

The *Nothobranchius* (Pisces, Cyprinodontidae) of Southern Africa and a new species from Lake Chilwa, Malawi

PART 1

R. A. JUBB

Due to the attractive colours of mature males, *Nothobranchius*, endemic to Africa, are popular aquarium species in many parts of the world. Amongst aquarists they are generally known as "killifishes" or "annual fishes". The term "annual" is used since it was originally thought that these fishes completed their entire life cycle within the course of a single year. In nature the aquatic habitats of these fishes usually dry up during seasonal periods of prolonged lack of rain, and the adults, which have spawned by this time, together with all other post-embryonic forms, die. The ability of *Nothobranchius* populations to survive both cyclically recurring periods of dryness, as well as to escape extinction due to erratic climatic conditions, has been found by Wourms (1964) to be due to the ability of individual eggs to enter into and remain in a state of developmental arrest or diapause during their normal ontogeny.

From a neat summary published by Klee (1965) no fewer than fourteen species of *Nothobranchius* have been described from the region embracing Tanzania, Mocambique and the north-eastern lowveld of the Republic of South Africa. These are:

- N. emini* Ahl, 1935. Single specimen. Kongoran Botto, Tanzania.
- N. guentheri* (Pfeffer), 1893. Zanzibar, Tanzania.
- N. kuhntae* (Ahl), 1926. Beira, Mozambique.
- N. mayeri* Ahl, 1935. Single specimen. Beira, Mozambique.
- N. melanospilus* (Pfeffer), 1896. Longo Bay, Zanzibar, Tanzania.
- N. mkuziensis* (Fowler), 1934. Mkuzi River, Natal, South Africa.
- N. neumanni* (Hilgendorf), 1905. North Ugogo, Tanzania.
- N. orthonotus* (Peters), 1844. Quelimane, Mozambique.
- N. palmquisti* (Loennberg), 1907. Tanga, Usambara, Tanzania.
- N. rachovii* Ahl, 1926. Beira, Mozambique.
- N. robustus* Ahl, 1935. Swampy bay of Tschangarra, North Usinja, Tanzania.
- N. taeniopygus* (Hilgendorf), 1888. Lake Tshaya, Bubu River, Tanzania.
- N. troemneri* (Myers), 1926. Based on single aquarium specimen from East Africa.
- N. vosseleri* Ahl, 1924. Single specimen. Mombo, Tanzania.

The approximate positions of the type localities of the species listed above are shown in fig. 1. A number of these species have not been recognized since, and Klee's (*loc. cit.*) proposed list of valid species and synonyms for this region is as follows:

- N. guentheri*
- N. melanospilus* (Synonym *N. seychellensis* Ahl, 1935).
- N. mkuziensis*
- N. neumanni*
- N. orthonotus* (Synonyms: *kuhntae*? *troemneri*? *mayeri*?).
- N. palmquisti* (Synonyms: *vosseleri*, *emini*).
- N. rachovii*
- N. taeniopygus* (*robustus*).

