative head length data				
	%s.l.	SD	CV	range	n	%b.l.	SD	CV	range	n	%h.l.	SD	CV	range	n
Dorsal fin:															
length at base	59.7	0.09	0.14	59.7-59.8	2	86.9	0.23	0.27	86.8-87.1	2	-	-	-	-	-
longest spine	13.4	0.04	0.29	13.4	2	19.5	0.08	0.41	19.5-19.6	2	-	-	-	-	-
longest branched ray ..	19.7	0.30	1.54	19.5-19.9	2	28.7	0.48	1.67	28.4-29.0	2	-	-	-	-	-
distance from snout ...	36.9	1.16	3.13	36.1-37.7	2	53.7	1.62	3.01	52.5-54.8	2	118.0	4.02	3.41	115.2-120.8	2
Anal fin:															
length at base	18.8	0.68	3.64	18.3-19.3	2	27.4	1.03	3.76	26.7-28.1	2	-	-	-	-	-
longest spine	16.9	0.11	0.65	16.8-16.9	2	24.5	0.19	0.78	24.4-24.7	2	-	-	-	-	-
longest branched ray ..	19.6	0.90	4.57	19.0-20.3	2	28.5	1.34	4.69	27.6-29.5	2	-	-	-	-	-
distance from snout ...	69.6	1.78	2.56	68.4-70.9	2	101.3	2.46	2.43	99.5-103.0	2	222.6	6.29	2.83	218.2-227.1	2
Pectoral fin:															
longest branched ray ..	26.1	1.34	5.12	25.2-27.0	2	38.0	1.90	5.00	36.6-39.3	2	-	-	-	-	-
distance from snout ...	32.2	0.09	0.28	32.1-32.2	2	46.8	0.08	0.16	46.8-46.9	2	102.9	0.57	0.56	102.5-103.3	2
Pelvic fin:															
longest branched ray ..	28.4	2.32	8.15	26.8-30.1	2	41.4	3.42	8.27	38.9-43.8	2	-	-	-	-	-
distance from snout ...	41.7	2.20	5.27	40.2-43.3	2	60.7	3.13	5.15	58.5-62.9	2	133.5	7.40	5.54	128.3-138.8	2
Caudal fin:															
longest ray	23.8	0.36	1.53	23.5-24.1	2	34.6	0.57	1.65	34.2-35.0	2	-	-	-	-	-

<u>Simochromis</u> <u>babaulti</u> Pellegrin 1927.

<u>Simochromis</u> <u>babaulti</u> Pellegrin, J. 1927: 500-501 (original sp. desc.,; one type - t.l. 76 mm - from Uvira, L. Tang.,Zaire; holotype at Paris Mus.).

__________ 1928: 82 (fig. of type).

Myers, G.S. 1936: 9 (desc., n. rec., four ex. - max. t.l. 61 mm- from Kigoma, L. Tang., Tanzania; discussion about the genera <u>Pseudotropheus</u> and <u>Simochromis</u>).

Poll, M. 1946: 262-263 (key), 264 (desc.; biblio.; Mus. collection info., four ex. - max. t.l. 82 mm - from stations in Zaire, Burundi & Tanzania on L. Tang.), Pl.1 fig.4 (lower pharyngeal bone photo).

__________ 1956: 85-92 (desc.; numerous collections from Zaire, Tanzania & Burundi portions of L. Rang., 218 ex. - max. t.l. 105 mm, - average $\frac{77.3 \text{ mm}}{128}$ & $\frac{66.7 \text{ mm}}{90\ ♀}$; fig. of specimen) Pl.4 fig. 4 (specimen photo).

Fryer, G. and Iles, T.D. 1972: 375 (male growth superiority), 501-507 (discussion of <u>Simochromis</u> phylogeny).

Axelrod, H.R. and Burgess, W. 1977: 361 (specimen colour photo).

Diagnosis:

Morphometric characteristics -

Simochromis babaulti morphometrically differs[1] (Tables 38-41) from all other Simochromis species and all Tropheus species in the body depth (as % s.l., 34.3 cf 37.1-41.8; as % b.l., 49.7 cf 53.6-60.6), interorbital width (as % s.l., 7.0 cf 8.3-12.4; as % h.l. 22.7 cf 27.9-41.8), longest dorsal fin branched ray (as % s.l., 15.8 cf 17.4-25.2; as % b.l., 22.9 cf 24.8-35.9), anal fin to snout distance (as % s.l., 66.0 cf 67.5-69.6) and longest anal spine (as % b.l., 22.4 cf 19.6-21.3, 23.8-24.5). Additionally, Simochromis babaulti differs[2] from all other Simochromis in the mouth length (as % s.l., 4.5 cf 3.9-4.1, 4.8-5.1; as % h.l., 14.5 cf 13.0-13.1, 16.5-17.0), lower pharyngeal bone width[3] (as % bone length, 97.2 cf 91.1-94.9, 100.0-101.8), and differs[4] from all Tropheus in the caudal peduncle depth (as % s.l., 10.6 cf 11.4-12.1), preorbital depth (as % s.l., 6.6 cf 7.7-9.5; as % h.l., 21.2 cf 24.9-32.1), head depth (as % s.l., 29.4 cf 33.0-36.2; as % h.l., 95.2 cf 112.0-116.7), eye diameter (as % s.l., 9.6 cf 7.3-8.9), cheek depth (as % s.l., 10.2 cf 11.3-12.4; as % h.l., 32.9 cf 38.8-40.1), mouth length (as % m.w., 38.2 cf 29.4-32.8, 44.6), dorsal fin length at base (as % s.l., 57.6

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1. The numeral sequence respectively compares each parameter of the Simochromis babaulti and all of the other Simochromis species and all of the Tropheus species.
2. The numeral sequence respectively compares each parameter of the Simochromis babaulti and all of the other Simochromis species.
3. The unidentified Simochromis sp. is not evaluated.
4. The numeral sequence respectively compares each parameter of the Simochromis babaulti and all of the Tropheus species.

cf 61.7-63.0; as % b.l., 83.4 cf 88.0-90.0), anal fin length at base (as % s.l., 18.3 cf 20.0-22.8; as % b.l., 26.5 cf 28.9-32.4), longest pectoral branched ray (as % s.l., 29.9 cf 32.8-35.7), longest pelvic branched ray (as % s.l., 27.0 cf 33.1-39.2, as % b.l., 39.1 cf 46.2-55.7), dorsal fin to snout distance (as % h.l., 111.1 cf 121.2-127.1), longest anal spine (as % b.l., 22.4 cf 2o.1-21.3, 23.8) and anal fin to snout distance (as % h.l., 213.9 cf 224.4-240.9).

Meristic characteristics -

The dorsal fin of Simochromis babaulti has 16 spines and 8-9 branched rays, as compared with all other Simochromis species which have 17-19 spines and 9-11 branched rays, and as compared with all Tropheus species which have 20-22 spines and 5-8 branched rays (Table 31). S. babaulti has a total of 24-25 dorsal fin rays, as compared with 26-29 for all other Simochromis species and Tropheus species. The anal fin of S. babulti has 3 spines and 7-8 branched rays, as compared with all Tropheus species which have 4-6 spines and 5-8 branched rays (Table 32). S. babaulti has 5-6 gill rakers below the articulation on the outer gill arch as compared with 10-12 gill rakers for all Tropheus species, S. curvifrons and S. diagramma (Table 33). S. babaulti has a mean value of 32 bicuspid teeth in the outer row of the upper jaw as compared with 27 for S. curvifrons, and 37-50 for all other Simochromis species and Tropheus species (Table 35; Table 38; Pl.4). S. babaulti has a mean value of 21 bicuspid teeth in the outer row of the lower jaw as compared with 34-49 for all Tropheus species, and has 3-6 conical teeth lateral to the inner tricuspid rows of the lower jaw - while Tropheus species do not have lower conical teeth.

Description:

All methods of count, measurement and statistical analysis are explained in Chapter 3 - "Laboratory Techniques." Tables 5-10 list the selected morphometric characteristics of the head, body and fins of Simochromis babaulti. Statistical comparisons of selected morphometrics of all known Simochromis and Tropheus species are shown on Tables 38-41. All S. babaulti specimens examined are sexually mature. Specimen field numbers, sizes, collection locations and collection dates are found in Chapter 3- "Material Examined."

Several examples of possible sexual dimorphism have been noted in S. babaulti. Tables 6 and 7 list the selected morphometric characteristics of the head and body for male and female representatives (respectively) of species, and Tables 9 and 10 list the selected morphometric characteristics of the fins for male and female representatives (resp.) of the species where sexual dimorphism may occur. Unfortunately, sufficient material was not available to substantiate this possible differentiation. The possibilities, however, are noted on these Tables. The average size (s.l.) of the males is about 4 mm greater than that of the females. The growth superiority of the male S. babaulti over the female was noted by Poll (1956). No meristic sexual differentiation was observed.

The fin formulae for S. babaulti are listed in Tables 31 and 32, and are compared with the other Simochromis species and with the Tropheus species.

Dorsal Fin Formula: $\frac{XVI,8}{1}$ $\frac{XVI,9}{3}$

(disagreeing with XVII in Pellegrin, 1927)

Anal Fin Formula: $\frac{III,7}{3}$ $\frac{III,8}{1}$

Pectoral Fin Formula: $\frac{16}{4}$

Pelvic Fin Formula: $\frac{1,5}{4}$

Caudal Fin Formula: 16 principle rays, I-14-I.

The gill raker counts for S. babaulti are listed on Table 33 and are compared with other Simochromis, species and with the Tropheus species. The gill rakers are conical in shape.

Gill Raker Count - number above, on and below the articulation: 2-1-5 (F.1), 3-1-5 (F.1), 2-1-6 (F.1), 3-1-6 (F.1); (disagreeing with 7 gill rakers in Pellegrin, 1927).

The selected scale meristics for S. babaulti are listed on Table 34 and are compared with the other Simochromis species and with the Tropheus species.

PLATE 4: Simochromis babaulti (GSA-SB403) - dentition, upper and lower jaw. Scale = 1 mm.

Lateral Line Count: 28+2 (F.1), 29+2 (F.2), 30+2 (F.1).

Cheek Scale Rows: 2 (F.1), 3 (F.3); (disagreeing with 1 row of scales in Pellegrin, 1927).

The dentition counts for S. babaulti are listed in Table 35 and are compared with the other Simochromis species and with the Tropheus species (pl.4). The pattern of the dentition is explained in the description of S. curvifrons.

Upper Jaw: 3-5 rows of tricuspid teeth, mode = 5 rows.

30-34 bicuspid teeth in the outer row, mean = 32 teeth; (disagreeing with 37-45 bicuspid teeth in Poll, 1956(a); agreeing with 34 bicuspids in Pellegrin, 1927).

4-7 conical teeth at each corner of the mouth, mode = 5 teeth.

Lower Jaw: 3-5 rows of tricuspid teeth, mode = 4 rows.

20-24 bicuspid teeth in the outer row, mean = 21 teeth.

3-6 conical teeth at each corner of the mouth, mode = 4 teeth.

The lower pharyngeal bone of Simochromis babaulti is triangular in shape with a median indentation on its posterior border (Pl.23 fig.6). There are 28-34 enlarged teeth on the posterior border of the bone which are anteriorly slanting unicusps with a poorly defined shoulder (not bicuspid as in Poll, 1956). There is a second row of similar teeth parallel to the previous row, but these

PLATE 5: Simochromis babaulti (GSA-SB8) - pharyngeal apophysis (H-type)
Scale = 1 mm. (composite of scanning electron micrographs).
ventral view.

teeth are not as enlarged as the former. All of the other teeth are unicuspid and slant posteriorly. There are 10-12 teeth parallel to the midline of the bone. The lower pharyngeal bone length (as % h.l.) and width (as % bone length) are listed on Table 36 and compared with all of the other Simochromis species and all of the Tropheus species.

Total length of the bone: 32.8-35.4 % of the h.l.

Total width of the bone: 94.8-100.0 % of the bone length.

The pharyngeal apophysis of three specimens of Simochromis babaulti were examined. The articulary surfaces were lima bean-shaped and the composition was Haplochromis-like (Regan, 1920). Below are the percentage contributions of parasphenoid (P), basioccipital (B) and pro-otic (PRO) to the articulary surface of each examined specimen (L = left facet and R = right facet):

GSA-SB8:	L - 83% P, 17% B	(Pl.5)
	R - 87% P, 13% B	
GSA-SB403:	L - 85% P, 13% B, 2% PRO	
	R - 84% P, 11% B, 5% PRO	
GSA-SB404:	L - 85% P, 13% B, 2% PRO	
	R - 76% P, 24% B.	

The vertebral counts of Simochromis babaulti are listed on Table 37 and are compared with all of the other Simochromis species and with the Tropheus species. There are 30-31 vertebrae in total, 14-15 precaudal and 16 caudal.

The vertebral counts of Simochromis babaulti are listed on Table 37 and are compared with all of the other Simochromis species and with the Tropheus species. There are 30-31 vertebrae in total, 14-15 precaudal and 16 caudal.

When alive Simochromis babaulti is a grey-green fish with eight to ten dark grey vertical bars on its side (Pl.21 fig.1). Its belly, chest, branchiostegal membrane and pelvic fins are white. The extreme margin of the dorsal fin is trimmed with black and red. There is a dark black band which extends 6-8 spines along the anterior one-third portion of the dorsal fin, while the rest of the dorsal is mottled in red-brown oval spots. The anal fin is white proximally and red distally, with the tips of the spinous membranes black. There are one to five orange oval spots on the anal branched rays of the males. Preserved specimens (Pl.3 fig.2) become grey, keeping the vertical bars on their sides, the black trim on the extreme margin of the dorsal fin and the dark black band on the dorsal fin, but losing all other fin coloration and the green hue on the body. No sexual dichromatism was noticed other than the presence of orange spots on the male anal fin.

Simochromis babaulti was collected in Kigoma Harbour (see Chapter 3 - "Material Examined" and Map 3) at 2-6 m depth. The area of collection was strewn with harbour debris and was heavily vegetated with macrophytes and algae-covered rocks. There were several rockless patches of sand up to 10 m in diameter, but also heavily vegetated. Most specimens of S. babaulti were collected over these sandy patches, contrary to Poll's (1956) statement that they are usually not found in this area.

TABLE 5

Simochromis babaulti (♂& ♀) : General Characteristics of the Head and Body

characteristic	relative standard length data					relative body length data					relative head length data				
	%s.l.	SD	CV	range	n	%b.l.	SD	CV	range	n	%h.l.	SD	CV	range	n
standard length	-	-	-	-	-	144.8	3.22	2.22	141.4-149.2	4	323.9	15.7	4.84	303.4-341.5	4
head length	30.9	1.52	4.92	29.3-33.0	4	44.8	3.22	7.17	41.4-49.2	4	-	-	-	-	-
body length	69.1	1.52	2.20	67.0-70.7	4	-	-	-	-	-	223.9	15.7	7.00	203.4-241.5	4
body depth	34.3	0.30	0.88	34.1-34.7	4	49.7	1.33	2.67	48.2-51.3	4	-	-	-	-	-
caudal peduncle depth ..	10.6	0.24	2.27	10.3-10.9	4	15.3	0.34	2.20	14.9-15.7	4	-	-	-	-	-
interorbital width	7.0	0.37	5.30	6.6-7.4	4	-	-	-	-	-	22.7	1.04	4.59	21.7-24.2	4
preorbital depth	6.6	0.39	5.93	6.1-7.0	4	-	-	-	-	-	21.2	0.95	4.47	19.9-22.0	4
head depth	29.4	0.14	0.48	29.3-29.6	4	-	-	-	-	-	95.2	4.63	4.87	88.9-100.0	4
snout length	9.6	0.70	7.26	9.0-10.5	4	-	-	-	-	-	31.0	1.20	3.87	29.3-31.9	4
postocular head	11.8	0.65	5.49	11.0-12.4	4	-	-	-	-	-	38.0	1.11	2.91	37.1-37.7	4
eye diameter	9.6	0.37	3.89	9.1-10.0	4	-	-	-	-	-	31.0	0.36	1.15	30.4-31.2	4
mouth width	11.8	0.74	6.26	10.9-12.6	4	-	-	-	-	-	38.1	2.49	6.53	35.4-40.9	4
mouth length	4.5	0.02	0.37	4.5	4	-	-	-	-	-	14.5	0.73	5.05	13.5-15.3	4
cheek depth	10.2	0.48	4.72	9.8-10.7	4	-	-	-	-	-	32.9	1.07	3.24	31.7-34.1	4
% mouth length/m.w.	38.2	2.55	6.69	35.5-41.4	4										

standard length range: 53.4-62.8 mm

body length range : 37.0-42.1 mm

head length range : 16.4-20.7 mm

TABLE 6

Simochromis babaulti (♂) : General Characteristics of the Head and Body

characteristic	relative standard length data					relative body length data					relative head length data				
	%s.l.	SD	CV	range	n	%b.l.	SD	CV	range	n	%h.l.	SD	CV	range	n
standard length	-	-	-	-	-	142.9	2.11	1.48	141.4-144.4	2	333.4	11.5	3.45	325.3-341.5	2
head length	30.0	1.04	3.45	29.3-30.7	2	42.9	2.11	4.93	41.4-44.4	2	-	-	-	-	-
body length	70.0	1.04	1.48	69.3-70.7	2	-	-	-	-	-	233.4	11.5	4.93	225.3-241.5	2
body depth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
caudal peduncle depth ..	10.7	0.21	2.00	10.6-10.9	2	-	-	-	-	-	-	-	-	-	-
interorbital width	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
preorbital depth	6.3	0.20	3.21	6.1-6.4	2	-	-	-	-	-	-	-	-	-	-
head depth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
snout length	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
postocular head	11.2	0.26	2.30	11.0-11.4	2	-	-	-	-	-	-	-	-	-	-
eye diameter	9.3	0.33	3.53	9.1-9.6	2	-	-	-	-	-	-	-	-	-	-
mouth width	-	-	-	-	-	-	-	-	-	-	40.1	1.07	2.67	39.3-40.9	2
mouth length	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
cheek depth	9.8	0.01	0.06	9.8	2	-	-	-	-	-	-	-	-	-	-

standard length range: 60.5-62.5 mm
body length range : 41.9-44.2 mm
head length range : 18.3-18.6 mm

TABLE 7

Simochromis babaulti (♀) : General Characteristics of the Head and Body

characteristic	relative standard length data					relative body length data					relative head length data				
	%s.l.	SD	CV	range	n	%b.l.	SD	CV	range	n	%h.l.	SD	CV	range	n
standard length	-	-	-	-	-	146.7	3.43	2.33	144.3-149.2	2	314.5	15.7	5.00	303.4-325.6	2
head length	31.8	1.59	5.00	30.7-33.0	2	46.7	3.43	7.33	44.3-49.2	2	-	-	-	-	-
body length	68.2	1.59	2.33	67.0-69.3	2	-	-	-	-	-	214.5	15.7	7.33	203.4-225.6	2
body depth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
caudal peduncle depth ..	10.4	0.15	1.43	10.3-10.5	2	-	-	-	-	-	-	-	-	-	-
interorbital width	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
preorbital depth	6.9	0.19	2.72	6.7-7.0	2	-	-	-	-	-	-	-	-	-	-
head depth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
snout length	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
postocular head	12.3	0.18	1.43	12.2-12.4	2	-	-	-	-	-	-	-	-	-	-
eye diameter	9.8	0.34	3.48	9.6-10.0	2	-	-	-	-	-	-	-	-	-	-
mouth width	-	-	-	-	-	-	-	-	-	-	36.0	0.95	2.65	35.4-36.7	2
mouth length	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
cheek depth	10.6	0.13	1.22	10.5-10.7	2	-	-	-	-	-	-	-	-	-	-

standard length range: 53.4-62.8 mm
body length range : 37.0-42.1 mm
head length range : 16.4-20.7 mm

TABLE 8

Simochromis babaulti (♂ & ♀) : General Characteristics of the Fins

characteristic	relative standard length data					relative body length data					relative head length data				
	%s.l.	SD	CV	range	n	%b.l.	SD	CV	range	n	%h.l.	SD	CV	range	n
Dorsal fin:															
length at base	57.6	1.68	2.92	56.2-59.5	4	83.4	2.02	2.43	81.1-85.9	4	-	-	-	-	-
longest spine	14.7	0.33	2.25	14.2-15.0	4	21.3	0.84	3.93	20.1-22.1	4	-	-	-	-	-
longest branched ray ..	15.8	1.17	7.35	14.6-17.0	4	22.9	1.49	6.49	21.1-24.6	4	-	-	-	-	-
distance from snout ...	34.3	1.01	2.95	33.2-35.7	4	49.7	2.42	4.88	48.0-53.2	4	111.1	3.91	3.52	108.1-116.4	4
Anal fin:															
length at base	18.3	0.47	2.56	18.0-19.0	4	26.5	0.81	3.05	25.6-27.4	4	-	-	-	-	-
longest spine	15.4	0.46	3.00	14.8-15.4	4	22.4	0.46	2.04	21.9-23.0	4	-	-	-	-	-
longest branched ray ..	18.6	1.63	8.80	16.2-20.0	4	26.8	1.82	6.77	24.2-28.3	4	-	-	-	-	-
distance from snout ...	66.0	0.42	0.64	65.5-66.6	4	95.6	2.60	2.72	93.2-99.3	4	213.9	9.51	4.44	201.9-225.1	4
Pectoral fin:															
longest branched ray ..	29.9	0.75	2.52	29.0-30.7	4	43.2	1.05	2.43	41.9-44.4	4	-	-	-	-	-
distance from snout ...	32.4	1.53	4.70	30.9-34.1	4	47.0	3.15	6.70	43.7-50.8	4	104.9	2.79	2.66	102.2-108.5	4
Pelvic fin:															
longest branched ray ..	27.0	1.26	4.65	25.8-28.4	4	39.1	2.38	6.07	36.9-41.3	4	-	-	-	-	-
distance from snout ...	39.3	1.44	3.67	38.1-41.4	4	57.0	3.37	5.91	53.8-61.8	4	127.2	1.96	1.54	125.6-130.1	4
Caudal fin:															
longest ray	22.5	0.91	4.06	21.2-23.1	4	32.6	1.64	5.01	30.5-34.4	4	-	-	-	-	-

TABLE 9

Simochromis babaulti (♂) : General Characteristics of the Fins

characteristic	relative standard length data					relative body length data					relative head length data				
	%s.l.	SD	CV	range	n	%b.l.	SD	CV	range	n	%h.l.	SD	CV	range	n
Dorsal fin:															
length at base	59.0	0.67	1.13	58.6-59.5	2	-	-	-	-	-	-	-	-	-	-
longest spine	-	-	-	-	-	20.8	0.95	4.57	20.1-21.5	2	-	-	-	-	-
longest branched ray ..	16.8	0.27	1.62	16.6-17.0	2	24.1	0.74	3.10	23.5-24.6	2	-	-	-	-	-
distance from snout ...	33.7	0.61	1.80	33.2-34.1	2	48.1	0.15	0.32	48.0-48.2	2	-	-	-	-	-
Anal fin:															
length at base	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
longest spine	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
longest branched ray ..	19.3	0.94	4.83	18.7-20.0	2	-	-	-	-	-	-	-	-	-	-
distance from snout ...	-	-	-	-	-	-	-	-	-	-	220.1	7.13	3.24	215.1-225.1	2
Pectoral fin:															
longest branched ray ..	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
distance from snout ...	31.1	0.37	1.19	30.9-31.4	2	44.5	1.19	2.67	43.7-45.3	2	-	-	-	-	-
Pelvic fin:															
longest branched ray ..	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
distance from snout ...	38.5	0.54	1.40	38.1-38.8	2	55.0	1.58	2.88	53.8-56.1	2	128.2	2.62	2.05	126.3-130.1	2
Caudal fin:															
longest ray	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE 10

<u>Simochromis babaulti</u> (♀) : General Characteristics of the Fins

characteristic	relative standard length data					relative body length data					relative head length data				
	%s.l.	SD	CV	range	n	%b.l.	SD	CV	range	n	%h.l.	SD	CV	range	n
Dorsal fin:															
length at base	56.2	0.02	0.04	56.2	2	-	-	-	-	-	-	-	-	-	-
longest spine	-	-	-	-	-	21.9	0.33	1.52	21.6-22.1	2	-	-	-	-	-
longest branched ray ..	14.9	0.37	2.48	14.6-15.1	2	21.8	1.05	4.81	21.1-22.6	2	-	-	-	-	-
distance from snout ...	35.0	0.99	2.83	34.3-35.7	2	51.3	2.65	5.16	49.5-53.2	2	-	-	-	-	-
Anal fin:															
length at base	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
longest spine	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
longest branched ray ..	17.8	2.15	12.1	16.2-19.3	2	-	-	-	-	-	-	-	-	-	-
distance from snout ...	-	-	-	-	-	-	-	-	-	-	207.7	8.12	3.91	201.9-213.4	2
Pectoral fin:															
longest branched ray ..	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
distance from snout ...	33.7	0.53	1.56	33.3-34.1	2	49.5	1.93	3.89	48.1-50.8	2	-	-	-	-	-
Pelvic fin:															
longest branched ray ..	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
distance from snout ...	40.2	1.73	4.31	39.0-41.4	2	59.0	3.92	6.64	56.2-61.8	2	126.2	0.87	0.69	125.6-126.8	2
Caudal fin:															
longest ray	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Simochromis curvifrons Poll 1942.

Simochromis curvifrons Poll, M. 1942: 344-356 (original sp. desc.; one type - t.l. 76 mm - and two cotypes - 106 & 114 mm - from Nyanza, L. Tang., Burundi; type and cotypes at Koninklijk Mus. voor Midden-Africa, Tervuren).

__________ 1946: 262-263 (key), 264-266 (desc.; biblio.; Mus. collection info.; fig. of type and of lower pharyngeal bone of type).

__________ 1956(a): 92-95 (desc.; collection info.; 34 ex. max. t.l. 133 mm, fig. of specimen, lower pharyngeal bone, dentition and gill rakers), Pl.4 fig.5 (specimen photo).

Fryer, G. and Iles, T.D. 1972: 35 (teeth).

Axelrod, H.R. and Burgess, W. 1977: 321 (specimen colour photograph by G.S. Axelrod, field no. GSA-SC5).

Pseudosimochromis curvifrons Nelissen, M.H.J. 1977(b): 730-731 (creation of the monotypic genus Pseudosimochromis, which is not accepted in this thesis - refer to Chapter 6).

Diagnosis:

Morphometric characteristics -

Simochromis curvifrons morphometrically differs[1] (Tables 38-41) from all other Simochromis species in the body depth (as % s.l. 40.7 cf

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1. The numeral sequence respectively compares each parameter of the Simochromis curvifrons and all of the other Simochromis species.

34.3-38.9), preorbital depth (as % s.l., 7.4 cf 5.6-6.6; as % h.l., 25.8 cf 17.8-22.0), head depth (as % s.l., 34.8 cf 29.4-31.1; as % h.l., 12.08 cf 95.2-103.7), postocular head (as % s.l., 13.3 cf 11.3-12.6; as % h.l., 46.2 cf 37.4-40.2), eye diameter (as % s.l., 7.8 cf 8.6-10.1), lower pharyngeal bone width[1] (as % bone length, 91.1 cf 94.9-101.8) and mouth length (as % m.w., 47.0 cf 32.8-41.1). Simochromis curvifrons morphometrically differs[2] from all Tropheus species in the mouth width (as % s.l., 10.1 cf 12.3-13.8; as % h.l., 35.1 cf 39.9-47.6), mouth length (as % h.l., 16.5 cf 13.5-15.6, 17.7) and dorsal fin to snout distance (as % h.l., 117.4 cf 121.2-127.1).

Meristic characteristics -

The dorsal fin of Simochromis curvifrons has 17-18 spines and 9-10 branched rays, as compared with all Tropheus species which have 20-22 spines and 5-8 branched rays (Table 31). The anal fin of S. curvifrons has 3 spines and 8-9 branched rays, as compared with all Tropheus species which have 4-6 spines and 5-8 branched rays (Table 32). S. curvifrons has 10 gill rakers below the articulation on the outer gill arch as compared with 5-7 gill rakers for Simochromis sp. A, S. babaulti and S. marginatus (Table 33). S. curvifrons has a mean value of 27 bicuspid teeth in the outer row of the upper jaw, as compared with 32-50 bicuspid teeth for all other

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1. As only one Simochromis sp. A lower pharyngeal bone was examined, a statistical t-test was not made between Simochromis sp. A and S. curvifrons.
2. The sequence respectively compares each parameter of the S. curvifrons and all of the Tropheus species.

Simochromis species and Tropheus species (Table 35; Table 38; Pl.6 fig.1). S. curvifrons has a mean value of 21 bicuspid teeth in the outer row of the lower jaw, as compared with 34-49 for all Tropheus species, and has 6-8 conical teeth lateral to the inner tricuspid rows of the lower jaw (Pl.6 figs. 2,3), while Tropheus species do not have lower conical teeth. These teeth are more fully developed in S. curvifrons than in any of the other Simochromis species, as they are significantly longer and more numerous (mode: 7 cf 4-5, resp.). Furthermore, the outer bicuspid teeth in the upper and lower jaws of S. curvifrons touch the inner tricuspid teeth (Pl.6 fig.2), while there is a noticeable gap between the first tricuspid row and the outer bicuspid in all other Simochromis species (Pl.12 fig.2) and all Tropheus species.

Description:

All methods of count, measurement and statistical analysis are explained in Chapter 3 - "Laboratory Techniques." Tables 11-12 list the selected morphometric characteristics of the head, body and fins of Simochromis curvifrons. Statistical comparisons of selected morphometrics of all known Simochromis and Tropheus species are shown on Tables 38-41. All these fish are sexually mature. Specimen field numbers, sizes, collection locations and collection dates are found in Chapter 3 - "Material Examined."

The fin formulae for S. curvifrons are listed on Table 31 and 32, and are compared with other Simochromis species and with the Tropheus species.

Dorsal Fin Formula: $\frac{XVII,10}{2}$ $\frac{XVIII,9}{1}$

Anal Fin Formula: $\frac{III,8}{2}$ $\frac{III,9}{1}$

Pectoral Fin Formula: $\frac{16}{2}$ $\frac{17}{1}$

Pelvic Fin Formula: $\frac{I,5}{3}$

Caudal Fin Formula: 16 principal rays, I-14-I.

The gill raker counts for S. curvifrons are listed on Table 33 and are compared with other Simochromis species and with the Tropheus species. The gill rakers are conical in shape.

Gill Raker Count - number above, on and below the articulation: 2-1-10 (F.3).

The selected scale meristics for S. curvifrons are listed on Table 34 and are compared with the other Simochromis species and with the Tropheus species.

Lateral Line Count: 30+2 (F.2), 30+3 (F.3).

Cheek Scale Rows: 4 (F.3).

The dentition counts for S. curvifrons are listed on Table 35 and are compared with the other Simochromis species and with the Tropheus species. The basic dentition pattern is similar in all Simochromis species (Pl.6 fig.1). The teeth are set in the

PLATE 6

Fig.1: Simochromis curvifrons (KMMA-129651) - dentition, upper and lower jaw. Scale = 1 mm.

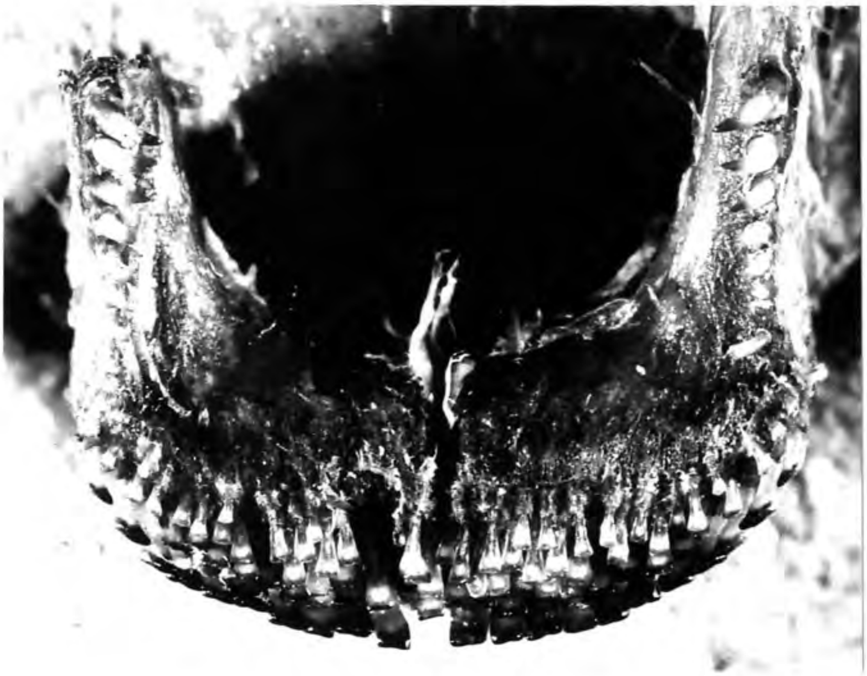

Fig.2: Simochromis curvifrons (KMMA-129651)- dentition, lower jaw. Scale = 1 mm.

Fig.3: Simochromis curvifrons (KMMA-129651)- dentition, lower conical teeth. Scale = 1 mm.

jaws in several series of parallel or concentric rows. The outer rows in the anterior portions of the upper and lower jaws are composed of bicuspid teeth, and the inner series of rows are composed of small tricuspid teeth (Pl.6 fig.2). The teeth are enlarged and conical at the sides of the upper jaw (Pl.6 fig.1). There is a toothless gap between the anterior bicuspids and the lateral conicals of the upper jaw. The lower jaw has an analogous set of laterally placed conical teeth that are smaller than those of the upper jaw. They are lateral to the inner tricuspid tooth rows. S. curvifrons has the most well developed set of lower conical teeth in the genus (Pl.6 fig.3), as they are largest and most numerous. The presence of lower jaw conical teeth has not been noted in previous literature.

Upper Jaw: 5-7 rows of tricuspid teeth, mode = 7 rows.
26-28 bicuspid teeth in the outer row, mean = 27 teeth: (disagreeing with 36-41 bicuspid teeth in Poll, 1956).
5-7 conical teeth at each corner of the mouth, mode = 6.

Lower Jaw: 5-6 rows of tricuspid teeth, mode = 6 rows.
20-22 bicuspid teeth in the outer row, mean = 21 teeth.
6-8 conical teeth at each corner of the mouth, mode = 7.

PLATE 7: Simochromis curvifrons (GSA-SC5) - pharyngeal apophysis (T-type). Scale = 1 mm. (composite of scanning electron micrographs).

ventral view.

The lower pharyngeal bone of Simochromis curvifrons is triangular in shape with a median indentation on its posterior border (Pl.23 fig.7). There are 28-32 enlarged teeth on the posterior border of the bone which are anteriorly slanting unicusps with a poorly defined shoulder. There is a second row of similar teeth parallel to the previous row, but the teeth are not as enlarged as the former. All of the other teeth are unicuspid and slant posteriorly. There are 9-11 teeth parallel to the midline of the bone. The triangular toothed area of the bone (as compared with the bone's overall size) is smaller than that for other Simochromis or Tropheus species. The lower pharyngeal bone length (as % h.l.) and width (as % bone length) are listed on Table 36 and compared with all of the other Simochromis species and all of the Tropheus species.

Total length of the bone: 32.9-33.3 % of the h.l.
Total width of the bone: 90.5-92.2 % of the body length.

The pharyngeal apophysis of three specimens of Simochromis curvifrons were examined. The articulary surfaces were oval-shaped and the composition was Tilapia-like (Regan, 1920), as they were all completely composed of the parasphenoid (Pl.7).

The vertebral counts of Simochromis curvifrons are listed on Table 37 and are compared with all of the other Simochromis species and with the Tropheus species. There are 31 vertebrae in total, 14 precaudal and 17 caudal, or 15 precaudal and 16 caudal.

When alive, Simochromis curvifrons is an olive-brown fish with 9-10 grey vertical bars on its side (Pl.20 fig.2). Its belly, chest and branchiostegal membrane are light green. Its pelvic, pectoral, anal and dorsal fins are clear, except for a grey trim along the distal margin of the dorsal fin and the occasional occurrence of 2 or 3 light yellow spots on the anal fin of both sexes. The caudal fin is grey anteriorly, fading to colourless posteriorly. There is a circular black spot, approximately one half of the diameter of the eye, on the most posterior portion of the operculum. Preserved specimens become grey-brown. The belly, chest and branchiostegal membrane become white and the light yellow spots on the anal fin often disappear. The grey trim on the dorsal fin and caudal fin coloration remain. No sexual dichromatism was noticed.

Simochromis curvifrons was collected in Kigoma Harbour (see Chapter 3 - "Material Examined" and Map 3) at 2-6 m depth. The habitat description is as explained for S. babaulti, as S. curvifrons was collected in the same area. S. curvifrons were all collected in rocky areas close to the shore.

