

## *Nothobranchius kardashevi* and *Nothobranchius ivanovae* (Cyprinodontiformes: Nothobranchiidae): two new annual killifishes from the Katuma River drainage, western Tanzania

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### Abstract

Two new annual killifish species, *Nothobranchius kardashevi*, new species, and *N. ivanovae*, new species, are described based on specimens collected in ephemeral pools in the Katuma River drainage system, western Tanzania. *Nothobranchius kardashevi*, new species, belongs to the *N. ugandensis* species group and *N. ivanovae* to the *N. taeniopygus* species group. Both are distinguished from the respective other group members by a diagnostic combination of male colouration and morphological characters.

### Zusammenfassung

Die beiden neuen Killifisch-Arten, *Nothobranchius kardashevi* nov. spec. und *N. ivanovae* nov. spec., werden auf der Grundlage von Exemplaren beschrieben, die in saisonalen Tümpeln im Einzugsgebiet des Katuma-Flusses in West-Tansania gesammelt wurden. *Nothobranchius kardashevi* nov. spec. gehört zur *N. ugandensis*-Artengruppe, *N. ivanovae* hingegen zur *N. taeniopygus*-Artengruppe. Sie unterscheiden sich jeweils von den anderen Gruppenangehörigen durch eine Kombination aus Farbmerkmalen bei den Männchen und morphologischen Kennzeichen.

### Résumé

Deux nouvelles espèces de killifish annuels, *Nothobranchius kardashevi*, nouvelle espèce, et *N. ivanovae*, nouvelle espèce, sont décrites sur base de spécimens collectés dans des mares éphémères dans le système de drainage de la Katuma River, à l'ouest de la Tanzanie. *Nothobranchius kardashevi*, nouvelle espèce, appartient au groupe *N. ugandensis* et *N. ivanovae*, au groupe *N. taeniopygus*. Tous deux se distinguent des autres membres respectifs des groupes par une combinaison diagnostique de la coloration du mâle et des caractéristiques morphologiques.

### Sommario

Due nuove specie di killifish annuali, *Nothobranchius kardashevi*, nuova specie, e *N. ivanovae*, nuova specie, sono descritte sulla base di esemplari raccolti in pozze effimere

nel sistema di drenaggio del fiume Katuma, Tanzania occidentale. *Nothobranchius kardashevi* appartiene al gruppo di specie *N. ugandensis*, mentre *N. ivanovae* al gruppo di specie *N. taeniopygus*. Entrambi sono distinti dai rispettivi altri membri del gruppo da una combinazione diagnostica comprendente la colorazione del maschio e caratteristiche morfologiche.

### INTRODUCTION

The killifish genus *Nothobranchius* occurs in the subtropical and tropical parts of eastern Africa, from Sudan to South Africa, and from Chad to Zanzibar and Mafia islands in Tanzania. All known species are annual fishes, living in temporary pools and swamps formed during the rainy season (Wildekamp 2004). Six *Nothobranchius* species are currently known from central Tanzania: *N. neumanni* from the Great Ruaha, Bubu, Wembere, and Malagarasi River basins, and Lakes Manyara and Victoria drainage systems; *N. robustus* from the Lake Victoria drainage system; *N. seegersi* from Malagarasi River basin; *N. taeniopygus* from the Wembere, Malagarasi, and Bubu River basins and the Lakes Victoria and Rukwa drainages systems; and at least two undescribed species: *N. sp. aff. neumanni* “Mbeya Type”, and *N. sp.* “Lake Victoria” (De Vos et al. 2001; Seegers 1997; Shidlovsky 2010; Valdesalici & Kardashev 2011; Wildekamp 1990, 2004).

In May 2011, Kiril Kardashev and Iva Ivanova collected specimens of two *Nothobranchius* species from ephemeral pools in the Katuma River drainage system, western Tanzania, during a *Nothobranchius* species survey. As a result of the present study, these specimens are herein described as *N. kardashevi*, new species, and *N. ivanovae*, new species.

## MATERIAL AND METHODS

Measurements and counts were taken as described in Amiet (1987), Huber (2000), and Valdesalici (2010). Measurements were made with a digital caliper, partly under a dissecting microscope, and rounded to the nearest 0.1 mm. If not stated otherwise, measurements are presented as percentages of standard length (SL), except for eye diameter and snout length, which are given as percentage of head length (HL). Terminology for the cephalic neuro-mast series follows Scheel (1968) and Huber (2000) and for the frontal squamation Hoedeman (1958). Osteological preparations (clearing and staining, below: C&S) were made according to Taylor and Van Dyke (1985), but not stained for cartilages. Morphological data from Seegers (1996), Valdesalici et al. (2009) and Wildekamp (1990, 1994) were used for comparisons.