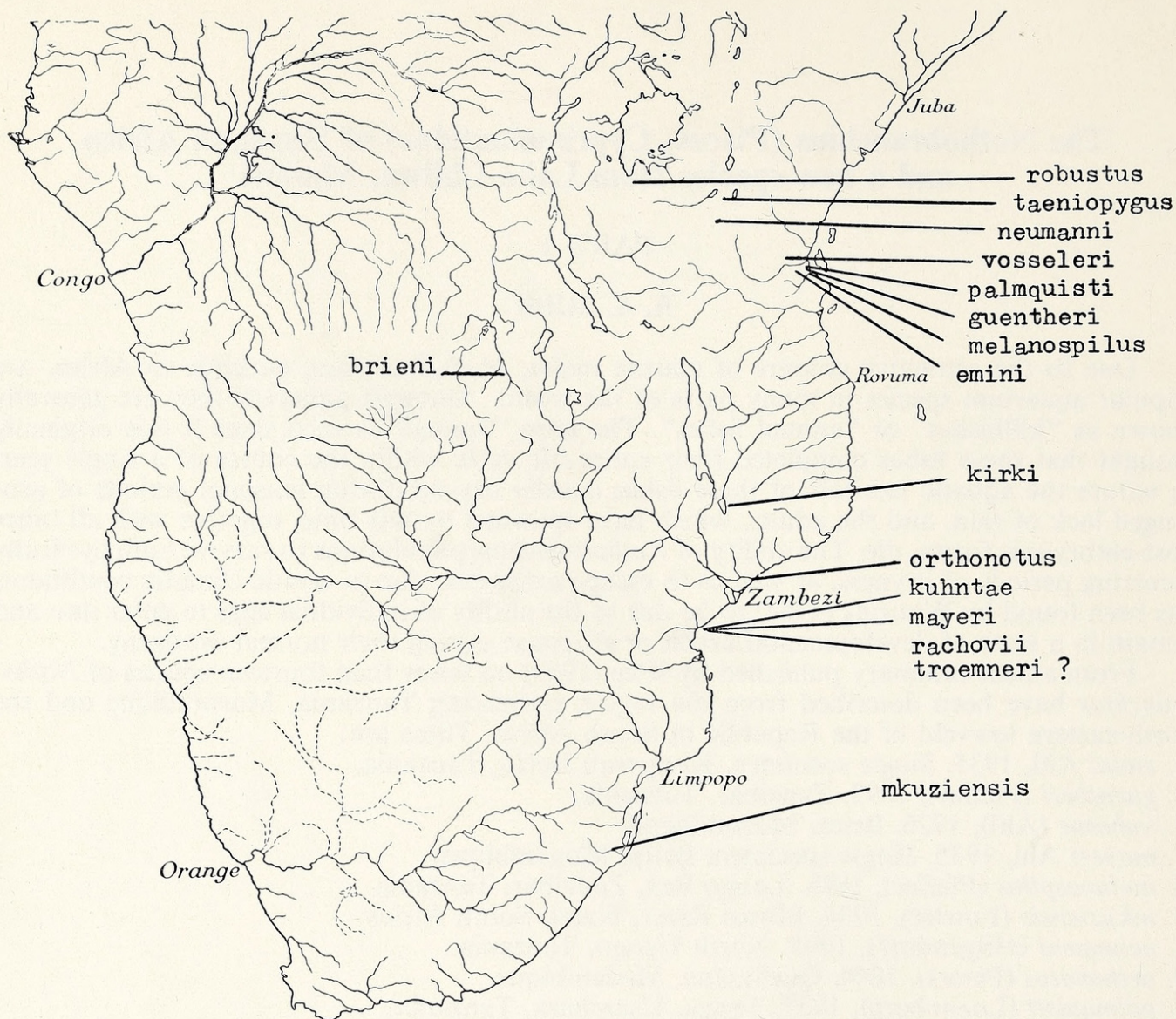


Fig. 1.

To a large extent this list is supported by the distribution of type localities shown on fig. 1 but it can be trimmed even further. There is some confusion about the status of Pfeffer's *melanospilus* (vide Boulenger, 1915, p. 34; Pfeffer, 1896, p. 48; Ahl, 1935, p. 128) and I am inclined to regard *melanospilus* as a synonym of *orthonotus*, the name originally used by Playfair & Günther (1866). It should be noted that Smith (1963) does not record *Nothobranchius* from the Seychelles and, indeed, it would be surprising to find representatives of this genus there, unless transported and transplanted by man.

Crass (1964) records *N. orthonotus* from the Ndumu Game Reserve, northern Natal. It was from the Mkuzi River, a short distance to the south of this, that Fowler's *mkuziensis* was described. Bruce Turner, American Museum of Natural History, has examined the type specimen of *mkuziensis* and has informed me (*in litt.*) that it is in poor condition. As the type locality has had its environment changed considerably by man for agricultural purposes the validity of *mkuziensis* will never be settled by actual specimens. It has been accepted that

mkuziensis is a synonym of the widely distributed *N. orthonotus*, but, after examining specimens of *N. rachovii*, as well as excellent slides supplied to me personally and illustrations published by Turner (1964), and referring them to Fowler's (1934) illustration, the possibility of *mkuziensis* being a synonym of *rachovii* must not be ruled out. It is probable that I was mistaken in not paying attention to the concentric bands on the caudal fin, and the blotches on the dorsal and anal fins, so reminiscent of the colour pattern of a male *rachovii* (see Jubb, 1967, fig. 180 and Turner, 1964, fig. 2), which are illustrated by Fowler. As regards the other proposed synonyms I can find no difference of opinion between Turner (*in litt.*) and Klee (*loc. cit.*). Whilst discussing *orthonotus* it is of interest to record the following remarks by Mr. E. J. Seymour, British Killifish Association, who was supplied with a colour slide of a male *N. orthonotus* from the Kruger National Park: "here *N. melanospilus* is regarded as the same fish as *N. orthonotus* so at least your colour slide clears that up."

