

# A new species of *Aulonogyrus* MOTSCHULSKY, 1853 from the eastern highlands of Zimbabwe (Coleoptera: Gyrinidae)

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### Abstract

*Aulonogyrus inyanganensis* sp.n. from the eastern highlands of Zimbabwe is described. Its male and female genitalia are illustrated. The new species is compared with the closely related taxa *A. formosus* (MODEER) and *A. formosus knysnanus* BRINCK stat.n. Characters which differentiate the three taxa are described and a key for identification is provided. From a zoogeographical viewpoint, *A. inyanganensis* is supposed to have originated due to its isolation from the more southern populations of the *A. formosus* complex as a result of climatic variations.

**Key words:** Coleoptera, Gyrinidae, *Aulonogyrus*, Zimbabwe, Ethiopian region, taxonomy, new species

### Introduction

In the summer of 1994, during a short trip to Zimbabwe, I collected water beetles in the Inyanga National Park. A new species of the genus *Aulonogyrus* MOTSCHULSKY was discovered. In the description, anatomical terms follow HOLMEN (1987).

#### Acronyms:

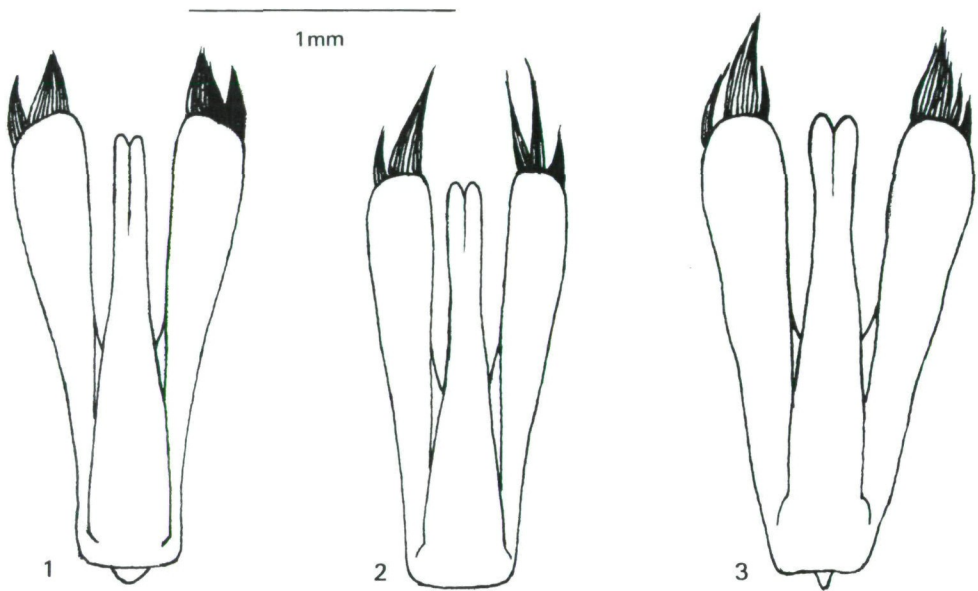
NMW	Naturhistorisches Museum, Wien	PB	coll. Per Brinck, Lund
MNHN	Museum national d'Histoire naturelle, Paris	PM	coll. Paolo Mazzoldi, Brescia
SMF	Senckenberg Museum, Frankfurt	MT	coll. Mario Toledo, Brescia
MSNM	Museo Civico di Storia Naturale, Milano	FP	coll. Fernando Pederzani, Ravenna
MSNB	Museo Civico di Scienze Naturali, Brescia	AS	coll. Antonio Schizzerotto, Trento

### *Aulonogyrus (Afrogyrus) inyanganensis* sp.n.

**TYPE LOCALITY:** Zimbabwe, Inyanga National Park, mountain stream on the western slope of Mt. Inyangani (Nyamziwa River, tributary of Inyangombe River), 2300 - 2350 m (see Fig. 14).

**TYPE MATERIAL:** **Holotype** ♂ (NMW): "Zimbabwe, Inyanga Nat. Park, Mt.Inyangani, m 2350, stream pools, 27.VII.1994, Mazzoldi P. leg.", with my holotype label. **Paratypes:** 35 specimens with the same label and 48 specimens labelled "Zimbabwe, Inyanga Nat. Park, Mt.Inyangani, m 2300, stream pools, 27.VII.1994, Mazzoldi P. leg.", all with my paratype labels, 3 exs. in NMW, 2 exs. in MNHN, 2 exs. in SMF, 4 exs. in PB, 2 exs. in MSNM, 2 exs. in MSNB, 2 exs. in MT, 2 exs. in FP, 2 exs. in AS, 62 exs. in PM.