Type material is deposited in the following institu-

tions: Royal Museum for Central Africa (MRAC), Tervuren, Belgium and Museo Civico di Storia Naturale "Giacomo Doria" (MSNG), Genova, Italy.

### *Nothobranchius kardashevi*, n. sp.

(Figs 1-2, Table I)

**Holotype:** MRAC B2-09-P-1, 1 male, 37.7 mm SL, pond on left side of the road from Kabungo to Iloba, Karira stream, Katuma river drainage, altitude 1023 m, Tanzania, 06°22.061'S, 030° 56.161'E, 21 May 2011, Kiril Kardashev and Iva Ivanova.

**Paratypes:** MRAC B2-09-P-2-5, 1 male, 36.1 mm SL C&S, 3 females, 29.3-33.6 mm SL; MSNG 56889, 1 male, 31.2 mm SL; same data as holotype.

**Diagnosis:** *Nothobranchius kardashevi* males similar to other members of *N. ugandensis* species group, differing from all other species of the genus by com-



Fig. 1. *Nothobranchius kardashevi*, adult male, about 35 mm SL, not preserved, Karira stream, western Tanzania. Photo by I. Ivanova.



Fig. 2. *Nothobranchius kardashevi*, adult female, about 30 mm SL, not preserved, Karira stream, western Tanzania. Photo by I. Ivanova.

**Table I.** Morphometric data for *Nothobranchius kardashevi*. Measurements were given as percentages of standard length in mm. Eye diameter and snout length were given as percentages of head length. Cleared and stained material is included.

	Holotype	Males (n = 3)	Females (n = 3)
Standard length (mm)	37.7	31.2-37.7	29.3-33.6
Body depth at pelvic fin	27.8	25.9-27.8	22.6-26.7
Predorsal length	57.8	57.8-60.2	55.3-57.4
Preanal length	63.1	57.0-63.1	61.4-64.1
Prepelvic length	51.7	47.4-51.7	49.8-54.7
Caudal peduncle length	24.6	19.1-24.6	22.9-25.5
Caudal peduncle depth	12.7	12.1-13.0	10.1-11.3
Dorsal fin base length	23.3	23.3-28.5	22.9-23.8
Anal fin base length	20.4	20.4-24.0	15.6-16.2
Head length	31.2	31.2-34.6	31.0-33.3
Snout length	26.2	24.8-27.8	21.7-25.0
Eye diameter	23.7	23.7-27.8	25.8-29.7

bination of male colouration characters consisting of light blue scales with a broad irregularly reticulated pattern on body forming oblique bars in bright red, vivid bright red colouration on the head and dorsum, yellow or blue anal fin, large vivid red spot pattern on dorsal and anal fins; rounded head, dorsal profile of head slightly concave to nearly straight, convex from nape to end of dorsal fin base; variable cephalic squamation. Differs from other members of the *N. ugandensis* species group by caudal fin spotted (vs. caudal fin plain). Distinguished from *N. nubaensis* by reduced red pigmentation, having irregular broad margin on scales (vs. regular reticulation), by hyaline pectoral fins (vs. red), and having blue anal fin and pelvic fins (vs. yellow). Distinguished from *N. ugandensis* by absence of dorsal, anal and caudal fin margin (vs. present, sometimes one or more margins absent), by broad irregular blotch pattern on dorsal fin in two colours (vs. only one colour and more regular pattern often reduced as a series of dots), by anal fin pattern with large irregular spots in two colours (vs. without any spots or if present in only one colour and reduced to a few dots), by broad spots on caudal fin (vs. if present, faint dots on yellow morph). In addition, *N. kardashevi* males have a relatively longer head compared to *N. nubaensis* (31.2-34.6 vs. 26.3-33.6% SL), relatively higher number of scales in longitudinal series (28-32 vs. 29-30), fewer anal fin rays (16-17 vs. 17-19), more slender caudal peduncle compared to *N. ugandensis* (12.1-13.0 vs. 12.5-16.2% SL), reduced number of circumpeduncular

scales (12 vs. 14 in *N. nubaensis* and 14-16 in *N. ugandensis*, and a different posterior supraorbital neuromast series (with two neuromasts vs. three in *N. ugandensis* and *N. nubaensis*).