TABLE 11

Simochromis curvifrons (♂ & ♀) : General Characteristics of the Head and Body

characteristic	relative standard length data					relative body length data					relative head length data				
	%s.l.	SD	CV	range	n	%b.l.	SD	CV	range	n	%h.l.	SD	CV	range	n
standard length	-	-	-	-	-	140.5	1.44	1.02	138.9-141.7	3	346.9	8.87	2.56	339.6-356.7	3
head length	28.8	0.73	2.53	28.0-29.4	3	40.5	1.44	3.54	38.9-41.7	3	-	-	-	-	-
body length	71.2	0.73	1.03	70.6-72.0	3	-	-	-	-	-	246.9	8.87	3.59	239.6-256.7	3
body depth	40.7	0.16	0.39	40.6-40.9	3	57.2	0.70	1.22	56.4-57.6	3	-	-	-	-	-
caudal peduncle depth ..	12.3	0.69	5.57	11.9-13.1	3	17.3	1.03	5.94	16.5-18.5	3	-	-	-	-	-
interorbital width	10.4	0.40	3.88	9.9-10.7	3	-	-	-	-	-	36.1	1.95	5.39	34.2-38.1	3
preorbital depth	7.4	0.32	4.31	7.2-7.8	3	-	-	-	-	-	25.8	1.77	6.89	24.5-27.8	3
head depth	34.8	0.47	1.35	34.3-35.1	3	-	-	-	-	-	120.8	3.74	3.09	118.0-125.0	3
snout length	7.7	0.82	10.7	6.8-8.4	3	-	-	-	-	-	26.6	2.37	8.92	24.2-28.9	3
postocular head	13.3	0.19	1.42	13.1-13.5	3	-	-	-	-	-	46.2	1.26	2.74	45.1-47.6	3
eye diameter	7.8	0.31	3.94	7.5-8.1	3	-	-	-	-	-	27.2	1.20	4.39	25.9-28.2	3
mouth width	10.1	0.09	0.90	10.0-10.2	3	-	-	-	-	-	35.1	0.67	1.91	34.4-35.7	3
mouth length	4.8	0.08	1.78	4.7-4.8	3	-	-	-	-	-	16.5	0.30	1.82	16.1-16.7	3
cheek depth	11.2	0.08	0.71	11.1-11.2	3	-	-	-	-	-	38.8	1.15	2.97	38.0-40.1	3
% mouth length/m.w.	47.0	0.42	0.90	46.7-47.5	3										

standard length range: 65.2-89.9 mm

body length range : 46.0-64.7 mm

head length range : 19.2-25.2 mm

TABLE 12

<u>Simochromis curvifrons</u> (♂ & ♀) : General Characteristics of the Fins

characteristic	relative standard length data					relative body length data					relative head length data				
	%s.l.	SD	CV	range	n	%b.l.	SD	CV	range	n	%h.l.	SD	CV	range	n
Dorsal fin:															
length at base	62.4	2.40	3.85	59.7-64.2	3	87.7	2.97	3.39	84.6-90.5	3	-	-	-	-	-
longest spine	14.1	1.14	8.11	12.9-15.2	3	19.8	1.80	9.10	17.9-21.5	3	-	-	-	-	-
longest branched ray ..	21.3	1.87	8.79	19.2-22.7	3	29.9	2.39	7.99	27.2-31.5	3	-	-	-	-	-
distance from snout ...	33.9	0.44	1.29	33.4-34.2	3	47.6	1.10	2.30	46.4-48.5	3	117.4	1.48	1.26	116.1-119.0	3
Anal fin:															
length at base	20.5	0.89	4.31	19.6-21.4	3	28.9	1.19	4.12	27.8-30.2	3	-	-	-	-	-
longest spine	14.1	1.30	9.18	12.9-15.5	3	19.9	2.02	10.1	17.9-22.0	3	-	-	-	-	-
longest branched ray ..	21.3	1.05	4.94	20.1-22.1	3	29.9	1.21	4.06	28.5-30.8	3	-	-	-	-	-
distance from snout ...	67.5	0.38	0.57	67.3-67.9	3	94.9	1.40	1.48	93.5-96.3	3	234.1	5.17	2.21	230.7-240.1	3
Pectoral fin:															
longest branched ray ..	33.7	0.89	2.63	33.0-34.7	3	47.4	0.76	1.60	46.7-48.2	3	-	-	-	-	-
distance from snout ...	29.7	0.97	3.27	28.6-30.3	3	41.8	1.76	4.23	39.7-42.8	3	103.0	1.25	1.21	102.0-104.4	3
Pelvic fin:															
longest branched ray ..	30.7	0.26	0.86	30.5-31.0	3	43.1	0.66	1.53	42.3-43.6	3	-	-	-	-	-
distance from snout ...	39.2	1.09	2.78	37.9-40.0	3	55.0	2.09	3.79	52.7-56.7	3	135.7	0.37	0.27	135.3-136.0	3
Caudal fin:															
longest ray	27.3	1.38	5.03	26.1-28.8	3	38.4	2.29	5.97	36.3-40.9	3	-	-	-	-	-

Simochromis diagramma (Günther) 1893.

Chromis diagramma Günther, A. 1893: 632 (original sp. desc.; three syntypes - max. t.l. 95 mm - from L. Tang.; types at British Mus. (NH)), Pl.58 fig.B (specimen).

Simochromis diagramma Boulenger, G.A. 1898: 19 (original of genus desc., C. diagramma type species, desc. of species with fig.).

__________ 1899: 105 (citation).

__________ 1901(a): 156 (new rec. by Moore).

__________ 1901(b): 451 (sp. desc.).

Moore, J.E.S. 1903: 198 (citation).

Pellegrin, J. 1904: 307 (desc.).

Boulenger, G.A. 1906: 571 (new rec. by Cunnington; desc., max. t.l. 185 mm).

__________ 1906-1916: 275 (desc.), fig. 187 (specimen).

__________ 1919: 17 (new rec. by Dhont-De Bie).

__________ 1920: 48 (new rec. by Stappers).

Regan, C.T. 1920: 40 (definition of Simochromis).

Borodin, N.A. 1936: 28 (desc., new rec.).

David, L. 1936: 156 (new rec.).

David, L. and Poll, M. 1937: 269 (citation and new rec.).

Poll, M. 1946: 262-263 (key), 263-264 (desc.; biblio.; Mus. collection info.), Pl.1 fig.6 (lower pharyngeal bone photograph).

__________ 1956: 78-85 (desc.; Mus. collection info.), fig.13 (specimen), Pl.10 fig.3 (photograph of mature dissected female).

Fryer, G. and Iles, T.D. 1972: 251, 257 (parasitised by Lironeca tanganyikae); 500 (ecology); 503 (pharyngeal apophysis probable derivation); 504, 507 (probable affinities).

Axelrod, H.R. and Burgess, W. 1977: 361 (specimen colour photo).

Diagnosis:

Morphometric characteristics -

Simochromis diagramma morphometrically differs[1] (Tables 38-41) from all other Simochromis species and all Tropheus species in the lower pharyngeal bone width[2] (as % bone length, 101.8 cf 89.4-97.2), and additionally differs[3] from all Simochromis species in the mouth width (as % s.l., 13.5 cf 10.1-12.0; as % h.l., 45.0 cf 31.7-40.1). S. diagramma morphometrically differs[4] from all Tropheus species in the preorbital depth (as % s.l., 6.6 cf 7.6-9.5; as % h.l., 22.0 cf 24.9-32.1), head depth (as % s.l., 31.1 cf 33.0-36.2; as % h.l., 103.7 cf 112.0-116.7), mouth length (as % s.l., 5.1 cf 4.0-4.4, 5.4; as % m.w., 38.2 cf 29.4-32.8, 44.6), postocular head (as % h.l., 39.8 cf 37.6, 41.6-45.6), dorsal fin base length (as % s.l., 60.4 cf 61.7-63.0), anal fin base length (as % s.l., 18.8 cf 20.0-22.8; as % b.l., 26.8 cf 28.9-32.4) and longest pelvic

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1. The numeral sequence respectively compares each parameter of the Simochromis diagramma and all of the other Simochromis species and all of the Tropheus species.
2. As only one Simochromis sp. A lower pharyngeal bone was examined, a statistical t-test was not made between Simochromis sp. A and S. diagramma.
3. The numeral sequence respectively compares each parameter of the S. diagramma and all of the other Simochromis species.
4. The numeral sequence respectively compares each parameter of the S. diagramma and all of the Tropheus species.

branched ray (as % s.l., 30.0 cf 33.1-39.2).

Meristic characteristics -

The dorsal fin of Simochromis diagramma has 17-19 spines and 9-11 branched rays, as compared with all Tropheus species which have 20-22 spines and 5-8 branched rays (Table 31). The anal fin of S. diagramma has 3 spines and 7-8 branched rays, as compared with all Tropheus species which have 4-6 spines and 5-8 branched rays (Table 32). S. diagramma has 10-12 gill rakers below the articulation on the outer gill arch as compared with 5-7 gill rakers in Simochromis sp. A, S. babaulti and S. marginatus (Table 33). S. diagramma has a mean value of 43 bicuspid teeth in the outer row of the upper jaw as compared with 27-37 bicuspid teeth in S.sp.A, S. babaulti and S. curvifrons, and has a mean value of 32 bicuspid teeth in the outer row of the lower jaw as compared with 21-29 in S.sp.A, S. babaulti, S. curvifrons, and 42-49 in T. brichardi, T. moorii and T. polli (Table 35; Pl.8 fig.1). S. diagramma has 8-12 (mode = 10)rows of tricuspid teeth behind the bicuspid rows in the upper and lower jaws, while all of the other Simochromis species have 3-9 (modes = 4-7) rows. S. diagramma has 5-11 (mode = 7) conical teeth in the sides of the upper jaw, while all other Simochromis species have 3-7 (modes = 5-6) conicals and all Tropheus species have 3-7 (modes = 5) conicals (Pl.8 fig.2). S. diagramma has 2-7 (mode = 4) conical teeth lateral to the inner tricuspid rows of the lower jaw - while Tropheus species do not have lower conical teeth. S. diagramma has 32-33 vertebrae in the axial skeleton, while all other Simochromis and all Tropheus, except T. polli, have 30-31 vertebrae. Of the six T. polli specimens examined, one has 30 vertebrae, four have 31, and one has 32. The S. diagramma lower pharyngeal bone has four enlarged teeth anterior to the enlarged (shouldered) unicuspid teeth on the bone's posterior margin. These four enlarged teeth are shouldered unicusps similar to those found only on the posterior margin of the bone in all other Simochromis and Tropheus species (Pl.23 figs. 8,9).

Description:

All methods of count, measurement and statistical analysis are explained in Chapter 3 - "Laboratory Techniques." Tables 13-18 list the selected morphometric characteristics of the head, body and fins of Simochromis diagramma. Statistical comparisons of selected morphometrics of all known Simochromis and Tropheus species are shown on Table 38-41. All fourteen S. diagramma are sexually mature. Specimen field numbers, sizes, collection locations and collection dates are found in Chapter 3 - "Material Examined."

Several examples of possible sexual dimorphism have been noted in S. diagramma. Tables 14 and 15 list the selected morphometric characteristics of the head and body for male and female representatives (resp.) of the species, and Tables 17 and 18 list the selected morphometric characteristics of the fins for male and female representatives (resp.) of the species where sexual dimorphism may occur. It is interesting to note that the males (s.l. range 108.2-144.4) are generally much larger than the females (s.l. range 54.3-95.2). It is not known if this is a consistent trend and a sexual dimorphic difference, but it may be, as the same male size superiority holds true in a less dramatic sense for S. babaulti (Poll, 1956). Furthermore, as a large quantity of material varying in size is not available, regression analysis was not performed for this species. Hence, much of the potential sexual dimorphism shown on the Tables may be due to proportional changes during growth. No meristic sexual differentiation was observed.

The fin formulas for S. diagramma are listed on Tables 31 and 32, and are compared with the other Simochromis species and with the Tropheus species.

Dorsal Fin Formula: $\frac{XVII,10}{3}$ $\frac{XVII,11}{3}$ $\frac{XVIII,9}{1}$ $\frac{XVIII,10}{5}$ $\frac{XIX,9}{2}$

Anal Fin Formula: $\frac{III,7}{2}$ $\frac{III,8}{12}$

Pectoral Fin Formula: $\frac{16}{6}$ $\frac{17}{8}$

Pelvic Fin Formula: $\frac{I,5}{14}$

Caudal Fin Formula: 16 principal rays, I-14-I.

PLATE 8

Fig. 1: Simochromis diagramma (GSA-SD500) - dentition, upper and lower jaw. Scale = 1 mm.

Fig. 2: Simochromis diagramma (GSA-SD500) - dentition, upper conical teeth. Scale = 1 mm.

The gill raker counts for S. diagramma are listed on Table 33 and are compared with the other Simochromis species and with the Tropheus species. The gill rakers are conical in shape.

Gill Raker Count - number above, on and below the articulation: 3-1-10 (F.2), 4-1-10 (F.1), 3-0-11 (F.4), 3-1-11 (F.2), 4-0-11 (F.1), 3-0-12 (F.1), 4-0-12 (F.2), 4-1-12 (F.1).

The selected scale meristics for S. diagramma are listed on Table 34 and are compared with the other Simochromis species and with the Tropheus species.

Lateral Line Count: 29+1 (F.1), 30+1 (F.1), 30+2 (F.6), 30+3 (F.2), 31+2 (F.3).

Cheek Scale Rows: 3 (F.1), 4 (F.11), 5 (F.1).

The dentition counts for S. diagramma are listed on Table 35 and are compared with the other Simochromis species and with the Tropheus species (Pl.8 figs.1,2). The pattern of dentition is explained in the description of S. curvifrons.

Upper Jaw: 8-12 rows of tricuspid teeth, mode = 10 rows.
38-46 bicuspid teeth in the outer row, mean = 43 teeth: (disagreeing with 56 bicuspid teeth in Günther, 1893, and disagreeing with 40-61 in Poll, 1956).
5-11 conical teeth at each corner of the mouth, mode - 7 teeth.

Lower Jaw: 8-12 rows of tricuspid teeth, mode = 10 rows.
26-27 bicuspid teeth in the outer row, mean = 32 teeth.
2-7 conical teeth at each corner of the mouth, mode = 4 teeth.

The lower pharyngeal bone of Simochromis diagramma is triangular in shape with a median indentation on its posterior border (Pl.23 figs.8,9). There are 28-32 enlarged teeth on the posterior border of the bone which are anteriorly slanting unicusps with a poorly defined shoulder. There is a second row of similar teeth parallel to the previous row which are also enlarged. The 10-12 teeth parallel to the middle of the bone, are all enlarged and progressively grow larger toward the posterior of the bone. All of the other teeth are unicuspid and slant posteriorly. The horns of the bone are more slender than those of other Simochromis or Tropheus species. The lower pharyngeal bone length (as % h.l.) and width (as % bone length) are listed on Table 36 and compared with all of the other Simochromis species and all of the Tropheus species.

Total length of the bone: 31.0-36.1 % of the h.l.
Total width of the bone: 95.2-106.1 % of the bone length.

The pharyngeal apophyses of eleven specimens of Simochromis diagramma were examined. The articulary surfaces were oval- or slightly pear-shaped and the composition was both Haplochromis-like and Tilapia-like (Regan, 1920). Below are the percentage contributions of the parasphenoid (P), basioccipital (B) and pro-otic (PRO)

PLATE 9

Fig. 1: Simochromis diagramma (GSA-SD9) - pharyngeal apophysis (H-type). Scale = 1 mm. ventral view.

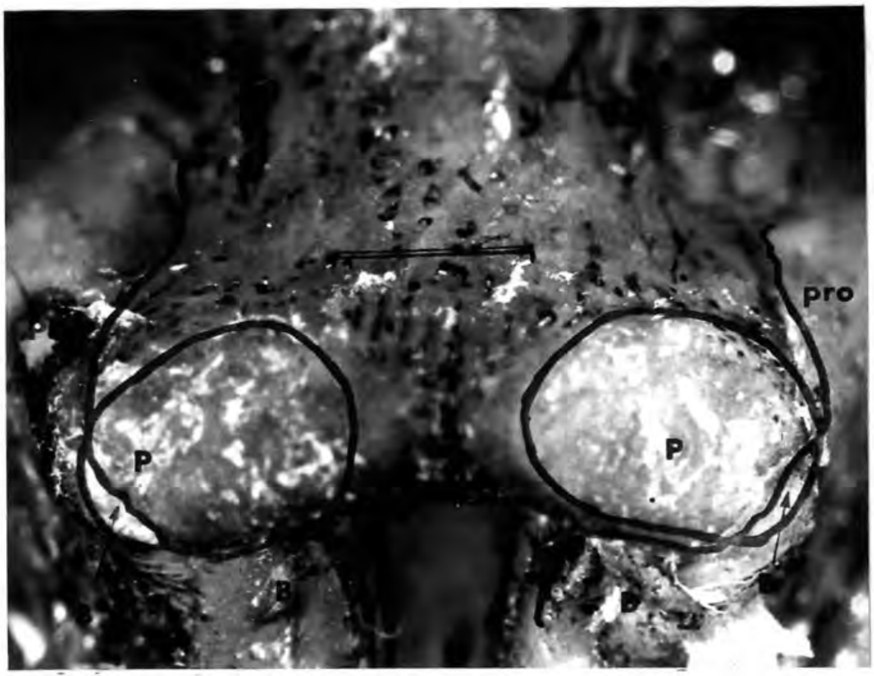

Fig. 2: Simochromis diagramma (GSA-SD503)- pharyngeal apophysis (H-type). Scale = 1 mm. ventral view .

PLATE 10

Fig. 1: <u>Simochromis diagramma</u> (GSA-SD500) pharyngeal apophysis (T-type). Scale = 1 mm. ventral view.

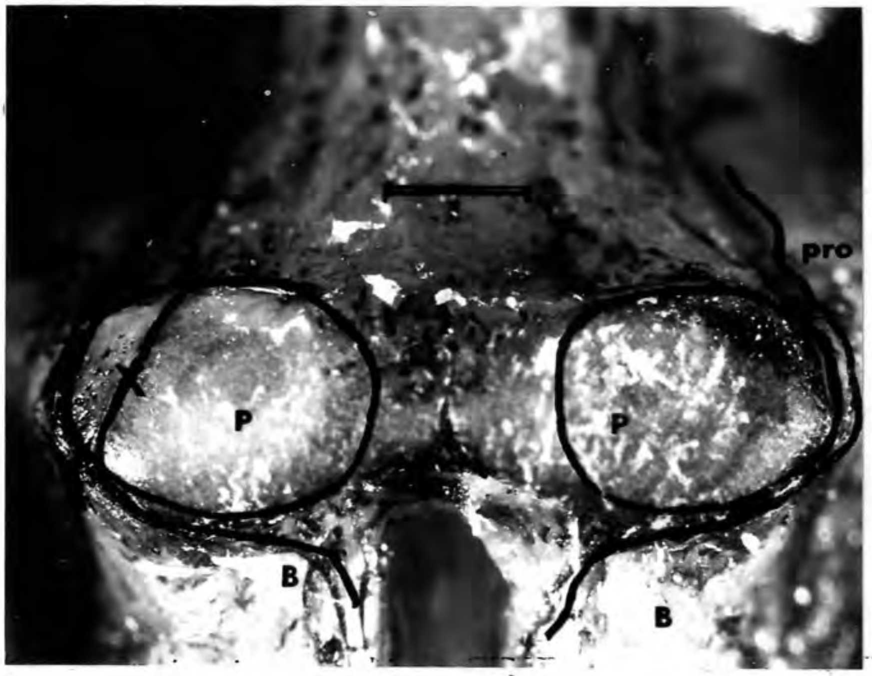

Fig. 2: <u>Simochromis diagramma</u> (GSA-SD501) pharyngeal apophysis (T-type). Scale = 1 mm. ventral view.

Fig. 3: <u>Simochromis diagramma</u> (GSA-SD509) pharyngeal apophysis (T-type). Scale = 1 mm. ventral view.

PLATE 11

Fig. 1: Simochromis diagramma (GSA-SD502) - pharyngeal apophysis (T-type). Scale = 1 mm. ventral view.

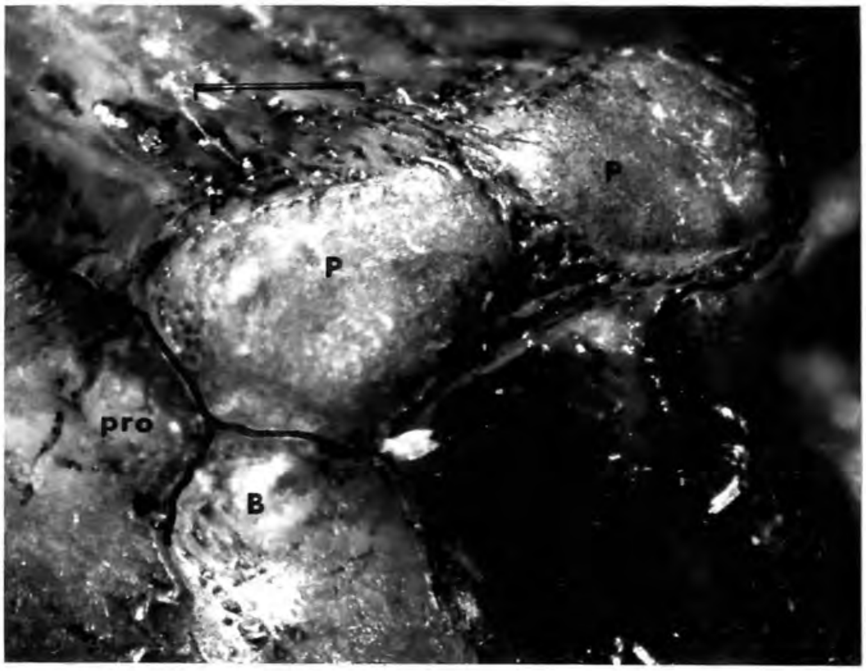

Fig. 2: Simochromis diagramma (GSA-SD502) - pharyngeal apophysis (T-type). Scale = 1 mm. lateral view.

to the articulary surface of each examined specimen (L = left facet and R = right facet).

GSA-SD500:	L & R - 100% P	(Pl.10 fig.1)
GSA-SD501:	L & R - 100% P	(Pl.10 fig.2)
GSA-SD502:	L & R - 100% P	(Pl.11 figs.1,2)
GSA-SD503:	L - 96% P, 4% B R - 90% P, 10% B	(Pl.9 fig.2)
GSA-SD504:	L - 100% P R - 98% P, 2% B	
GSA-SD505:	L - 98% P, 2% B R - 100% P	
GSA-SD506:	L & R - 100% P	
GSA-SD507:	L & R - 100% P	
GSA-SD508:	L & R - 100% P	
GSA-SD509:	L & R - 100% P	(Pl.10 fig.3)
GSA-SD9:	L - 90% P, 10% B R - 88% P, 12% B	(Pl.9 fig.1)

The vertebral counts of *Simochromis diagramma* are listed on Table 37 and are compared with all of the other *Simochromis* species and with the *Tropheus* species. There are 32-33 vertebrae in total, 15 precaudal and 17 caudal, or 16 precaudal and 16 caudal, or 16 precaudal and 17 caudal.

When alive, *Simochromis diagramma* is a grey-brown fish with 9-12 dark grey vertical bars on its side (Pl.21 fig.2). Its belly, chest and pelvic fin are white. Its branchiostegal membrane is solid black in adult males, and spotted black on white in some mature female and juvenile specimens. The dorsal fin is light grey with a brick-red band running through its center from the 4th, 5th or 6th spine to the branched rays, fading gradually toward its posterior extreme. The dorsal fin is also thinly trimmed with a brick-red band. The caudal fin is dark grey anteriorly, fading to light gray posteriorly. The pectoral and anal fins are light grey, and there are one to three brick-red egg spots (Wickler, 1963; pers. obs.) on the anal fin of the males. There is an oval black spot, approximately one half of the eye diameter, on the most posterior portion of the operculum. Preserved specimens become grey, keeping the vertical bars on their sides, the black or spotted branchiostegal membrane, the opercular spot, and the dorsal fin, caudal fin, pectoral fin and anal fin grey colorations. All of the brick-red coloration becomes grey shortly after preservation. No sexual dichromatism was noticed other than the egg spots on the anal fin.

Simochromis diagramma was collected in Kigoma Harbour (see Chapter 3 - "Material Examined" and Map 3) at 2-8 m depth. The habitat description is as explained for *S. babaulti*, as *S. diagramma* was collected in the same area. *S. diagramma* was collected in both the rocky and sandy areas.

TABLE 13

Simochromis diagramma (♂ & ♀) : General Characteristics of the Head and Body

characteristic	relative standard length data					relative body length data					relative head length data				
	%s.l.	SD	CV	range	n	%b.l.	SD	CV	range	n	%h.l.	SD	CV	range	n
standard length	-	-	-	-	-	143.0	2.72	1.90	137.8-146.9	14	333.6	14.9	4.48	313.1-364.8	14
head length	30.0	1.33	4.44	27.4-31.9	14	43.0	2.72	6.32	37.8-46.9	14	-	-	-	-	-
body length	70.0	1.33	1.90	68.1-72.6	14	-	-	-	-	-	233.6	14.9	6.39	213.1-264.8	14
body depth	38.9	1.45	3.73	35.9-41.1	14	55.6	2.59	4.66	50.8-60.4	14	-	-	-	-	-
caudal peduncle depth ..	12.2	0.42	3.49	11.3-13.0	14	17.4	0.70	4.00	16.1-18.5	14	-	-	-	-	-
interorbital width	10.1	0.62	6.14	9.0-11.1	14	-	-	-	-	-	33.8	3.29	9.75	28.5-38.4	14
preorbital depth	6.6	0.53	8.04	6.1-7.9	13	-	-	-	-	-	22.0	2.51	11.5	19.2-26.6	13
head depth	31.1	1.24	3.99	28.6-32.7	13	-	-	-	-	-	103.7	7.16	6.90	93.8-119.4	13
snout length	9.5	0.77	8.14	8.2-10.7	13	-	-	-	-	-	31.5	2.14	6.79	28.0-34.0	13
postocular head	12.0	0.58	4.82	10.5-12.7	13	-	-	-	-	-	39.8	1.45	3.64	37.8-42.3	13
eye diameter	8.6	0.69	8.08	7.3-9.8	14	-	-	-	-	-	28.5	1.53	5.37	25.4-30.8	14
mouth width	13.5	0.85	6.28	12.8-15.0	14	-	-	-	-	-	45.0	4.53	10.1	38.9-53.6	14
mouth length	5.1	0.47	9.12	4.6-6.1	13	-	-	-	-	-	17.0	1.76	10.3	14.5-20.7	13
cheek depth	10.7	0.97	9.07	9.5-12.2	13	-	-	-	-	-	35.7	4.77	13.4	29.6-44.5	13
% mouth length/m.w.	38.2	4.14	10.9	30.9-45.0	13										

standard length range: 54.3-144.4 mm
body length range : 37.1-102.7 mm
head length range : 17.2-41.7 mm

TABLE 14

<u>Simochromis diagramma</u> (♂) : General Characteristics of the Head and Body

characteristic	relative standard length data					relative body length data					relative head length data				
	%s.l.	SD	CV	range	n	%b.l.	SD	CV	range	n	%h.l.	SD	CV	range	n
tandard length	-	-	-	-	-	140.6	1.53	1.09	137.8-142.0	6	346.4	9.70	2.80	338.1-364.8	6
ead length	28.9	0.78	2.71	27.4-29.6	6	40.6	1.53	3.77	37.8-42.0	6	-	-	-	-	-
ody length	71.1	0.8	1.1	70.4-72.6	6	-	-	-	-	-	246.4	9.70	3.94	238.1-264.8	6
ody depth	-	-	-	-	-	53.6	1.92	3.58	50.8-55.5	6	-	-	-	-	-
audal peduncle depth ..	-	-	-	-	-	17.0	0.56	3.27	16.1-17.7	6	-	-	-	-	-
nterorbital width	10.6	0.36	3.38	10.3-11.1	6	-	-	-	-	-	36.8	1.53	4.16	34.7-38.4	6
reorbital depth	7.0	0.60	8.55	6.3-7.9	5	-	-	-	-	-	24.3	2.16	8.85	22.0-26.6	5
ead depth	-	-	-	-	-	-	-	-	-	-	108.9	6.23	5.72	103.4-119.4	5
nout length	9.4	0.35	3.72	8.9-9.8	5	-	-	-	-	-	32.8	0.99	3.03	31.6-34.0	5
ostocular head	11.4	0.54	4.71	10.5-11.8	5	-	-	-	-	-	39.7	0.92	2.31	38.5-41.0	5
ye diameter	7.9	0.39	4.96	7.3-8.4	6	-	-	-	-	-	27.4	1.39	5.08	25.4-29.1	6
outh width	14.1	0.65	4.61	13.2-15.0	6	-	-	-	-	-	49.0	2.86	5.84	45.6-53.6	6
outh length	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
heek depth	11.7	0.39	3.32	11.2-12.2	5	-	-	-	-	-	40.7	2.30	5.66	38.3-44.5	5

standard length range: 108.2-144.4 mm
body length range : 76.2-102.7 mm
head length range : 32.0-41.7 mm

TABLE 15

Simochromis diagramma (♀) : General Characteristics of the Head and Body

characteristic	relative standard length data					relative body length data					relative head length data				
	%s.l.	SD	CV	range	n	%b.l.	SD	CV	range	n	%h.l.	SD	CV	range	n
:tandard length	-	-	-	-	-	144.7	1.95	1.35	141.5-146.9	8	323.9	9.94	3.07	313.1-341.2	8
.ead length	30.9	0.93	3.03	29.3-31.9	8	44.7	1.95	4.35	41.5-46.9	8	-	-	-	-	-
ody length	69.1	0.9	1.4	68.1-70.7	8	-	-	-	-	-	223.9	9.94	4.44	213.1-241.2	8
ody depth	-	-	-	-	-	57.2	1.84	3.21	54.6-60.4	8	-	-	-	-	-
:audal peduncle depth ..	-	-	-	-	-	17.7	0.66	3.74	16.6-18.5	8	-	-	-	-	-
.nterorbital width	9.7	0.49	5.03	9.0-10.5	8	-	-	-	-	-	31.5	2.24	7.11	28.5-35.8	8
›reorbital depth	6.3	0.26	4.06	6.1-6.9	8	-	-	-	-	-	20.5	1.26	6.15	19.2-22.9	8
ıead depth	-	-	-	-	-	-	-	-	-	-	100.4	5.80	5.78	93.8-111.5	8
;nout length	9.5	0.97	10.22	8.1-10.7	8	--	-	-	-	-	30.8	2.37	7.69	28.0-33.7	8
›ostocular head	12.3	0.27	2.19	11.9-12.7	8	-	-	-	-	-	39.9	1.76	4.42	37.8-42.3	8
:ye diameter	9.1	0.36	3.92	8.7-9.8	8	-	-	-	-	-	29.3	1.05	3.58	28.1-30.8	8
nouth width	13.0	0.62	4.75	12.1-13.7	8	-	-	-	-	-	42.1	3.03	7.19	38.9-46.6	8
nouth length	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
:heek depth	10.0	0.50	4.97	9.5-10.9	8	-	-	-	-	-	32.5	2.45	7.55	29.6-37.3	8

standard length range: 54.3-95.2 mm

body length range : 37.1-67.3 mm

head length range : 17.2-27.9 mm

TABLE 16

Simochromis diagramma (♂ & ♀) : General Characteristics of the Fins

characteristic	relative standard length data					relative body length data					relative head length data				
	%s.l.	SD	CV	range	n	%b.l.	SD	CV	range	n	%h.l.	SD	CV	range	n
Dorsal fin:															
length at base	60.4	1.31	2.16	58.0-62.5	14	86.3	1.59	1.84	84.5-88.9	14	-	-	-	-	-
longest spine	13.3	1.29	9.71	11.2-16.0	14	19.0	2.11	11.1	15.7-23.4	14	-	-	-	-	-
longest branched ray ..	21.3	1.94	9.09	18.3-24.0	14	30.5	2.34	7.67	26.9-33.9	14	-	-	-	-	-
distance from snout ...	36.0	1.24	3.45	34.2-37.8	13	51.5	2.40	4.66	48.1-55.3	13	119.8	5.31	4.43	111.7-132.1	13
Anal fin:															
length at base	18.8	0.82	4.35	17.9-20.6	14	26.8	1.12	4.17	25.1-28.9	14	-	-	-	-	-
longest spine	13.9	0.94	6.76	12.4-16.0	14	19.9	1.65	8.27	17.5-23.4	14	-	-	-	-	-
longest branched ray ..	21.4	1.72	8.05	18.3-23.9	14	30.6	2.19	7.16	26.1-33.9	14	-	-	-	-	-
distance from snout ...	68.5	1.01	1.47	67.2-70.3	13	98.1	3.16	3.23	93.4-103.0	13	228.1	8.34	3.66	216.1-247.3	13
Pectoral fin:															
longest branched ray ..	30.9	1.37	4.45	28.3-33.0	14	44.1	2.47	5.58	39.8-47.6	14	-	-	-	-	-
distance from snout ...	31.3	1.05	3.36	29.4-32.5	13	44.8	2.24	5.00	41.4-47.6	13	104.0	3.27	3.15	101.1-111.5	13
Pelvic fin:															
longest branched ray ..	30.0	2.48	8.26	26.3-33.8	14	42.9	3.01	7.01	38.5-47.9	14	-	-	-	-	-
distance from snout ...	40.0	1.31	3.27	37.2-41.8	13	57.2	2.70	4.72	52.5-61.2	13	133.1	5.13	3.86	127.2-145.8	13
Caudal fin:															
longest ray	26.5	1.03	3.89	24.6-27.4	14	37.8	1.62	4.30	35.3-40.7	14	-	-	-	-	-

TABLE 17

Simochromis diagramma (♂): General Characteristics of the Fins

characteristic	relative standard length data					relative body length data					relative head length data				
	%s.l.	SD	CV	range	n	%b.l.	SD	CV	range	n	%h.l.	SD	CV	range	n
Dorsal fin:															
length at base	61.2	0.89	1.46	60.4-62.5	6	-	-	-	-	-	-	-	-	-	-
longest spine	12.3	0.85	6.93	11.2-13.4	6	17.3	1.26	7.29	15.7-18.9	6	-	-	-	-	-
longest branched ray ..	23.0	1.21	5.23	20.7-24.0	6	32.4	1.74	5.36	29.1-33.9	6	-	-	-	-	-
distance from snout ...	35.3	1.10	3.12	34.2-36.7	5	49.6	1.56	3.15	48.1-52.1	5	122.6	5.85	4.77	117.4-132.1	5
Anal fin:															
length at base	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
longest spine	13.2	0.45	3.45	12.4-13.6	6	18.5	0.70	3.76	17.5-19.3	6	-	-	-	-	-
longest branched ray ..	22.8	1.06	4.66	21.2-23.9	6	32.0	1.44	4.48	29.7-33.9	6	-	-	-	-	-
distance from snout ...	67.9	0.30	0.44	67.6-68.4	5	95.3	1.13	1.19	93.4-96.1	5	235.8	7.26	3.08	228.4-247.3	5
Pectoral fin:															
longest branched ray ..	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
distance from snout ...	30.5	0.92	3.02	29.4-31.5	5	42.8	1.38	3.23	41.4-44.4	5	105.9	4.57	4.31	101.1-111.5	5
Pelvic fin:															
longest branched ray ..	32.4	1.27	3.92	30.8-33.8	6	45.5	2.13	4.67	42.4-47.9	6	-	-	-	-	-
distance from snout ...	-	-	-	-	-	55.0	1.81	3.29	52.5-56.8	5	136.2	6.91	5.08	129.3-145.8	5
Caudal fin:															
longest ray	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE 18

Simochromis diagramma (♀) : General Characteristics of the Fins

characteristic	relative standard length data					relative body length data					relative head length data				
	%s.l.	SD	CV	range	n	%b.l.	SD	CV	range	n	%h.l.	SD	CV	range	n
Dorsal fin:															
length at base	59.7	1.23	2.05	58.0-62.0	8	-	-	-	-	-	-	-	-	-	-
longest spine	14.0	1.05	7.48	12.3-16.0	8	20.3	1.65	8.14	17.5-23.4	8	-	-	-	-	-
longest branched ray ..	20.1	1.29	6.44	18.3-21.6	8	29.0	1.57	5.43	26.9-31.7	8	-	-	-	-	-
distance from snout ...	36.5	1.16	3.18	34.7-37.8	8	52.8	1.97	3.74	49.0-55.3	8	118.1	4.45	3.77	111.7-126.0	8
Anal fin:															
length at base	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
longest spine	14.5	0.79	5.43	13.6-16.0	8	21.0	1.34	6.38	19.4-23.4	8	-	-	-	-	-
longest branched ray ..	20.4	1.40	6.84	18.3-21.7	8	29.5	2.10	7.10	26.1-31.8	8	-	-	-	-	-
distance from snout ...	68.9	1.09	1.58	67.2-70.3	8	99.8	2.77	2.78	95.1-103.0	8	223.2	4.36	1.95	216.1-229.4	8
Pectoral fin:															
longest branched ray ..	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
distance from snout ...	31.8	0.83	2.62	30.4-32.5	8	46.0	1.77	3.84	42.9-47.6	8	102.8	1.46	1.42	101.5-106.0	8
Pelvic fin:															
longest branched ray ..	28.3	1.49	5.26	26.3-30.9	8	40.9	1.83	4.46	38.5-43.7	8	-	-	-	-	-
distance from snout ...	-	-	-	-	-	58.6	2.22	3.78	54.7-61.2	8	131.1	2.58	1.97	127.2-135.7	8
Caudal fin:															
longest ray	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Simochromis marginatus Poll 1956.

Simochromis marginatus Poll, M. 1956: 96-98 (original sp. desc.; one type - t.l. 89 mm - and four paratypes - 65-87 mm - from Manga, L. Tang., Zaire; type at Koninklijk Mus. voor Midden-Africa, Tervuren).

Axelrod, H.R. and Burgess, W. 1977: 321 (specimen colour photograph by G.S. Axelrod, field no. GSA-SM10).