The description of Hilgendorf's (1905) *neumanni* states that there are 32—36 scales around the body in front of the ventrals, but, the excellent illustrations of the type specimens, male and female, indicate that this is more likely to be 22—26. If this assumption is correct then I propose that *N. neumanni*, for this as well as geographical reasons, be regarded as a synonym of the widely distributed *N. taeniopygus*. This latter species is recorded from the streams of Lake Victoria (Greenwood, 1966), Lake Bangwelu, Upper Zambezi and Kafue River systems (Bell-Cross, 1965). I have examined specimens from a flood pool, Kafue River, between Mazabuka and the Kafue River Bridge. Both Klee (*loc. cit.*) and Bell-Cross (*loc. cit.*) consider *N. brienii* Poll, 1938, to be a synonym of *N. taeniopygus*. Under the name *brienii* Tait (1965) has described in some detail the habits and appearance of this species. I am indebted to Mr. G. Bell-Cross for notes and a colour photograph of an adult male *N. taeniopygus* from the Kafue River system.

There is no difficulty about the identification of a living specimen of an adult male of Ahl's *rachovii* with its spectacular colour pattern, particularly the caudal fin. The known distribution of this species extends from Beira southwards along the lowveld region to pans in the Kruger National Park, Eastern Transvaal, situated between the Olifants River (Limpopo system) and the Nwanetzi River (Incomati system) (Pienaar, 1968). Pans near this site are where the first specimens of *N. orthonotus* were collected in the Kruger National Park.

Table 1 is a summary of the general colour patterns of mature male specimens of *N. taeniopygus*, supplied by Bell-Cross, *N. guentheri* and *N. palmquisti*, supplied by Haas, *N. rachovii*, supplied by Haas and Pafenyk, *N. orthonotus* supplied by Pienaar and Rose, and an undescribed *Nothobranchius*, supplied by Kirk and Goldberg. The colour slides of this latter species, discovered by Kirk in the Lake Chilwa drainage system, Malawi, were of the first mature male discovered, as well as of mature males in America which were bred from fish sent via West Germany. Every attempt has been made to confine these patterns to those of mature adult males as there are considerable variations in colour patterns during the various stages of development of the male from the immature stage to the plumage of a mature adult male. As pointed out by Tait (*loc. cit.*) development of the colour pattern starts in males at a size of about 25 mm., but previous to this their colour and appearance is similar to that of the rather drab females.

The inland species *N. taeniopygus* is distributed along the western section of the region under discussion and the colour pattern of mature adult males can be recognized. The two species *N. orthonotus* and *N. rachovii* inhabiting suitable waters along the Mozambique coastal plains and lowveld of the eastern Transvaal and northern Natal can also be recognized. It is not as easy to separate *N. guentheri* and *N. palmquisti* individually but they can be separated from the three species mentioned above without difficulty. Resembling *N. guentheri* and *N. palmquisti* to some extent, but, differing markedly in the colour pattern of the dorsal and anal fins of mature adult males, is the *Nothobranchius* species discovered by R. G. Kirk,

fish biologist, in the drainage system of Lake Chilwa, Malawi. From fig. 1 it will be seen that the type locality is practically in the centre of the Tanzania, Mozambique, northern Natal region. This *Nothobranchius* is now described as a new species.

***Nothobranchius kirki* sp. nov.**

HOLOTYPE: An adult male, total length 45 mm., Std. length 37.5 mm., collected on the 21st July, 1966, by Mr. R. G. Kirk, fish biologist, Agricultural Research Services, Ministry of Natural Resources, Malawi, in a pool adjacent to the Likangala River which forms part of the Lake Chilwa endoreic drainage basin, Malawi. Registered No. P.F. 994, Albany Museum, Grahams-town.