**DESCRIPTION:** Elongate oval, rather depressed. Dorsal side shiny, dark aenescent-olivaceous, with yellow pronoto-elytral border. Underside black with the exception of: procoxae, prosternum, proepisterna, hypomera and epipleura yellow; mentum, mesepisterna and mesepimera brown; mesosternum brown, its posterior part yellow; mesocoxae brown, its posterior tips yellow; metacoxae black, posterior tips with a very narrow yellow margin; abdominal sternite VII black, posterior margin brown; fused gonocoxosternites brown, with wide yellow margin posteriorly.



Figs. 1 - 3: Aedeagus, dorsal view, of 1) *Aulonogyrus formosus formosus* (South Africa, Cape Province, Cape Peninsula); 2) *Aulonogyrus formosus knysnanus* (South Africa, Cape Province, stream between Prince Albert Pass and Knysna); 3) *Aulonogyrus inyangensis* sp.n. (Zimbabwe, Inyanga National Park, Mt. Inyangani).

Head dark bronzy-olivaceous, anteriorly covered by a reticulation of polygonal, isodiametric meshes which become obliterated posteriorly, so that the vertex appears shiny; with few scattered punctures, these being a bit thicker around the inner margin of eyes; two evident depressions visible between the eyes. Labrum short, transverse, weakly rounded anteriorly and provided with a fringe of whitish hairs; dark aenescent dorsally, covered by a weak reticulation of very small, transversely elongated meshes. Clypeus with anterior border almost straight or slightly concave, weakly wrinkled, covered by a strong reticulation of polygonal, isodiametric meshes and by scattered small punctures, dark bronzy-olivaceous with slight purple reflections. Fronto-clypeal suture distinct.

Pronotum dark, bronzy-olivaceous with weak purple reflections and yellow lateral margins, covered by a reticulation of polygonal, isodiametric meshes. The reticulation is particularly evident at the sides, where it forms two distinct reticulated fields, but is almost obliterated on the pronotal disc, with strong punctures which are thicker in the smooth discal area and become much rarer in the reticulated lateral fields. In the central discal area the punctation is distinctly double, much smaller punctures being interspersed between the big ones.

Elytra dark bronzy-olivaceous with yellow lateral margins; elytral surface smooth, covered by a thick punctation, with 11 longitudinal, reticulated striae. Striae 1 and 2 weak, interrupted anteriorly; no. 1 almost obliterated in the first half of elytra; striae 3 to 6 complete but weakly impressed, rather widely furrowed, with golden or silvery reticulation at the bottom of the furrows; striae 7 to 11 distinctly impressed, narrowly canalculated. Elytral intervals 1 to 5 flat, 6 and especially 7 weakly convex; all smooth and punctate, of about the same width; interval 8 flat, entirely covered by strong reticulation, impunctate, about 2/3 the width of interval 9; interval 9 strongly convex, with a central strip which is smooth and punctate; intervals 10 and 11 convex, both strongly reticulated at the sides but weakly reticulated, almost smooth along a central strip;

no. 10 as wide or slightly wider than 8, impunctate, almost as elevated as 9 and 11; no. 11 slightly wider than 10, with a few scattered punctures in its anterior part. Elytral truncation weakly convex, both sutural and epipleural angle obtuse, widely rounded, almost obliterated.

Legs reddish-yellow with protibiae slightly infuscated, this infuscation being represented by a very indistinct brown patch, visible on the ventral side of the article. Protibiae with external border weakly sinuous (Fig. 9).

♂: Antero-external angle of protibiae weakly but distinctly produced; protarsi dilated, rather elongated oval. Posterior margin of fused gonocoxosternites with two lateral notches. Aedeagus as in Fig. 3; median lobe rather wide, with an evident constriction in the middle and a wide notch at the apex; lateral lobes stout, wide, symmetrically rounded at the apex.