Diagnosis:

Morphometric characteristics -

Simochromis marginatus morphometrically differs[1] (Tables 38-41) from all of the other Simochromis species and all of the Tropheus species in the interorbital width (as % s.l., 8-3 cf 7.0, 9.3-12.4), anal fin base length (as % b.l., 25.5 cf 26.5-32.4), and additionally differs[2] from all of the other Simochromis species in the lower pharyngeal bone length[3] (as % h.l., 31.8 cf 33.2-34.2), lower pharyngeal bone width[3] (as % bone length, 94.9 cf 91.1, 97.2-101.8),

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1. The numeral sequence respectively compares each parameter of the Simochromis marginatus and all of the other Simochromis species and all of the Tropheus species.

2. The numeral sequence respectively compares each parameter of the S. marginatus and all of the other Simochromis species.

3. As only one Simochromis sp. A,lower pharyngeal bone was examined, a statistical t-test was not made between S. marginatus and S. sp.A.

mouth length (as % m.w., 32.8 cf 38.2-47.0) and longest dorsal branched ray (as % s.l., 17.4 cf 15.8, 19.7-21.3; as % b.l., 24.8 cf 22.9, 28.7-30.5). S. marginatus morphometrically differs[1] from all of the Tropheus species in the caudal peduncle depth (as % s.l., 10.8 cf 11.4-12.1; as % h.l., 15.3 cf 16.3-17.2), preorbital depth (as % s.l., 6.3 cf 7.7-9.5; as % h.l., 20.8 cf 24.9-32.1), head depth (as % s.l., 30.1 cf 33.0-36.2; as % h.l., 100.0 cf 112-116.7), interorbital width (as % h.l., 27.9 cf 35.7-41.8), cheek depth (as % h.l., 31.3 cf 38.8-40.1), dorsal fin base length (as % s.l., 58.5 cf 61.7-63.0; as % b.l., 83.5 cf 88.0-99.0), anal fin base length (as % s.l., 17.9 cf 20.0-22.8), longest pelvic branched ray (as % s.l., 27.5 cf 33.1-39.2; as % b.l., 39.2 cf 46.2-55.7) and dorsal fin to snout distance (as % h.l., 117.3 cf 121.2-127.1).

Meristic characteristics -

The dorsal fin of Simochromis marginatus has 17 spines and 9 dorsal rays, as compared with all Tropheus which have 20-22 spines and 5-8 branched rays (Table 31). The anal fin of S. marginatus has 3 spines and 7 branched rays, as compared with all Tropheus species which have 4-6 spines and 5-8 branched rays (Table 32). S. marginatus has a total of 10 anal rays, as compared with 11-12 rays usually found in Simochromis sp. A, S. curvifrons, S. diagramma, and all Tropheus species (Table 32). S. marginatus

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1. The sequence respectively compares each parameter of the S. marginatus and all of the Tropheus species.

has 5-6 gill rakers below the articulation on the outer gill arch as compared with 10-12 gill rakers for S. curvifrons, S. diagramma and all Tropheus species (Table 33). S. marginatus has 39 bicuspid teeth in the outer row of the lower jaw, as compared with 21-32 bicuspid teeth for all other Simochromis species (Table 35; Table 38; Pl.12 figs.1,2). Further, S. marginatus has 3-8 (mode = 5) very small conical teeth lateral to the inner tricuspid rows of the lower jaw - while Tropheus species do not have lower conical teeth.

A dark black band or "margin", which extends the entire length of the upper dorsal fin, distinguishes mature S. marginatus from all other Simochromis species except Simochromis sp. A. S. babaulti has an analogous black band, but it extends only 6-8 spines along the anterior (one third portion) of the dorsal fin (Pl.20 fig.1, Pl.21 fig.1).

Description:

All methods of count, measurement and statistical analysis are explained in Chapter 3 - "Laboratory Techniques." Table 19-24 list the selected morphometric characteristics of the head, body and fins of Simochromis marginatus. Statistical comparisons of selected morphometrics of all known Simochromis and Tropheus species are shown on Tables 38-41. All S. marginatus specimens examined are sexually mature. Specimen field numbers, sizes, collection locations and collection dates are found in Chapter 3- "Material Examined."

Several examples of possible sexual dimorphism have been noted in S. marginatus.Tables 20 and 21 list the selected morphometric characteristics of the head and body for male and female representatives (resp.) of the species, and Tables 23 and 24 list the selected morphometric characteristics of the fins for male and female representatives (resp.) of the species where sexual dimorphism may occur. Unfortunately, sufficient female material (2 specimens) was unavailable to substantiate this possible differentiation. The possibilities, however, are noted on these Tables. The average size (s.l.) of the males is about 5 mm greater than that of the females. The growth superiority of the male S. marginatus could be comparable to that of the male S. babaulti as was noted by Poll (1956). No meristic sexual differentiation was observed.

The fin formulae for S. marginatus are listed on Tables 31 and 32, and are compared with the other Simochromis species and with the Tropheus species.

Dorsal Fin Formula: $\frac{XVII,9}{8}$

Anal Fin Formula: $\frac{III,7}{8}$

Pectoral Fin Formula: $\frac{15}{1}$ $\frac{16}{7}$

Pelvic Fin Formula: $\frac{1,5}{8}$

Caudal Fin Formula: 16 principal rays, I-14-I.

PLATE 12

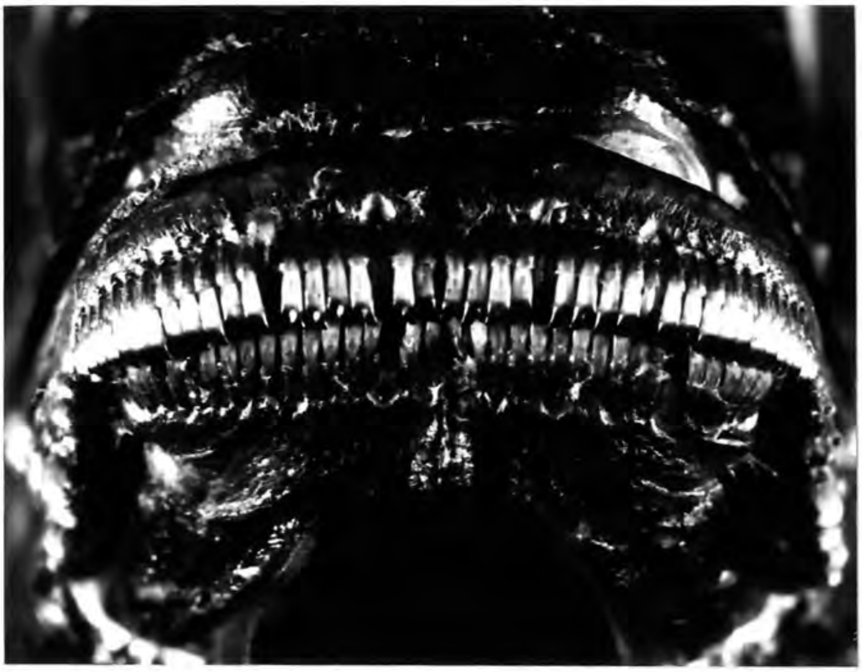

Fig. 1: Simochromis marginatus (GSA-SM600) - dentition, upper and lower jaw. Scale = 1 mm.

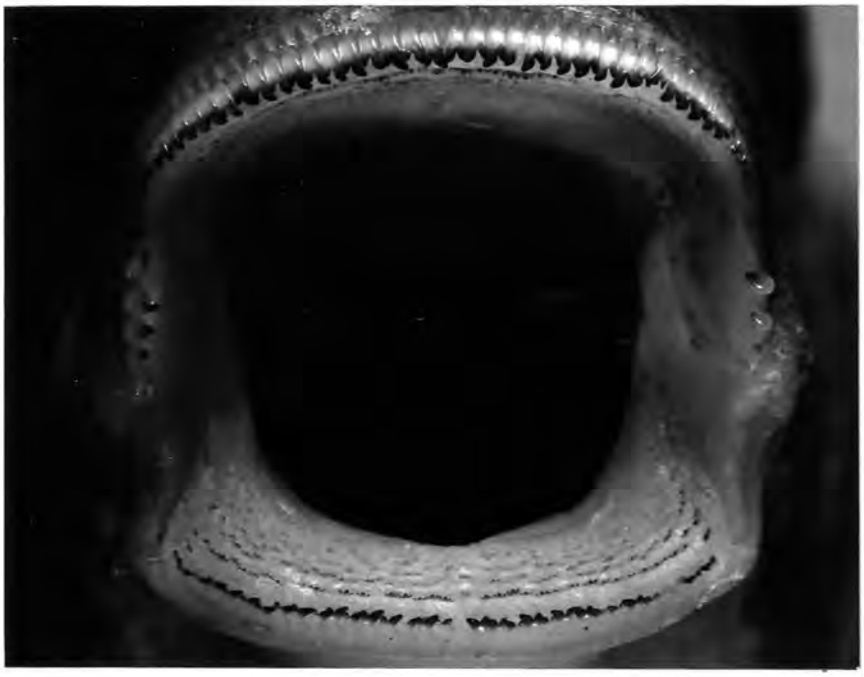

Fig. 2: Simochromis marginatus (GSA-SM605) - dentition, mouth open. Scale = 1 mm.

The gill raker counts for S. marginatus are listed on Table 33 and are compared with the other Simochromis species and with the Tropheus species. The gill rakers are conical in shape.

Gill Raker Count - number above, on and below the articulation: 3-0-5 (F.3), 3-1-5 (F.1), 4-1-5 (F.1), 3-0-6 (F.2), 4-0-6 (F.1).

The selected scale meristics for S. marginatus are listed on Table 34 and are compared with the other Simochromis species and with the Tropheus species.

Lateral Line: 29+2 (F.1), 29+3 (F.3), 30+3 (F.2).

Cheek Scale Rows: 3 (F.4), 4 (F.3).

The dentition counts for S. marginatus are listed on Table 35 and are compared with other Simochromis species and with other Tropheus species (Pl.12 figs.1,2). The pattern of dentition is explained in the description of S. curvifrons.

Upper Jaw: 6-9 rows of tricuspid teeth, mode = 7 rows.
44-50 bicuspid teeth in the outer row, mean = 45 teeth.
3-7 conical teeth at each corner of the mouth, mode = 6 teeth.

Lower Jaw: 6-8 rows of tricuspid teeth, mode = 6 rows.
34-42 bicuspid teeth in the outer row, mean = 39 teeth.
3-8 conical teeth at each corner of the mouth, mode = 5 teeth.

PLATE 13

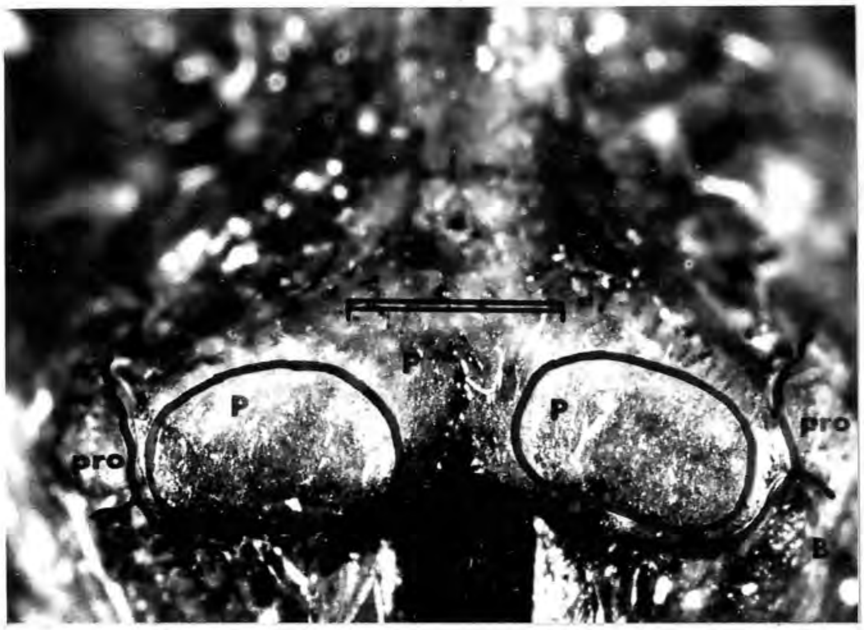

Fig.1: Simochromis marginatus (GSA-SM 602) - pharyngeal apophysis (T-type) Scale = 1 mm. ventral view.

Fig. 2: Simochromis marginatus (GSA-SM603)- pharyngeal apophysis (T-type). Scale = 1 mm. ventral view.

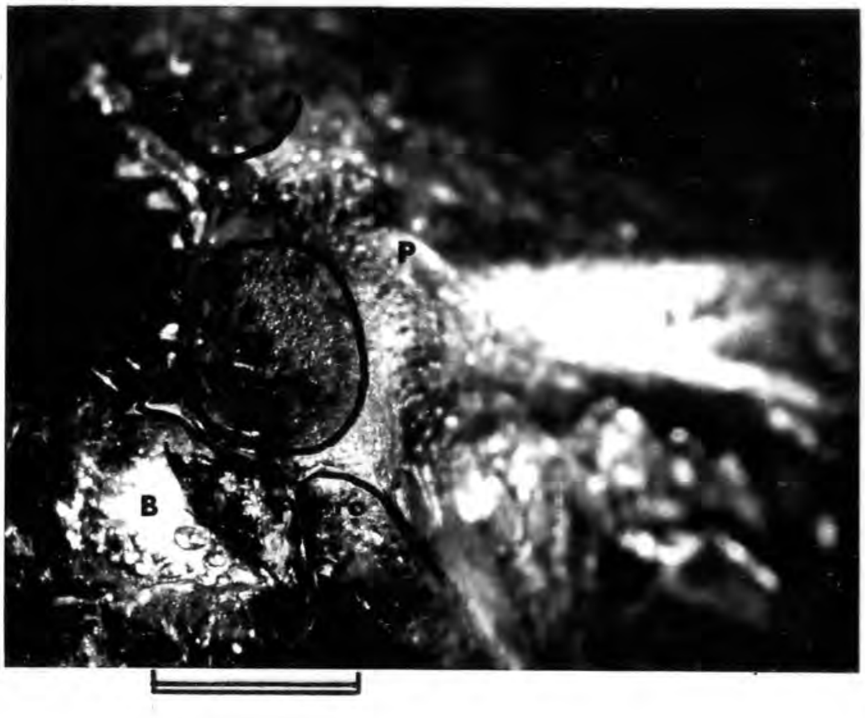

Fig. 3: Simochromis marginatus (GSA-SM 603) - pharyngeal apophysis. Scale = 1 mm. lateral view.

The lower pharyngeal bone of Simochromis marginatus is triangular in shape with a median indentation on its posterior border (Pl.23 fig.10). There are 28-32 enlarged teeth on the posterior border of the bone which are anteriorly slanting unicusps with a poorly defined shoulder. There is a second row of similar teeth parallel to the previous row, but these teeth are not as enlarged as the former. All of the other teeth are unicuspid and slant posteriorly. There are 13-17 teeth parallel to the midline of the bone. The horns of the bone are more robust than those of any other Simochromis or Tropheus species. The lower pharyngeal bone length (as % h.l.) and width (as % bone length) are listed on Table 36 and compared with all of the other Simochromis species and all of the Tropheus species.

Total length of the bone: 31.0-32.8% of the h.l.

Total width of the bone: 92.9-96.5% of the bone length.

The pharyngeal apophyses of six specimens of Simochromis marginatus were examined. The articulatory surfaces were oval-shaped and the composition was Tilapia-like (Regan, 1920), as they were all completely composed of the parasphenoid (Pl.13 figs.1-3).

The vertebral counts of Simochromis marginatus are listed on Table 37 and are compared with all of the other Simochromis species and with the Tropheus species. There are 31 vertebrae in total, 14 precaudal and 17 caudal.

When alive, Simochromis marginatus is a grey-brown fish with 7-8 indistinct vertical bands on its side (Pl.21 fig.1).

Its belly, chest, pelvic fin and branchiostegal membrane are white. The dorsal fin is light grey with a wide dark black margin along its distal edge, beginning at the 3rd and 4th spine and running to the 4th, 5th or 6th branched ray. The dorsal fin is also thinly trimmed with yellow-orange along its distal margin. The pectoral fins are light grey and the anal fin is white with a light orange-brown trim along its distal margin. The caudal fin is black proximally, becoming yellow and finally white distally. Preserved specimens lose all coloration with the exception of grey and black (Pl.2 fig.2). The distinct vertical bands on the side of the body, the black dorsal fin margin, the black marking on the caudal fin and the light grey coloration on the pectoral fin remain after preservation. All distinctive markings were lost from one specimen that was badly preserved (pl.3 fig.1). No sexual dichromatism was noticed.

Simochromis marginatus was collected in Kigoma Harbour (see Chapter 3 - "Material Examined" and Map 3) at 2-6 m depth. The habitat description is as explained for S. babaulti, as S. marginatus was collected in the same area. S. marginatus was collected in both the rocky and sandy areas.

TABLE 19

Simochromis marginatus (♂&♀) : General Characteristics of the Head and Body

characteristic	relative standard length data					relative body length data					relative head length data				
	%s.l.	SD	CV	range	n	%b.l.	SD	CV	range	n	%h.l.	SD	CV	range	n
standard length	-	-	-	-	-	142.8	3.04	2.13	139.3-147.2	8	334.8	16.3	4.88	312.0-354.2	8
head length	29.9	1.48	4.95	28.2-32.1	8	42.8	3.04	7.11	39.3-47.2	8	-	-	-	-	-
body length	70.1	1.48	2.11	67.9-71.8	8	-	-	-	-	-	234.8	16.3	6.96	212.0-254.2	8
body depth	37.6	1.38	3.68	34.8-39.2	8	53.6	1.48	2.76	51.2-55.4	8	-	-	-	-	-
caudal peduncle depth ..	10.8	0.34	3.17	10.4-11.5	8	15.3	0.51	3.35	14.6-16.2	8	-	-	-	-	-
interorbital width	8.3	0.28	3.33	8.0-8.9	8	-	-	-	-	-	27.9	1.93	6.91	25.1-29.1	8
preorbital depth	6.3	0.18	2.82	5.8-6.3	7	-	-	-	-	-	20.8	0.69	3.34	19.8-21.7	7
head depth	30.1	1.16	3.87	28.5-31.8	7	-	-	-	-	-	100.0	6.03	6.04	92.1-107.6	7
snout length	9.8	0.95	9.61	8.4-10.8	7	-	-	-	-	-	32.6	1.87	5.76	29.6-34.7	7
postocular head	11.3	0.30	2.67	10.9-11.8	7	-	-	-	-	-	37.4	1.61	4.30	35.6-40.3	7
eye diameter	9.0	0.53	5.89	8.3-9.8	7	-	-	-	-	-	30.0	1.07	3.55	28.0-30.9	7
mouth width	12.0	0.28	2.34	11.5-12.3	8	-	-	-	-	-	40.1	2.02	5.03	37.5-43.5	8
mouth length	3.9	0.24	6.21	3.6-4.2	8	-	-	-	-	-	13.1	0.95	7.21	12.2-14.6	8
cheek depth	9.4	0.57	6.06	8.9-10.4	7	-	-	-	-	-	31.3	2.41	7.68	28.4-34.7	7
% mouth length/m.w.	32.8	2.45	7.47	29.4-36.0	8										

Standard length range : 93.7-83.0 mm

Body length range : 66.3-56.6 mm

Head length range : 24.6-26.8 mm

TABLE 20

Simochromis marginatus (♂) : General Characteristics of the Head and Body

characteristic	relative standard length data					relative body length data					relative head length data				
	%s.l.	SD	CV	range	n	%b.l.	SD	CV	range	n	%h.l.	SD	CV	range	n
standard length	-	-	-	-	-	141.4	1.95	1.38	139.3-144.6	6	342.0	11.2	3.26	324.0-354.2	6
head length	29.3	0.97	3.31	28.2-30.9	6	41.4	1.95	4.71	39.3-44.6	6	-	-	-	-	-
body length	70.7	0.97	1.37	69.1-71.8	6	-	-	-	-	-	241.0	11.2	4.6	224.0-254.2	6
body depth	38.2	0.76	1.98	37.1-39.2	6	-	-	-	-	-	-	-	-	-	-
caudal peduncle depth ..	10.9	0.33	3.02	10.4-11.4	6	15.4	0.52	3.38	14.6-16.2	6	-	-	-	-	-
interorbital width	-	-	-	-	-	-	-	-	-	-	28.7	1.40	4.86	26.0-29.9	6
preorbital depth	6.2	0.08	1.29	6.1-6.3	5	-	-	-	-	-	-	-	-	-	-
head depth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
snout length	9.5	0.86	9.12	8.4-10.4	5	-	-	-	-	-	-	-	-	-	-
postocular head	11.1	0.20	1.76	10.9-11.4	5	-	-	-	-	-	-	-	-	-	-
eye diameter	8.8	0.45	5.10	8.3-9.4	5	-	-	-	-	-	-	-	-	-	-
mouth width	-	-	-	-	-	-	-	-	-	-	40.7	1.82	4.46	38.2-43.5	6
mouth length	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
cheek depth	-	-	-	-	-	-	-	-	-	-	32.5	1.67	5.13	30.5-34.7	5

standard length range: 84.9-93.7 mm
body length range : 58.7-66.3 mm
head length range : 24.6-27.4 mm

TABLE 21

<u>Simochromis marginatus</u> (♀) : General Characteristics of the Head and Body

characteristic	relative standard length data					relative body length data					relative head length data			
	%s.l.	SD	CV	range	n	%b.l.	SD	CV	range	n	%h.l.	SD	CV	range
standard length	-	-	-	-	-	146.9	0.37	0.26	146.6-147.2	2	313.2	1.70	0.54	312.0-314.4
head length	31.9	0.17	0.54	31.8-32.1	2	46.9	0.37	0.80	46.6-47.2	2	-	-	-	-
body length	68.1	0.17	0.26	67.9-68.2	2	-	-	-	-	-	213.2	1.70	0.80	212.0-214.4
body depth	35.8	1.37	3.82	34.8-36.7	2	-	-	-	-	-	-	-	-	-
caudal peduncle depth ..	10.4	0.03	0.26	10.4-10.5	2	14.8	0	0	14.8	2	-	-	-	-
interorbital width	-	-	-	-	-	-	-	-	-	-	25.4	0.47	1.85	25.1-25.8
preorbital depth	5.9	0.15	2.61	5.8-6.0	2	-	-	-	-	-	-	-	-	-
head depth	-	-	-	-	-	-	-	-	-	-	-	-	-	-
snout length	10.8	0.06	0.53	10.7-10.8	2	-	-	-	-	-	-	-	-	-
postocular head	11.6	0.28	2.45	11.4-11.8	2	-	-	-	-	-	-	-	-	-
eye diameter	9.6	0.40	4.19	9.3-9.8	2	-	-	-	-	-	-	-	-	-
mouth width	-	-	-	-	-	-	-	-	-	-	38.0	0.84	2.20	37.5-38.6
mouth length	-	-	-	-	-	-	-	-	-	-	-	-	-	-
cheek depth	-	-	-	-	-	-	-	-	-	-	28.4	0.04	0.14	28.4-28.5

standard length range: 83.0-83.3 mm
body length range : 26.4-26.7 mm
head length range : 56.6 mm

TABLE 22

Simochromis marginatus (♂ & ♀) : General Characteristics of the Fins

characteristic	relative standard length data					relative body length data					relative head length data				
	%s.l.	SD	CV	range	n	%b.l.	SD	CV	range	n	%h.l.	SD	CV	range	n
Dorsal fin:															
length at base	58.5	1.65	2.83	55.8-60.1	8	83.5	0.95	1.14	82.2-84.5	8	-	-	-	-	-
longest spine	12.7	0.74	5.83	11.4-13.7	8	18.1	0.95	5.25	16.8-19.6	8	-	-	-	-	-
longest branched ray ..	17.4	1.37	7.89	15.5-19.7	8	24.8	1.63	6.59	22.8-27.9	8	-	-	-	-	-
distance from snout ...	35.3	1.35	3.83	33.6-37.2	7	50.7	2.91	5.74	46.8-54.8	7	117.3	2.70	2.31	113.0-121.8	7
Anal fin:															
length at base	17.9	0.83	4.65	16.8-18.7	8	25.5	0.72	2.83	24.4-26.4	8	-	-	-	-	-
longest spine	13.8	0.72	5.25	12.8-15.1	8	19.6	1.04	5.29	18.1-21.0	8	-	-	-	-	-
longest branched ray ..	17.8	1.07	6.01	16.4-19.7	8	25.4	1.30	5.12	23.8-27.8	8	-	-	-	-	-
distance from snout ...	67.7	1.34	2.00	65.7-69.4	7	97.0	3.61	3.72	92.9-102.1	7	224.7	8.48	3.77	215.2-240.7	7
Pectoral fin:															
longest branched ray ..	33.5	1.73	5.17	30.8-36.0	8	47.8	2.52	5.27	44.9-53.0	8	-	-	-	-	-
distance from snout ...	31.5	2.00	6.35	29.6-34.3	7	45.1	3.76	8.34	42.0-50.5	7	104.3	3.03	2.91	99.6-107.5	7
Pelvic fin:															
longest branched ray ..	27.5	1.54	5.60	25.0-29.8	8	39.2	1.80	4.58	36.1-42.4	8	-	-	-	-	-
distance from snout ...	41.1	2.30	5.59	38.5-44.8	7	58.9	4.24	7.20	54.4-65.7	7	136.3	6.00	4.41	131.3-147.8	7
Caudal fin:															
longest ray	22.6	0.93	4.14	21.1-23.8	8	32.2	0.84	2.60	31.1-33.2	8	-	-	-	-	-

TABLE 23

Simochromis marginatus (♂) : General Characteristics of the Fins

characteristic	relative standard length data					relative body length data					relative head length data				
	%s.l.	SD	CV	range	n	%b.l.	SD	CV	range	n	%h.l.	SD	CV	range	n
orsal fin:															
length at base	59.4	0.55	0.93	58.4-60.1	6	83.9	0.58	0.70	82.9-84.5	6	-	-	-	-	-
longest spine	13.0	0.58	4.46	12.4-13.7	6	-	-	-	-	-	-	-	-	-	-
longest branched ray ..	17.9	1.01	5.62	17.0-19.7	6	25.4	1.41	5.55	23.6-27.9	6	-	-	-	-	-
distance from snout ...	34.6	0.77	2.21	33.6-35.6	5	49.1	1.53	3.12	46.8-50.4	5	-	-	-	-	-
nal fin:															
length at base	18.2	0.69	3.80	16.8-18.7	6	25.7	0.70	2.74	24.4-26.4	6	-	-	-	-	-
longest spine	-	-	-	-	-	19.5	1.13	5.78	18.1-21.0	6	-	-	-	-	-
longest branched ray ..	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
distance from snout ...	-	-	-	-	-	95.3	2.56	2.68	92.9-99.7	5	215.8	0.94	0.44	223.3-240.7	2
ectoral fin:															
longest branched ray ..	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
distance from snout ...	30.4	0.85	2.80	29.6-31.8	5	43.1	1.65	3.83	42.0-46.0	5	-	-	-	-	-
elvic fin:															
longest branched ray ..	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
distance from snout ...	40.0	1.39	3.49	38.5-41.7	5	56.7	2.08	3.67	54.4-59.5	5	-	-	-	-	-
audal fin:															
longest ray	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE 24

Simochromis marginatus (♀) : General Characteristics of the Fins

characteristic	relative standard length data					relative body length data					relative head length data				
	%s.l.	SD	CV	range	n	%b.l.	SD	CV	range	n	%h.l.	SD	CV	range	n
Dorsal fin:															
length at base	55.9	0.14	0.26	55.8-56.0	2	82.2	0	0	82.2	2	-	-	-	-	-
longest spine	11.8	0.57	4.77	11.4-12.2	2	-	-	-	-	-	-	--	-	-	-
longest branched ray ..	15.6	0.13	0.83	15.5-15.7	2	23.0	0.25	1.09	22.8-23.1	2	-	-	-	-	-
distance from snout ...	37.1	0.16	0.43	37.0-37.2	2	54.5	0.37	0.69	54.2-54.8	2	-	-	-	-	-
Anal fin:															
length at base	16.9	0.04	0.25	16.9	2	24.8	0.12	0.50	24.7-24.9	2	-	-	-	-	-
longest spine	-	-	-	-	-	20.1	0.87	4.36	19.4-20.7	2	-	-	-	-	-
longest branched ray ..	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
distance from snout ...	-	-	-	-	-	101.2	1.25	1.23	100.4-102.1	2	228.3	7.21	3.16	215.2-216.5	5
Pectoral fin:															
longest branched ray ..	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
distance from snout ...	34.2	0.17	0.49	34.1-34.3	2	50.3	0.37	0.75	50.0-50.5	2	-	-	-	-	-
Pelvic fin:															
longest branched ray ..	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
distance from snout ...	43.9	1.30	2.97	43.0-44.8	2	64.5	1.75	2.71	63.3-65.7	2	-	-	-	-	-
Caudal fin:															
longest ray	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Tropheus brichardi Nelissen & Thys 1975.

Tropheus brichardi Nelissen, M.H.J. and Thys van den Audenaerde, D.F.E. 1975: 974-980 (original sp. desc. with figure; holotype - s.l. 68.2 mm ♀, allotype - s.l. 77.2 mm ♂, paratypes - s.l. 42.8-86.3 mm - from Nyanza, Burundi, L. Tanganyika; type material at Koninklijk Mus. voor Midden-Africa, Tervuren).

Diagnosis:

Morphometric characteristics -

Tropheus brichardi morphometrically differs[1] (Table 38-41) from all other Tropheus species and all Simochromis species in the lower pharyngeal bone length[2] (as % h.l., 36.3 cf 30.3-34.2) and differs[3] from all Tropheus, except T. moorii, and all Simochromis, in the anal fin base length (as % s.l., 22.8 cf 17.9-21.3). T. brichardi morphometrically differs[4] from all other Tropheus in interorbital width (as % s.l., 10.1 cf

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1. The numeral sequence respectively compares each parameter of the Tropheus brichardi and all of the other Tropheus species and all of the Simochromis species.
2. As only one Simochromis sp. A lower pharyngeal bone was examined, a statistical t-test was not made between Simochromis sp. A and T. brichardi.
3. The numeral sequence respectively compares each parameter of T. brichardi and the other Tropheus species, except T. moorii, and all of the Simochromis species.
4. The numeral sequence respectively compares each parameter of the T. brichardi and all of the other Tropheus species.

10.9-12.4), longest anal branched ray (as % b.l., 24.8 cf 28.4-34.7), and differs[1] from all Tropheus, except T. moorii, in interorbital width (as % h.l., 35.7 cf 38.10-41.8), snout length (as % s.l., 7.2 cf 10.0-10.3; as % h.l., 25.4 cf 33.4-33.7), eye diameter (as % s.l., 8.2 cf 7.3, 8.9), preoribital depth (as % h.l., 28.1 cf 24.9, 32.1), postocular head (as % h.l., 45.6 cf 37.6-41.6), mouth length (as % h.l., 15.6 cf 13.5, 17.7; as % m.w., 32.8 cf 29.4, 44.6), longest dorsal branched ray (as % s.l., 18.3 cf 22.2-25.2; as % b.l., 25.5 cf 32.1-35.9), longest anal branched ray (as % s.l., 17.8 cf 21.9-24.4, anal fin to snout distance (as % h.l., 240.9 cf 224.4-233.0), longest pectoral branched ray (as % b.l., 45.8 cf 49.9-51.7), longest pelvic branched ray (as % b.l., 46.2 cf 51.6-55.7) and pelvic fin to snout distance (as % h.l., 146.6 cf 132.5-138). T. brichardi morphometrically differs[2] from all T. moorii in the interorbital width (as % s.l., 10.1 cf 10.9, with 95% confidence[3]), lower pharyngeal bone length (as % h.l., 36.3 cf 33.6, with 99% confidence), lower pharyngeal bone width (as % bone length, 95.1 cf 89.4, with 99% confidence), longest pectoral branched ray (as % s.l., 32.8 cf 35.7, with 90% confidence;

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1. The numeral sequence respectively compares each parameter of T. brichardi and the other Tropheus species, except T. moorii.
2. The numeral sequence respectively compares each parameter of T. brichardi and T. moorii.
3. The probability of rejection of the t-test Null hypothesis in a comparison between sample means.

as % b.l., 45.8 cf 51.0, with 95% confidence), longest anal branched ray (as % b.l., 24.8 cf 28.4, with 90% confidence), anal fin to snout distance (as % h.l., 240.9 cf 227.1, with 90% confidence) and pectoral fin to snout distance (as % h.l., 115.1 cf 105.3, with 99% confidence). T. brichardi morphometrically differs[1] from all Simochromis species in head depth (as % s.l., 33.0 cf 29.4-31.1, 34.8) and mouth length (as % s.l., 4.4 cf 3.9-4.1, 4.5-5.1).

Meristic characteristics -

The dorsal fin of Tropheus brichardi has 21 spines and 6 branched rays, as compared with all Simochromis species which have 16-19 spines and 8-11 branched rays (Table 31). The anal fin of T. brichardi has 6 spines and 5-6 branched rays, as compared with all Simochromis species which have 3 spines and 7-9 branch rays (Table 32). T. brichardi has 10 gill rakers below the articulation on the outer gill arch, as compared with 5-7 gill rakers for Simochromis sp. A, S. babaulti and S. marginatus (Table 33). T. brichardi has a mean value of 42 bicuspid teeth in the outer row of the lower jaw, as compared with 21-39 bicuspid teeth for all Simochromis species (Table 35; Table 38). Furthermore, like all Tropheus species, T. brichardi has several small tricuspid teeth between the anterior bicuspid and lateral conicals of the upper jaw

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1. The sequence respectively compares each parameter of T. brichardi and all of the Simochromis species.

which are not part of the inner series of tricuspid rows. *T. brichardi* has 1-3 (mode = 3) of these tricuspid teeth, which are referred to as "lateral transition teeth at each corner (of the mouth)" on Table 35. *Simochromis* species have a toothless gap between the anterior bicuspid teeth of the upper jaw and the conical teeth. *T. brichardi* has 30 vertebrae in its axial skeleton, as compared with 31-33 in all other *Tropheus* species (except one specimen of *T. polli*), as well as *S. curvifrons*, *S. diagramma* and *S. marginatus* (Table 37). Furthermore, *T. brichardi* has 14 precaudal vertebrae as compared with 15-16 in all other *Tropheus* species.

Description:

All methods of count, measurement and statistical analysis are explained in Chapter 3 - "Laboratory Techniques." Tables 25 and 26 list the selected morphometric characteristics of the head, body and fins of *Tropheus brichardi*. Statistical comparisons of selected morphometrics of all known *Simochromis* and *Tropheus* species are shown on Tables 38-41. Both *T. brichardi* specimens examined are sexually mature females. Specimen field numbers, sizes, collection locations and collection dates are found in Chapter 3- "Material Examined."

The analysis of this species shows a very close resemblance to *T. moorii*, and could possibly be a morphometrically small member of this species. This possibility cannot be substantiated here, due to the lack of material. The morphometric differentiation noted could be due to the proportional differences resulting from the size (e.g. the head of a small specimen is usually proportionally larger in body size than it is in an adult specimen). Additional material must be examined in order to come to any firm conclusions on the taxonomic validity of T. brichardi.

The fin formulae for T. brichardi are listed on Tables 31 and 32, and are compared with the other Tropheus species and with the Simochromis species.

Dorsal Fin Formula: $\frac{XXI,6}{2}$

Anal Fin Formula: $\frac{VI,5}{1}$ $\frac{VI,6}{1}$

Pectoral Fin Formula: $\frac{16}{2}$

Pelvic Fin Formula: $\frac{1,5}{2}$

Caudal Fin Formula: 16 principle rays, I-14-I.

The gill raker counts for T. brichardi are listed on Table 33 and are compared with the other Tropheus species and with the Simochromis species.

Gill Raker Count - number above, on and below the articulation: 2-1-10 (F.2).

The selected scale meristics for T. brichardi are listed on Table 34 and are compared with the other Tropheus species and with the Simochromis species.

Lateral Line Count: 29+2 (F.2).

Cheek Scale Rows: 4 (F.2).

The dentition counts for T. brichardi are listed on Table 35 and are compared with other Tropheus species and with the Simochromis species. The pattern of the dentition is explained in the description of T. moorii.

Upper Jaw: 5-7 rows of tricuspid teeth, mode = 7 rows.
44 bicuspid teeth in the outer row.
1-3 lateral tricuspid teeth at each corner of the mouth, mode = 3 teeth.
4-5 conical teeth at each corner of the mouth, mode = 5 teeth.

Lower Jaw: 5-6 rows of tricuspid teeth, mode = 6 rows.
40-44 bicuspid teeth in the outer row, mean = 42 teeth.
No conical teeth.

The lower pharyngeal bone of Tropheus brichardi is triangular in shape with a median indentation on its posterior border (Pl.23 fig.2). There are 36-38 enlarged teeth on the posterior border of the bone which are anteriorly slanting unicusps with a poorly defined shoulder. There is a second row of similar teeth parallel to the previous row, but these teeth are not as enlarged as the former. All of the other teeth are unicuspid and slant posteriorly. There are 10-12 teeth parallel to the midline of the bone. The lower pharyngeal bone length (as % h.l.) and width (as % bone length) are listed on Table 36 and compared with all of the other Tropheus species and Simochromis species.

Total length of the bone: 36.3-36.4 of h.l.

Total width of the bone: 94.9-95.3% of the body length.

The pharyngeal apophyses of two specimens of Tropheus brichardi were examined. The articulary surfaces were circular in shape and the composition was Tilapia-like (Regan, 1920), as they were all completely composed of the parasphenoid.