**Description:** See Figs 1-2 for overall appearance and Table I for morphometric data for the type series. Robust *Nothobranchius* with rounded body, maximum length recorded in males 37.7 mm SL. Dorsal profile slightly concave to nearly straight on head, convex from nape to end of dorsal fin base, ventral profile convex, slightly concave on caudal peduncle posterior to dorsal and anal fin. Snout slightly pointed, mouth directed upwards, lower jaw longer than upper jaw, posterior end of rictus at same level as or slightly above centre of eye. Branchiostegal membrane projecting posteriorly from opercle. Dorsal and anal fins located posterior to mid-body, tips rounded with short filamentous rays. Both fins with papillate contact organs on fin rays. Dorsal fin tip reaching caudal fin. Number of dorsal fin rays 17-18, anal fin rays 16-17. Pectoral fin (18-20 rays) approximately triangular; in some specimens pectoral fins reach pelvic fins, and pelvic fins (6 rays) reach the anus. Caudal fin rounded (24-28 rays).

Scales cycloid, body and head entirely scaled, except for ventral surface of head. Scales in median lateral series 28-32 + 1-2 on caudal fin base. Transverse row of scales 12. Circumpeduncular scales 12. Cephalic squamation pattern variable. Frontal neuromast series of the 'open' type. Anterior supraorbital series with one or two neuromast. Posterior



head scales light blue, dark red margin of some scales on dorsal part of body and caudal peduncle broader. Snout, frontal, and dorsal portion of head red. Operculum with 3 oblique stripes extending from eye to dorsal part of the head; branchiostegal membrane whitish. Dorsal fin light blue with irregular rows of dark red spots and dots; proximally somewhat fused forming an irregular blotch, medially elongated on fin rays, distally denser and smaller. Anal fin light blue with few dark red proximal spots and dots. Irregular violet spots are present over entire dorsal fin and anal fin. Pelvic fins light blue, red dots near the base. Pectoral fins hyaline with light blue margins. Caudal fin light blue with dark red spots and dots, proximally fused forming an irregular blotch more dotted distally. Iris golden.

Female (Fig. 2). Body and head scales pale brown, with silver iridescence on scale centre. Opercular region silver. Abdomen silver. All fins hyaline. Iris golden.

**Etymology:** The species name is dedicated to my friend, aquarist, collector, and discoverer of the species, Kiril Kardashev from Dupnitsa, Bulgaria.

**Distribution and habitat:** (Figs 3-4) *Nothobranchius kardashevi* is currently only known from a residual pool in the temporary Karira stream,



Fig. 4. Type locality of *Nothobranchius kardashevi* and *N. ivanovae*. Residual pool in Karira stream, western Tanzania. Photo by K. Kardashev.

Katuma River drainage, western Tanzania. The other fish present were *N. ivanovae*, new species, and unidentified *Barbus* species.

***Nothobranchius ivanovae*, n. sp.**

(Figs 5-6, Table II)

**Holotype:** MRAC B2-09-P-6, 1 male, 44.7 mm SL, pond on left side of the road from Kabungo to Iloba, Karira stream, Katuma river drainage, altitude 1023 m, Tanzania, 06°22.061'S, 030°56.161'E, 21 May 2011, Kiril Kardashev and Iva Ivanova.

**Paratypes:** MRAC B2-09-P-7-12, 4 males 34.4-35.8 mm SL, 2 females 29.2-33.1 mm SL; MRAC B2-09-P-13-15, 3 males 30.1-35.7 mm SL C&S; same data as holotype; MSNG 56890, 1 male 32.1 mm SL; 2 females 27.5-27.6 mm SL; series of ponds on right side of the road from Kabungo to Iloba, Katuma river drainage, altitude 1010 m, Tanzania, 06°25.413'S, 030°53.223'E, 22 May 2011, Kiril Kardashev and Iva Ivanova.