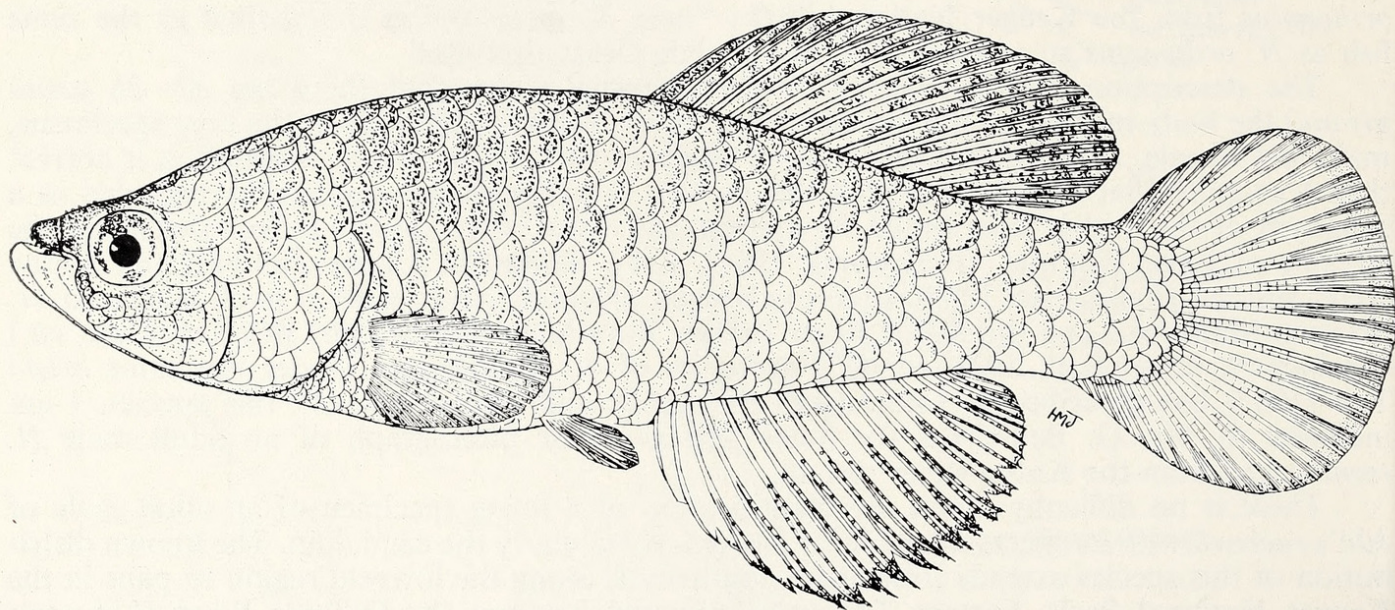


Fig. 2. Male paratype *Nothobranchius kirki* sp. nov. Std. length 35 mm., total length 41 mm.

DESCRIPTION: This species has been described from the holotype and nine paratypes, No. P.F. 995, from the same locality, four males and five females. The values in parentheses are those of the type.

In percentage of standard length: Total length 116.0—120.0 (120.0); depth 30.0—33.5 (32.0); length of head 30.0—34.0 (32.0); snout to origin of dorsal 58.0—62.4 (61.5); snout to origin of pectoral 31.6—33.5 (32.0); snout to origin of ventrals 48.0—53.5 (50.6); snout to origin of anal 60.6—68.8 (62.5). Ovigerous females gave the higher values.

In percentage of length of head: Length of snout 19.0—23.0 (20.7); eye 20.0—26.0 (25.0); interorbital width 39.8—42.7 (41.6).

Scales markedly deciduous in preserved material, 26—28 in longitudinal series, lateral line pores absent. Scales around body immediately in front of pelvic fins 22—24.

Snout short, flat and broad. In mature males the snout is covered with numerous small tubercles which extend to forehead, edges of adjacent scales and margins of orbits. These tubercles also appear on rays of dorsal and anal fins. Mouth directed upwards, lower jaw projecting. Teeth in upper jaw conical, sharply pointed, those of outer series largest; teeth in lower jaw mostly coarse with flattened crowns.

Dorsal fin 15—17 (16); anal 15—18 (16). Origin of dorsal fin over origin of anal except in some distorted ovigerous females where the anal fin is displaced slightly posteriorly. Mature males have tips of anal and caudal rays extended to beyond membrane of these fins,

a feature not evident in female material available. In specimens of the same size there is no significant difference in size of the anal fins, but males have slightly larger dorsal fins, the posterior rays being longer.

COLOURATION: For the description of the colours of living mature adult males I am indebted to Mr. R. G. Kirk and Dr. R. J. Goldstein. The former supplied a colour transparency of one of the first males discovered near Lake Chilwa (Jubb, 1967), and the latter a description (Goldberg, 1968) and colour transparencies. Figure 3, a monochrome photograph of Kirk's first mature adult male, has been used to facilitate the description of this beautiful fish. Basically in the illustration all the black may be regarded as some shade of crimson, and the white as some shade of turquoise. The detailed description is as follows: Scale centres iridescent turquoise (2) edged crimson (1), edging on scales forming a reticular pattern when fully developed; ventrum crimson from midway between insertion of pectorals to and along base of anal fin (12); crimson region broadest between ventrals and anal fin; pectorals (14) pectorals practically transparent, pale olive; pelvics ventrals (13) crimson tipped with black; anal crimson at base (12), then a clear band (11) colourless or pale turquoise, the rest of the anal (10), except for the extreme edge where the extended rays are black, being crimson.