The vertebral counts of Tropheus brichardi are listed on Table 37 and are compared with all of the other Tropheus species and with the Simochromis species. There are 30 vertebrae in total, 14 precaudal and 16 caudal.

As both Tropheus brichardi specimens were donated to this project by the Koninklijk Museum voor Midden-Africa, Tervuren, a first-hand description of the live coloration cannot be made. Nelissen and Thys (1975, p. 979), however, describe the coloration as follows: "The fish is brown with a darker caudal fin, but on the back a very conspicuous saddle-like, yellowish white spot appears about from the 4th up to the 11th spine of the dorsal fin. On the belly an equal spot can be seen. The lips, which are pale, are surrounded by a dark ring. On the posterior part of the anal fin 5 to 8 yellow or orange spots may be seen. The eye is white, except for the black pupil. The upper part of the eye is sometimes yellowish." The preserved specimen loses all detailed coloration. The body and fins are all medium-brown with no distinctive markings. No sexual dimorphism or dichromatism was noted in the literature.

A detailed description of the habitat is unavailable. According to Nelissen and Thys (1975), *T. brichardi* is found at a few meters depth, living amongst large rocks.

TABLE 25

Tropheus brichardi (♀ only) : General Characteristics of the Head and Body

characteristic	relative standard length data					relative body length data					relative head length data				
	%s.l.	SD	CV	range	n	%b.l.	SD	CV	range	n	%h.l.	SD	CV	range	n
standard length	-	-	-	-	-	139.7	1.56	1.11	138.6-140.8	2	352.1	9.88	2.81	345.1-359.1	2
head length	28.4	0.80	2.81	27.8-29.0	2	39.7	1.56	3.92	38.6-40.8	2	-	-	-	-	-
body length	71.6	0.80	1.11	71.0-72.2	2	-	-	-	-	-	252.1	9.88	3.92	245.1-259.1	2
body depth	38.8	0.24	0.62	38.6-38.9	2	54.2	0.94	1.74	53.5-54.8	2	-	-	-	-	-
caudal peduncle depth ..	11.7	0.63	5.42	11.2-12.1	2	16.3	1.07	6.53	15.5-17.1	2	-	-	-	-	-
interorbital width	10.1	0.22	2.18	10.0-10.3	2	-	-	-	-	-	35.7	1.77	4.98	34.4-36.9	2
preorbital depth	8.0	0.33	4.14	7.8-8.2	2	-	-	-	-	-	28.1	0.38	1.34	27.8-28.4	2
head depth	33.0	0.08	0.23	32.9-33.0	2	-	-	-	-	-	116.1	2.99	2.58	114.0-118.2	2
snout length	7.2	0.30	4.20	7.0-7.4	2	-	-	-	-	-	25.4	1.78	7.00	24.2-26.7	2
postocular head	13.0	0.90	6.92	12.3-13.6	2	-	-	-	-	-	45.6	1.88	4.12	44.3-47.0	2
eye diameter	8.2	0.20	2.46	8.1-8.4	2	-	-	-	-	-	28.9	0.10	0.34	28.8-29.0	2
mouth width	13.5	0.11	0.85	13.4-13.6	2	-	-	-	-	-	47.6	0.93	1.96	47.0-48.3	2
mouth length	4.4	0.01	0.27	4.4	2	-	-	-	-	-	15.6	0.40	2.53	15.3-15.9	2
cheek depth	11.3	0.16	1.38	11.2-11.5	2	-	-	-	-	-	39.9	0.57	1.43	39.5-40.3	2
% mouth length/m.w. ...	32.8	0.19	0.58	32.7-32.9	2										

standard length range: 63.2-74.2 mm
body length range : 45.6-52.7 mm
head length range : 17.6-21.5 mm

TABLE 26

Tropheus brichardi (♀ only) : General Characteristics of the Fins

characteristic	relative standard length data					relative body length data					relative head length data				
	%s.l.	SD	CV	range	n	%b.l.	SD	CV	range	n	%h.l.	SD	CV	range	n
Dorsal fin:															
length at base	63.0	0.44	0.70	62.7-63.3	2	88.0	0.36	0.41	87.7-88.2	2	-	-	-	-	-
longest spine	12.9	0.84	6.52	12.3-13.4	2	18.0	0.97	5.41	17.3-18.6	2	-	-	-	-	-
longest branched ray ..	18.3	0.30	1.65	18.0-18.5	2	25.5	0.70	2.76	25.0-26.0	2	-	-	-	-	-
distance from snout ...	36.1	2.09	5.77	34.7-37.6	2	50.5	3.48	6.88	48.0-52.9	2	127.1	3.77	2.97	124.4-129.8	2
Anal fin:															
length at base	22.8	1.33	5.85	21.8-23.7	2	31.8	2.22	6.96	30.3-33.4	2	-	-	-	-	-
longest spine	14.4	0.43	2.99	14.1-14.7	2	20.1	0.82	4.10	19.5-20.7	2	-	-	-	-	-
longest branched ray ..	17.8	0.05	0.27	17.7-17.8	2	24.8	0.34	1.39	24.6-25.0	2	-	-	-	-	-
distance from snout ...	68.4	1.00	1.46	67.7-69.1	2	95.6	2.46	2.58	93.9-97.3	2	240.9	3.24	1.34	238.6-243.2	2
Pectoral fin:															
longest branched ray ..	32.8	1.85	5.63	31.5-34.1	2	45.8	3.09	6.74	43.6-48.0	2	-	-	-	-	-
distance from snout ...	32.7	2.88	8.80	30.7-34.8	2	45.8	4.53	9.91	42.5-49.0	2	115.1	6.91	6.00	110.2-120.0	2
Pelvic fin:															
longest branched ray ..	33.1	2.02	6.11	31.6-34.5	2	46.2	3.34	7.22	43.9-48.6	2	-	-	-	-	-
distance from snout ...	41.6	1.15	2.77	40.8-42.5	2	58.2	2.26	3.88	56.6-59.8	2	146.6	0.06	0.04	146.5-146.6	2
Caudal fin:															
longest ray	23.5	1.66	7.08	22.3-24.7	2	32.8	2.69	8.19	30.9-34.7	2	-	-	-	-	-

Tropheus duboisi Marlier 1959.

Tropheus duboisi Marlier, G. 1959: 181-183 (original sp. desc.; holotype - s.l. 103.8 mm, eleven paratypes - from Bemba, L. Tang., Zaire; holotype at Koninklijk Mus. voor Midden-Africa, Tervuren); fig. of type.

Ladiges, W. 1959: 431-8 (fig. with colour notes).

Chlupaty, P. 1961: 5-6 (fig., breeding in aquaria).

Fryer, G. and Iles, T.D. 1972: 106 (clutch size); 126 (brooding duration); 526 (co-existance with T. moorii); 529 (coloration, ecology notes); 536 (evolutionary data).

Axelrod, H.R. and Burgess, W. 1977; 208-292 (colour photograph of juvenile); 338-339 (colour photographs of three colour morphs-narrow olive banded, wide olive banded and white banded - by G.S. Axelrod).

Diagnosis:

Morphometric characteristics -

Tropheus duboisi morphometrically differs[1] (Tables 38-41) from all other Tropheus species and all Simochromis species in the interorbital width (as % s.l., 11.7 cf 7.0-10.9, 12.4; as % h.l., 38.0 cf 22.7-36.5, 41.8), head depth (as % s.l., 36.2 cf 29.4-34.8), mouth length (as % s.l., 5.4 cf 3.9-5.1; as % h.l., 17.7 cf 13.0-17.0), cheek depth (as % s.l., 12.4 cf 9.2-11.7) and body depth

---

1. The numeral sequence respectively compares each parameter of Tropheus duboisi and all of the other Tropheus species and all of the Simochromis species.

(as % b.l., 60.6 cf 49.7-57.2). Additionally, Tropheus duboisi differs[1] from all other Tropheus species in the head length (as % s.l., 30.8 cf 28.4-30.0; as % b.l., 45.0 cf 39.7-42.9), body length (as % s.l., 69.3 cf 70.0-71.6), body depth (as % s.l., 41.8 cf 38.8-39.9), postocular head (as % s.l., 11.6 cf 12.3-13.0; as % h.l., 37.6 cf 41.6-45.6), eye diamemeter (as % s.l., 8.9 cf 7.3-8.3), mouth width (as % s.l., 12.3 cf 13.5-13.8; as % h.l., 39.9 cf 45.9-47.6), preorbital depth (as % h.l., 24.9 cf 27.9-32.1), mouth length (as % m.w., 44.6 cf 29.4-32.8), longest dorsal fin spine (as % s.l., 14.6 cf 12.9-13.4; as % b.l. 21.1 cf 18.0-19.1), longest dorsal fin branched ray (as % s.l., 22.2 cf 18.3-19.4, 25.2; as % b.l., 32.1 cf 25.5-27.6, 35.9), length at the base of the anal fin (as % s.l., 20.0 cf 21.3-22.8; as % b.l., 28.9 cf 30.4 - 32.4), longest anal fin spine (as % s.l., 16.4 cf 14.4-14.9; as % b.l., 23.8 cf 20.1-21.3), longest anal fin branched ray (as % s.l., 21.9 cf 17.8-19.9, 24.4; as % b.l., 31.5 cf 24.8-28.4, 34.7), dorsal fin to snout distance (as % h.l., 121.2 cf 125.2-127.1), and differs[2] from all Simochromis species in the caudal peduncle depth

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1. The numeral sequence respectively compares each parameter of Tropheus duboisi and all of the other Tropheus species.
2. The numeral sequence respectively compares each parameter of Tropheus duboisi and all of the Simochromis species.

(as % s.l., 11.4 cf 10.6-10.8, 12.2-14.2; as % b.l., 16.6 cf 15.3, 17.3-20.6), head depth (as % h.l., 116.7 cf 95.2-103.7, 120.8) and in the longest pelvic fin branched ray (as % s.l., 35.7 cf 27.0-30.7; as % b.l., 51.6 cf 39.1-43.1).

Meristic characteristics -

The dorsal fin of Tropheus duboisi has 20-21 spines and 6-7 branched rays, as compared with all Simochromis species which have 16-19 spines and 8-11 branched rays (Table 31). The anal fin of T. duboisi has 5-6 spines and 5-7 branched rays, as compared with all Simochromis species which have 3 spines and 7-9 branched rays (Table 32). T. duboisi has 15 pectoral rays, as compared with 16-17 in almost all other Tropheus species (except T. polli) and almost all other Simochromis species (Table 32). T. duboisi has 10-12 gill rakers below the articulation on the outer gill arch, as compared with 5-7 gill rakers for Simochromis sp. A, S. babaulti and S. marginatus (Table 33). T. duboisi has a mean value of 34 bicuspid teeth in the outer row of the lower jaw, as compared with 42-49 bicuspid teeth in all other Tropheus species, and 21-29 bicuspid teeth in Simochromis sp. A, S. babaulti and S. curvifrons (table 35; Table 38, Pl.14 fig.1). As described for T. brichardi, T. duboisi has 1-4 (mode = 3) tricuspid transition teeth in the upper jaw between the anterior bicuspids and the lateral conicals, while all Simochromis species have a toothless gap. The mouth of T. duboisi is slightly smaller, more terminal and less inferior than that of T. moorii.

Description:

All methods of count, measurement and statistical analysis are explained in Chapter 3 - "Laboratory Techniques." Tables 27 and 28 list the selected morphometric characteristics of the head, body and fins of Tropheus duboisi. Statistical comparisons of selected morphometrics of all known Simochromis and Tropheus species are shown on Tables 38-41. All T. duboisi specimens examined are sexually mature. No morphometric or meristic sexual differentiation was observed. Several colour "morphs" were found in different locations (see Chapter 3 - "Materials Examined "). but no morphometric or meristic differentiation was found between the chromatic groups. Specimen field numbers, sizes, collection locations and collection dates are found in Chapter 3 - "Material Examined."

The fin formulae for T. duboisi are listed on Tables 31 and 32, and are compared with the other Tropheus species and with the Simochromis species.

Dorsal Fin Formula: $\frac{XX,6}{1}$ $\frac{XX,7}{4}$ $\frac{XXI,6}{40}$

Anal Fin Formula: $\frac{V,6}{38}$ $\frac{V,7}{2}$ $\frac{VI,5}{1}$ $\frac{VI,6}{4}$

Pectoral Fin Formula: $\frac{15}{45}$

Pelvic Fin Formula: $\frac{I,5}{45}$

Caudal Fin Formula: 16 principal rays, I-14-I.

PLATE 14

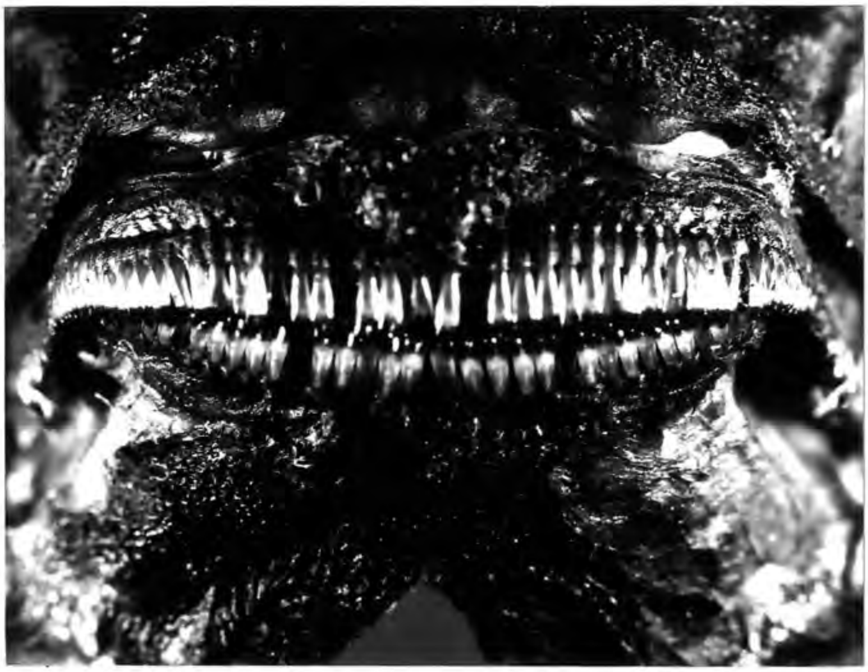

Fig. 1: Tropheus duboisi (GSA-TD65) - dentition, upper and lower jaw. Scale = 1 mm.

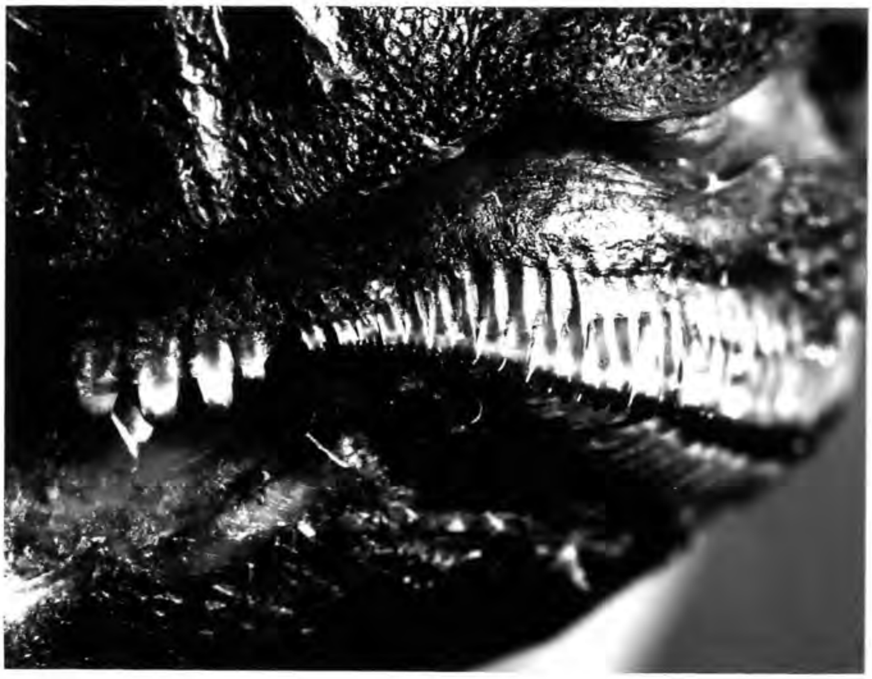

Fig. 2: Tropheus duboisi (GSA-TD65) - dentition, upper conical teeth. Scale = 1 mm.

The gill raker counts for *T. duboisi* are listed on Table 33 and are compared with the other *Tropheus* species and with the *Simochromis* species.

Gill Raker Count - number above, on and below the articulation: 2-1-10 (F.22), 3-0-10 (F.2), 3-1-10 (F.4), 2-1-11 (F.6), 3-0-11 (F.5), 3-1-11(F.1), 2-1-12 (F.4), 3-0-12 (F.1).

The selected scale meristics for *T. duboisi* are listed on Table 34 and are compared with the other *Tropheus* species and with the *Simochromis* species.

Lateral Line Count: 28+2 (F.1), 28+3 (F.5), 29+2 (F.6), 29+3 (F.10), 30+1 (F.1), 30+2 (F.21), 30+3 (F.1).

Cheek Scale Rows: 3 (F.38), 4 (F.7).

The dentition counts for *T. duboisi* are listed on Table 35 and are compared with the other *Tropheus* species and with the *Simochromis* species (Pl.14 figs. 1,2). The pattern of dentition is explained in the description of *T. moorii.*

Upper Jaw: 7-11 rows of tricuspid teeth, mode = 8 rows.
35-46 bicuspid teeth in the outer row, mean = 40 teeth.
1-4 lateral tricuspid teeth at each corner of the mouth, mode = 3 teeth.
3-6 conical teeth at each corner of the mouth, mode = 5 teeth.

Lower Jaw: 8-12 rows of tricuspid teeth, mode = 10 rows.
30-37 bicuspid teeth in the outer row, mean = 34 teeth.
No conical teeth.

The lower pharyngeal bone of <u>Tropheus duboisi</u> is triangular in shape with a median indentation on its posterior border (Pl.23 fig.3). There are 38-44 enlarged teeth on the posterior border of the bone which are anteriorly slanting unicusps with a poorly defined shoulder. There is a second row of similar teeth parallel to the previous, but these teeth are not as enlarged as the former. All of the other teeth are unicuspid and slant posteriorly. There are 11-13 teeth parallel to the midline of the bone. The lower pharyngeal bone length (as % h.l.) and width (as % bone length) are listed on Table 36 and compared with all of the other <u>Tropheus</u> species and all of the <u>Simochromis</u> species.

Total length of the bone: 31.9-34.8% of the h.l.
Total width of the bone: 87.6-97.9% of the bone length.

The pharyngeal apophysis of eleven specimens of <u>Tropheus duboisi</u> were examined. The articulary surfaces were round-(or slightly oval-) shaped and the composition was both <u>Haplochromis</u>-like and <u>Tilapia</u>-like (Regan, 1920). Below are the percentage contributions of the parasphenoid (P), basioccipital (B) and pro-otic (PRO) to the articulatory surface of each specimen examined (L = left facet and R = right facet).

PLATE 15

Fig. 1: Tropheus duboisi (GSA-TD65) - pharyngeal apophysis (H-Type). Scale = 1 mm. ventral view.

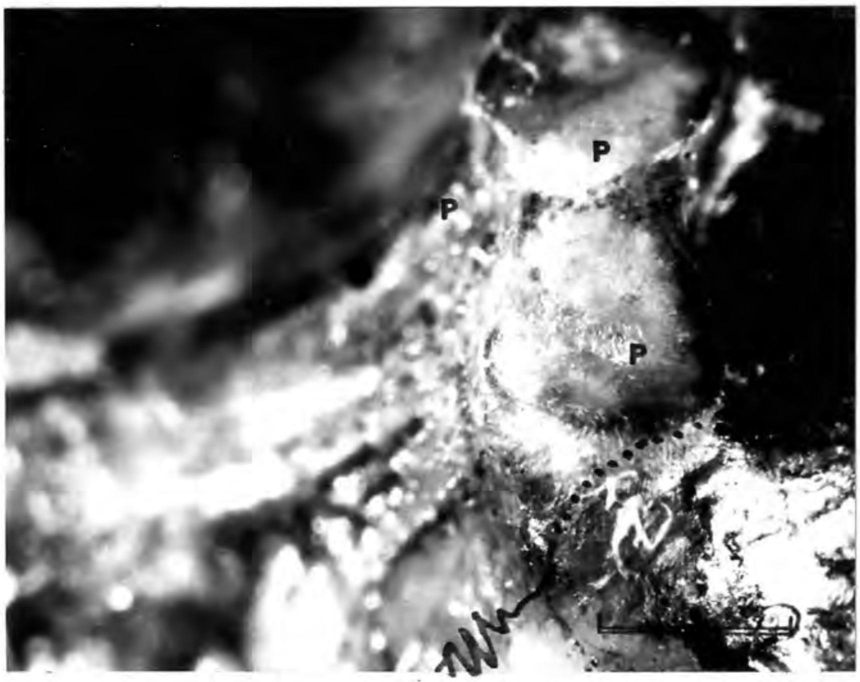

Fig. 2: Tropheus duboisi (GSA-TD65) - pharyngeal apophysis (H-type). Scale = 1 mm. lateral view - articulation cartilage intact.

PLATE 16

Fig. 1: Tropheus duboisi (GSA-TD 67) - pharyngeal apophysis (H-type) Scale = 1 mm. lateral view - articulation cartilage intact.

Fig.2: Tropheus duboisi (GSA-TD67) pharyngeal apophysis (H-type). Scale = 1 mm. ventral view.

Fig. 3: Tropheus duboisi (GSA-TD 67) - pharyngeal apophysis (H-type)

Scale = 1 mm. lateral view - articulation cartilage intact.

PLATE 17: Tropheus dubois (GSA-TD4) - pharyngeal apophysis (T-type). Scale = 1 mm. (composite of scanning electron micrographs). ventral view.

GSA-TD61:	L & R - 100% P	
GSA-TD62:	L & R - 100% P	
GSA-TD63:	L - 97% P, 3% B	
	R - 99% P, 1% B	
GSA-TD64:	L - 100% P	
	R - 97% P, 3% B	
GSA-TD65:	L - 98% P, 2% B	(Pl. 15 figs 1,2)
	R - 100% P	
GSA-TD66:	L & R - 100% P	
GSA-TD67:	L - 99% P, 1% B	(Pl. 16 figs 1-3)
	R - 100% P	
GSA-TD68:	L & R - 100% P	
GSA-TD69:	L & R - 100% P	
GSA-TD70:	L & R - 100% P	
GSA-TD4:	L & R - 100% P	(Pl.17).

The vertebral counts of Tropeus duboisi are listed on Table 37 and are compared with all of the other Tropheus species and with the Simochromis species. There are 31 vertebrae in total, 15 precaudal and 16 caudal.

When alive, the adult Tropheus duboisi are dark blue-grey fish with a slate blue head (Pl.22 fig.1). All of the fins are blue-grey. There is a narrow yellow, narrow white (Pl.22 fig.1), or wide yellow vertical band along the side of the fish extending from the 5th, 6th or 7th spine to the middle of the belly. The juveniles (pl.22 fig.1) are jet-black with 10-15 series of vertical white spots running across the head, body and fins. Preserved specimens have (up till this point - 1 1/2 years) kept most of the described coloration.

<u>Tropheus duboisi</u> was collected at Kitwe Point (Map 3), Kiti Point (Map 4), Bulu Point (Map 6) and Halembe (Map 5) at 10-15 m depth (see Chapter 3 - "Material Examined"). The fish was found amongst algae coated rocks and seldom strayed more than 3 m from a given area, even when pursued.

TABLE 27

<u>Tropheus duboisi</u> (♂ & ♀) : General Characteristics of the Head and Body

characteristic	relative standard length data					relative body length data					relative head length data				
	%s.l.	SD	CV	range	n	%b.l.	SD	CV	range	n	%h.l.	SD	CV	range	n
standard length	-	-	-	-	-	145.0	2.07	1.43	142.7-149.0	45	322.7	9.97	3.09	304.0-334.4	45
head length	30.8	1.12	3.64	28.8-32.9	45	45.0	2.07	4.60	42.7-49.0	45	-	-	-	-	-
body length	69.3	1.12	1.62	67.1-71.3	45	-	-	-	-	-	222.7	9.97	4.48	204.0-234.4	45
body depth	41.8	1.13	2.71	39.5-43.8	45	60.6	1.97	3.26	56.8-63.6	45	-	-	-	-	-
caudal peduncle depth ..	11.4	0.34	2.97	11.0-12.0	45	16.6	0.65	3.91	15.8-17.4	45	-	-	-	-	-
interorbital width	11.7	0.43	3.67	10.7-12.3	45	-	-	-	-	-	38.0	1.48	3.90	35.6-40.1	45
preorbital depth	7.7	0.77	10.1	6.4-9.0	45	-	-	-	-	-	24.9	1.99	7.99	22.0-27.9	45
head depth	36.2	1.15	3.18	34.4-37.7	45	-	-	-	-	-	116.7	2.64	2.26	112.0-121.5	45
snout length	10.3	1.03	10.0	8.5-12.0	45	-	-	-	-	-	33.4	2.83	8.49	29.5-38.8	45
postocular head	11.6	0.76	6.61	10.2-12.7	45	-	-	-	-	-	37.6	2.30	6.11	33.7-41.5	45
eye diameter	8.9	0.40	4.47	8.3-9.4	45	-	-	-	-	-	29.0	1.31	4.52	27.5-31.2	45
mouth width	12.3	0.95	7.74	10.7-13.6	45	-	-	-	-	-	39.9	2.89	7.26	35.6-44.5	45
mouth length	5.4	0.33	6.09	4.9-5.9	45	-	-	-	-	-	17.7	1.09	6.12	16.7-19.8	45
cheek depth	12.4	0.52	4.19	11.8-13.2	45	-	-	-	-	-	40.1	1.61	4.01	37.6-42.5	45
% mouth length/m.w. ...	44.6	3.32	7.45	38.9-48.6	45										

standard length range: 68.2-96.1 mm

body length range : 46.7-67.5 mm

head length range : 20.1-29.9 mm

TABLE 28

<u>Tropheus</u> <u>duboisi</u> (♂ & ♀) : General Characteristics of the Fins

characteristic	relative standard length data					relative body length data					relative head length data				
	%s.l.	SD	CV	range	n	%b.l.	SD	CV	range	n	%h.l.	SD	CV	range	n
Dorsal fin:															
length at base	61.7	1.12	1.81	60.2-63.3	45	89.5	1.77	1.98	85.9-92.1	45	-	-	-	-	-
longest spine	14.6	0.52	3.58	13.8-15.6	45	21.1	0.92	4.38	19.8-23.2	45	-	-	-	-	-
longest branched ray ..	22.2	2.10	9.43	19.8-26.6	32	32.1	3.09	9.64	28.4-38.1	32	-	-	-	-	-
distance from snout ...	37.6	0.79	2.11	36.4-39.0	45	54.5	1.69	3.10	51.9-57.3	45	121.2	3.31	2.73	116.6-125.7	4
Anal fin:															
length at base	20.0	0.54	2.68	19.1-21.0	45	28.9	0.99	3.44	27.4-30.5	45	-	-	-	-	-
longest spine	16.4	0.64	3.91	15.4-17.5	45	23.8	1.13	4.74	22.4-26.1	45	-	-	-	-	-
longest branched ray ..	21.9	1.84	8.40	18.6-24.3	33	31.5	2.47	7.84	27.3-34.8	33	-	-	-	-	-
distance from snout ...	69.6	1.13	1.63	67.7-71.4	45	100.8	2.35	2.33	98.1-105.0	45	224.4	7.38	3.29	210.6-237.4	4
Pectoral fin:															
longest branched ray ..	35.6	3.33	9.35	29.7-39.8	45	51.7	4.87	9.42	42.6-58.0	45	-	-	-	-	-
distance from snout ...	31.4	1.29	4.11	29.9-33.5	45	45.6	2.22	4.87	42.9-48.8	45	101.4	4.17	4.11	98.0-112.1	4
Pelvic fin:															
longest branched ray ..	35.7	2.82	7.90	31.1-39.9	34	51.6	3.88	7.53	44.7-56.7	34	-	-	-	-	-
distance from snout ...	41.1	1.70	4.13	38.1-43.8	45	59.6	2.91	4.88	54.7-63.8	45	132.5	5.37	4.05	125.9-139.6	4
Caudal fin:															
longest ray	26.2	2.85	10.9	21.4-30.0	30	37.8	4.27	11.3	31.0-44.6	30	-	-	-	-	-

Tropheus moorii Boulenger 1898.

Tropheus moorii Boulenger, G.A. 1898: 17-18 (original sp. and genus desc. *T. moorii* type sp.; five syntypes - max. t.l. 110 mm- from Kinyamkolo, L. Tang., Zambia; type at British Museum (NH)); pl. 5 fig. 2 (specimen).

__________ 1899: 105 (citation).

__________ 1901(b): 449 (desc.); pl. 20 fig. 3 (specimen).

Moore, J.E. 1903: 196 (desc.); fig. (specimen).

Pellegrin, J. 1904: 305 (desc., comments on buccal incubation); pl. 7 fig. 2 (specimen).

Boulenger, G.A. 1906: 570 (collection and desc.).

__________ 1906-1916: 276 (desc.); fig. 188 (specimen).

__________ 1920: 48 (new record; desc.).

Regan, C.T. 1920: 41 (definition of genus and comments upon *Tropheus* affinities).

Poll, M. 1946: 266-267 (desc.; biblio.; Mus. collection info.; places *T. annectens* as a synonym of *T. moorii*); pl.1 fig. 8 (lower pharyngeal bone).

Poll. M. 1956(a): 98-101 (desc.), fig. 17 (specimen and dentition).

Marlier, G. 1959: 164-183 (habitat and colour varieties).

Ladiges, W. 1959: 431-438 (colour notes).

Chlupaty, P. 1961: 359-360 (breeding, colours of young and adult).

Matthes, H. 1962: 48, fig. 2 (colour notes); 4(photo).

Wickler, W. 1962(a): 129-164 (anatomical and behavioural notes).

__________ 1962(b): 1092-1093 (behaviour notes).

Wickler, W. 1963: 83-96 (phylogenetic interpretation of taxonomic characters; breeding, pharyngeal apophysis notes; hypothesized interrelationships).

_________ 1966: 127-138: (socio-sexual behaviour).

_________ 1969: 967-987: (breeding habits and social structure).

Fryer, G. and Iles, T.D. 1972: 35,68 (dentition); 106, 122-124, 157, 191-192, 408, pl. 5B (spawning, brood size, buccal incubation, breeding behaviour, breeding appeasement movements); 212 (dorsal fin); 289(threat aggression rituals); 319 (polymorphism); 476 (Girrelid similarities); 480-481 (possible function derivations); 514-517 (comparison with Haplochromis nigricans and Pseudotropheus); 504, 507, 536 (probable affinities); 500-502, 526-529, 538, 559, 585 (ecology, feeding, Haplochromis affinities, co-existence with T. duboisi, incipient speciation, interpopulation differences, hybridization, coloration, pharyngeal apophysis).

Axelrod, H.R. and Burgess, W. 1977: 209, 293 (specimen colour photographs); 334-337 (8 photographs of various Tropheus moorii morphs collected and photographed by G.S. Axelrod; red form, field no. GSA-TM49; red-orange-blotched (incorrectly marked "Red form from south"), GSA-TM62; brown Kigoma ♀♀ and olive-yellow Kigoma ♂♂ (incorrectly marked "Yellow-belly form" and "Form from Kigoma") in aquaria - no field nos. ; brown Kigoma ♀ (marked "brown form"), GSA-TM10: green form, GSA-TM30; yellow-finned form, GSA-TM61, developing juvenile from Kigoma area).

Axelrod, G.S. 1977: 1-2, 11 (comparison with T. polli).

Tropheus moorii moorii Nelissen M.H.J. 1977; 17-29, fig. (desc. of T.m. kassabae, n. ssp. from Kasaba Bay Zambia; holotype s.l.

92.5 mm, 18 paratypes s.l. 53.5-97.0 mm; types at Koninklijk Mus. voor Midden-Africa, Tervuren).

Tropheus annectens Boulenger, G.A. 1900: 148, pl. 52 fig. 2 (original sp. desc., 2 syntypes each 80 mm t. l.; collected in Albertville, L. Tang., Zaire; type at Koninklijk Mus. voor Midden-Africa, Tervuren and British Museum (NH), London).

__________ 1901: 450 (desc.).

Moore, J.E.S. 1903: 189 (citation).

Pellegrin, J. 1904: 306 (desc.).

Boulenger, G.S. 1906 - 1916: 278 (desc. with fig., doubts as to validity of species).

Regan, C.T. 1920: 41 (definition of Tropheus, doubt about the validity of T. annectens, possibly synonymous with T. moorii, temporarily accepts validity).

Poll, M. 1946: 266-267 (places T. annectens as a synonym of T. moorii due to T. moorii's intra-specific morphometric variation and the paucity of T. annectens material).

Diagnosis:

Morphometric characteristics -

Tropheus moorii morphometrically differs[1] (Tables 38-41) from all other Tropheus species, except T. brichardi, and all Simochromis species in the preorbital depth (as % s.l., 8.3 cf 5.6-7.7, 9.5; as % h.l., 27.9 cf 17.8-25.8, 32.1) and anal fin base length (as % s.l., 22.7 cf 17.9-21.3; as % b.l., 32.4 cf

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1. The numeral sequence respectively compares each parameter of Tropheus moorii and the other Tropheus species, except T. brichardi, and all of the Simochromis species.

25.5-30.4). T. moorii morphometrically differs[1] from all other Tropheus species in the interorbital width (as % s.l., 10.9 cf 10.1, 11.7-12.4), longest anal branched ray (as % b.l., 28.4 cf 24.8, 31.5-34.7), lower pharyngeal bone width (as % bone length, 89.4 cf 95.0-95.7), and differs[2] from all other Tropheus species, except T. brichardi, in the snout length (as % s.l., 8.8 cf 10.0-10.3; as % h.l., 29.2 cf 33.4-33.7), postocular head (as % s.l., 12.9 cf 11.6-12.3; as % h.l., 43.0 cf 37.6-41.6), eye diameter (as % s.l., 8.3 cf 7.3, 8.9; as % h.l., 27.8 cf 24.7, 29.0), mouth length (as % s.l., 4.4 cf 4.0, 5.4; as % h.l., 14.8 cf 13.5, 17.7; as m.w., 32.2 cf 29.4, 44.6), interorbital width (as % h.l., 36.5 cf 38.0-41.8), longest dorsal branched ray (as % s.l., 19.4 cf 22.2-25.2; as % b.l., 27.6 cf 32.1-35.9), longest anal branched ray (as % s.l., 19.9 cf 21.9-24.4), anal fin to snout distance (as % s.l., 67.9 cf 68.9-69.6) and longest caudal fin ray (as % s.l., 24.5 cf 26.2-45.7; as % b.l., 34.9 cf 37.8-65.0). Tropheus moorii morphometrically differs[3] from all Simochromis species in the

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1. The numeral sequence respectively compares each parameter of T. moorii and all of the other Tropheus species.

2. The numeral sequence respectively compares each parameter of T. moorii and the other Tropheus species, except T. brichardi. Morphometric differentiation between T. moorii and T. brichardi is examined earlier in this chapter in the description of T. brichardi.

3. The numeral sequence respectively compares each parameter of T. moorii and all of the Simochromis species.

preorbital depth (as % s.l., 8.3 cf 5.6-7.4), head depth (as % h.l., 112.0 cf 95.2-103.7, 120.8), anal fin base length (as % s.l., 22.7 cf 17.9-20.5; as % b.l., 32.4 cf 25.5-28.9); longest pelvic fin branched ray(as % s.l., 36.6 cf 27.0-30.7; as % b.l., 52.2 cf 39.1-43.1), dorsal fin to snout distance (as % h.l., 125.2 cf 111.1-119.8), longest anal fin spine (as % b.l., 21.3 cf 19.6-19.9, 22.4-24.5) and longest pectoral branched ray (as % b.l., 51.0 cf 38.0-47.8).

Meristic characteristics -

The dorsal fin of Tropheus moorii has 20-22 spines and 5-7 branched rays, as compared with all Simochromis species which have 16-19 spines and 8-11 branched rays (Table 31). The anal fin of T. moorii has 4-6 spines and 5-7 branched rays, as compared with all Simochromis species which have 3 spines and 7-9 branched rays (Table 32). T. moorii has 10-12 gill rakers below the articulation on the outer gill arch, as compared with 5-7 gill rakers for Simochromis sp. A, S. babaulti and S. marginatus (Table 33). T. moorii has a mean value of 45 bicuspid teeth in the outer row of the lower jaw, as compared with 21-39 bicuspid teeth for all Simochromis species, 34 for T. duboisi, 42 for T. brichardi and 49 for T. polli (Pl.18 fig.1). As described for T. brichardi, T. moorii has 0-5 (mode = 3) tricuspid transition teeth in the upper jaw between the anterior bicuspids and the lateral conicals, while all Simochromis species have a toothless gap.

Description:

All methods of count, measurement and statistical analysis are explained in Chapter 3 - "Laboratory Techniques." Tables 29 and 30 list the selected morphometric characteristics of the head, body and fins of Tropheus moorii. Statistical comparisons of selected morphometrics of all known Simochromis and Tropheus species are shown on Tables 38-41. All T. moorii specimens examined are sexually mature. No morphometric or meristic sexual differentiation was observed, other than differences in body coloration (sometimes, but usually not, considered a morphometric characteristic). Several colour "morphs" were found in different locations (see Chapter 3 - "Materials Examined") in addition to an instance of sexual dichromatism. No morphometric or meristic differentiation was found between the chromatic groups. Specimen field numbers, sizes, collection locations and collection dates are found in Chapter 3 - "Material Examined."