♀: Antero-external angle of protibiae almost imperceptibly produced; protarsi not dilated, parallel-sided. Posterior margin of fused gonocoxosternites ending with a short appendix, distinctly concave in the centre (Fig. 12). Gonocoxae and tergal halves IX as in Fig. 6.

**HABITAT:** The stream where the beetles were collected flows through an open mountain steppe with scattered bushes of Proteaceae, but most of it is shaded by a kind of small "gallery forest" formed by bushes (mainly Ericaceae) growing along its banks; the stream is made up of a succession of rather deep, sunken pools, with a gravelly and stony bottom, connected by small waterfalls. The beetles were collected while whirling under water in big swarms in the deepest part of the pools, always in the shade. Three other species of Gyrinidae were found in association with *A. inyanganensis*: *Aulonogyrus flavipes* (BOHEMAN), *Aulonogyrus caffer selindanus* BRINCK and *Orectogyrus mirabilis arnoldi* OCHS, but the other two species of *Aulonogyrus* were very rare (only one specimen of each was found).

**DISTRIBUTION:** The species is probably endemic to the small streams flowing from the top of Mount Inyangani, the highest mountain of Zimbabwe, in the mountain steppe zone. In the streams at lower altitudes of the Inyanga National Park and on the mountains to the south of Inyanga (Vumba and Chimanimani Mountains which are not as high as Mt. Inyangani) I found only 4 other species of *Aulonogyrus* (*A. algoensis* REGIMBART, *A. flavipes*, *A. caffer selindanus* and *A. rhodesianus* BRINCK). One cannot rule out the possibility that the species might inhabit the mountain ranges immediately to the north of Inyanga, which are almost as high as Mt. Inyangani.

**ETYMOLOGY:** The species is named in reference to the type locality.

### Discussion

The new species belongs to the *Aulonogyrus marginatus* group (see BRINCK 1955b) and within this it is closely related to two other taxa, *A. formosus* (MODEER) and *A. knysnanus* BRINCK. Since these species are very similar to each other, it is necessary to examine their relationships in detail.

*Aulonogyrus formosus* is a species of the Cape Province of South Africa, where it is relatively common, especially in the mountain ranges of the southwestern area; *A. knysnanus*, on the other hand, was described by BRINCK (1955a) on the basis of a single population (30 specimens) in Knysna forest, eastern Cape Province. According to BRINCK (1955b), the two species can be distinguished by: a) body shape more convex and broadly oval in *A. formosus*, more depressed and elongated in *A. knysnanus*; b) 3rd and 5th elytral intervals distinctly broader than the respective outer interval in *A. formosus*, while in *A. knysnanus* they are not broader or only slightly broader; c) middle lobe of the aedeagus shorter, with more swollen basal part and slightly constricted middle, and lateral lobes more rounded in *A. knysnanus*.

In December 1991 / January 1992 I had the possibility to collect water beetles in the Cape Province of South Africa, including the Knysna area. The material collected there contained many specimens belonging to the *A. formosus* - *A. knysnanus* complex. Study of these specimens made me doubt the validity of *A. knysnanus*, since, although the specimens from the Knysna area

agreed with the description of this species, I found it difficult to separate them from specimens of *A. formosus*. Thanks to the kindness of P. Brinck, two specimens from the Knysna area were compared with typical specimens of *A. knysnanus* and were found to coincide with them, but P. Brinck himself, who has now seen more specimens of *A. knysnanus*, expressed the opinion (Brinck 1995, in litteris) that *A. knysnanus* should now be considered a subspecies of *A. formosus*.

I have examined the following material of these two taxa:

*Aulonogyrus formosus* : 1 ex., "S Africa, Cape Province, Cape Peninsula, tributary of Krom river along road M 65, 29.XII.1991, leg. Mazzoldi P."; 16 exs., "S Africa, Cape Province, Cape Peninsula, small stream near road to Da Gama Park, 29.XII.1991, leg. Mazzoldi P." (the specimens from Cape Peninsula can be considered topotypical, see BRINCK 1955a); 1 ex., "S Africa, Cape Province, Grabouw, stream on road Grabouw-Franschhoek, m 350, 30.XII.1991, leg. Mazzoldi P."; 2 exs., "S Africa, Cape Province, Grabouw, Du Toits river on road Grabouw-Franschhoek, m 300-350, 31.XII.1991, leg. Mazzoldi P."; 1 ex., "S Africa, Cape Province, Franschhoekpas, Du Toits river near Franschhoekpas, m 450, 31.XII.1991, leg. Mazzoldi P."; 1 ex., "S Africa, Cape Province, stream near Theewaterskloof Dam, 31.XII.1991, leg. Mazzoldi P.", all in PM.  
*Aulonogyrus knysnanus* : 21 exs., "S Africa, Cape Province, road Avontuur-Knysna, stream between Prince Albert Pass and Knysna, 4.1.1992, leg. Mazzoldi P.", PM and PB.