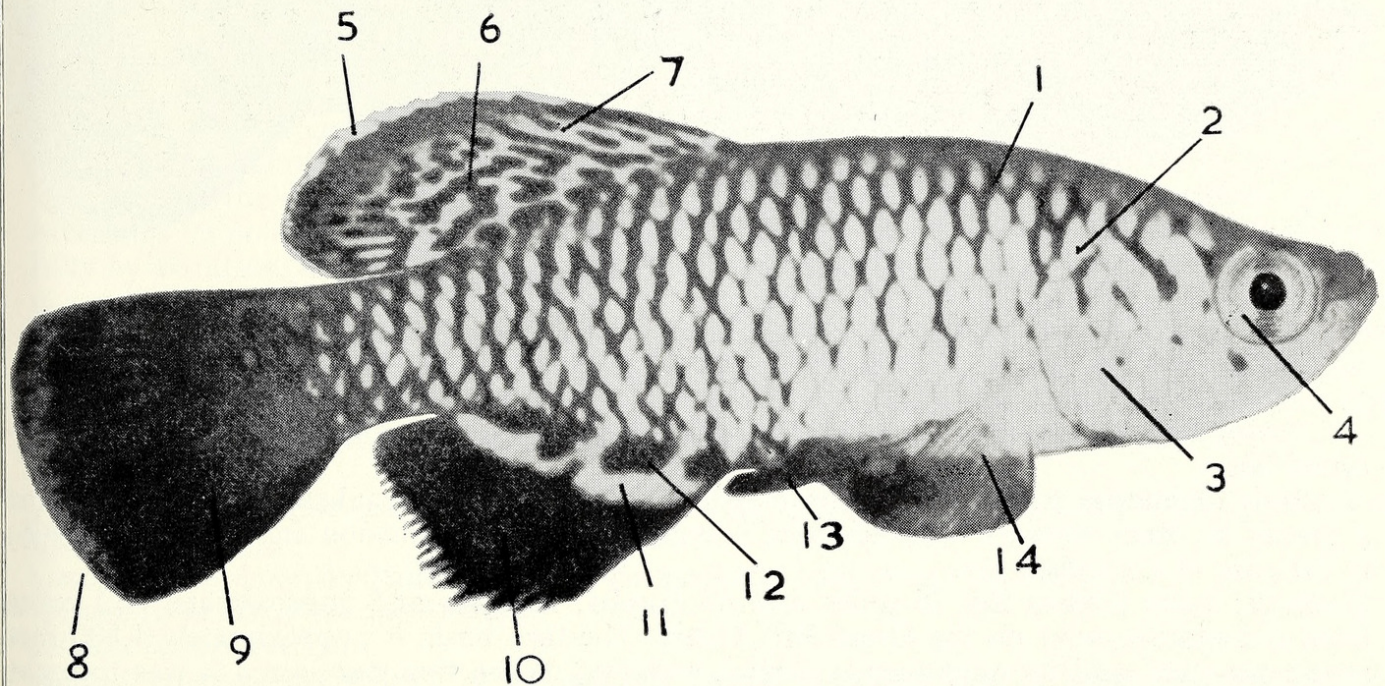


Fig. 3. Key to colour pattern: 1, crimson; 2, turquoise; 3, turquoise with crimson markings; 4, golden, tinted turquoise; 5, edge turquoise; 6, crimson to red-brown; 7, membrane pale turquoise or olive; 8, colourless transparent border; 9, crimson; 10, crimson; 11, colourless or pale turquoise; 12, crimson; 13, crimson tipped black; 14, membrane practically colourless or pale olive.

Caudal crimson (9), darker at base, with narrow black band, or, as in some specimens, a colourless posterior border (8). In either pattern the tips of any extended rays are black. The dorsal fin has membrane pale olive or pale turquoise (7) with crimson to red-brown spots and irregular bands (6); membrane darker towards extremity with edge turquoise (5).

The pupil of the eye has a narrow golden border, the iris being golden, tinted turquoise in places with traces of pigmented vertical dark bar through eye (4). Chin and throat pale golden olive, operculum (3) turquoise with crimson markings.

Specimens preserved in 5% formalin solution are practically featureless. Both sexes have numerous small black dots visible through the scales, males being generally darker as shown in fig. 2. The membrane of the dorsal fin is pigmented giving a blotchy effect. The pale band in the anal fin, No. 11 in fig. 3, becomes a pigmented band of small dots in preserved material. This pale band, shown broken (11) in fig. 3 is sometimes continuous as shown in fig. 4, a photograph taken in North America of a male *N. kirki* (third generation) from Malawi stock. The pale band at the posterior extremity of the caudal fin is also pigmented with minute dots, as are extended tips of the rays of the anal fin and articulations of the lepidotrichia of both fins.