The fin formulae for T. moorii are listed on Tables 31 and 32, and are compared with the other Tropheus species and with the Simochromis species.

Dorsal Fin Formula: $\frac{\text{XX,6}}{1}$ $\frac{\text{XX,7}}{2}$ $\frac{\text{XXI,5}}{2}$ $\frac{\text{XXI,6}}{32}$ $\frac{\text{XXI,7}}{3}$ $\frac{\text{XXII,5}}{5}$ $\frac{\text{XXII,6}}{12}$ $\frac{\text{XXII,7}}{3}$

Anal Fin Formula: $\frac{\text{V,5}}{1}$ $\frac{\text{V,6}}{9}$ $\frac{\text{V,7}}{2}$ $\frac{\text{VI,5}}{8}$ $\frac{\text{VI,6}}{38}$ $\frac{\text{VI,7}}{2}$

Pectoral Fin Formula: $\frac{15}{1}$ $\frac{16}{56}$ $\frac{17}{3}$

PLATE 18

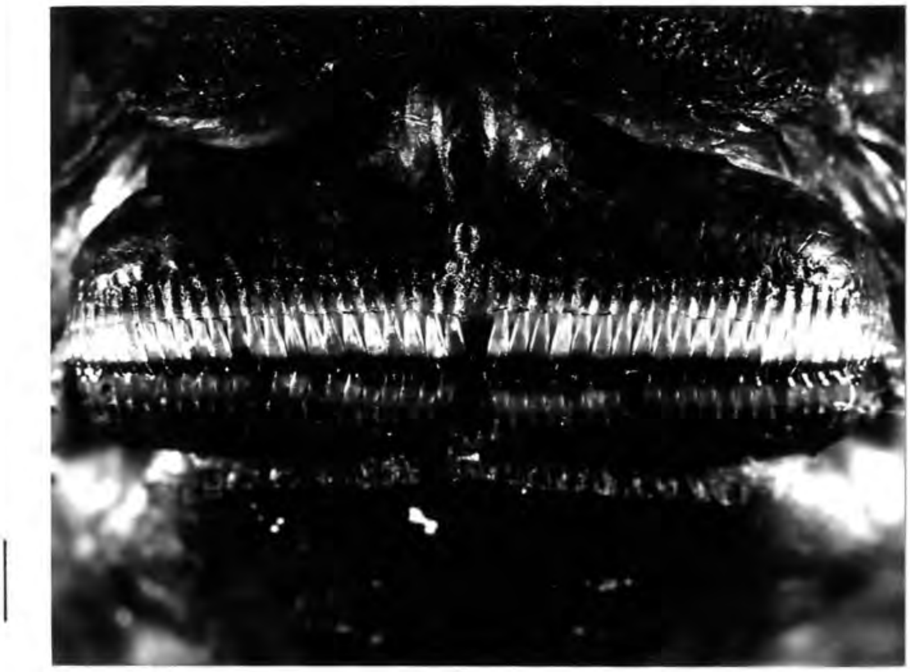

Fig. 1: Tropheus moorii (GSA-TM1) - dentition, upper and lower jaw. Scale = 1 mm.

Fig. 2: Tropheus moorii (GSA-TM1) - dentition, upper conical teeth. Scale = 1 mm.

Pelvic Fin Formula: $\frac{1,5}{60}$

Caudal Fin Formula: 16 principal rays, I-14-I.

The gill raker counts for T. moorii are listed on Table 33 and are compared with the other Tropheus species and with the Simochromis species.

Gill Raker Count - number above, on and below the articulation: 2-1-9 (F.1), 2-0-10 (F.5), 2-1-10 (F.17), 3-0-10 (F.18), 3-1-10 (F.7), 3-0-11 (F.8), 3-1-11 (F.3), 3-1-12 (F.1).

The selected scale meristics for T. moorii are listed on Table 34 and are compared with the other Tropheus species and with the Simochromis species.

Lateral Line Count: 28+1 (F.4), 27+2 (F.1), 28+0 (F.2), 28+1 (F.8), 28+2 (F.20), 29+0 (F.4), 29+1 (F.11), 29+2 (F.7), 30+1 (F.2), 30+2 (F.1).

Cheek Scale Rows: 4(F.29), 5 (F.30), 6(F.1).

The dentition counts for T. moorii are listed on Table 35 and are compared with the other Tropheus species and with the Simochromis species. The basic dentition pattern is similar in all Tropheus species (Pl.18 figs 1,2). The teeth are set in the jaws in several series of parallel or concentric rows. The outer rows in the anterior portions of the upper and lower jaws are composed of bicuspid teeth. The teeth are enlarged and conical at the sides of the upper jaw (Pl.18 fig.2). There are small tricuspid teeth (termed "lateral transition teeth" on Table 35) between the anterior bicuspids and lateral conicals. This has not been noted in previous literature, and the inflated bicuspid counts noted in the past leads one to presume that these tricuspids were counted along with the more anterior bicuspids in the upper jaw. There are no conical teeth in the lower jaw.

Upper Jaw: 7-11 rows of tricuspid teeth, mode = 9 rows.
42-50 bicuspid teeth in the outer row, mean = 45 teeth.
0-5 lateral tricuspid teeth at each corner of the mouth, mode = 3 teeth.
4-7 conical teeth at each corner of the mouth, mode = 5 teeth.

Lower Jaw: 6-11 rows of tricuspid teeth, mode = 8 rows.
40-48 bicuspid teeth in the outer row, mean = 45 teeth.
No conical teeth.

Poll (1956) noted 45-72 external "bicuspids", which compare with the above external bicuspid counts (40-50) plus lateral tricuspid tooth counts (1-4 at each corner of the mouth), thus (approx,) 42-68 external bicuspids plus tricuspids.

The lower pharyngeal bone of Tropheus moorii is triangular in shape with a median indentation on its posterior border (Pl.23 fig.4). There are 40-46 enlarged teeth on the posterior margin

Fig. 1: Tropheus moorii (GSA-TM2) pharyngeal apophysis (T-type)
Scale = 1 mm.
ventral view.

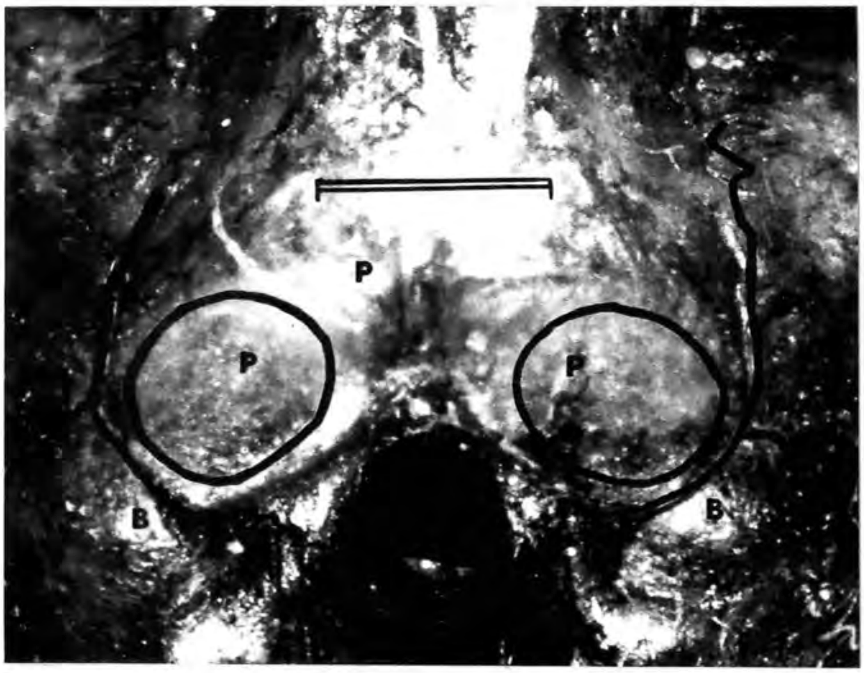

Fig. 2: Tropheus moorii (GSA-TM7) pharyngeal apophysis (T-type). Scale = 1 mm.
ventral view.

Fig. 3: Tropheus moorii (GSA-TM14) pharyngeal apophysis (T-type).
Scale = 1 mm.
ventral view.

of the bone which are anteriorly slanting unicusps with a poorly defined shoulder. There is a second row of similar teeth parallel to the previous row, but these teeth are not as enlarged as the former. All of the other teeth are unicuspid and slant posteriorly. There are 10-13 teeth parallel to the midline of the bone. The lower pharyngeal bone length (as % h.l.) and width (as % bone length) are listed on Table 36 and compared with all of the other Tropheus species and with the Simochromis species.

Total length of the bone: 32.3-35.4% of the h.l.

Total width of the bone: 87.2-92.5% of the bone length.

The pharyngeal apophyses of eleven specimens of Tropheus moorii were examined. The articulating surfaces were circular in shape and the composition was Tilapia-like (Regan, 1920), as they were completely composed of the parasphenoid (Pl.19, figs 1-3).

The vertebral counts of Tropheus moorii are listed on Table 37 and are compared with all of the other Tropheus species and with the Simochromis species. There are 31 vertebrae in total, 15 precaudal and 16 caudal.

There are many known colour varieties of Tropheus moorii (Scheuermann, 1975, 1976(a), 1976(b), 1977; Steack 1977) (Map 2 & Table 1). Nine varieties were found during the collection work for this thesis (Chapter 3 - "Materials Examined"), 2 of which were examples of sexual dichromatism. No meristic or morphometric differences were noted between the colour varities.

Sexual dichromatism was noticed in the Kigoma collection. This was previously thought to represent two different colour populations. The live males (termed olive-yellow morph) are yellow-olive coloured, with 8-10 light yellow vertical bands across the sides of their bodies (Pl.22, fig.2). Their chests and bellies are often bright yellow. The dorsal and anal fins are yellow, and have an orange trim distally. Several small oval orange spots are found on the posterior third of the anal fin. The pectoral and caudal fins are light green, and the pelvic fin is clear. Preserved material becomes green-brown, with the vertical bands often remaining distinguishable. All yellow and orange coloration gradually fades away. The live females (termed Brown Morph) of this population are a medium brown coloured, with 7-10 faint green vertical bands across the sides of their bodies (Pl.22 fig.3). Their chests and bodies are often bright yellow. The dorsal and anal fins are clear with splashes of light brown and a thin orange trim. The caudal fin is medium brown, and the pectoral and pelvic fins are light brown. Preserved specimens become medium brown, losing all other coloration.

A third colour type was collected at Bulu Point (Pl.22 fig.6). The live fish (termed Red morph) (both sexes) is grey with splashes of red on the sides of its body and splashes of black on the side of its head and chest. The fins are all grey. There are often 2-5 small red oval spots (in both sexes) on the anal fin. Preserved specimens become medium grey-brown, losing all red coloration.

A fourth colour type was collected at Kiti Point (pl.22 fig.4). The live fish (termed Green morph) (both sexes) has a dark green body and caudal fin. The dorsal, anal, pectoral, and pelvic fins are light green. The anal fin often has small orange-brown oval spots (in both sexes). There is a thin, and often indistinguishable, orange trim on the distal margins of the dorsal and anal fins. Preserved specimens become dark brown-green and lose all other coloration.

A fifth colour variety was collected at Kipili Bay (Pl.22 fig.5). The live fish (termed Yellow-finned morph , both sexes) has a brown body and caudal fin. The anal and dorsal fins are light brown with a yellow trim distally. The pelvic and pectoral fins are bright yellow. Preserved specimens become medium brown and lose all other coloration.

A sixth colour variety was collected west of Sibwesa (no photo available). The live fish (termed Rainbow morph , both sexes) has a dark grey-blue body with a mixed colour band of red, blue, and yellow on its side, varying in size. The fins are grey-blue. Preserved specimens become grey-brown and lose all other coloration.

A seventh colour variety was collected at Edith Bay (Pl.22 fig.7). The live fish (termed Red-orange spotted morph , both sexes) is grey with splashes of orange and red on the sides of its body and splashes of black on the side of its head and chest. The fins are all grey. There are often 2-5 small red oval spots (in both sexes) on the anal fin. Preserved specimens become medium grey-brown, losing all orange and red coloration.

An eighth and ninth variety were found north of Kigoma by Tanzanian fishermen. The exact locations are unknown. The eighth variety is chocolate brown over its body and all of its fins (Pl.22

fig.8). The fish does not change colour when preserved. The ninth variety is light yellow-brown over its body and caudal fin. The dorsal fin and anal fin are almost clear and distally trimmed with orange (Pl.22 fig.9). The chest and belly are yellow. Several orange spots appear on the anal fin in both sexes. Preserved specimens become light brown, losing all other coloration.

Tropheus moorii was collected at a depth of 2-8 m (see Chapter 3 - "Material Examined") and is always found amongst the rocks. It is most prominent in the shallower end of the depth range.

TABLE 29

<u>Tropheus</u> <u>moorii</u> (♂ & ♀) : General Characteristics of the Head and Body

characteristic	relative standard length data					relative body length data					relative head length data				
	%s.l.	SD	CV	range	n	%b.l.	SD	CV	range	n	%h.l.	SD	CV	range	n
standard length	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
head length	30.0	1.40	4.66	27.6-32.2	60	42.9	2.88	6.72	38.2-49.0	60	-	-	-	-	-
body length	70.0	1.41	2.01	67.1-72.4	60	-	-	-	-	-	-	-	-	-	-
body depth	39.9	1.20	3.01	38.1-42.4	60	57.1	2.49	4.36	53.1-63.2	60	-	-	-	-	-
caudal peduncle depth ..	11.8	0.50	4.28	10.7-12.9	60	16.8	0.85	5.07	15.1-18.7	60	-	-	-	-	-
interorbital width	10.9	0.55	5.07	9.7-11.8	60	-	-	-	-	-	36.5	2.25	6.16	33.0-41.6	60
preorbital depth	8.3	0.67	8.03	6.7-9.6	60	-	-	-	-	-	27.9	1.96	7.02	23.8-31.8	60
head depth	33.5	1.38	4.11	30.8-36.5	60	-	-	-	-	-	112.0	5.85	5.23	101.9-123.9	60
snout length	8.8	1.70	19.4	3.9-11.7	60	-	-	-	-	-	29.2	4.96	17.0	14.2-36.6	60
postocular head	12.9	0.73	5.66	11.2-14.1	60	-	-	-	-	-	43.0	2.20	5.12	37.9-47.3	60
eye diameter	8.3	1.16	14.0	7.1-11.5	60	-	-	-	-	-	27.8	4.47	16.1	23.1-41.3	60
mouth width	13.8	1.09	7.94	11.9-15.8	60	-	-	-	-	-	45.9	2.96	6.46	39.7-49.8	60
mouth length	4.4	0.58	13.1	3.2-5.5	60	-	-	-	-	-	14.8	1.62	11.0	11.5-17.9	60
cheek depth	11.6	1.42	12.2	7.7-13.2	60	-	-	-	-	-	38.8	4.40	11.3	27.4-44.4	60
% mouth length/m.w. ...	32.2	3.47	10.8	26.5-39.4	60										

standard length range: 50.4-90.1 mm
body length range : 36.1-64.4 mm
head length range : 14.3-29.1 mm

TABLE 30

<u>Tropheus</u> <u>moorii</u> (♂ & ♀) : General Characteristics of the Fins

characteristic	relative standard length data					relative body length data					relative head length data				
	%s.l.	SD	CV	range	n	%b.l.	SD	CV	range	n	%h.l.	SD	CV	range	n
Dorsal fin:															
length at base	63.0	1.69	2.69	60.6-66.9	60	90.0	3.14	3.49	84.5-97.0	60	-	-	-	-	-
longest spine	13.4	0.77	5.78	11.7-14.7	60	19.1	1.18	6.17	16.7-21.8	60	-	-	-	-	-
longest branched ray ..	19.4	1.51	7.80	16.7-21.7	60	27.6	2.26	8.16	23.5-31.0	44	-	-	-	-	-
distance from snout ...	37.5	1.27	3.39	34.7-39.9	60	53.6	2.67	5.00	48.8-59.4	60	125.2	4.34	3.47	116.0-133.3	60
Anal fin:															
length at base	22.7	1.19	5.24	20.6-25.2	60	32.4	1.73	5.35	28.9-36.2	60	-	-	-	-	-
longest spine	14.9	0.79	5.30	13.4-16.4	60	21.3	1.25	5.88	19.1-23.9	60	-	-	-	-	-
longest branched ray ..	19.9	1.90	9.55	16.9-23.4	49	28.4	2.90	10.2	23.8-33.9	49	-	-	-	-	-
distance from snout ...	67.9	1.29	1.90	65.5-70.7	60	97.0	2.81	2.90	90.2-102.8	60	227.1	10.9	4.82	207.9-247.4	60
Pectoral fin:															
longest branched ray ..	35.7	2.04	5.71	31.2-39.1	55	51.0	3.35	6.55	45.0-56.9	55	-	-	-	-	-
distance from snout ...	31.5	1.37	4.40	28.7-33.9	60	45.0	2.56	5.70	40.5-50.3	60	105.3	4.90	4.65	97.4-116.8	60
Pelvic fin:															
longest branched ray ..	36.6	3.70	10.1	29.6-45.2	50	52.2	5.26	10.1	42.2-63.4	50	-	-	-	-	-
distance from snout ...	40.7	1.76	4.32	37.8-43.8	60	58.2	3.26	5.60	52.2-64.3	60	133.7	18.6	13.9	125.0-153.8	60
Caudal fin:															
longest ray	24.5	3.28	13.4	19.0-30.0	40	34.9	4.96	14.2	26.6-43.4	40	-	-	-	-	-

Tropheus polli G.S. Axelrod 1977.

Tropheus sp. Axelrod, H.R. & Burgess, W. 1977: 348 (holotype colour photograph by G.S. Axelrod).

Tropheus polli Axelrod, G.S. 1977: 1-14 (original sp. desc., fig. of holotype, colour plate of holotype and plate of lower pharyngeal bone).

Diagnosis:

Morphometric characteristics -

Tropheus polli morphometrically differs[1] (Tables 38-41) from all other Tropheus species and all Simochromis species in the interorbital width (as % s.l., 12.4 cf 7.0-11.7; as % h.l., 41.8 cf 22.7-38.0), preorbital depth (as % s.l., 9.5 cf 5.6-8.3; as % h.l., 32.1 cf 17.8-28.1), eye diameter (as % h.l., 24.7 cf 27.2 cf 32.2), mouth length (as % m.w., 29.4 cf 32.2-47.0), longest dorsal branched ray (as % s.l., 25.2 cf 15.8-22.2; as % b.l., 35.9 cf 22,9-32.1), longest anal branched ray (as % s.l., 24.4 cf 17.8-21.9; as % b.l., 24.7 cf 24.8-31.5), longest pelvic branched ray (as % s.l., 39.2 cf 27.0-36.6) and longest caudal ray (as % s.l., 45.7 cf 22.5-27.3; as % b.l., 65.0 cf 32.2-38.4). Additionally, T. polli morphometrically differs[2] from all of the Simochromis species in head depth (as % h.l., 112 cf 95.2-103.7, 120.8), dorsal fin to snout distance (as % h.l., 126 cf 111.1-119.8), anal fin base length (as % b.l., 30.4 cf 25.5-28.9) and longest pelvic branched ray (as % b.l.,

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1. The numeral sequence respectively compares each parameter of T. polli and all of the other Tropheus species and all of the Simochromis species.
2. The numeral sequence respectively compares each parameter of T. polli and all of the Simochromis species.

55.7 cf 39.1-43.1).

Meristic characteristics -

The dorsal fin of Tropheus polli has 20-21 spines and 7-8 branched rays, as compared with all Simochromis species which have 16-19 spines and 8-11 branched rays (Table 31). The anal fin of T. polli has 4 spines and 7-8 branched rays, as compared with all other Tropheus species (except T. annectens) which have 5-7 spines and 5-7 branched rays, and as compared with all Simochromis species which have 3 spines and 7-9 branched rays (Table 32). T. polli has 10-11 gill rakers below the articulation on the outer gill arch, as compared with 5-7 gill rakers for S. sp. A., S. babaulti, and S. marginatus (Table 33). T. polli usually has 6 scale rows on the cheek, as compared with 2-5 scale rows in most other Tropheus and Simochromis species (Table 34). T. polli has mean values of 50 and 49 bicuspid teeth in the outer rows of the upper and lower jaws respectively, as compared with 27-45 and 21-45 bicuspid teeth in the upper and lower jaws, respectively, for all other Tropheus and Simochromis species (Table 35). As described for T. brichardi, T. polli has 1-3 (mode = 2) tricuspid transition teeth in the upper jaw between the anterior bicuspids and the lateral conicals, while all Simochromis species have a toothless gap.

The taxonomic description of Tropheus polli, along with other comparisons to Tropheus species, can be found in the publication bound with this thesis. The relative morphometric ranges of values (which is not found in the publication) can be found on Tables 42 and 43. The relative length and width of the pharyngeal bone, and the vertebral counts as compared with all other Tropheus species and Simochromis species can be found on Tables 36 and 37 respectively.

The dentition description within the *Tropheus polli* new species publication is incorrect, as the lateral tricuspid teeth of the upper jaw were assumed bicuspid (see dentition discussion of *T. moorii*). The corrected dentition counts for *T. polli* are listed on Table 35 and are compared to the other *Tropheus* species and to the *Simochromis* species. The pattern of dentition is explained in the description of *T. polli*.

Upper Jaw: 5-7 rows of tricuspid teeth, mode = 6 rows.
44-54 bicuspid teeth in the outer row, mean = 50 teeth.
1-3 lateral tricuspid teeth at each corner of the mouth, mode = 2 teeth.
4-5 conical teeth at each corner of the mouth, mode = 5 teeth.

Lower Jaw: 5-7 rows of tricuspid teeth, mode = 6 rows.
44-54 bicuspid teeth in the outer row, mean = 49 teeth.
No conical teeth.

Table 31

Dorsal Fin Meristics

species (♂ & ♀)	n	n distribution for the dorsal ray formula																	n distribution for the total number of dorsal fin rays					
		(24)* XVI' 8"	(25) XVI 9	(26) XVII 9	(27) XVII 10	(28) XVII 11	(27) XVIII 9	(28) XVIII 10	(28) XIX 9	(26) XX 6	(27) XX 7	(28) XX 8	(26) XXI 5	(27) XXI 6	(28) XXI 7	(27) XXII 5	(28) XXII 6	(29) XXII 7	24	25	26	27	28	29
Simochromis sp.	2	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-
S. babaulti	4	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3	-	-	-	-
S. curvifrons	3	-	-	-	2	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-
S. diagramma	14	-	-	-	3	3	1	5	2	-	-	-	-	-	-	-	-	-	-	-	-	4	10	-
S. marginatus	8	-	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-	-
Tropheus brichardi	2	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	2	-	-
T. duboisi	45	-	-	-	-	-	-	-	-	1	4	-	-	40	-	-	-	-	-	-	1	44	-	-
T. moorii	60	-	-	-	-	-	-	-	-	1	2	-	2	32	3	5	12	3	-	-	3	39	15	3
T. polli	6	-	-	-	-	-	-	-	-	-	-	2	-	-	4	-	-	-	-	-	-	-	6	-

* total number of dorsal fin rays.

' dorsal spines.

" dorsal branched rays.

Table 32

Anal, Pectoral, Pelvic and Caudal Fin Meristics

species	n	n distribution for the anal fin formula											n distribution for the total number of anal fin rays				n distribution for the pectoral ray count		
(♂ & ♀)		(10)* III' 7"	(11) III 8	(12) III 9	(11) IV 7	(12) IV 8	(10) V 5	(11) V 6	(12) V 7	(11) VI 5	(12) VI 6	(13) VI 7	10	11	12	13	15	16	17
<u>Simochromis</u> sp.	2	-	2	-	-	-	-	-	-	-	-	-	-	2	-	-	-	2	-
<u>S. babaulti</u>	4	3	1	-	-	-	-	-	-	-	-	-	3	1	-	-	-	4	-
<u>S. curvifrons</u>	3	-	2	1	-	-	-	-	-	-	-	-	-	2	1	-	-	2	1
<u>S. diagramma</u>	14	2	12	-	-	-	-	-	-	-	-	-	2	12	-	-	-	6	8
<u>S. marginatus</u>	8	8	-	-	-	-	-	-	-	-	-	-	8	-	-	-	1	7	-
<u>Tropheus brichardi</u>	2	-	-	-	-	-	-	-	-	1	1	-	-	1	1	-	-	2	-
<u>T. duboisi</u>	45	-	-	-	-	-	-	38	2	1	4	-	-	39	6	-	45	-	-
<u>T. moorii</u>	60	-	-	-	-	-	1	9	2	8	38	2	1	17	40	2	1	56	3
<u>T. polli</u>	6	-	-	-	5	1	-	-	-	-	-	-	-	5	1	-	3	3	-

* total number of anal fin rays.

' anal spines.

" anal branched rays

Pelvic fin formula: 1,5)
Caudal fin formula: I-14-I) for all of the above species and n specimens

Table 33

Gill Raker Counts

species (♂ & ♀)	n	n distribution for the gill raker count below the articulation								n distribution for the gill raker count (number above, on and below the articulation):																									
		5	6	7	8	9	10	11	12	2* 1' 5"	3 0 5	3 1 5	4 1 5	2 1 6	3 0 6	3 1 6	4 0 6	2 1 7	3 1 7	2 1 9	2 0 10	2 1 10	3 0 10	3 1 10	4 1 10	1 1 11	2 1 11	3 0 11	3 1 11	4 0 11	2 1 12	3 0 12	3 1 12	4 0 12	4 1 12
Simochromis sp.	2	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S. babaulti	4	2	2	-	-	-	-	-	-	1	-	1	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S. curvifrons	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
S. diagramma	14	-	-	-	-	-	3	7	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	1	-	-	4	2	1	-	1	-	2	1
S. marginatus	8	5	3	-	-	-	-	-	-	-	3	1	1	-	2	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tropheus brichardi .	2	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
T. duboisi	45	-	-	-	-	-	28	12	5	-	-	-	-	-	-	-	-	-	-	-	-	22	2	4	-	-	6	5	1	-	4	1	-	-	-
T. moorii	60	-	-	-	-	-	48	11	1	-	-	-	-	-	-	-	-	-	-	1	5	17	18	7	-	-	-	8	3	-	-	-	1	-	-
T. polli	6	-	-	-	-	-	2	4	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	1	3	-	-	-	-	-	-	-	-

* gill rakers above the articulation.

' gill rakers on the articulation.

" gill rakers below the articulation.

Table 34

Scale Meristics: Lateral Line and Cheek Scale Row Counts

species	n	n distribution for lateral line scale count					n distribution for lateral line + pored caudal scale count														n distribution for the cheek scale rows				
(♂ & ♀)		27	28	29	30	31	27' 1"	27 2	28 0	28 1	28 2	28 3	29 0	29 1	29 2	29 3	30 1	30 2	30 3	31 2	2	3	4	5	6
<u>Simochromis</u> sp.	2	-	-	1	1	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	2	-	-
<u>S. babaulti</u>	4	-	1	2	1	-	-	-	-	-	1	-	-	-	2	-	-	1	-	-	1	3	-	-	-
<u>S. curvifrons</u>	3	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	2	1	-	-	-	3	-	-
<u>S. diagramma</u>	13	-	-	1	9	3	-	-	-	-	-	-	-	1	-	-	1	6	2	3	-	1	11	1	-
<u>S. marginatus</u>	7	-	-	4	3	-	-	-	-	-	-	-	-	-	1	3	-	-	3	-	-	4	3	-	-
<u>Tropheus brichardi</u>	2	-	-	2	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	2	-	-
<u>T. duboisi</u>	45	-	6	16	23	-	-	-	-	-	1	5	-	-	6	10	1	21	1	-	-	38	7	-	-
<u>T. moorii</u>	60	5	30	22	3	-	4	1	2	8	20	-	4	11	7	-	2	1	-	-	-	-	29	30	1
<u>T. polli</u>	6	-	-	2	4	-	-	-	-	-	-	-	-	-	-	2	-	4	-	-	-	-	-	1	5

' lateral line scale count terminating at the structural base of the hypural plate.

" pored scales on the caudal fin continuing from the lateral line.

Table 35

Dentition Counts

species	upper/lower jaw	bicuspid teeth in the outer row					rows of tricuspid teeth			lateral transition * teeth at each corner			conical teeth at each corner		
(♂ & ♀)		$\bar{x}$	SD	CV	range	n	mode	range	n	mode	range	n	mode	range	n
Simochromis sp.	upper jaw	37	1.4	3.8	36-38	2	5	4-5	2	0	0	2	6	4-6	2
	lower jaw	29	1.4	4.9	28-30	2	5	5	2	-	-	0	-	-	0
S. babaulti	upper jaw	32	2.0	6.3	30-34	3	5	3-5	3	0	0	4	5	4-7	4
	lower jaw	21	2.3	11	20-24	3	4	3-5	3	0	0	3	4	3-6	3
S. curvifrons	upper jaw	27	1.0	3.7	26-28	3	7	5-7	3	0	0	3	6	5-7	3
	lower jaw	21	1.0	4.8	20-22	3	6	5-6	3	0	0	3	7	6-8	3
S. diagramma	upper jaw	43	2.8	6.4	38-46	10	10	8-12	7	0	0	10	7	5-11	10
	lower jaw	32	3.4	11	26-27	10	10	8-12	7	0	0	7	4	2-7	7
S. marginatus	upper jaw	45	2.2	4.9	44-50	8	7	6-9	5	0	0	8	6	3-7	8
	lower jaw	39	2.8	7.1	34-42	8	6	6-8	5	0	0	5	5	3-8	5
Tropheus brichardi	upper jaw	44	0	0	44	2	7	5-7	2	3	1-3	2	5	4-5	2
	lower jaw	42	2.8	6.7	40-44	2	6	5-6	2	0	0	2	0	0	2
T. duboisi	upper jaw	40	4.2	10	35-46	9	8	7-11	7	3	1-4	9	5	3-6	9
	lower jaw	34	2.4	7.1	30-37	9	10	8-12	7	0	0	7	0	0	7
T. moorii	upper jaw	45	2.1	4.6	42-50	9	9	7-11	7	3	0-5	9	5	4-7	9
	lower jaw	45	1.9	4.2	40-48	9	8	6-11	7	0	0	7	0	0	7
T. polli	upper jaw	50	3.7	7.7	44-54	5	6	5-7	5	2	1-3	5	5	4-5	6
	lower jaw	49	4.2	9.0	44-54	5	6	5-7	5	0	0	3	0	0	3

* refer to text for definition and explanation.

Table 36

Lower Pharyngeal Bone Morphometrics

species	bone length as a % of head length					bone width as a % of bone length				
(♂ & ♀)	$\bar{x}$	SD	CV	range	n	$\bar{x}$	SD	CV	range	n
Simochromis sp.	30.3	-	-	30.3	1	100.0	-	-	100.0	1
S. babaulti	34.2	1.30	3.80	32.8-35.4	4	97.2	2.61	2.68	94.8-100.0	4
S. curvifrons	33.2	0.25	0.76	32.9-33.3	3	91.1	0.94	1.03	90.5-92.2	3
S. diagramma	33.4	1.64	4.91	31.0-36.1	11	101.8	3.98	3.91	95.2-106.1	11
S. marginatus	31.8	0.74	2.32	31.0-32.8	7	94.9	1.47	1.54	92.9-96.5	7
Tropheus brichardi	36.3	0.06	0.16	36.3-36.4	2	95.1	0.31	0.33	94.9-95.3	2
T. duboisi	33.3	0.88	2.63	31.9-34.8	11	95.0	3.57	3.75	87.6-97.9	11
T. moorii	33.6	0.96	2.87	32.3-35.4	11	89.4	1.56	1.74	87.2-92.5	11
T. polli	31.1	0.88	2.84	29.8-32.5	5	95.7	3.83	4.01	91.5-98.8	5

Note: The data from the lower pharyngeal bone of T. polli paratype s.l. 106.5 mm is included in this table, but not in the n.sp. description.

Table 37

Vertebrae Counts

Species (♂ & ♀)	n	n distribution for the total number of vertebrae				n distribution for the precaudal + caudal vertebrae						
						(30)	(30)	(31)	(31)	(32)	(32)	(33)
		30	31	32	33	14+16	15+15	14+17	15+16	15+17	16+16	16+17
Simochromis sp.	2	2	-	-	-	2	-	-	-	-	-	-
S. babaulti	4	3	1	-	-	3	-	-	1	-	-	-
S. curvifrons	3	-	3	-	-	-	-	1	2	-	-	-
S. diagramma	8	-	-	7	1	-	-	-	-	4	3	1
S. marginatus	8	-	8	-	-	-	-	8	-	-	-	-
Tropheus brichardi	2	2	-	-	-	2	-	-	-	-	-	-
T. duboisi	11	-	11	-	-	-	-	-	11	-	-	-
T. moorii	11	-	11	-	-	-	-	-	11	-	-	-
T. polli	6	1	4	1	-	-	1	-	4	-	1	-

Table 38

Probability Rejection[x] of the t-test Null hypothesis in a Comparison Between Selected Sample Means of Head, Body and Pharyngeal Bone Morphometrics (as % s.l.) and Dental Meristics of *Simochromis* and *Tropheus* species.

characteristic (as % s.l.)	*S.* sp.								*S. babaulti*						
	S. babaulti	*S. curvifrons*	*S. diagramma*	*S. marginatus*	*T. brichardi*	*T. duboisi*	*T. moorii*	*T. polli*	*S. curvifrons*	*S. diagramma*	*S. marginatus*	*T. brichardi*	*T. duboisi*	*T. moorii*	*T. polli*
head length	-	98	-	-	95	-	-	-	90	-	-	-	-	-	-
body length	-	98	-	-	95	-	-	-	90	-	-	-	-	-	-
body depth	99	99	-	-	90	99	99	-	99	99	99	99	99	99	99
caudal peduncle depth	99	95	99	99	95	99	99	99	99	99	-	95	99	99	99
interorbital width	99	95	90	99	90	99	99	99	99	99	99	99	99	99	99
preorbital depth	95	99	95	99	99	99	99	99	95	-	-	98	99	99	99
head depth	95	99	-	-	90	99	99	-	99	98	-	99	99	99	99
snout length	-	-	-	-	90	95	-	-	95	-	-	98	-	-	-
postocular head	-	90	-	99	-	90	-	-	98	-	-	-	-	99	-
eye diameter	-	99	98	95	98	99	95	99	99	98	90	98	99	95	99
mouth width	95	-	99	99	99	99	99	99	98	99	-	95	-	99	99
mouth length	99	99	98	-	98	99	-	-	99	95	99	99	99	-	95
cheek depth	90	99	90	-	99	99	95	99	98	-	95	95	99	90	99
Lower pharyngeal bone:															
bone length (as % head length)	NA	NA	NA	NA	NA	NA	NA	NA	-	-	99	90	-	-	99
bone width (as % bone length)	NA	NA	NA	NA	NA	NA	NA	NA	98	90	90	-	-	99	-
Dentition (bicuspid teeth):															
upper jaw (outer row)	90	99	98	99	98	-	99	99	98	99	99	99	98	99	99
lower jaw (outer row)	95	99	-	99	95	95	99	99	-	99	99	99	99	99	99

characteristic (as % s.l.)	*S. curvifrons*						*S. diagramma*					*S. marginatus*				*T. brichardi*			*T. duboisi*		*T. moorii*
	S. diagramma	*S. marginatus*	*T. brichardi*	*T. duboisi*	*T. moorii*	*T. polli*	*S. marginatus*	*T. brichardi*	*T. duboisi*	*T. moorii*	*T. polli*	*T. brichardi*	*T. duboisi*	*T. moorii*	*T. polli*	*T. duboisi*	*T. moorii*	*T. polli*	*T. moorii*	*T. polli*	*T. polli*
head length	-	-	-	99	-	-	-	-	95	-	-	-	90	-	-	99	-	-	99	95	-
body length	-	-	-	99	-	-	-	-	95	-	-	-	90	-	-	99	-	-	99	95	-
body depth	90	99	99	-	-	-	90	-	99	99	-	-	99	99	90	99	-	-	99	99	-
caudal peduncle depth	-	99	-	99	-	-	99	-	99	99	-	98	99	99	99	-	-	-	99	99	-
interorbital width	-	99	-	99	-	99	99	-	99	99	99	99	99	99	99	99	95	99	99	99	99
preorbital depth	95	99	-	-	95	99	-	99	99	99	99	99	99	99	99	-	-	95	99	99	99
head depth	99	99	98	95	-	-	90	90	99	99	99	98	99	99	99	99	-	-	99	99	-
snout length	99	98	-	99	-	95	-	99	98	-	-	99	-	-	-	99	-	95	99	-	90
postocular head	99	99	-	99	-	98	99	90	90	99	-	99	-	99	99	98	-	-	99	95	90
eye diameter	90	99	-	99	-	-	-	-	95	-	99	90	-	-	99	98	-	95	99	99	95
mouth width	99	99	99	99	99	99	99	-	99	-	-	99	-	99	99	90	-	-	99	99	-
mouth length	-	99	99	99	-	99	99	90	98	99	99	95	99	98	-	99	-	-	99	99	90
cheek depth	-	99	-	99	-	-	99	-	99	95	95	99	99	99	99	99	-	-	99	99	-
Lower pharyngeal bone:																					
bone length (as % head length)	-	98	99	-	-	99	95	95	-	-	98	99	99	99	-	99	99	99	-	99	99
bone width (as % bone length)	99	99	98	90	-	90	99	95	99	99	98	-	-	99	-	-	99	-	99	-	99
Dentition (bicuspid teeth):																					
upper jaw (outer row)	99	99	99	99	99	99	-	-	90	90	99	-	99	-	98	-	-	90	99	99	99
lower jaw (outer row)	99	99	99	99	99	99	99	99	-	99	99	-	99	99	99	99	90	90	99	99	95

[x] All values given are probability percentages. Probability rejection values only given if greater than 90%, 95%, 98% or 99%. (NA = not available).