**Diagnosis:** *Nothobranchius ivanovae* males similar to other members of *N. taeniopygus* species group, differing from all other species of the genus by caudal and anal fin with a broad light sub-marginal band and dark margin. Differs from the similar and geographically closest *N. taeniopygus* from Ipati River ("phenotype 4" sensu Wildekamp 2004) by the following combination of characters: caudal fin red (vs. caudal fin pale brownish red) with subdistal band (vs. without band), anal fin with a creamy yellow broad submarginal band (vs. thin white band), and from *N. taeniopygus* from Wogo river ("phenotype 2" sensu Wildekamp 2004) by the following combination of characters: blue-grey scales (vs. light blue), caudal fin red (vs. pale brownish grey) with a subdistal and distal band (vs. without any band). In addition, *N. ivanovae* males have a relatively shorter head compared to *N. taeniopygus* "Ipati river" (29.5-34.6 vs. 33.0-37.5% SL), smaller eye (22.8-29.0 vs. 30.7-38.9% HL) more scales on lateral line (31 vs. 28-30), more dorsal and anal fin rays (17-18 vs. 14-15 and 17-18 vs. 15-17, respectively), shorter head compared to *N. taeniopygus* "Wogo river" (29.5-34.6 vs. 33.6-35.4% SL), more scales on lateral line (31 vs. 30), and more dorsal fin rays (17-18 vs. 15).

**Description:** See Figs 3-4 for overall appearance and Table II for morphometric data for the type series. Deep bodied *Nothobranchius*, laterally com-

pressed, maximum length recorded in males 44.7 mm SL. Dorsal profile slightly concave to strongly concave on head, convex from nape to end of dorsal fin base, ventral profile convex, slightly concave on caudal peduncle posterior to dorsal and anal fin. Snout slightly pointed, mouth directed upwards, lower jaw longer than upper jaw, posterior end of rictus at same level as or slightly above centre of eye. Branchiostegal membrane projecting posteriorly from opercle. Dorsal and anal fins located posterior to mid-body, tips rounded with short filamentous rays. Both fins with papillate contact organs on fin rays. Dorsal fin tip not reaching caudal fin. Number of dorsal fin rays 17-18, anal fin rays 17-18. Pectoral fin (20 rays) approximately triangular; in some specimens pectoral fins reach origin of pelvic fins, and pelvic fins (6-8 fin rays) reach the anal fin origin. Caudal fin rounded (24-26 rays).

Scales cycloid, body and head entirely scaled, except for ventral surface of head. Scales in median lateral series 31 + 3-4 on caudal fin base. Transverse row of scales 12. Circumpeduncular scales 14. Cephalic squamation pattern variable. Frontal neuromast series of the 'open' type. Anterior supraorbital series in shallow grooves, each with two or three neuromasts. Posterior supraorbital series with three neuromasts. One neuromast on each scale of median longitudinal series. Six branchiostegal rays. Vomerine teeth present in a small patch. Lateral process of post-temporal not present. Second pharyngobranchial with one tooth. Bifid anterodorsal process of urohyal. Number of vertebrae 28. Premaxilla and dentary with many irregularly distributed unicuspid, slightly curved teeth of different size, a small number of larger ones on the outer row of upper and lower jaw. Females smaller than



**Fig. 5.** *Nothobranchius ivanovae*, adult male, about 35 mm SL, not preserved, Katuma River drainage, western Tanzania. Photo by I. Ivanova.



**Fig. 6.** *Nothobranchius ivanovae*, adult female, about 30 mm SL, not preserved, Katuma River drainage, western Tanzania. Photo by I. Ivanova.

**Table II.** Morphometric data of *Nothobranchius ivanovae*. Measurements were given as percentages of standard length in mm. Eye diameter and snout length were given as percentages of head length. Cleared and stained material is included.

	Holotype	Males (n = 6)	Females (n = 4)
Standard length (mm)	44.7	32.1-44.7	27.5-33.1
Body depth at pelvic fin	24.2	24.2-31.2	22.6-24.3
Predorsal length	52.1	50.5-59.7	59.4-67.0
Preanal length	57.4	54.3-60.1	61.9-64.8
Prepelvic length	48.0	46.2-53.8	50.9-53.7
Caudal peduncle length	22.5	22.1-25.0	21.7-24.6
Caudal peduncle depth	12.5	11.4-14.3	9.5-12.3
Dorsal fin base length	29.3	25.0-31.3	16.7-23.9
Anal fin base length	22.5	22.3-25.5	13.4-17.4
Head length	29.5	29.5-34.6	30.9-33.3
Snout length	24.2	23.5-28.2	21.2-29.4
Eye diameter	24.2	22.8-29.0	22.7-31.7

males, maximum observed size 33.1 mm SL. In females, dorsal fin rounded, anal fin triangular with rounded tip, branchiostegal membrane not projecting from opercle.