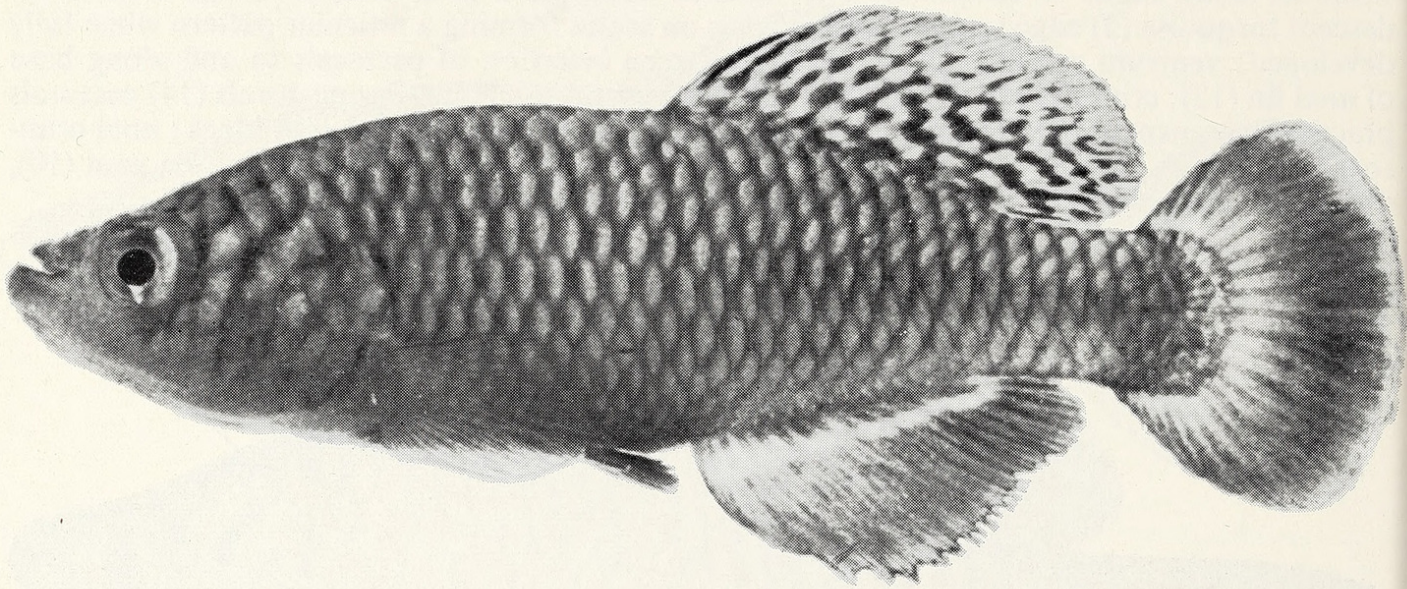


Fig. 4. Photograph by Dr. Goldstein of a male *N. kirki*, third generation, bred in America.

Living female specimens of *N. kirki* are drab silvery-grey with pale olive or pale turquoise-tinted fins.

It is of interest to note that male breeding colours have been taken as characteristic of a species by other workers. This has been accepted both by Greenwood and Trewavas (1966) in the case of Cichlids.

HABITAT: Lake Chilwa lies 16 miles east of Zomba, Malawi, and approximately 32 miles from the nearest point on the Great Rift Valley. The lake basin is approximately 1,800 feet above sea level, and its catchment is, today, endoreic. When first discovered it was thought to have evolved as part of Lake Malawi, but, recent investigations (Kirk, 1967) indicate that at one stage it formed a single body of water with Lake Chiuta which overflows into the Lugenda River, a major tributary of the Rovuma River system. It should be noted that on some maps Lake Chilwa is marked as Lake Shirwa.

At present Lake Chilwa has an open area of water of some 260 square miles, and surrounding marshes of about the same area. From observations recorded during historical times it is evident that the area of this productive lake varies considerably both annually and over long periods. It lies in an area of variable summer rainfall, which accounts for its annual rise and fall in water level, and it also lies in the path of occasional Indian Ocean cyclones which cross the Mozambique Channel and move inland accompanied by heavy rains. These extraordinary rains account for the huge areas that get inundated every decade or so. The lake drainage system therefore provides a suitable habitat for *Nothobranchius*.

The water in the lake and surrounding marshes is saline but this varies greatly according to the season, being about .01 p/1000 after good rains, to about 1 p/1000 at the end of the dry season which is during the months August to November.

The lake is extremely productive and according to Kirk (*loc. cit.* & *in litt.*) practically the entire shoreline of Lake Chilwa is obstructed by dense growth of marginal vegetation, mainly *Typha*, but with occasional tracts of *Phragmites* and *Papyrus*. At low water the marshes are particularly dense, particularly to the north and north-west, the beds of reeds being interspersed with lagoons which cover a large area. In short the whole habitat provides excellent cover for small species of fishes and this probably accounts for the fact that *N. kirki* has remained undiscovered for such a long period.