Table 39

Probability Rejection[x] of the t-test Null Hypothesis in a Comparison Between Selected Sample Means of Head and Body (as % b.l., h.l. or m.w.) of the *Simochromis* and *Tropheus* species.

characteristic	as %	*S.* sp.								*S. babaulti*							*S. curvifrons*						*S. diagramma*					*S. marginatus*				*T. brichardi*			*T. duboisi*		*T. moorii*
		S. babaulti	*S. curvifrons*	*S. diagramma*	*S. marginatus*	*T. brichardi*	*T. duboisi*	*T. moorii*	*T. polli*	*S. curvifrons*	*S. diagramma*	*S. marginatus*	*T. brichardi*	*T. duboisi*	*T. moorii*	*T. polli*	*S. diagramma*	*S. marginatus*	*T. brichardi*	*T. duboisi*	*T. moorii*	*T. polli*	*S. marginatus*	*T. brichardi*	*T. duboisi*	*T. moorii*	*T. polli*	*T. birchardi*	*T. duboisi*	*T. moorii*	*T. polli*	*T. duboisi*	*T. moorii*	*T. polli*	*T. moorii*	*T. polli*	*T. polli*
head length	b.l.	-	98	-	-	95	-	-	-	90	-	-	-	-	-	-	-	-	-	99	-	-	-	-	99	-	-	-	98	-	-	99	-	-	99	99	-
body depth	b.l.	98	98	-	-	-	99	90	-	99	99	99	98	99	99	98	-	99	99	99	-	-	90	-	99	95	-	-	99	99	-	99	-	-	99	99	-
caudal peduncle depth	b.l.	99	95	99	99	95	99	99	99	98	99	-	-	99	99	99	-	99	-	90	-	-	99	90	99	98	-	90	99	99	99	-	-	-	-	90	-
interorbital width	h.l.	99	95	-	-	90	99	99	99	99	99	99	99	99	99	99	-	99	-	95	-	99	99	-	99	99	99	99	99	99	99	95	-	95	99	99	99
preorbital depth	h.l.	99	99	95	99	99	99	99	99	99	-	-	99	99	99	99	95	99	-	-	90	99	-	99	99	99	99	99	99	99	99	95	-	95	99	99	99
head depth	h.l.	-	99	-	-	95	99	99	99	99	95	-	99	99	99	99	99	99	-	98	98	99	-	95	99	99	98	99	99	99	99	-	-	-	99	99	-
snout length	h.l.	95	-	95	99	-	99	-	95	95	-	-	99	-	-	-	99	99	-	99	-	99	-	99	95	-	90	99	-	90	-	99	-	98	99	-	95
postocular head	h.l.	90	98	-	90	90	-	90	-	99	95	-	99	-	99	98	99	99	-	99	98	99	99	99	99	99	95	99	-	99	99	99	-	90	99	99	-
eye diameter	h.l.	90	98	99	95	95	99	-	99	99	99	-	99	99	-	99	-	99	-	95	-	95	95	-	-	-	99	-	90	-	99	-	-	98	90	99	90
mouth width	h.l.	95	99	99	99	99	99	99	99	-	98	-	99	-	99	99	99	99	99	99	99	99	99	-	99	-	-	99	-	99	99	99	-	-	99	99	-
mouth length	h.l.	90	99	99	-	98	99	-	-	99	98	95	-	99	-	-	-	99	90	90	90	99	99	-	90	99	99	99	99	99	-	98	-	90	99	99	90
cheek depth	h.l.	98	99	90	-	99	99	99	99	99	-	-	99	99	98	99	-	99	-	-	-	-	95	-	99	95	90	99	99	99	99	-	-	-	90	-	-
mouth length	m.w.	-	99	-	99	98	-	99	99	99	-	99	95	99	99	99	99	99	99	-	99	99	99	90	99	99	99	-	99	-	98	99	-	90	99	99	90

[x] All values given are probability percentages. Probability rejection values only given if greater than 90%. 95%, 98% or 99%.

Table 40

Probability Rejection[x] of the t-test Null Hypothesis in a Comparison Between Selected Sample Means of Fin Morphometrics (as % s.l.) of *Simochromis* and *Tropheus* Species.

characteristic (as % s.l.)	*S.* sp.								*S. babaulti*							*S. curvifrons*						*S. diagramma*					*S. marginatus*				*T. brichardi*			*T. duboisi*		*T. moorii*
	S. babaulti	*S. curvifrons*	*S. diagramma*	*S. marginatus*	*T. brichardi*	*T. duboisi*	*T. moorii*	*T. polli*	*S. curvifrons*	*S. diagramma*	*S. marginatus*	*T. brichardi*	*T. duboisi*	*T. moorii*	*T. polli*	*S. diagramma*	*S. marginatus*	*T. brichardi*	*T. duboisi*	*T. moorii*	*T. polli*	*S. marginatus*	*T. brichardi*	*T. duboisi*	*T. moorii*	*T. polli*	*T. brichardi*	*T. duboisi*	*T. moorii*	*T. polli*	*T. duboisi*	*T. moorii*	*T. polli*	*T. moorii*	*T. polli*	*T. polli*
Dorsal fin:																																				
length at base	-	-	-	-	99	98	99	95	95	99	-	98	99	99	99	90	98	-	-	-	-	99	98	99	99	99	99	99	99	99	-	-	-	99	-	-
longest spine	99	-	-	-	-	99	-	-	-	90	99	98	-	99	99	-	95	-	-	-	-	-	-	99	-	-	-	99	98	-	99	-	-	99	99	-
longest branched ray ..	98	-	-	90	95	-	-	99	99	99	90	95	99	99	99	-	99	-	-	95	99	99	90	-	99	99	-	99	99	99	98	-	99	99	99	99
distance from snout ...	95	95	-	-	-	-	-	-	-	95	-	-	99	99	95	98	-	-	99	99	95	-	-	99	99	-	-	99	99	90	98	-	-	-	-	-
Anal fin:																																				
length at base	-	-	-	-	90	99	99	99	99	-	-	99	99	99	99	99	99	90	-	99	-	95	99	99	99	99	99	99	99	99	99	-	95	99	99	99
longest spine	98	90	99	99	98	-	99	99	-	99	99	90	99	-	90	-	-	-	99	-	-	-	-	99	99	-	-	99	99	90	99	-	-	99	99	-
longest branched ray ..	-	-	-	90	-	90	-	99	90	98	-	-	99	-	99	-	99	95	-	-	98	99	98	-	98	99	-	99	99	99	99	-	99	99	99	99
distance from snout ...	98	-	-	-	-	-	90	-	99	99	90	98	99	99	99	-	-	-	99	-	90	-	-	99	-	-	-	99	-	-	-	-	-	99	-	90
Pectoral fin:																																				
longest branched ray ..	99	99	99	99	90	99	99	99	99	-	99	95	99	99	99	99	-	-	-	90	-	99	90	99	99	99	-	90	99	-	-	90	-	-	-	-
distance from snout ...	-	95	-	-	-	-	-	-	95	-	-	-	-	-	-	95	-	-	95	95	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pelvic fin:																																				
longest branched ray ..	-	-	-	-	-	99	99	99	99	95	-	99	99	99	99	-	99	-	99	99	99	98	-	99	99	99	99	99	99	99	-	-	99	-	99	90
distance from snout ...	-	-	-	-	-	-	-	-	-	-	-	-	95	-	-	-	-	90	90	-	-	-	-	95	-	-	-	-	-	-	-	-	-	-	-	-
Caudal fin:																																				
longest ray	-	95	99	-	-	-	-	99	99	99	-	-	98	-	99	-	99	90	-	-	99	99	99	-	95	99	-	99	-	99	-	-	99	95	99	99

[x] All values given are probability percentages. Probability rejection values only given if greater than 90%, 95%, 98% or 99%.

Table 41

Probability Rejection[x] of the *t*-test Null Hypothesis in a Comparison Between Selected Sample Means of Fin Morphometrics (as % b.l. or % h.l.) of *Simochromis* and *Tropheus* Species.

characteristic	as %	S. sp. vs S. babaulti	S. sp. vs S. curvifrons	S. sp. vs S. diagramma	S. sp. vs S. marginatus	S. sp. vs T. brichardi	S. sp. vs T. duboisi	S. sp. vs T. moorii	S. sp. vs T. polli	S. babaulti vs S. curvifrons	S. babaulti vs S. diagramma	S. babaulti vs S. marginatus	S. babaulti vs T. brichardi	S. babaulti vs T. duboisi	S. babaulti vs T. moorii	S. babaulti vs T. polli
Dorsal fin:																
length at base	b.l.	90	-	-	99	90	95	-	-	90	99	-	95	99	99	99
longest spine	b.l.	95	-	-	90	-	95	-	-	-	90	99	98	-	99	98
longest branched ray	b.l.	99	-	-	98	95	-	-	99	99	99	90	90	99	99	99
distance from snout	b.l.	-	98	-	-	-	-	-	-	-	-	-	-	99	99	-
distance from snout	h.l.	-	-	-	-	-	-	95	90	90	99	98	99	99	99	99
Anal fin:																
length at base	b.l.	-	-	-	98	-	95	99	99	95	-	95	99	99	99	99
longest spine	b.l.	99	90	99	99	98	-	99	99	90	99	99	99	98	90	95
longest branched ray	b.l.	-	-	-	98	90	-	-	98	90	99	-	-	99	-	99
distance from snout	b.l.	90	95	-	-	-	-	95	-	-	-	-	-	99	-	-
distance from snout	h.l.	-	-	-	-	90	-	-	-	95	98	-	95	98	95	95
Pectoral fin:																
longest branched ray	b.l.	98	99	99	99	90	99	99	99	99	-	99	-	99	99	99
distance from snout	b.l.	-	95	-	-	-	-	-	-	90	-	-	-	-	-	-
distance from snout	h.l.	-	-	-	-	-	-	-	-	-	-	-	95	-	-	-
Pelvic fin:																
longest branched ray	b.l.	-	-	-	-	-	99	98	99	95	95	-	95	99	99	99
distance from snout	b.l.	-	90	-	-	-	-	-	-	-	-	-	-	90	-	-
distance from snout	h.l.	-	-	-	-	-	-	-	-	99	95	98	99	90	-	99
Caudal fin:																
longest branched ray	b.l.	-	-	98	99	-	-	-	99	98	99	-	-	95	-	99

characteristic	as %	S. curvifrons vs S. diagramma	S. curvifrons vs S. marginatus	S. curvifrons vs T. brichardi	S. curvifrons vs T. duboisi	S. curvifrons vs T. moorii	S. curvifrons vs T. polli	S. diagramma vs S. marginatus	S. diagramma vs T. brichardi	S. diagramma vs T. duboisi	S. diagramma vs T. moorii	S. diagramma vs T. polli	S. marginatus vs T. brichardi	S. marginatus vs T. duboisi	S. marginatus vs T. moorii	S. marginatus vs T. polli	T. brichardi vs T. duboisi	T. brichardi vs T. moorii	T. brichardi vs T. polli	T. duboisi vs T. moorii	T. duboisi vs T. polli	T. moorii vs T. polli
Dorsal fin:																						
length at base	b.l.	-	99	-	-	-	-	99	-	99	99	99	99	99	99	99	-	-	-	-	-	-
longest spine	b.l.	-	90	-	95	-	-	-	-	99	-	-	-	99	95	-	99	-	-	99	99	-
longest branched ray	b.l.	-	99	90	-	90	99	99	98	90	99	99	-	99	99	99	99	-	99	99	99	99
distance from snout	b.l.	98	-	-	99	99	90	-	-	99	98	-	-	99	99	-	99	-	-	90	-	-
distance from snout	h.l.	-	-	98	98	99	98	-	90	-	99	95	99	99	99	99	98	-	-	99	99	-
Anal fin:																						
length at base	b.l.	98	99	-	-	99	95	99	99	99	99	99	99	99	99	99	99	-	-	99	99	99
longest spine	b.l.	-	-	-	99	90	-	-	-	99	99	-	-	99	99	90	99	-	-	99	99	-
longest branched ray	b.l.	-	99	98	-	-	98	99	99	-	98	99	-	99	99	99	99	90	99	99	99	99
distance from snout	b.l.	-	-	-	99	-	-	-	-	99	-	-	-	99	-	-	-	-	-	99	98	-
distance from snout	h.l.	-	-	-	99	-	-	-	90	-	-	-	95	-	-	-	99	90	-	-	-	-
Pectoral fin:																						
longest branched ray	b.l.	95	-	-	-	90	-	99	-	99	99	99	-	95	98	-	90	95	-	-	-	-
distance from snout	b.l.	95	-	-	99	95	-	-	-	-	-	-	-	-	-	-	-	-	-	-	90	-
distance from snout	h.l.	-	-	95	-	-	-	-	99	95	-	-	99	90	-	-	99	99	98	99	-	-
Pelvic fin:																						
longest branched ray	b.l.	-	99	-	99	99	99	99	-	99	98	99	99	99	99	99	90	-	99	-	98	-
distance from snout	b.l.	-	-	-	98	90	-	-	-	98	-	-	-	-	-	-	-	-	-	95	-	-
distance from snout	h.l.	-	-	99	-	-	-	-	99	-	-	95	90	90	-	-	99	-	99	-	98	-
Caudal fin:																						
longest branched ray	b.l.	-	99	90	-	-	99	99	99	-	95	99	-	99	-	99	-	-	99	98	99	99

[x] All values given are probability percentages. Probability rejection values only given if greater than 90%, 95%, 98% or 99%.

TABLE 42

Morphometric ratio ranges for Tropheus polli
General Characteristics of the Head and Body

Characteristic (n=6)	% s.l. range	% b.l. range	% h.l. range
standard length	-	138.5-146.8	313.7-359.6
head length	27.8-31.9	38.5-46.8	-
body length	68.1-72.2	-	214.7-259.6
body depth	35.7-41.6	49.7-61.1	-
caudal peduncle depth ..	11.1-12.7	15.4-18.4	-
interorbital width	11.9-13.2	-	38.8-46.0
preorbital depth	8.8-10.7	-	28.7-34.1
head depth	31.1-36.6	-	107.2-116.6
snout length	8.3-11.6	-	29.8-37.9
postocular head	11.5-12.9	-	38.9-44.0
eye diameter	6.8-7.9	-	23.2-27.5
mouth width	12.7-14.3	-	45.0-48.3
mouth length	3.5-4.3	-	11.8-14.7
cheek depth	10.4-12.6	-	27.5-42.2

TABLE 43

Morphometric ratio ranges for Tropheus polli

General Characteristics of the Fin

Characteristic (n=6)	% s.l. range	% b.l. range	% h.l. range
Dorsal fin:			
length at base	61.0-64.6	87.4-90.5	-
longest spine	12.7-14.8	18.0-21.4	-
longest branched ray ..	23.1-26.7	33.4-37.9	-
distance from snout ...	34.5-37.4	48.0-60.4	121.5-134.0
Anal fin:			
length at base	21.0-22.4	29.5-31.0	-
longest spine	13.8-15.4	19.7-22.6	-
longest branched ray ..	22.7-26.8	31.6-38.6	-
distance from snout ...	66.9-70.3	94.8-103.2	220.5-249.8
Pectoral fin:			
longest branched ray ..	31.3-36.6	43.3-53.2	-
distance from snout ...	28.2-33.4	39.2-49.1	99.7-107.5
Pelvic fin:			
longest branched ray ..	37.7-40.1	52.4-57.5	-
distance from snout ...	38.2-43.5	53.2-63.9	135.7-141.5
Caudal fin:			
longest ray	40.8-48.9	57.6-71.8	-

CHAPTER 5

CLASSIFICATION OF TANGANYIKAN CICHLIDAE AND THE TAXONOMIC IMPORTANCE OF THE PHARYNGEAL APOPHYSIS.

Ancestral relationships of the Great Lake cichlids have been investigated on several fronts. Behavioural characteristics have recently been given considerable weight in systematic evaluation, but the vast bulk of work has been done on morphology. This has been generally centered around the trophic specializations developed by the cichlids. These trophic specializations include dentition, jaw modifications, and the pharyngeal bone complex. The pharyngeal bone complex along with the pharyngeal apophysis has been, since Regan (1920), the most significant characteristic in the classification of higher cichlid taxa.

Basic ancestral affinities have been hypothesised on the basis of the state of the pharyngeal apophysis and bone complex. This complex consists of five bones - a fused lower set of two bones (termed the "lower pharyngeal bone"), and a complex of three bones on the roof of the pharynx (termed the "upper pharyngeal bones"). The fusion of the lower two bones is a specialization found in only a few advanced teleost taxa which created an important evolutionary potential that was advantageously exploited by the cichlid group (Liem, 1973). The two sets of pharyngeal bones are positioned in such a manner that all food must pass between them (see figure 1). Often called the pharyngeal mill, these bones contain specialized implanted teeth which macerate the food and thus aid in

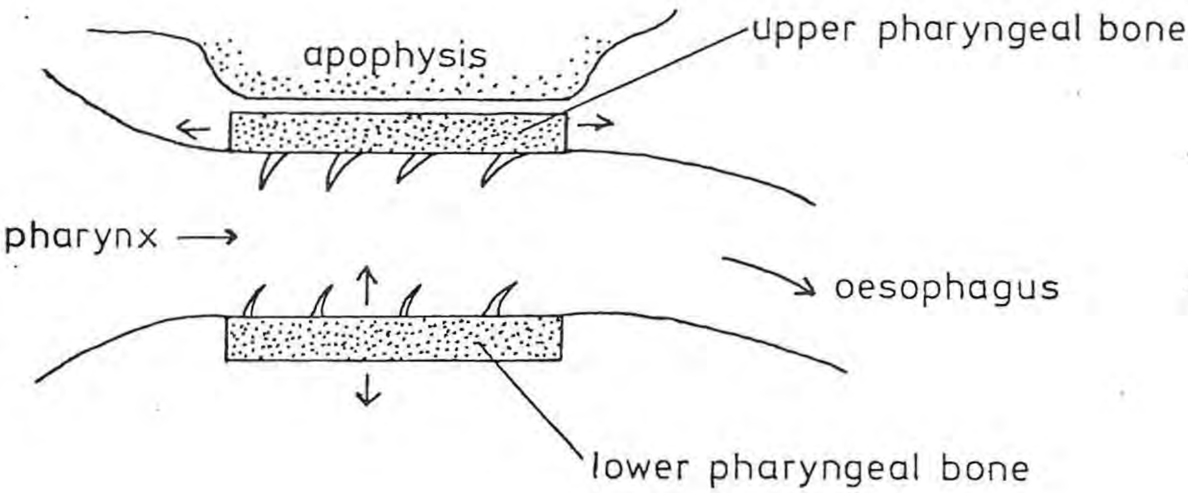

FIGURE 1

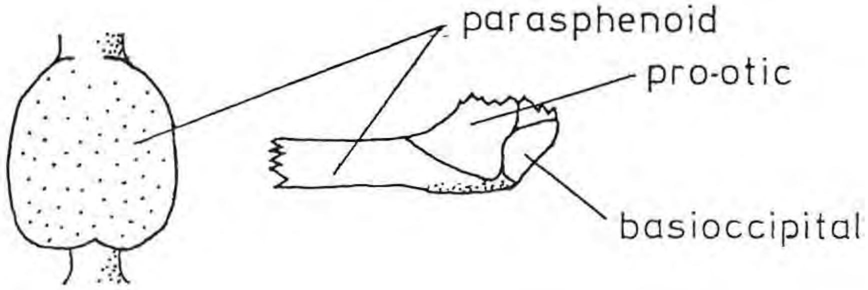

FIGURE 2

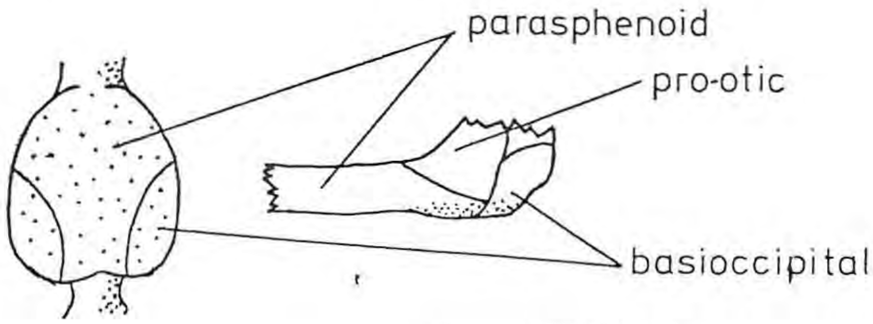

FIGURE 3

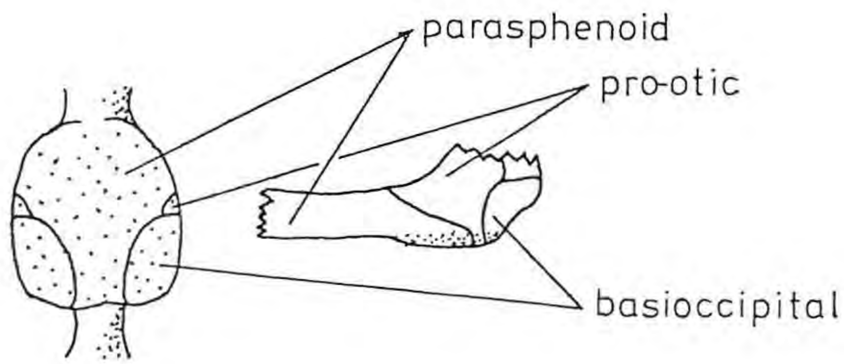

FIGURE 4

Fig.1. Diagrammatic representation of the lateral view of a cichlid pharyngeal apparatus. From Fryer and Iles (1972, p. 37).

Figs. 2-4. The pharyngeal apophyses of various fish. Dorsal view followed by lateral view. After Fryer and Iles (1972, p. 40).

the digestive process.

> "Observations on the form and function of the pharyngeal bones and teeth in cichlids of diverse feeding habits indicate that these structures play an important part in feeding."

(Greenwood, 1954, p. 409).

The musculature of the cichlid pharyngeal complex enables it to have crushing, shearing and mashing actions. The dentition on these bones varies from generalized to extremely specialized, depending upon the fish and its diet. The upper pharyngeal bones ride (or slide) on the pharyngeal apophysis, an articular surface composed of several facets on the posterior end of the base of the skull.

The use of the pharyngeal apophysis as a basis of derivation and classification was formulated in 1920 by C.T. Regan.

> "The character of most importance in classification is the structure of the apophysis that supports the upper pharyngeals; the majority of African Cichlidae may be divided into those with the pharyngeal apophysis formed by the paraspenoid only (Tilapia types), and those in which the apophysis is formed by the parasphenoid in the middle and basioccipital at the sides (Haplochromis type)"

(p. 34).

Thus articulation has been considered to be functionally important since it does not always lie on the same neurocranial bones. Two generalized types of apophyses have been noted, the

Tilapia type and the Haplochromis type. Apophysial facets of the genus Tilapia lie on only one neurocranial element, the parasphenoid (see figure 2). The pharyngeal apophysis of the Haplochromis species is contributed to by two or three neurocranial elements. Although the parasphenoid is still involved, the basioccipital bones invade the apophysial region on both sides postero-laterally, as can be seen in figure 3. In a few Haplochromis species, the pro-otics also contribute to the formation of the apophysis, as illustrated in figure 4. Trewavas (1935) and Greenwood (1954) showed that several Haplochromis mollusc crushers have this pro-otic contribution. This basic difference in the structure of apophysis types has been noted throughout the family Cichlidae and has been given evolutionary significance, dividing the family into two groups, the tilapiine group (possessing the Tilapia or "T"-type apophysis) and the haplochromine group (possessing the Haplochromis or "H"-type apophysis) (Hoedeman, 1947, 1954, 1975). These two groups have been assumed to be monophyletic in nature and if Regan's theory is correct, then all of the cichlids in Lakes Malawi and Victoria, except for Tilapia and Sarotherodon, are derived from Haplochromis stock, as they all have an "H"-type apophysis. In Lake Tanganyika, however, the cichlids exhibit both apophysis types. Fryer and Iles (1972) further suggested that Tylochromis, a non-endemic Lake Tanganyikan cichlid, has a separate ancestry from the other cichlids of the lake, due to its marked degree of differentiation. Thus, according to Fryer and Iles, Lake Tanganyikan cichlids had at least a three-fold origin.

For forty years Regan's (1920) hypothesis was accepted and never seriously tested, although the validity of using the pharyngeal apophysis in classification was critized by Borodin as early as 1936. Borodin's research contained so many errors and misidentifications that his criticism was not taken seriously and went virtually unnoticed (Fryer and Iles, 1972). Wickler (1963) evaluated the taxonomic validity of the pharyngeal apophysis as the main morphological distinction between Hoedeman's (1947, 1954, 1975), Haplo chrominae and Tilapiinae. Wickler was primarily concerned with the generic relationships of Haplochromis, Tropheus and Petrochromis. Petrochromis was considered a Tilapia relative by Matthes and Trewavas (1960), primarily on the basis of the composition of its pharyngeal apophysis. Tropheus was also considered a Tilapia relative due to its apophysis composition and many dorsal fin rays (Regan, 1920). Wickler suggested that this subfamilial evaluation should include as many comparative characteristics as possible. His study employed behaviour (into which he includes ecology, all animal movements, and "way of life"), coloration and the structure of the Ovarschenkel (believed to be analogous to the mammalian uterine horn). He found the mating behaviour of Petrochromis to be close to that of Haplochromis, and also noted that the egg spots (dummies) on the anal fin of Petrochromis was a Haplochromis characteristic. He observed that the left Ovarschenkel was completely atrophied, a characteristic of some Haplochromis related Mbuna genera (Fryer, 1959). Peters (1957) showed that the left Ovarschenkel of Hemichromis bimaculatus (a Haplochromis related fish) is smallerthan the right and produces less eggs. Wickler points out that this condition is common amongst mouth-brooders laying few large eggs and extends the argument to include his observations of Simochromis. My own examinations of the Ovarschenkel of Simochromis sp. A., S. babaulti, S. curvifrons, S. diagramma, S. marginatus, Tropheus brichardi, T. duboisi, T. moorii and T. polli find that it is missing on the left side. The evaluation of this situation is assumed to follow directly from Wickler's line of reasoning, that the condition is a Haplochromis mouth brooder specialization. Wickler (1962(b) also examined Tropheus and found its fighting behaviour, movement and coloration in regard to its breeding behaviour to be Haplochromis-like, specifically referring to H. burtoni. Tropheus, however, does not possess egg spots, as the anal fin markings are smaller and paler than the fish's eggs (Wickler, 1963). Wickler points out minor modifications in behaviour between Haplochromis and Tropheus and claims that these are due to ecological specialization. As an example of this modification he states that although Haplochromis is restricted to the bottom rocky substrate during spawning, Tropheus can spawn in open water. Personal observation, however, disagrees with this finding and indicates that Tropheus is also restricted to the bottom rocky substrate.

Wickler's (1963) evaluation casts doubt on the taxonomic validity of the pharyngeal apophysis. He considers the possibility of convergence in all of his examined characters doubtful, and therefore states that Tropheus and Petrochromis are more closely related to Haplochromis than to Tilapia. Furthermore, he suggests that Simochromis might also be related to Haplochromis, in spite of its T-type apophysis. Although *Simochromis* was not evaluated in detail, Wickler did note the egg spots on *S. diagramma*. The anal fin spots of *S. curvifrons*, however, resemble those of *Tropheus* and are not egg dummies. In conclusion, Wickler found the *Haplochromis* grouping incomplete and the *Tilapia* grouping polyphyletic when their division is based upon the composition of the pharyngeal apophysis. It should be noted that although Hoedeman (1975) reiterates his earlier work (1947, 1954) almost verbatim, he does not cite any of Wickler's (1963, 1966, 1969) work.

This pharyngeal apophysis of *Tropheus moorii* was re-examined by Burchard and Wickler (1965) and found to be H-type, agreeing with Wickler's (1963) evidence of a *Tropheus*-*Haplochromis* comparison. Along with the long-standing postulate of a close relationship between *Tropheus*, *Simochromis* and *Petrochromis* (Regan 1920), this would lead one to expect all three genera to have an H-type pharyngeal apophysis. According to Fryer and Iles (1972, p. 503), re-examination by Dr. P.H. Greenwood showed, however, that *Petrochromis* and *Simochromis* had a T-type pharyngeal apophysis.

During this study, the pharyngeal apophyses of *Tropheus* and *Simochromis* were examined. As with all vertebrae articulations, there is a cartilaginous sheath separating the moving bones involved in the articulation (Hildebrand, 1974). The base of the neurocranium is separated from the dorsal portion of the upper pharyngeal bones by two cartilaginous sheaths, one covering the articulary area on the base of the neurocranium and the other covering the analogous area on the dorsal surface of the upper pharyngeal bones. The neurocranial sheath was similar in all *Simochromis* and *Tropheus* species examined in that it was paired and usually optically symmetrical in shape, the two facets lying opposite to each other about the median saggital plane and within the same coronal plane at the base of the neurocranium (Pls. 5,6,9-11,13,15-17 & 19).. The assumption is made that this sheath delineates the facet of articulation. Each cartilaginous pad covering the apophysis has a slight depression in its centre and is either oval (Simochromis curvifrons, S. diagramma part, S. marginatus, Tropheus duboisi part), lima bean-shaped (S. babaulti), pear-shaped (S. diagramma part), or round (T. duboisi part, T. moorii), and each possesses a low but distinctly raised rim about its perimeter[1].

The examination of the apophyses of Tropheus and Simochromis revealed that both the Haplochromis and Tilapia type were found within each genus. Furthermore, although the shape of each facet of a pair within a specimen was usually comparable, the bone composition in the H-type apophyses was often different. In Tropheus, the apophyses of T. brichardi and T. moorii (Pl.19 figs.1-3) were solely composed of the para-sphenoid and thus T-type. This finding is inconsistent with the observations of Burchard and Wickler (1965). Tropheus duboisi, however, has both types of apophyses (pls.15-17) although the basioccipital contributions of the H-type are rather small (1-3% of the total area). In Simochromis, the apophyses of S. curvifrons (Pl.7) and S. marginatus (Pl.13) were soley composed of the parasphenoid and thus T-type. S. babaulti's apophyses were H-type (Pl.5) often having a contribution from the pro-otic

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1. It should be noted that although the fishes examined vary in size, all of the specimens were histologically determined to be sexually mature. They can therefore be considered adults (P.B.N. Jackson, pers. comm.)

as well as the basioccipital and parasphenoid. The percentage contribution of the basioccipital varied from 11-24%. Trewavas (1935) pointed out this occurrence during her examination of Lake Nyasa (Lake Malawi) cichlids.

> "There is considerable variation, both individual and specific, in the degree to which the basioccipital participates in the articular facet"

(Trewavas, 1935, p.70). It is interesting to note, however, that considerable differentiation in relative composition has also been found within specimens. This can be clearly seen when comparing the left and right pharyngeal facets in Simochromis babaulti (Pl.5) which vary as much as 12%. Simochromis diagramma possesses both types of apophyses (Pls.9-11) with the basioccipital contribution varying up to 12%.

The practical difficulty involved in the study and evaluation of the pharyngeal apophysis was considerable enough to confuse many researchers. Some of this confusion was investigated and corrected by Trewavas in 1947. Further confusion has often been caused by investigators relying on juvenile specimens for data and information. For example, juveniles of Haplochromis ishmaeli have widely separated apophyseal facets that are not characteristic of the adult. Also, young Astatoreochromis alluaudi have an apophysis that is identical with the adult Haplochromis mahagiensis (Greenwood, 1954). As pointed out earlier in this Chapter, the genus Tropheus was long thought to have a T-type apophysis. Upon re-examination, however, Tropheus moorii was shown to have an H-type apophysis (Burchard and Wickler, 1965).

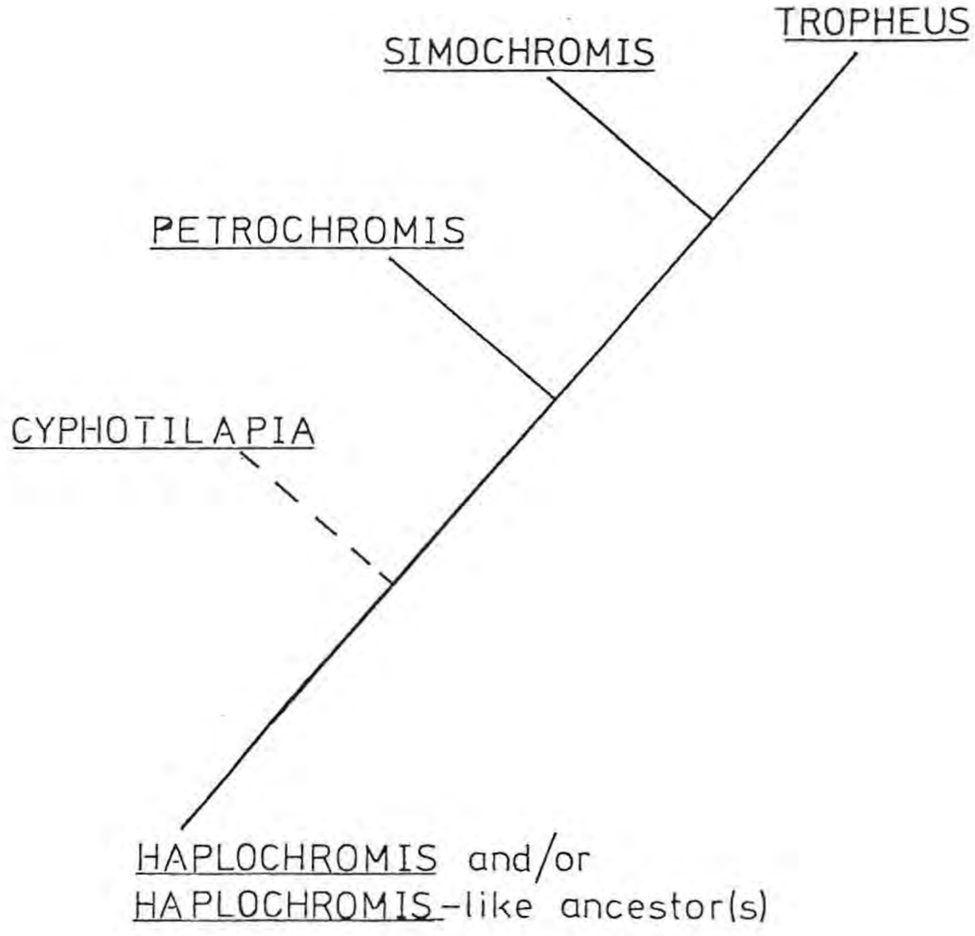

Figure 5. Suggested phyletic relationships of four Lake Tanganyikan genera.
After Fryer and Iles (1972, p. 507).

Observations made during this thesis work differ from Buchard and Wickler's conclusions, as Tropheus moorii was found to have a T-type apophysis. At the present, I can only speculate as to reasons for this incompatibility. One possibility is that there may be variability in the composition of the apophysis (as seen in T. duboisi) exhibited in different T. moorii populations. A second possibility is that the re-evaluation by Buchard and Wickler (1965) may have been erroneous. The neurocranial mound upon which the T. moorii pharyngeal apophysis rests is composed of the parasphenoid, basioccipital and pro-otic bones. Although the aritculation is located on the apex of this mound, the slope of descent away from the articulation and toward the braincase is gradual and carries the suture lines separating the bones. Without the cartilage intact, it would be easily mistaken to assume that this raised surrounding area is part of the apophysis itself.

Fryer and Iles (1972) attribute greater significance to the superficial and behavioural similarities demonstrated by Wickler (1963) than to the evidence afforded by the pharyngeal apophysis. They propose that Petrochromis, Tropheus, Petrotilapia, Cyphotilapia and Simochromis are all derived from the same ancestor regardless of the apophysial differences (see figure 5). According to Fryer and Iles (1972, p. 502), although Regan (1920) stated that the pharyngeal apophysis was the "character of most importance in classification," no concrete justification for this statement was ever given by the proponent. Furthermore, reason was never given to justify its phyletic importance. While admitting that they cannot explain why the apophysis should differ in genera, they point out that correlations between the structure of the apophysis and its function cannot always be made.

> "Species with different feeding habits often have similar apophyses. Provided its size is adequate, it seems that functionally, the composition of the apophysis is unimportant."

(Fryer and Iles, 1972, p. 503).

The pharyngeal apophysis types vary intraspecifically in Simochromis diagramma and Tropheus duboisi, and they vary interspecifically in Simochromis and Tropheus. Furthermore, it can be seen in S. babaulti (pl.5) that the suture lines of the paired parasphenoid bones vary arbitrarily to a significant degree in the genera under consideration. With the postulate of functional insignificance of the apophysis composition in mind (Fryer and Iles, 1972), it can be conjectured that this arbitrary suture variation would continue through or around the apophysis. To a certain extent, this would make only extreme differentiation in composition significant.