**Colour in life:** Males (Fig. 5). Body and head scales light blue-grey with thin dark red margin, forming a reticulated pattern on body and head. Snout, frontal, and dorsal portion of head pale brown. Branchiostegal membrane whitish. Dorsal fin grey-green with irregular rows of dark red small dots; proximally larger, distally denser and smaller, dark red spots on upper anterior margin. Anal fin cream with a proximal red line and broad dark red-brown margin. Pelvic fins cream, red-brown near the base and with a brown rim. Pectoral fins hyaline with light blue margins. Caudal fin red, narrow submarginal orange band, with a broad black margin. Iris silver, with faint black vertical bar through centre of eye.

Female (Fig. 6). Body and head scales grey brown with brown scale margin, forming a reticulated pattern. Opercular region silver to golden. Abdomen silver to golden. All fins hyaline. Iris silver.

**Etymology:** The species name is dedicated to the aquarist, collector, and discoverer of the species, Iva Ivanova from Dupnitsa, Bulgaria.

**Distribution and habitat:** (Figs 3-4) *Nothobranchius ivanovae* is currently known from a large swampy area that covers about 50 km from Kabungo to Sibwesa, and belongs to the Katuma river drainage, western Tanzania. The type locality

was at the time of collection a residual pool in the dry bed of Karira stream. Other fish species present were *N. kardashevi* and unidentified *Barbus* species.

**Discussion:** *Nothobranchius kardashevi* clearly belongs to the *N. ugandensis* species group (Valdesalici 2009). The *N. ugandensis* species group has a wide distribution, ranging from Sudan (seasonal rivers around Nuba mountains) and Ethiopia (Alvero River drainage) in the north to the Bubu River drainage and Lake Rukwa drainage systems in Tanzania in the south. *Nothobranchius kardashevi* seems to be related to *N. sp.* "Lake Victoria", both have large red spots on the anal fin (vs. usually absent or with few small spots in *N. ugandensis* and the anal fin completely spotted in *N. nubaensis*). The latter species is still not formally described, but seems, based on distribution and colouration, an artificial assemblage of several related species. Populations are known from the Lake Victoria and Rukwa drainage systems, and the Malagarasi River basin. The closest geographically known related species are the populations of *N. sp.* "Lake Victoria" (known as *N. sp.* "Limba Limba" or *N. sp.* "TSTS 10-5") found in the Malagarasi drainage, and *N. sp.* "Piti River" in the Lake Rukwa drainage (Seegers 1997; Shidlovsky 2010, Wildekamp 1990). Both are clearly separated from *N. kardashevi* due to their distinctive anal fin coloration (yellow vs. blue), caudal fin pattern (plain or with proximal part spotted vs. completely spotted) and spot coloration on the dorsal and anal fins

(one colour vs. two colours). The light blue with red spots caudal fin pattern can be found in other species, which belong to different subgenera or species groups: *N. eggersi* (*Adiniops*), *N. jubbi* (*Nothobranchius*), and in *Zononothobranchius*: *N. malaissei*, and *N. symoensi*, both belonging to the *N. taeniopygus* species group and not to the *N. ugandensis* species group like *N. kardashevi*.

*Nothobranchius ivanovae* belongs to the *N. taeniopygus* species group, an assemblage of species, that has a wide distribution in Tanzania and Zambia (Valdesalici & Amato 2011). Within this group, *N. ivanovae* shows similarities with some populations of *N. taeniopygus*. This latter species was first described by Hilgendorf in 1891, and was redescribed by Wildekamp in 1990. The neotype, designated from Kapatu Creek on Wembere drainage, received a proper description. In the central Tanzanian shield (Giddele et al. 2002) *Nothobranchius taeniopygus* is widespread from the drainage of the Bubu River in the east, to Lake Victoria and Eyasi drainage systems in the north, the Malagarasi River drainage in the west, and Lake Rukwa drainage in the south. Seegers (1996) was first to report on different, geographically restricted forms within this species, and recently Wildekamp (2004) recognized the different known forms of *N. taeniopygus* as four distinct phenotypes.

*Nothobranchius ivanovae* is clearly separated from the known phenotypes by its unique combination of characters.

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