Although Lake Chilwa has no outlet, several rivers flow into it, the three largest entering the lake from the south-east. These are the Sombaxini, Palombe and Likanagala rivers, the latter two draining the Mlange and Zomba plateaux respectively. It was in isolated pools adjacent to the Likanagala River, and near the main body of water of Lake Chilwa that *N. kirki* were first discovered. Lake Chilwa is shallow, the deepest water being about 20 feet, and the adjacent pools and lagoons are both shallow and warm. Observations made during August 1966 at a pool containing *N. kirki* gave a water temperature reading of 31.0 C (88.0 F.), pH 8.0 and salinity 16.5 mg/litre.

BREEDING HABITS AND BEHAVIOUR: Apart from the fact that female *N. kirki* collected during July and August were ovigerous with eggs 1.0—1.3 mm. in diameter, translucent off-white in colour with large centrally-located oil droplets visible in the yolk, nothing is known of the breeding habits of *N. kirki*. These fish would be ready for spawning as August is the beginning of the dry season when isolated pools would start drying up. It is unlikely that the breeding habits of *N. kirki* differ materially from those of *N. taeniopygus* described so carefully by Wourms (*loc. cit.*), or behaviour of *N. brienii* described by Tait (*loc. cit.*). *N. taeniopygus* is a substrate spawner. Wourms supplied a substrate of fine white quartz sand for his investigations. A spawning male drives a female onto the surface of the substrate. Eggs and sperm are deposited in a depression in the substrate formed by the joint action of the two fishes, now in close opposition to one another. The eggs are then covered over with the caudal fins and the pair move away from the spawning site.

AFFINITIES: Kirk (*loc. cit.*) collected the following species within the Lake Chilwa basin and drainage system:

Gnathonemus macrolepidotus (Peters), *Petrocephalus catostoma* (Günther).

Cyphomyrus discorhynchus (Peters).

Alestes imberi Peters.

Barbus trimaculatus Peters, *B. paludinosus* Peters, *B. manicensis* Pellegrin, *B. tangandensis* Jubb, *B. innocens* Pfeffer, *B. toppini* Boulenger.

Beirabarus radiatus (Peters).

Labeo cylindricus Peters.

Clarias gariepinus (Burchell), *B. theodora* Weber.

Pareutropius longifilis (Steindachner).

Tilapia shirana chilwae Trewavas, *T. sparrmanii*, *T. melanopleura*.

Haplochromis callipterus (Günther), *Hemihaplochromis philander* (Weber).

Except for *Barbus innocens*, which is closely related to the widely-distributed *B. unitaeniatus* Günther, all the above species are found in the inland waters of the east coast of Africa, some of them being widely distributed in Africa. The presence of *Pareutropius longifilis* is of particular interest as it is known only from the Ruvuma, Rufigi and Kingani River systems. Trewavas (1966) has re-examined the syntypes of *Eutropius longifilis* Steindachner, 1916, and

has found that they have 3 soft dorsal rays only, and are conspecific with *Pareutropius micristius* Regan, 1920. It would not be surprising, therefore, to find *N. kirki* associated with the Ruvuma and Rufigi River systems. In the colour pattern of an adult breeding male *N. kirki* comes nearest to the closely related *N. guentheri* and *N. palmquisti*, but differs entirely in the colour patterns of the dorsal and anal fins, as shown on Table 1. It also differs from its western relatives, *N. rubroreticulatus* Blache and Miton, from the Chad basin, and the *N. kiyawensis* Ahl, *N. gambiensis* (Svennson) group. This latter species, considered by Klee (*loc. cit.*) to be a synonym of *N. kiyawensis*, was first described from a single female specimen, but later Johnels (1954) described a mature male in full plumage.

ACKNOWLEDGEMENTS: The taxonomy of the freshwater fishes of southern Africa is part of a research programme carried out at the Albany Museum, and which is sponsored by the Council for Scientific and Industrial Research, Pretoria. Collaborators in this investigation have been mentioned in the text. Illustrations in colour of the species *N. orthonotus*, *N. rachovii* and the new species *N. kirki* will be found facing page 121, Jubb 1967, and the former two species in Pienaar 1968, pages 60—64. These latter illustrations are of particular interest as they include the females of the species. Mrs. H. M. Jubb kindly prepared the drawing of the paratype, fig. 2.