Greenwood (1965(a))noted that the overall size of the neurocranial mound on which the pharyngeal apophysis rests was reduced and the basioccipital contribution to the apophysis was smaller in aquarium-raised specimens of Astatoreochromis alluaudi, a cichlid mollusc eater from Lake Victoria than in specimens caught in the wild. This variation was caused by a change in the fish's natural diet to a mollusc-free one. The variations in the apophysis composition were not, according to Greenwood, of sufficient range to alter the apophysis to that of a T-type. Nevertheless, this plasticity was of significant variation.

In conclusion, doubt has been cast upon the taxonomic validity of the composition of the pharyngeal apophysis as an indicator of affinity at the subfamilial level due to its seeming lack of functional relationship, postulated arbitrary variation, interspecific variability in Simochromis and Tropheus, and intraspecific variability in S. diagramma and T. duboisi. My observations of the Simochromis and Tropheus species show that the interspecific variations in Simochromis and Tropheus and the intraspecific variability in S. diagramma and T. duboisi are not anomalies. Thus, the apophysis cannot be considered a reliable cichlid taxonomic characteristic at any level of classification, unless its validity is substantiated in each instance.

CHAPTER 6

GENERIC REVISION OF SIMOCHROMIS AND TROPHEUS

The genera Tropheus and Simochromis were first proposed, in that order, by Boulenger in 1898. At that time, both genera were monotypic, with Tropheus moorii Boulenger (1898) being the type species of Tropheus and Chromis diagramma Günther (1893) proposed as that of Simochromis. Boulenger's brief description of the two genera made little comparison between the two taxa, although striking similarities come to light when one compares the two descriptions. These similarities consist of the ctenoid scales; outer row of bicuspid teeth in the upper and lower jaws, followed interiorly by minute bands of tricuspid teeth; enlarged conical teeth at the sides of the mouth on the upper jaw; concealed maxillary under the preorbital; body depth into total length (2 1/2 - 2 2/3X); head length into the total length (3 1/4 - 3 1/2X); snout length into head length (3 1/2 - 4X); and cheek scale row (4 series). The differences in the two descriptions consist of the dorsal fin meristics (21 spines and 5-6 branched rays for Tropheus cf 17-18 spines and 9-10 branched rays for Simochromis), anal fin meristics (6 spines and 5-6 branched rays for Tropheus cf 3 spines and 7-8 branched rays for Simochromis), vertebral counts (17 precaudal + 16 caudal vertebrae for Tropheus cf 15 precaudal + 16-17 caudal for Simochromis) gill rakers (11-12 for Tropheus cf 12-13 for Simochromis), scale counts (30-32 total length and 22-25 upper lateral line for Tropheus cf 31-33 total length and 20-23 upper lateral line for Simochromis) and total length (110 mm for Tropheus cf 105 mm for Simochromis).

Regan (1920) redefined the genera and postulated that they were closely related. At this time, Simochromis was still monotypic and Tropheus had two representatives, T. moorii and T. annectens Boulenger 1900, which Poll (1946) placed in synonymy with T. moorii. Comparisons of Regan's (1920) key and text, again yield a striking similarity between the two genera and minimal differentiation. These similarities are the slight elevation of the posterior portion of the parasphenoid, the Tilapia-type composition of the pharyngeal apophysis with oval or circular facets, the wide subterminal mouth, an outer anterior series of bicuspid teeth with well defined and enlarged lateral conical teeth, the inner series of small tricuspid teeth behind the bicuspid rows of the upper and lower jaws, the united (by suture) ethmoid and vomer, and the large, weakly denticulate scales. The differences between Regan's two descriptions consist of the dorsal fin meristics (20-21 spines and 5-6 branched rays for Tropheus cf 17-19 spines and 9-10 branched rays for Simochromis), anal fin meristics (4-6 spines and 5-7 branched rays for Tropheus cf 3 spines and 7-9 branched rays for Simochromis), vertebral counts (same as Boulenger 1898), total length scale count (28-32 for Tropheus cf 33-36 for Simochromis).

Some of the differences noted by Boulenger (1898) are inconsequential (e.g., gill rakers, 11-12 for Tropheus cf 12-13 for Simochromis; total length, 110 mm for Tropheus, cf 105 mm for Simochromis). Furthermore, most of the remaining distinctions noted by both Boulenger (1898) and Regan (1920) have been eliminated at the generic level due to subsequent species additions to both genera, creating overlapping morphometrics and meristics. Hence, a generic revision and redescription of the taxa are necessary.

The selected morphometric evaluation (Chapter 4, Tables 38-41 and text) of the individual species of Simochromis and Tropheus yielded no generic distinctions of this kind. Furthermore, several of the meristic distinctions noted by Boulenger (1898) and Regan (1920) were found no longer to exist as such. The gill raker counts (below the articulation on the outer gill arch) overlap in the two genera (Table 33), with Simochromis sp.A, S. babaulti and S. marginatus having 5-7 gill rakers, and Simochromis curvifrons, S. diagramma and all Tropheus species having 10-12 gill rakers. The lateral line scale counts (Table 34) are 28-31 for all Simochromis species and 27-30 for all Tropheus species. The vertebral counts (Table 37) are 30-33 in total, 14-16 precaudal and 16-17 caudal for all Simochromis species, and 30-32 in total, 14-16 precaudal and 15-16 caudal for all Tropheus species. The remaining distinctions are the dorsal fin and anal fin spine and ray counts. Although a separation can be drawn along these lines, the branched ray counts overlap and the spine counts are sequential. The dorsal fin count (Table 31) is 16-19 spines plus 8-11 branched rays for all Simochromis species and 20-22 spines plus 5-8 branched rays for all Tropheus species. The anal fin count (Table 32) is 3 spines plus 7-9 branched rays for all Simochromis species and 4-6 spines plus 5-8 branched rays for all Tropheus species. It is interesting to note that the total dorsal fin ray count ranges (Table 31) overlap, namely 24-28 rays for Simochromis and 26-29 rays for Tropheus, and the anal fin ray count ranges (Table 32) overlap, namely 10-12 rays for Simochromis and 11-13 rays for Tropheus.

Simochromis and Tropheus can be separated from all other Lake Tanganyikan cichlids on the basis of their dentition, which is similar in both genera (Pl.6,8,14,18). The teeth are set in the jaws in several series of parallel or concentric rows. The outer row in the anterior portion of the upper jaw and lower jaw is composed of bicuspid teeth, and the inner series of rows are composed of small tricuspid teeth. The teeth are enlarged and conical at the sides of the upper jaw, and Tropheus has small tricuspids between the anterior bicuspids and the lateral conicals. In addition to the dentition, the position of the mouth and form of the snout is similar in the two genera. The mouth is subterminal with the lower jaw shorter than the upper, and the snout is more or less convex (Pls 20-22) in varying degrees amongst the individual species. This tooth configuration and mouth structure are preliminarily considered to be apomorphic characteristics that radically differ from the generalized Tilapia or Haplochromis condition (as in Poll, 1956(a)). This specialization is adapted for Aufwuchs eating or grazing (Fryer & Iles, 1972; pers. obs.).

On the basis of the dentition and mouth form, it is considered very probable that the Tropheus-Simochromis species complex is a monophyletic assemblage on the genus level. A much more detailed investigation of the taxa, evaluating a complex of characters of determined phyletic importance (i.e., apomorphic cf plesiomorphic characters) must be carried out, however, in order to satisfy this suggestion (as proposed by Hennig, 1966; and discussed by Brundin, 1966, 1972). It is not considered likely that the mouth and dental similarities of the two genera evolved by parallel or convergent evolution, although it has been suggested (Trewavas, 1949) that a genus of Malawi Mbuna, Pseudotropheus, has evolved by convergence to a point where their dentition is very similar to that of the Simochromis-Tropheus complex, Myers (1936) being the first to note the similarity between Pseudotropheus and Simochromis babaulti. Trewavas suggested that the meristic and coloration differentiation between Simochromis and Pseudotropheus allude to their different phyletic origin. While I of course, also consider their (Simochromis & Pseudotropheus) geographic separation to be an important factor in this context, one cannot assume, however, that Simochromis and Tropheus were never micro-geographically separated within the lacustrine system.

It is questionable whether Simochromis and Tropheus should be separated at the generic level by so few characters (i.e., anal and dorsal fin meristics) containing so little differentiation. The interspecific variation for the anal and dorsal fin meristics in Tropheus is greater than the variation between the two genera. Although all Simochromis have 3 anal spines, the Tropheus moorii examined have 5-6 (or 4-6 if T. annectens is considered) and T. duboisi have 5-6 anal spines. The variation of anal spine count within a species is not unknown in cichlids. Bruton (1975) notes that Sarotherodon placidus can have 3 or 4 anal spines. Thus, the paucity of significant differentiation in the original descriptions of the genera Simochromis and Tropheus, permits a working hypothesis that the assemblage may be a monophyletic unit (for the above reasons). This allows me to propose that the two genera should be united under Tropheus until more detailed phylogenetic evidence proves this to be incorrect.

It is proposed that genus Tropheus be divided into the sub-genera Tropheus (Tropheus) and Tropheus (Simochromis)along the lines of its previous division in two separate genera. Characterristics of the sub-genera within this division include the anal and dorsal meristic counts (previously discussed) and also two modifications of the dentition noted in Chapter 4, but apparently not mentioned in previous literature. The first of these dental modifications is found in the lower jaw of all Tropheus (Simochromis) species (but not in Tropheus (Tropheus) species), which have a set of laterally placed conical teeth analogous to those in the upper jaw. They are smaller than the upper conicals and lateral to the inner tricuspid tooth rows of the lower jaw. Secondly, there are small tricuspid teeth (termed "lateral transition teeth" on Table 35) between the anterior bicuspid and lateral conicals in the upper jaw of all Tropheus(Tropheus) species. Tropheus (Simochromis) species have a toothless gap in place of these external tricuspids. It is conjectured that the presence of conicals on the lower jaw is an apomorphic characteristic. With the generalized Haplochromis bicuspid dentition,(Greenwood, 1974) described in Poll (1956(a)), in mind, this conjecture seems safe enough to account for the presence of the lower conicals. Tricuspids in the external tooth series, however, are usually considered a derived characteristic in _Haplochromis_-related fishes, while their absence is considered plesiomorphic. At the advanced level of derivation which these fishes have reached, however, the opposite may be the case. It is possible that tricuspid teeth between the anterior bicuspids and lateral conicals of the upper jaw are a rudimentary vestige of the internal tricuspid rows - assuming that they continued to the external tooth series in the lateral portion of the jaw. Nevertheless, these two dental modifications support the proposed division. It is probable, on the available evidence that _Tropheus_ (_Tropheus_) and _Tropheus_ (_Simochromis_) are monophyletic assemblages within the _Tropheus_ complex.

It is appreciated that, in the light of the newly recognized dental differences, _Tropheus_ (_Simochromis_) and _Tropheus_ (_Tropheus_) could be considered distinct enough to support the previous separation on a generic level. This is further supported by my belief that the two subgenera are each monophyletic units. My present evidence, however, indicates the probability that the two sub-genera are sister groups. Although these postulates must be supported with further evidence through additional research, I feel that my proposed classification is the most suitable and useful at this time. Assuming the monophyly of these related taxa, the phylogenetic relationships of the complex can best be portrayed by regarding them as subgenera of a single monophyletic genus. Furthermore, present differentiation between most of the Lake Tanganyikan genera is more substantial than between that of _Tropheus_ (_Tropheus_) and _Tropheus_ (_Simochromis_) even when the new dental evidence is weighed. In addition, intrageneric differentiation of the proposed Tropheus genus is comparable to that found in several Lake Tanganyikan cichlid genera.

Tropheus (Simochromis) curvifrons was placed into a monotypic genus, Pseudosimochromis, by Nelissen (1977(b), p. 731) because

> "... it was found that Simochromis curvifrons Poll, 1942 differs in so many respects from all other Simochromis and Tropheus species..."

I do not consider this genus to be taxonomically valid for the following reasons: Firstly, the evidence presented in this thesis argues strongly in favour of the hypothesis that this taxon is monophyletic, best represented at the genus level, containing the two sub-genera Tropheus(Tropheus) and Tropheus (Simochromis). Secondly, while Nelissen's paper is admittedly short, pending a more detailed publication, it contains no discussion, or reference, even by implication, of a phylogenetically acceptable argument (in the Hennigian sense) for his contention. Thirdly, Nelissen bases his new genus on eight morphometric comparisons. Two of his comparisons are repetitive, as he creates four morphometric ratios from only two valid morphological differences (i.e., snout length is expressed as both % of h.l. and of eye diameter; mouth width is expressed as both % h.l. and % of interorbital width). One of his comparisons is invalid as there is no statistical difference between his figures (i.e., postocular part of head as % h.l., $\bar{x}$ = 50 & SD = 2.7 for Pseudosimochromis cf $\bar{x}$ = 42 & SD = 4.2 to $\bar{x}$ = 46 & SD = 15.8 for all Simochromis species). This appears to be an unacceptably wide range of standard deviation. This leaves only five morphometric comparisons. It should be noted in this connection that almost every species in the Tropheus (including

Simochromis) assemblage can be separated from the remainder of the genus in 4-10 morphometric and/or meristic characters (see Chapter 4 - "Diagnosis" for each species). Thus, application of Nelissen's apparently subjective analysis could create a monotypic genus from almost each Tropheus species. Thus, Pseudosimochromis is not accepted as a valid taxon at this time.

Finally, comment must be made on the lower pharyngeal bones of Tropheus (Pl.23 figs.1-10). As can be seen from their descriptions in Chapter 4, the lower pharyngeal bones of Tropheus (Tropheus) and Tropheus (Simochromis) are all very much alike with the exception of Tropheus (Simochromis) diagramma. Furthermore, Tropheus (Simochromis) species generally (except Tropheus sp. A) have slightly more robust pharyngeal teeth than do Tropheus (Tropheus) species. The arrangement, tooth size and tooth shape of T. (S.) diagramma's pharyngeal teeth are similar to that found in Haplochromis callipterus (Günther 1893), an African riverine cichlid which was suggested to be representative of the ancestoral condition for the Haplochromis species flock in Lake Malawi (Trewavas, 1948). The arrangement and tooth shape also resemble that found in Haplochromis horei(Günther, 1893), a Lake Tanganyikan cichlid, although the H. horei teeth are much larger. Thus, this can be considered a plesiomorphic condition, while the reduction in pharyngeal tooth size and the change in arrangement in all other Tropheus (Simochromis) species can be considered a derived condition. I postulate that Tropheus (Tropheus) and Tropheus (Simochromis) - except T. (S.) diagramma, show convergence in the varying reduction of the pharyngeal bone tooth size.

Although a quantitative and detailed evaluation of the phylogeny of the Tropheus complex has not yet been undertaken, a very preliminary working hypothesis can be established on the basis of the conjectures made and other available information. This supports the suggestion of Fryer & Iles (1972), illustrated in fig. 5, Chapter 5. Although not shown on this cladogram, T. (S.) diagramma seems to be the most primitive Tropheus (Simochromis) species on the basis of its lower pharyngeal bone.

KEY FOR TROPHEUS

Tropheus can be separated from all other Lake Tanganyikan Cichlidae on the basis of its dentition. The teeth are set in the jaws in several series of parallel or concentric rows. The outer row of the anterior portion of the upper jaw and lower jaw is composed of bicuspid teeth,and the inner series of rows are composed of small tricuspid teeth. The teeth are enlarged and conical at the sides of the upper jaw, and Tropheus (Tropheus) has small tricuspids between the anterior bicuspids and the lateral conicals. The position of the mouth is subterminal with the lower jaw shorter than the upper, and the snout is more or less convex in varying degrees amongst the individual species. (all values below are sample means)

1) 3 spines and 7-9 branched rays in the anal fin; 16-19 spines and 8-11 branched rays in the dorsal fin; 2-8 laterally placed conical teeth in the lower jaw; no tricuspid teeth in the outer row of the upper jaw.....5 Tropheus (Simochromis).

   4-6 spines and 5-8 branched rays in the anal fin; 20-22 spines and 5-8 branched rays in the dorsal fin; no laterally placed conical teeth in the lower jaw; 0-5 tricuspid teeth in the outer row of the upper jaw, between the anterior bicuspids and the lateral conicals.....2 Tropheus (Tropheus).

2) Caudal fin emarginate (slightly to deeply); interorbital width, 10.1-11.7 % s.l. & 35.7-38.0 % h.l.; preorbital depth, 7.7-8.3 % s.l. & 24.9-28.1 % h.l.; mouth length, 32.2-44.6 % m.w.; longest branched dorsal ray, 18.3-22.2 % s.l. & 25.5-32.1 % b.l.; longest branched anal ray, 17.8-21.9 % s.l. & 24.8-31.5 % b.l.; longest caudal ray, 23.5-26.2 % s.l. & 32.8-37.8 % b.l.; eye diameter, 8.2-8.9% s.l. & 27.8-29.0 % h.l.; 5-7 anal spines (except T. (T.) annectens).....3.

Caudal fin lunate; interorbital width, 12.4 % s.l. & 41.8 % h.l.; preorbital depth, 9.5 % s.l. & 32.1 % h.l.; mouth length, 29.4 % m.w.; longest branched dorsal ray, 25.2 % s.l. & 35.9 % b.l.; longest branched anal ray, 24.4 % s.l. & 34.7 % b.l.; longest caudal ray, 45.7 % s.l. & 65.0 % b.l.; eye diameter, 7.3% s.l. & 24.7 % h.l.; 4 anal spines .....T. (T.) polli (App.3).

3) Head depth, 33.0-33.5 % s.l.; mouth length, 4.4 % s.l. & 14.8-15.6 % h.l. & 32.2-32.8 % m.w.; postocular head, 12.9-13.0 % s.l. & 43.0-45.6 % h.l.; mouth width, 13.5-13.8 % s.l. & 45.9-47.6 % h.l.; head length, 39.7-42.9 % b.l.; preorbital depth, 27.9-28.1 % h.l.; longest anal spine, 14.4-14.9 % s.l. & 20.1-21.3 % b.l.; longest anal branched ray, 17.8-19.9 % s.l. & 24.8-28.4 % b.l.; 16-17 pectoral rays.....4.

Head depth, 36.2 % s.l.; mouth length, 5.4 % s.l. & 17.7 % h.l. & 44.6 % m.w.; postocular head 11.6 % s.l. & 37.6% h.l.; mouth width, 12.3 % s.l. & 39.9 % h.l.; head length, 45.0 % b.l.; preorbital depth, 24.9 % h.l.; longest anal spine 16.4 % s.l. & 23.8 % b.l.; longest anal branched ray, 21.9 %; s.l. & 31.5 % b.l.; 15 pectoral rays .....T.(T.) duboisi (pp.130-143).

4) Interorbital width, 10.1 % s.l.; lower pharyngeal bone length, 36.3 % h.l.; lower pharyngeal bone width, 95.1 % bone length; longest pectoral branched ray, 32.8 % s.l. & 45.8 % b.l.; longest anal branched ray, 24.8 % b.l.; pectoral fin to snout distance, 115.1 % h.l. ..... T. (T.) brichardi (pp. 120-129).

Interorbital width, 10.9 % s.l.; lower pharyngeal bone length, 33.6 % h.l.; lower pharyngeal bone width, 89.4 % bone length; longest pectoral branched ray, 35.7 % s.l. & 51.0 % b.l.; longest anal branched ray, 28.4 % b.l.; pectoral fin to snout distance, 105.3 % h.l. ..... T. (T.) moorii (pp. 144-159).

5) 10-12 gill rakers below the articulation on the outer gill arch ..... 6.

5-7 gill rakers below the articulation on the outer gill arch ..... 7.

6) Body depth, 40.7 % s.l.; preorbital depth, 7.4 % s.l. & 25.8 % h.l.; head depth, 34.8 % s.l. & 120.8 % h.l.; postocular head, 13.3 % s.l. & 46.2 % h.l.; eye diameter, 7.8 % s.l.; mouth length, 47.0 % m.w. ...... T. (S.) curvifrons (pp. 75-85).

Body depth, 38.9 % s.l.; preorbital depth, 6.6 % s.l. & 22.0 % h.l.; head depth, 31.1 % s.l. & 103.7 % h.l.; postocular head, 12.0 % s.l. & 39.8 % h.l.; eye diameter, 8.6 % s.l.; mouth length, 38.2 % m.w. ..... T. (S.) diagramma (pp. 86-104).

7) Body depth, 37.1-37.6 % s.l. & 53.6-53.9 % b.l.; interorbital width, 8.3-9.3 % s.l. & 27.9-29.9 % h.l.; longest dorsal branched ray, 17.4-19.7 % s.l. & 24.8-28.7 % b.l.; anal fin to snout distance, 67.7-69.6 % s.l.; mouth length, 3.9-4.1 % s.l. & 13.0-13.1 % h.l.; 4 rows of cheek scales ..... 8.

Body depth, 34.3 % s.l. & 49.7 % b.l.; interorbital width, 7.0 % s.l. & 22.7 % h.l.; longest dorsal branched ray, 15.8 % s.l. & 22.9 % b.l.; anal fin to snout distance, 66.0 % s.l.; mouth length, 4.5 % s.l. & 14.5 % h.l.; 2-3 rows of cheek scales ..... T. (S.) babaulti (pp. 59-74).

8) Caudal peduncle depth, 10.8 % s.l. & 15.3 % b.l.; mouth length, 32.8 % m.w.; preorbital depth, 6.3 % s.l. & 20.8 % h.l.; mouth width, 12.0 % s.l. & 40.1 % h.l.; longest pectoral ray, 33.5 % s.l. & 47.8 % b.l.; postocular head, 11.3 % s.l. & 37.4 % h.l.; eye diameter, 9.0 % s.l. & 30.0 % h.l. ..... T. (S.) marginatus (pp. 105-119).

Caudal peduncle depth, 14.2 % s.l. & 20.6 % b.l.; mouth length, 41.1 % m.w.; preorbital depth, 5.6 % s.l. & 17.8 % h.l.; mouth width, 9.9 % s.l. & 31.7 % h.l., longest pectoral ray, 26.1 % s.l. & 38.0 % b.l.; postocular head, 12.6 % s.l. & 40.2 % h.l.; eye diameter, 10.1 % s.l. & 32.2 % h.l. ..... T. (Simochromis) sp. A (pp.49-58).

SUMMARY

African cichlids were long thought to have a dichotomous ancestry, either being related to a *Haplochromis*-like or to a *Tilapia*-like ancestor (Regan, 1920). Regan hypothesized that the composition of the pharyngeal apophysis at the base of the neurocranium was the most important taxonomic characteristic in determining this relationship. In his evaluation of Lake Tanganyikan genera, Regan mentions that *Simochromis* and *Tropheus* are closely related to each other, and together have a *Tilapia* ancestry. Wickler (1963) suggested that *Tropheus moorii* was a *Haplochromis* relative on the basis of an anatomical and ethological comparison, and disputed Regan's *Haplochromis/Tilapia* relationship theory as being phylogenetically invalid. Burchard and Wickler (1965) re-examined the pharyngeal apophysis of *Tropheus moorii* and found it to be of the *Haplochromis* type, substantiating Wickler's previous conclusions about *T. moorii*, and eliminating the contradiction with Regan's cichlid relationship theory. *Simochromis*, however, was still found to have a *Tilapia*-type pharyngeal apophysis (Fryer and Iles, 1972), and according to Regan's postulate of a dichotomous cichlid ancestry, could not be closely related to *Tropheus*.

The purpose of this thesis is to investigate the taxonomic status of *Simochromis* and *Tropheus*, making a contribution to the resolution of the previously mentioned problem. The thesis includes a review of the geographical formation and biological isolation of Lake Tanganyika, as well as comments on aspects of the faunal colonization, adaptive radiation and speciation within the lake. Material for the study was collected during three visits to Lake Tanganyika in 1976-1977. Specimens of all known species of *Tropheus* and *Simochromis* were collected (with the exception of *T. brichardi*), and one new species of *Tropheus*, *Tropheus polli* G.S. Axelrod 1977, was found and described. Additionally, a new species of *Simchromis* was found and will be described in a forthcoming paper. Nine colour varieties of *Tropheus moorii* and three colour varieties of *Tropheus duboisi* were found and described. Some museum type specimens were also

examined. A diagnosis and description is given using morphometrics and meristics of the five species of Simochromis and four species of Tropheus. Photographs depicting the live coloration of most Tropheus and Simochromis species are included. A dissection and cleaning technique for the pharyngeal apophysis and lower pharyngeal bone is explained, together with a method for the interpretation of relative bone composition of the pharyngeal apophysis. Photographs of the lower pharyngeal bone of each considered species and the pharyngeal apophysis of most species are included. In addition, the dentition is examined, evaluated and figured.

It is shown that some of the generic differences noted by Boulenger (1898) and Regan (1920) for Simochromis and Tropheus are not differences of consequence. Most of the remaining distinctions have been eliminated due to subsequent species additions to both genera, with resultant overlap in morphometrics and meristics.

Doubt has been cast upon the taxonomic validity of the composition of the pharyngeal apophysis as an indicator of affinity at the subfamilial level. This is shown by its seeming lack of functional relationship, apparent arbitrary variation, interspecific variability in Simochromis and Tropheus, and intraspecific variability in S. diagramma and T. duboisi. Thus, the apophysis cannot be considered a reliable cichlid taxonomic characteristic at any level of classification, unless its validity is substantiated in each instance. Furthermore, it is considered very probable that the Tropheus-Simochromis species complex is a monophyletic assemblage at the genus level, on the basis of similar dentition and mouth form, which is unique in Lake Tanganyika. It is proposed on phyletic grounds that Simochromis and Tropheus be united into the one genus Tropheus. It is further suggested that Tropheus be divided into the subgenera, Tropheus (Tropheus) and Tropheus (Simochromis), along the lines of its previous division in two separate genera. Characteristics supporting this division include differences in the anal and dorsal fin meristic counts noted in the original descriptions of the genera. In addition, two modifications of the dentition were found during the course of this study which are not mentioned in any previous literature. It is considered probable, that *Tropheus* (*Tropheus*) and *Tropheus* (*Simochromis*) are monophyletic sister groups within the *Tropheus* complex. *Pseudosimochromis* Nelissen 1977 is not considered to be a taxonomically valid genus on either phyletic or gradistic grounds, and is included within *Tropheus* (*Simochromis*). It is postulated that *Tropheus*(*Tropheus*) and *Tropheus* (*Simochromis*) show convergence in the reduction of the pharyngeal bone tooth size, which is considered to be a derived condition. The lower pharyngeal bone of *T.* (*S.*) *diagramma* is considered to be plesiomorphic in tooth arrangement, size and shape. A preliminary working hypothesis is established on the basis of the conjectures made and other available information which supports the phyletic relationship suggested by Fryer and Iles (1972). An illustration is given.

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Note: References for the attached publication (G.S. Axelrod, 1977) are included in the reference list above.

APPENDIX 1

THE KNOWN CICHLID GENERA OF LAKE TANGANYIKA

Asprotilapia Boulenger 1901
x*Astatoreochromis* Pellegrin 1903
Aulonocranus Regan 1920
Bathybates Boulenger 1898
Boulengerochromis Pellegrin 1904
Callochromis Regan 1920
Cardiopharynx Poll 1942
Chalinochromis Poll 1974
Cunningtonia Boulenger 1906
Cyathopharynx Regan 1920
Cyphotilapia Regan 1920
Ectodus Boulenger 1898
Eretmodus Boulenger 1898
Grammatotria Boulenger 1899
x*Haplochromis* Hilgendorf 1888
Haplotaxodon Boulenger 1906
Hemibates Regan 1920
Julidochromis Boulenger 1898
x*Lamprologus* Schilthuis 1890
Leptochromis Regan 1920
Lestradea Poll 1943
Limnochromis Regan 1920
Limnotilapia Regan 1920
Lobochilotes Boulenger 1915
Ophthalmochromis Poll 1956
Ophthalmotilapia Pellegrin 1904
Orthochromis Greenwood 1954
Perissodus Boulenger 1898
Petrochromis Boulenger 1898
x*Sarotherdon* Rüppell 1852
Simochromis Boulenger 1898
Spathodus Boulenger 1901
Tanganicodus Poll 1950
Telmatochromis Boulenger 1898
x*Tilapia* Smith 1940
Trematocara Boulenger 1899
Triglachromis Poll & Thys 1974
Tropheus Boulenger 1898
x*Tylochromis* Regan 1920
Xenotilapia Boulenger 1899

x non endemic

Note: The above authors are not cited in the reference list with regard to this appendix.

APPENDIX 2

THE SYMBOLS AND ABBREVIATIONS USED IN THIS THESIS.

app. = appendix
B = basioccipital bone
biblio. = bibliography
b.l. = body length
BM (NH) = British Museum (Natural History)
C = centigrade
cf = compare
cm = centimeter
conc. = concentrated
CV = coefficient of variation
desc. = description
E = east
ex. = example
F. = frequency
fig. = figure
G.S.A. = G.S. Axelrod
h.l. = head length
H-type = *Haplochromis*-type
i.e. = id est (that is)
Ill. = illustration
info. = information
Km = kilometer
KMMA = Koninklijk Mus. voor Midden-Africa, Tervuren.
L = left
L. = lake
m = meters
max. = maximum
mins. = minutes
mm = millimeters
m.p. = melting point
Mus. = Museum
m.w. = mouth width
n = number of specimens
N = north
no. = number
n. rec. = new record
p = page
P = parasphenoid bone
pers. comm. = personal communication
pers. obs. = personal observation
Pl. = plate
PRO = pro-otic bone
R = right
resp. = respectively
S = south
SB = *Simochromis babaulti*
SC = *Simochromis curvifrons*
SD = *Simochromis diagramma*
SD = standard deviation
secs. = seconds
s.l. = standard length
SM = *Simochromis marginatus*
sp. = species
SS = *Simochromis* sp. A
t = absolute value of student's *t*-test distribution
Tang. = Tanganyika
TB = *Tropheus brichardi*
TD = *Tropheus duboisi*
t.l. = total length
TM = *Tropheus moorii*
TP = *Tropheus polli*
T-type = *Tilapia*-type
X = multiplication (in text)
X = a crack, not a suture line (on Plates)
$\bar{x}$ = mean of x
♂ = male
♀ = female

The
J. L. B. SMITH INSTITUTE OF
ICHTHYOLOGY

SPECIAL PUBLICATION
No. 17

A NEW SPECIES OF *TROPHEUS* (PISCES: CICHLIDAE) FROM LAKE TANGANYIKA

BY
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RHODES UNIVERSITY
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November 1977

ABSTRACT

Tropheus polli, a sp. nov. (Pisces: Cichlidae) from Lake Tanganyika, is described and compared with *T. moorii* Boulenger 1898, *T. annectens* Boulenger 1900, *T. duboisi* Marlier 1959, *T. brichardi* Nelissen & Thys 1975, and *T. moorii kasabae* Nelissen 1977. Included are detailed morphometric data with a figure and colour plate, a lower pharyngeal bone description with electron micrograph scans, and a type locality map.

ABSTRAIT

On décrit *Tropheus polli* du Lac Tanganika et le compare à *T. moorii* Boulenger 1898, *T. annectens* Boulenger 1900, *T. duboisi* Marlier 1959, *T. brichardi* Nelissen & Thys 1975, et *T. moorii kasabae* Nelissen 1977. Cette étude comprend des données morphométriques détaillées avec une illustration et une plaque en couleurs, une description de l'arête pharyngienne inférieure avec des photographies faites au microscope électronique, et une carte indiquant la localité du type.

ABSTRAKT

Tropheus polli eine bisher unbekannte Art (in Pisces: Cichlidae) vom Tanganjika-See, ist beschrieben und vergleichen mit *T. moorii* Boulenger 1898, *T. annectens* Boulenger 1900, *T. duboisi* Marlier 1959, *T. brichardi* Nelissen & Thys 1975, und *T. moorii kasabae* Nelissen 1977. Eingeschlossen sind genaue morphometrische Angaben mit einer Abbildung und einem Farbbild; auch einer Beschreibung und Elektronmikrographbildern der unteren Pharingealknochenplatte und eine Fund-Ortkarte der Arten.

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A NEW SPECIES OF *TROPHEUS** (PISCES: CICHLIDAE) FROM LAKE TANGANYIKA

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Boulenger described the first *Tropheus* species, *T. moorii*, in 1898. Since then, many different colour forms have been noted (Scheuermann 1975, 1976, 1976(a), 1977; Staeck 1977). Marlier (1959) discovered that one of these colour forms was also morphometrically different and reproductively isolated from Boulenger's *T. moorii*. He described the fish as a new species and named it *Tropheus duboisi*. Two further new species have been recently described: *Tropheus brichardi* by Nelissen and Thys in 1975 and *T. moorii kasabae* by Nelissen in 1977. Although many colour forms of *T. moorii* are known, no biometric or behavioural differences have yet been found which suggest that any of these forms represent a distinct species (Marlier 1959; Nelissen 1977). During a visit to Lake Tanganyika in September 1976, the author collected six specimens of *Tropheus* whose coloration and morphometric features appear sufficiently distinct from the previously described taxa to warrant the establishment of a new species. This fish coexists with a red morph of *T. moorii*. There are no intermediates between the two *Tropheus* species. To date, *Tropheus* species have only been found in Lake Tanganyika.

TROPHEUS POLLI sp. nov. (Fig. 1)

Diagnosis: In its general appearance *Tropheus polli* closely resembles *T. moorii*, but its overall brown body coloration which is patterned with olive vertical stripes and its fin markings distinguish it from all other *Tropheus* species (see Coloration and Plate 1). Coloration, however, cannot in itself be considered a reliable characteristic as *Tropheus* species have many colour morphs. The caudal fin of *T. polli* is lunate, as opposed to emarginate (slightly to deeply) in *T. moorii* and all other known *Tropheus* species. The lengths (as % s.l. or % b.l.) of *T. polli's* longest branched dorsal, pelvic, anal and caudal fin rays are greater than those of *T. moorii* or any other *Tropheus* species, while the longest spines of the dorsal, pelvic, and anal fins are of a comparable relative size. *Tropheus polli's* mouth length (as % h.l.) is smaller than that of any other *Tropheus* species. Additionally, *T. polli* differs from *T. moorii* in the interorbital width (as % s.l. or % h.l.), preorbital depth (as % s.l. or % h.l.), snout length (as % s.l. or % h.l.), postocular

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**This new species and* Tropheus annectens *yield biometric data with values intermediate between those used in the original descriptions of the genera* Tropheus *and* Simochromis *Boulenger, 1898, and therefore a generic revision is necessary. The proposed gradistic unification will be accomplished in a paper to be published early in 1978, which will be followed by a phylogenetic evaluation of the same genera,* Petrochromis *Boulenger, 1898 and* Cyphotilapia *Regan, 1920.*

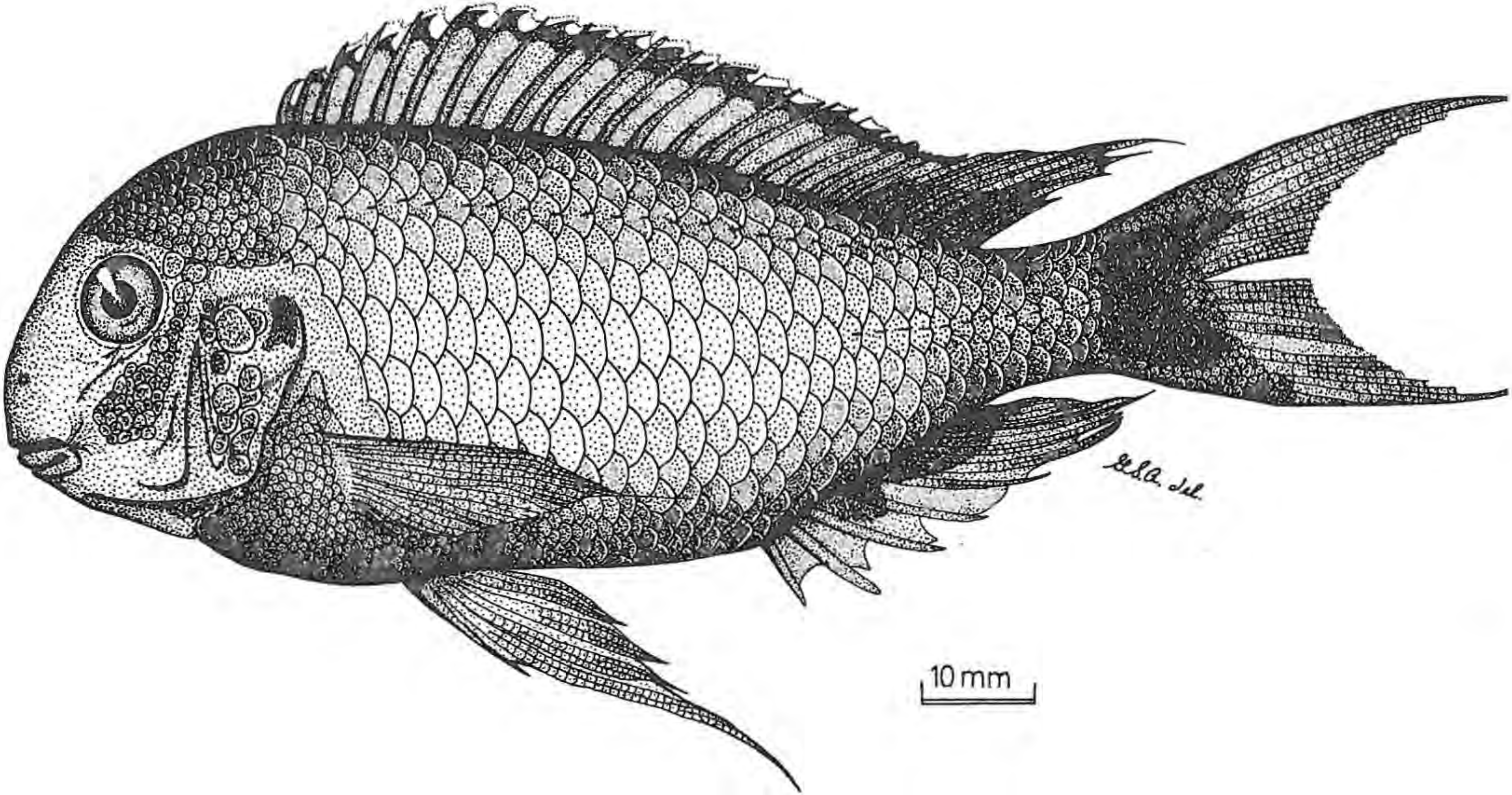


Figure 1: *Tropheus polli* sp. nov., holotype. (Drawing by G. S. Axelrod)

portion of the head (as % s.l. or % h.l.), eye diameter (as % s.l. or % h.l.) and mouth length (as % of mouth width). *Tropheus polli* has four anal spines as opposed to five, six or seven in most other *T. moorii* and all other *Tropheus* species. Finally, the standard length of a *T. polli* adult is larger than that of any other *Tropheus* species. These and other significant morphometric differences can be seen in Table 6.

The only other *Tropheus* with four anal spines is *Tropheus annectens* Boulenger from Albertville, Zaïre. According to Poll 1946 (p. 267), *Tropheus annectens* differs from *T. moorii* in total length (80 mm cf 118 mm respectively) and in the number of anal spines (4 cf 5–6 respectively). However, due, as he puts it, to the "intraspecific variability of Cichlidae" and the paucity of *T. annectens* material, Poll could not consider *T. annectens* a valid species and places it in synonymy with *T. moorii*. The *Tropheus annectens* type specimens in the British Museum (NH), London and the Musée Royal d l'Afrique Centrale, Tervuren are in poor condition. However, according to Poll 1946, *T. annectens* has a slightly emarginate caudal fin as opposed to the lunate caudal fin of *T. polli*. This has been substantiated by the author's examination of the type specimen in the BM(NH) and by personal communication with Dr Thys van den Audenaerde (Musée Royal de l'Afrique Centrale). Furthermore, there is a substantial difference in the total maximum length of *T. polli* and *T. annectens* (164,5 mm cf 80 mm respectively).

This fish has been named in honour of Dr Max Poll (Musée Royal de l'Afrique Centrale, Tervuren), one of the greatest ichthyologists of our time. He has done more to advance our knowledge and understanding of Lake Tanganyikan fishes than any other man.

Description: The data tabulated below represent the mean values of counts and measurements taken from the holotype and five paratypes. The percentage values are followed by their standard deviation (SD – by the n-1 method) and coefficient of variation (CV = SD/$\bar{x}$ X 100%), and all are those used by most authors (such as Nelissen & Thys 1975 and Nelissen 1977) in recent descriptions of cichlid fishes. Counts and measurements are identical to those defined by Trewavas (1935) and Hubbs and Lagler (1947) except for the following:

(1) fork length: snout tip to the shortest mid-caudal rays.
(2) caudal peduncle depth: narrowest portion of the caudal peduncle.
(3) preorbital depth: least depth across the preorbital (from the orbital circumference to the bone edge).
(4) head depth: depth of the head at the posterior border of the preoperculum.
(5) mouth width: projection across the mandible.
(6) mouth length: projection to the tip of the mandible.
(7) branched ray counts: the last ray is always counted if it is separated at the base of the fin.
(8) anal fin to snout: diagonal from the insertion of the first anal spine to the tip of the snout.
(9) pectoral fin to snout: projection to the tip of the snout.
(10) pelvic fin to snout: diagonal from the insertion of the pelvic spine to the tip of the snout.
(11) longest caudal ray: total length minus standard length.

TABLE 1

General characteristics of the head and body

(body length (b.l.) = standard length (s.l.) – head length (h.l.))

s.l. range 77,0–110,6 mm

characteristic	%s.l.	SD	CV	%b.l.	SD	CV	%h.l.	SD	CV
standard length	—	—	—	142	3,12	2,20	338	17,4	5,16
head length	29,7	1,54	5,19	42,2	3,12	7,40	—	—	—
body length	70,3	1,54	2,19	—	—	—	238	17,3	7,25
body depth	39,3	1,98	5,04	55,9	3,74	6,69	—	—	—
caudal peduncle depth	12,1	0,55	4,56	17,2	1,01	5,88	—	—	—
head width	19,6	0,75	3,83	—	—	—	66,0	2,37	3,60
interorbital width	12,4	0,51	4,16	—	—	—	41,8	2,56	6,13
preorbital depth	9,5	0,74	7,81	—	—	—	32,1	1,90	5,91
head depth	33,3	1,83	5,49	—	—	—	112	3,41	3,04
snout length	10,0	1,29	12,8	—	—	—	33,7	2,99	8,87
postocular head	12,3	0,53	4,34	—	—	—	41,6	2,11	5,07
eye diameter	7,3	0,47	6,45	—	—	—	24,7	1,64	6,65
mouth width	13,6	0,58	4,24	—	—	—	46,0	1,41	3,06
mouth length	4,0	0,33	8,11	—	—	—	13,5	1,20	8,87
cheek depth	11,7	0,79	6,73	—	—	—	39,4	2,78	7,05

TABLE 2

Dorsal fin characteristics

Formula: $\frac{XX,8}{2}, \frac{XXI,7}{4}$

characteristic	%s.l.	SD	CV	%b.l.	SD	CV	%h.l.	SD	CV
length at base	62,5	1,36	2,17	88,9	1,42	1,60	—	—	—
longest spine	13,3	0,74	5,57	19,0	1,25	6,58	—	—	—
longest branched ray	25,2	1,37	5,42	35,9	1,50	4,18	—	—	—
distance from snout	37,2	2,19	5,87	53,0	4,12	7,78	126	4,92	3,92

TABLE 3

Anal fin characteristics

Formula: $\frac{IV,7}{5}, \frac{IV,8}{1}$

characteristic	%s.l.	SD	CV	%b.l.	SD	CV	%h.l.	SD	CV
length at base	21,3	0,51	2,37	30,4	0,54	1,78	—	—	—
longest spine	14,6	0,64	4,40	20,7	1,24	5,97	—	—	—
longest branched ray	24,4	1,58	6,46	34,7	2,36	6,81	—	—	—
distance from snout	68,9	1,21	1,75	98,0	3,27	3,33	233	11,3	4,84

TABLE 4

Pectoral fin characteristics

Formula: $\frac{15}{3}, \frac{16}{3}$

characteristic	%s.l.	SD	CV	%b.l.	SD	CV	%h.l.	SD	CV
longest branched ray	35,1	1,93	5,52	49,9	3,56	7,14	—	—	—
distance from snout	30,8	2,05	6,65	43,8	3,81	8,69	104	3,41	3,28

TABLE 5

Pelvic fin characteristics

Formula: 1,5

characteristic	%s.l.	SD	CV	%b.l.	SD	CV	%h.l.	SD	CV
longest branched ray	39,2	0,87	2,22	55,7	1,81	3,25	—	—	—
distance from snout	41,0	1,99	4,86	58,4	4,06	6,96	138	2,51	1,81

Caudal fin characteristics

16 principal rays, I – 14 – I
longest ray: 45,7% of s.l. (SD 3,71, CV 8,12)
65,0% of b.l. (SD 5,83, CV 8,96)

Gill rakers

The gill rakers are conical in shape. All specimens were examined. Number above, on and below the articulation:
2 – 1 – 9 + 1 (F.1), 2 – 1 – 8 + 2 (F.1), 1 – 1 – 9 + 2 (F.1), 2 – 1 – 9 + 2 (F.3).

Scale counts

Lateral line count: 29 + 3 (F.2), 30 + 2 (F.4).
Around the caudal peduncle: 16
Above the lateral line: 5 (F.3), 6 (F.3) – to the origin of the dorsal fin.
Below the lateral line: 10 (F.3), 11 (F.3) – to the origin of the anal fin.
Cheek scale rows: 5 (F.1), 6 (F.5).

Dentition

Upper jaw: 5 to 7 rows of tricuspid teeth, mode = 6 rows.
50–58 bicuspid teeth in the outer row, mean = 54 teeth.
4–5 conical teeth at each corner of the mouth.
Lower jaw: 5–7 rows of tricuspid teeth, mode = 6 rows.
44–54 bicuspid teeth in the outer rows, mean = 49 teeth.

Lower pharyngeal bone: (see Plate 2, 3 & 4)

This bone has been examined in the holotype and three of the paratypes (s.l. 77,0 mm, 96,3 mm, 105,9 mm). It is triangular in shape with a median indentation on the posterior border, and does not differ noticeably from the bone described for *Tropheus*

Plate 1: *Tropheus polli* sp. nov., holotype with live coloration (Photo by G. S. Axelrod)

moorii kasabae (see Nelissen 1977) and *T. brichardi* (see Nelissen & Thys 1975). Additionally, it does not differ significantly from the examined specimens of *T. moorii moorii* or *duboisi*. There are 40–46 enlarged teeth on the posterior border of the bone. These teeth slant anteriorly and are unicusps, having a poorly defined shoulder and not a "minor cusp". In all previous descriptions of *Tropheus* species, these teeth have been referred to as "very weakly bicuspid". Geometrically speaking, the teeth in question have only one local maximum, which is also the absolute maximum of their curve. As relative maxima and minima occur at transition points between rising and falling portions of a curve, a bicuspid tooth must have two relative maxima and one relative minimum. Hence, the teeth in question are unicuspid. All the other teeth are unicuspid and slant posteriorly. 9–11 teeth occur on the midline.

Total length of the bone: 29,8–32,5% of h.l.

Total width of the bone: 91,5–98,8% of the total bone length.

Length of the toothed area: 39,8–44,7% of the total bone length.

Width of the toothed area: 145–163% of its length.

Coloration (refer to Plate 1)

The live fish has an overall brown body coloration which is patterned with olive vertical stripes. The anal fin is brown near its base, but yellow near its margin. There are several orange spots between the four anal spines. A dark brown saddle is present on the caudal fin, highlighted with yellow. Preserved specimens have a brown-grey body coloration. The detailed colour pattern fades gradually with time, but the distinctive dark brown saddle on the caudal fin remains.

Habitat

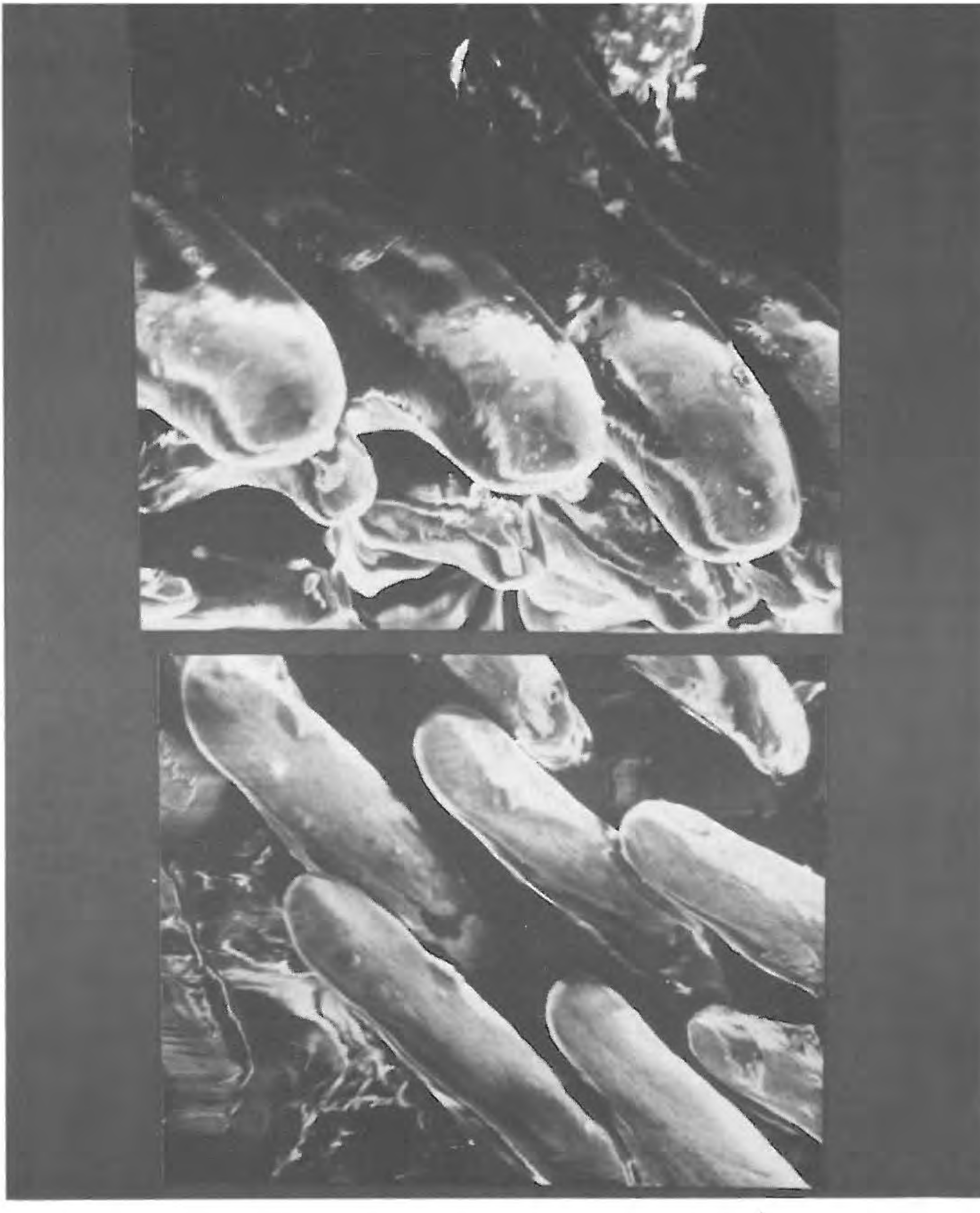
Tropheus polli, like other *Tropheus* species, occurs among the rocks and stones in the littoral region of the lake. The fish seldom strays more than six or seven meters from a given area, even when pursued. It was found at depths of between six and ten metres.

Geographic distribution

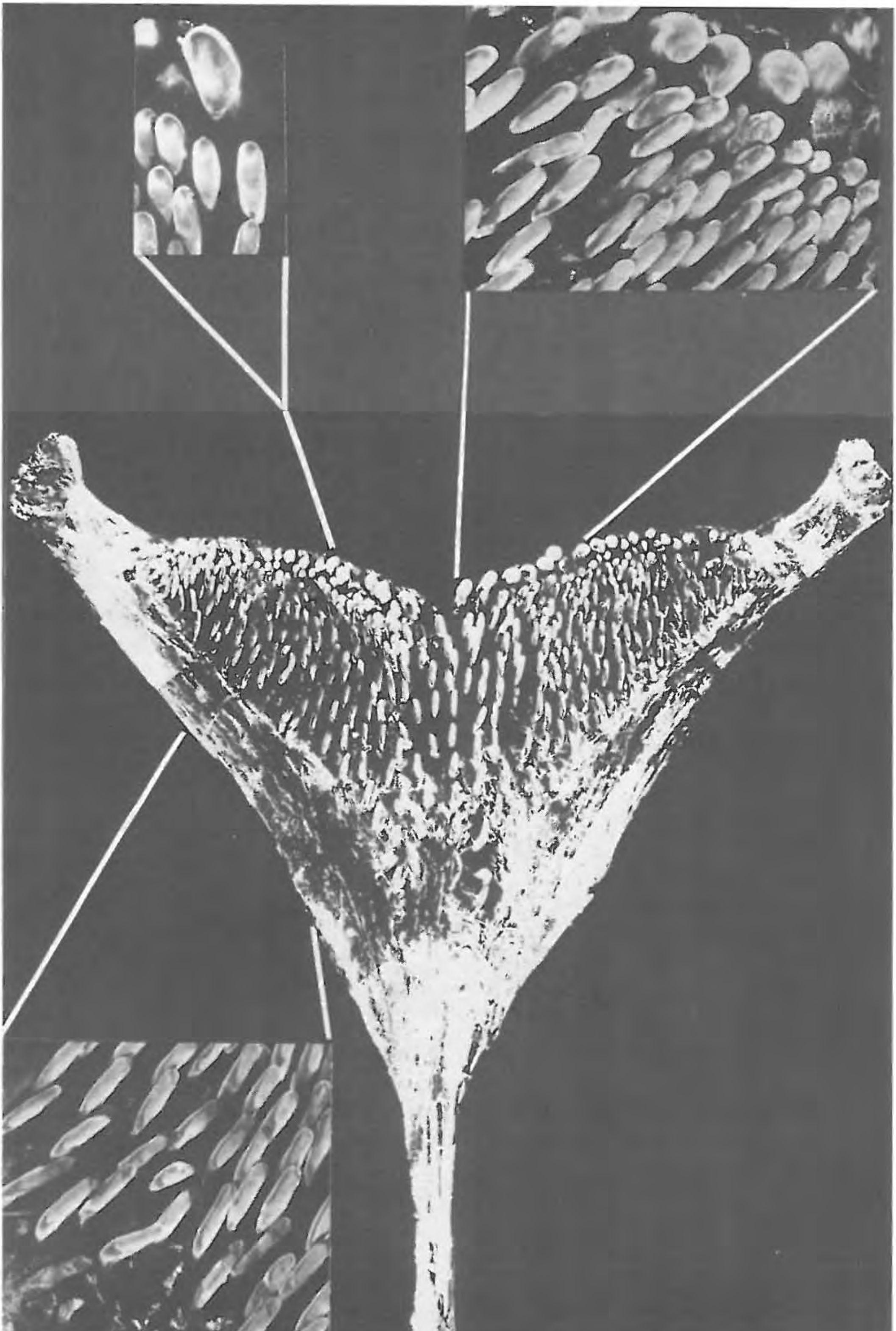
Tropheus polli, like the other *Tropheus* species, has only been found in Lake Tanganyika. All of the type specimens were collected south of Bulu Island (see Map 1). To date, *T. polli* has only been found around Bulu Point and Bulu Island, Kigoma District, Tanganyika Province, Tanzania (approx. 6°01'S, 29°45'E).

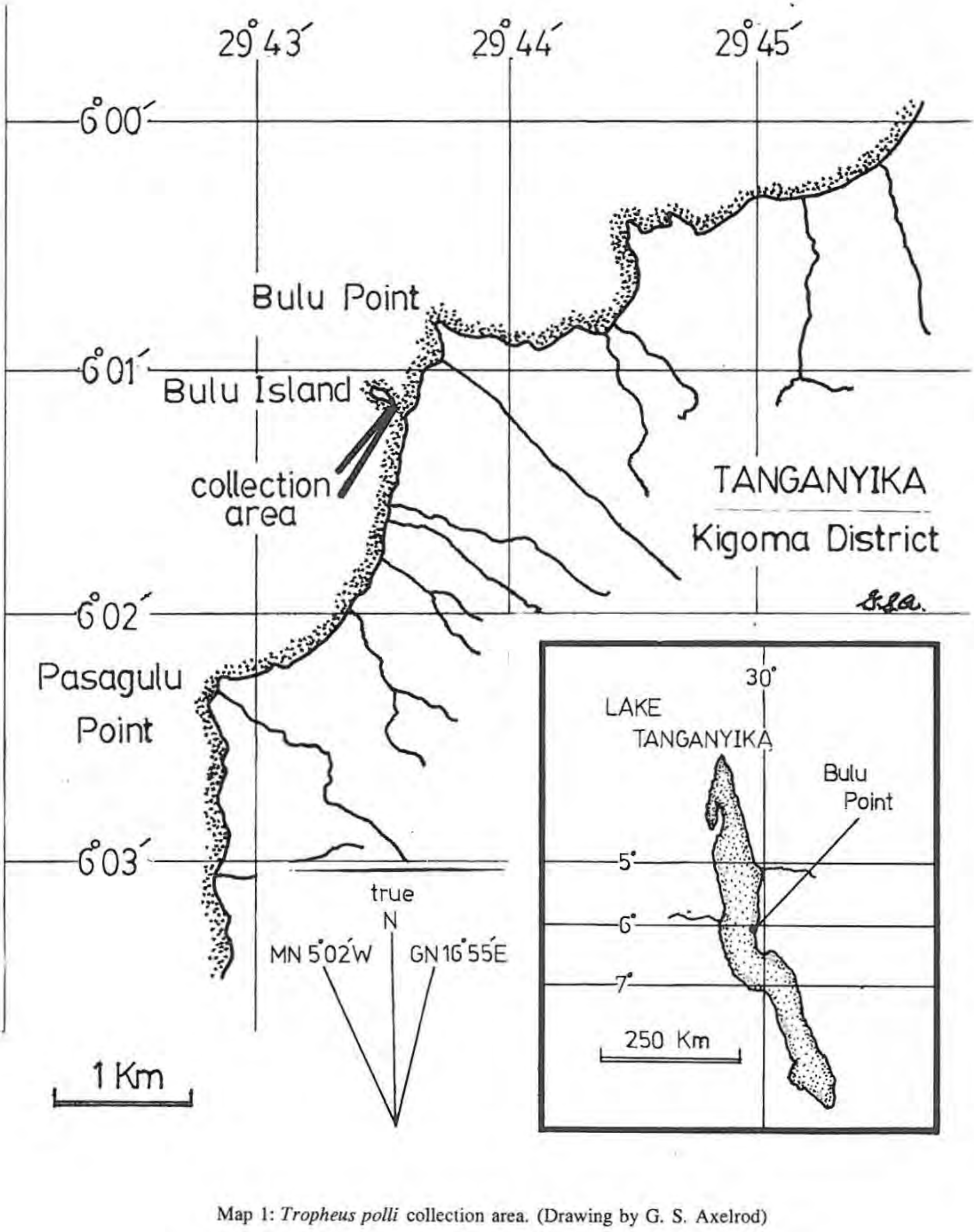
Type-material:	J. L. B. Smith Institute of Ichthyology, Rhodes University, Grahamstown, South Africa.
Holotype:	No. RUSI 921, Family No. 350; ♀, s.l. 95,3 mm, t.l. 139,3 mm.
Paratypes:	No. RUSI 922, Family No. 350; ♀, s.l. 96,3 mm, t.l. 143,4 mm.
	♂♂, s.l. 110,6 mm & 106,5 mm & 105,9 mm & 77,0 mm; t.l. respectively 164,5 mm & 150,6 mm & 157,0 mm & 108,4 mm.

All of the types were collected by the author at the same location (see Geographic distribution) in September 1976.



Plates 2–4: Electron micrograph scans of the lower pharyngeal bone and teeth from a *T. polli* paratype (s.l. = 96,3 mm). Plate 2 – upper left – shows the enlarged posterior teeth of the lower pharyngeal bone as they would be viewed dorso-posteriorly (mag. 300 ×). Plate 3 – lower left – shows the narrow unicuspid teeth located anteriorly to those of Plate 2. Plate 4 – opposite page – a composite of electron micrograph scans showing the lower pharyngeal bone (mag. 15,5 ×) with enlargements of various teeth (mag. 50 ×). From the upper enlargements, one can see the shoulder of enlarged teeth on the posterior border of the bone. (Photos by G. S. Axelrod and L. Vleggaar).





Map 1: *Tropheus polli* collection area. (Drawing by G. S. Axelrod)

Table 6

Some comparative morphometric values for the four species of Tropheus

characteristic	as %	*T. polli* % mean	*T. polli* SD	*T. polli* n	*T. m. moorii* % mean	*T. m. moorii* SD	*T. m. moorii* n	*T. duboisi* % mean	*T. duboisi* SD	*T. duboisi* n	*T. brichardi* % mean	*T. brichardi* SD	*T. brichardi* n	*T. m. kasabae* % mean	*T. m. kasabae* SD	*T. m. kasabae* n
body length (b.l.)	s.l.	70,3	1,54	6	70,0	1,41	60	69,3	1,12′	45	—	—	—	—	—	—
head length (h.l.)	s.l.	29,7	1,54	6	30,0	1,41	60	30,8	1,12′	45	—	—	—	—	—	—
longest branched dorsal fin ray	b.l.	35,9	1,50	6	27,6	2,26*	44	32,1	3,09*	32	23,8	1,13*	9	26,3	1,56*	19
longest branched pelvic fin ray	b.l.	55,7	1,87	6	52,2	5,26	50	51,6	3,88′	34	46,1	3,80*	9	46,2	7,70*	19
longest branched anal fin ray	b.l.	34,7	2,36	6	28,4	2,90*	49	28,9	0,99*	33	25,6	1,48*	9	25,3	1,92*	19
anal fin – length at base	b.l.	30,4	0,54	6	32,4	1,73*	60	31,5	2,47	45	29,2	1,92	9	28,9	4,52	19
longest caudal ray	b.l.	65,0	5,83	6	34,9	4,96*	40	37,8	4,27*	30	35,4	1,83*	9	30,9	2,17*	19
interorbital width	h.l.	41,8	2,56	6	36,5	2,25*	60	38,0	1,48*	45	35,2	3,18*	9	42,3	3,43	19
preorbital width	h.l.	32,1	1,90	6	27,9	1,96*	60	24,9	1,99*	45	—	—	—	29,8	2,83′	19
snout length	h.l.	33,7	2,99	6	29,2	4,96′	60	33,4	2,83	45	28,1	2,54*	9	34,0	3,41	19
postocular portion of head	h.l.	41,6	2,11	6	43,0	2,20	60	37,6	2,30*	45	45,4	1,89*	9	46,0	2,71*	19
eye diameter	h.l.	24,7	1,64	6	27,8	4,47′	60	29,0	1,31*	45	28,7	1,58*	9	24,1	1,90	19
mouth width (m.w.)	h.l.	46,0	1,41	6	45,9	2,96	60	39,9	2,89*	45	53,4	1,88*	9	50,1	4,30′	19
mouth length	h.l.	13,5	1,20	6	14,8	1,62′	60	17,7	1,09*	45	16,7	1,55*	9	16,3	1,43*	19
mouth length	m.w.	29,4	2,00	6	32,2	3,47′	60	44,6	3,32*	45	—	—	—	32,7	2,51*	19
size range (standard length)	—	77,0–110,6 mm			50,4–90,1 mm			68,2–96,1 mm			60,7–77,2 mm			53,5–97,0 mm		

Notes

(1) The data for *T. brichardi* and *T. m. kasabae* are taken from Nelissen & Thys (1975) and Nelissen (1977) respectively.

(2) n = the number of specimens.

(3) The above date were evaluated using the "Student's" t-test (′) and (*) correspond to > 90% and > 99% respectively, the percent probability rejection of the null hypothesis, which states that there is no statistical difference between the two mean values for a characteristic. The particular characteristic for the species is compared against the same characteristic of *T. polli*.

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PLATE 20

Fig. 1: Simochromis babaulti male (GSA-SB8), Scale = 10 mm

Fig. 2: Simochromis curvifrons female (GSA-SC5), Scale = 10 m.

PLATE 21

Fig. 1: Simochromis marginatus male (GSA-SM10), Scale = 10 mm.

Fig. 2: Simochromis diagramma male (GSA-SD508), Scale = 10 mm.

Figure 1

Tropheus duboisi
White-banded morph

female (GSA-TD62)

scale = 10 mm

Figure 2

Tropheus moorii
Yellow-olive morph

male (GSA-TM13)

scale = 10 mm

Figure 3

Tropheus moorii
Brown morph

female (GSA-TM14)

scale = 10 mm

Figure 4

Tropheus moorii
Green morph

male (GSA-TM28)

scale = 10 mm

Figure 5

Tropheus moorii
Yellow-finned morph

male (GSA-TM61)

scale = 10 mm

Figure 6

Tropheus moorii
Red morph

male (GSA-TM48)

scale = 10 mm

Figure 7

<u>Tropheus moorii</u>
Red-orange spotted morph

male (GSA-TM62)

scale = 10 mm

Figure 8

<u>Tropheus moorii</u>
unidentified morph

female (GSA-TM63)

scale = 10 mm

Figure 9

<u>Tropheus moorii</u>
unidentified morph

female (GSA-TM64)

scale = 10 mm

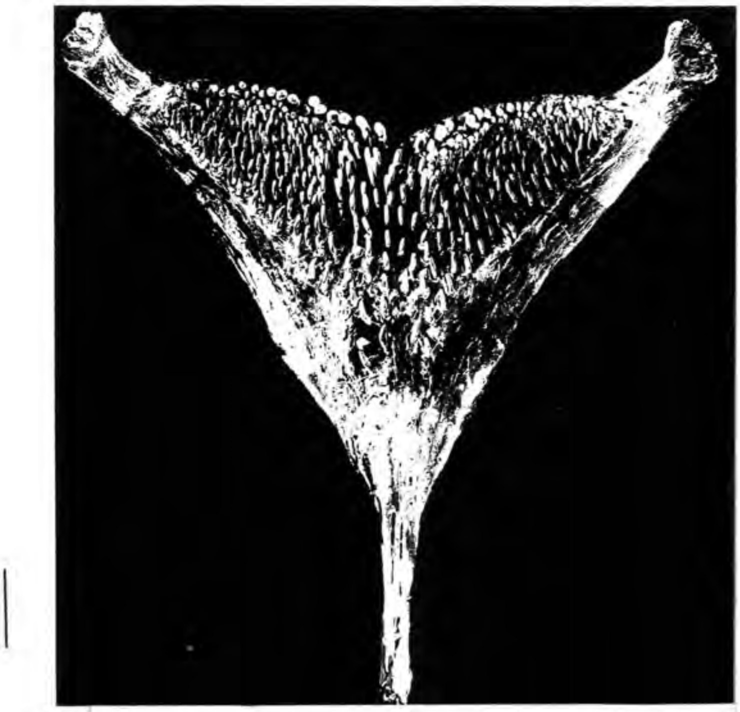


Figure 1

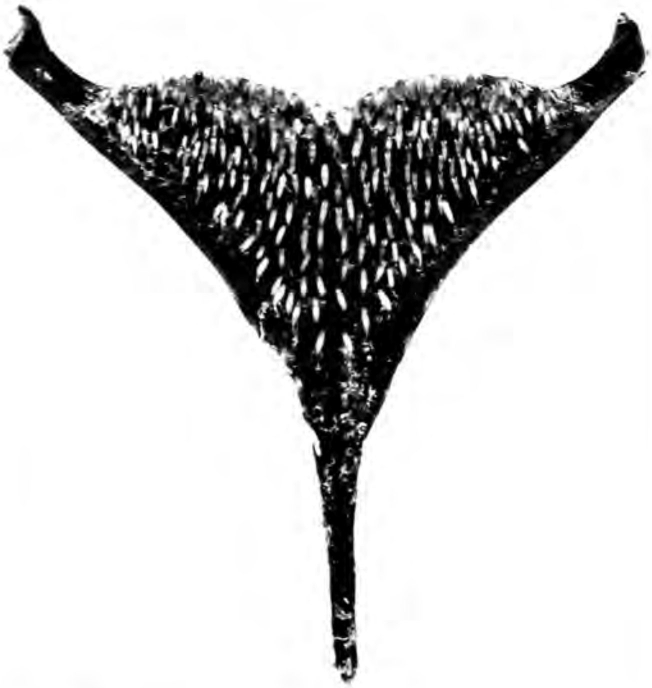
Tropheus polli (GSA-TP2)

lower pharyngeal bone

scale = 1 mm

Figure 2

Tropheus brichardi
(KMMA-P76-9-P-41)
lower pharyngeal bone
scale = 1 mm



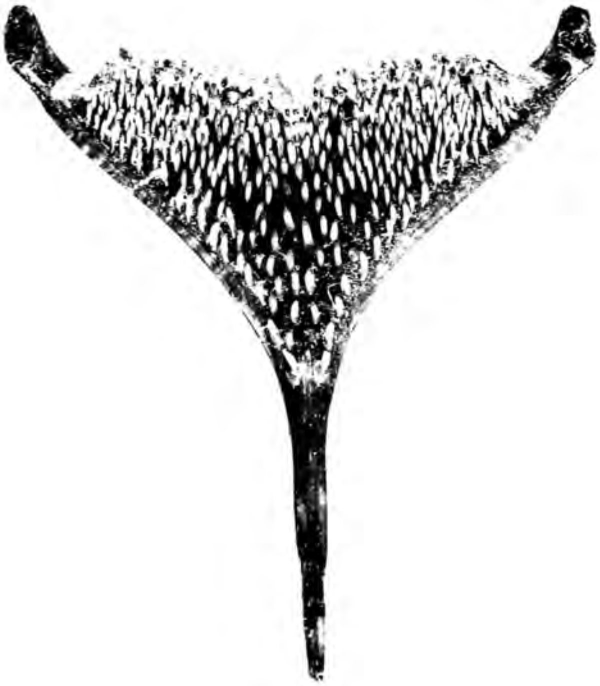
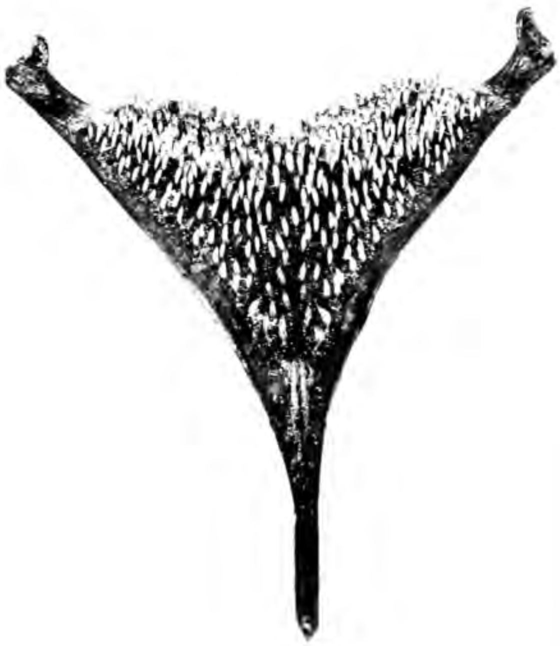


Figure 3

Tropheus duboisi (GSA-TD62)
lower pharyngeal bone
scale = 1 mm

Figure 4

Tropheus moorii (GSA-TM4)
lower pharyngeal bone
scale = 1 mm



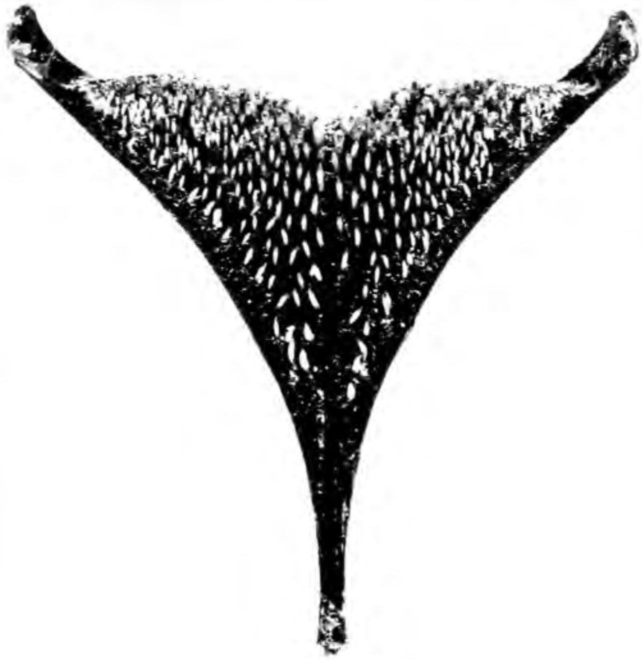


Figure 5
Simochromis sp. A (GSA-SS604)
lower pharyngeal bone
scale = 1 mm

Figure 6
Simochromis babaulti
(GSA-SB8)
lower pharyngeal bone
scale = 1 mm

Figure 7
Simochromis curvifrons
(KMMA-129651)
lower pharyngeal bone
scale = 1 mm

Figure 8

Simochromis diagramma
(GSA-SD508)

lower pharyngeal bone

scale = 1 mm

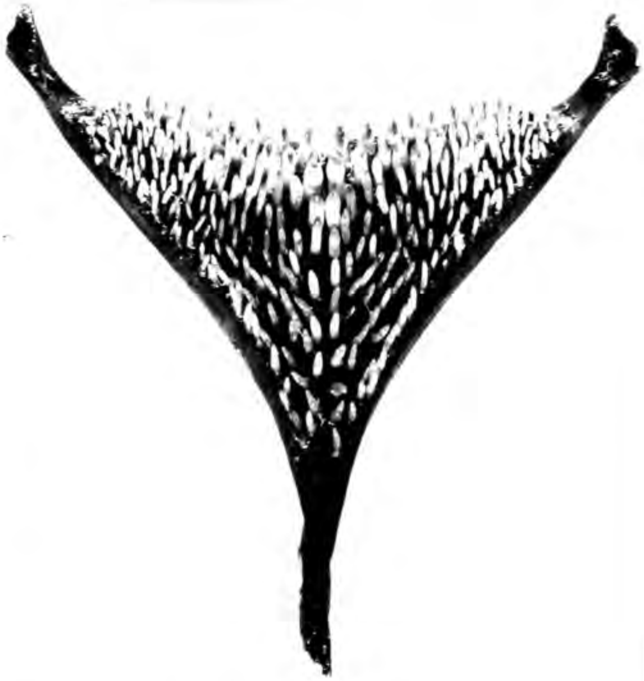


Figure 9

Simochromis diagramma
(GSA-SD500)

lower pharyngeal bone

scale = 1 mm

Figure 10

Simochromis marginatus
(GSA-SM601)

lower pharyngeal bone

scale = 1 mm