I wish to thank Mr. R. G. Kirk for supplying the material and data relating to *N. kirki* and Mr. C. F. Jacot Guillarmod, Director of the Albany Museum, for reading and publishing this paper.

(Addresses of collaborators overseas:

Dr. R. J. Goldstein, Department of Biology, Emory University, Atlanta, Georgia, 30322.

Mr. R. Haas, Department of Zoology, University of California, Los Angeles, California, 91364.

Mr. B. J. Turner, American Museum of Natural History, Central Park West, 79th Street, New York, 10024.

Mr. E. J. Seymour, British Killifish Association, 12A, Hoylake Court, Ardler, Dundee, Scotland.)

Part 2 deals with additional material from Moçambique.

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TABLE I

Species	Scales	Dorsal	Caudal
<i>N. taeniopygus</i> D 15—18 A 15—19 L.L. 27—32 Tr. 22—26	Edged carmine or brick-red, centres iridescent turquoise.	Membrane liver-coloured or brick-red, turquoise spots or blotches.	Dark red or brick-red at base, fading to bright orange band with distinct black border.
<i>N. guentheri</i> D 17—18 A 18—19 L.L. 27—30 Tr. 24—28	Edged carmine or dark red; centres iridescent turquoise.	Membrane olive with dark red or liver-coloured spots, fin darker towards ex- tremity and bordered with white.	Carmine to dark red with paler band towards ex- tremity, border jet-black.
<i>N. palmquisti</i> D 15—16 A 14—15 L.L. 26—28 Tr. 22—26	Edged carmine or dark red; centres iridescent turquoise.	Membrane olive with small spots, reddish at base, be- coming liver-coloured to- wards extremity.	Entirely carmine with pale or transparent border.
<i>N. rachovii</i> D 14—16 A 15—16 L.L. 25—27 Tr. 22—24	Edged carmine; centres iri- descent turquoise.	Membrane turquoise with large liver-coloured spots or blotches forming irregular transverse bands, fin bor- dered faintly with white.	Four to six concentric bands spotted or mottled tur- quoise at base, then turquoise band followed by brilliant orange band, which pales to yellow, then a distinct black band faintly edged with white.
<i>N. orthonotus</i> D 14—16 A 14—17 L.L. 27—32 Tr. 22—27	Edged maroon or liver- coloured; centres iridescent blue, turquoise or dark green.	Membrane olive with nume- rous small liver-coloured spots, extremity of fin being dark and often edged with white.	Dark olive with rays, and sometimes small spots liver-coloured.
<i>N. sp. nov.</i> D 14—16 A 15—18 L.L. 26—28 Tr. 22—24	Edged crimson; centres iri- descent turquoise.	Membrane pale olive with large carmine or red-brown spots and irregular bands, extremity of fin darker and bordered with white or pale turquoise.	Entirely crimson, the base being darker and extremity colourless or edged with thin black border.

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Anal	Ventral	Pectoral	Ventral surface and eye
brick-red at base followed by darkish band, the remaining two-thirds being bright orange, bordered ventrally by a black band.	Carmine or orange-red with black tips.	Transparent pale olive or orange membrane.	Distinctly rufous especially lower parts of gill cover and mandible, scales on head also turquoise. Iris golden or tinted blue, pupil bordered gold, vertical dark bar through eye.
membrane pale olive with carmine or liver-coloured spots, the extremities of some rays black.	Dark olive tipped black.	Transparent Pale olive membrane.	Golden-olive with some red on gill cover and lower part of mandible. Iris golden tinted blue, pupil bordered gold with darker vertical bar through eye.
membrane olive with small carmine to liver-coloured spots near base.	Olive tipped with dark red.	Transparent pale olive membrane.	Golden-olive. Iris turquoise with traces of vertical dark band through eye.
membrane turquoise with large liver-coloured spots forming irregular bands, the fin being bordered ventrally with thin white band.	Turquoise with large brick-red or liver-coloured spot at base of fin.	Transparent olive membrane crimson tinted in axil of fin.	From vent to gill opening golden-olive, the sides of the head and lower jaw being carmine. Iris turquoise, pupil edged with gold, black or dark vertical bar through eye.
membrane pale olive with numerous liver-coloured or magenta spots, extremity mauve tinted with white border.	Liver coloured, often tipped with white.	Transparent pale olive.	Golden, green tinted, with numerous small liver-coloured spots. Iris golden with dark vertical band through eye.
crimson at base, then pale olive or pale turquoise band with remainder of fin crimson. Tips of fin rays black.	Crimson tipped black.	Transparent pale olive or turquoise.	From vent to beyond ventrals distinctly rufous, but throat and lower jaw olive. Iris golden, tinted turquoise in places, traces of darker vertical bar through eye.



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