The characters discussed above are difficult to evaluate, so in order to solve the problem of the relationship between *A. formosus* and *A. knysnanus*, and between these two and the new species, I carried out a series of measurements on samples of the three taxa and subjected the data to statistical analyses (SOKAL & ROHLF 1981).

Methods of measurements, raw data and statistical procedures employed:

A sample of 20 randomly-chosen specimens was selected for each of the three taxa (all the specimens available, 19, for *A. formosus knysnanus*); length and width of the specimens were measured with a Wild M3C stereomicroscope equipped with a micrometric grid at a magnification of 15.4x. The length of the specimen was measured from the anterior border of clypeus to the posterior tip of elytra; the width was measured at the point of maximum width, that is shortly behind the humeri. The measures were converted into mm and the length/width ratio was calculated for each specimen. As it was evident that there were differences between the means of the three taxa, further statistical analyses were carried out. First of all I tried to assess whether significant differences in size existed between the three populations. To this end, the three groups of data on length were subjected to Bartlett's test for homogeneity of variance. The variances were found to be heterogeneous, therefore the lengths were analysed using first the nonparametric Kruskal-Wallis test and then the nonparametric STP procedure for unplanned pairwise comparisons (for the latter procedure, which requires equal sample size, a single casually chosen variate was eliminated from the data relative to *A. formosus formosus* and *A. inyangensis*). A correlation analysis between length and width was executed and the correlation coefficients found; when they were tested for homogeneity, they were found to be significantly different. A regression of length versus width was carried out and the regression coefficients were found. The elytral intervals 3-4-5-6 and 8-9-10-11 were also measured in the same specimens using the same equipment at a magnification of 25x. In order to ensure as much uniformity as possible, all the measures were taken shortly behind the pronoto-elytral border, at the level of about 1/8 of the elytral length. For each specimen the following ratios of widths of elytral intervals were then calculated: 3/4, 5/6, 8/9, 10/9, 10/11. The groups of data relative to each ratio in each species were then subjected to Bartlett's test of homogeneity of variance, and all the variances were found to be homogeneous with the exception of those relative to the ratios between intervals 3 and 4. As a consequence, the ratios between intervals 3 and 4 were first analysed using the non-parametric Kruskal-Wallis test and then compared using the nonparametric STP procedure for unplanned pairwise comparisons (for the latter procedure again a single casually chosen variate was eliminated from the data relative to *A. formosus formosus* and *A. inyangensis*). All the other ratios were analysed employing a single classification ANOVA and then the 'T' method for multiple unplanned comparisons between pairs of means.

The following tables give the raw data (tables 1 to 4) and the results of the statistical analyses (tables 5 to 9).

Ex. no.	<i>A. formosus formosus</i>			<i>A. formosus knysnanus</i>			<i>A. inyanganensis</i> n.sp.		
	L	W	L/W	L	W	W/L	L	W	W/L
1	7.05	3.85	1.83	7.22	3.85	1.872	7.87	4.1	1.92
2	6.48	3.53	1.837	6.56	3.77	1.739	7.95	4.18	1.902
3	6.4	3.53	1.814	7.3	4.1	1.78	7.63	3.85	1.979
4	7.22	3.85	1.872	6.64	3.53	1.884	8.04	4.1	1.96
5	6.48	3.49	1.859	7.38	4.02	1.837	7.3	3.85	1.894
6	6.72	3.53	1.907	7.13	3.77	1.891	7.54	4.02	1.878
7	7.22	3.77	1.913	7.22	3.9	1.853	7.87	4.02	1.959
8	5.82	3.12	1.868	6.4	3.61	1.773	7.79	4.06	1.919
9	7.05	3.77	1.87	7.54	4.02	1.878	7.54	3.98	1.897
10	7.05	3.85	1.83	6.89	3.69	1.867	7.63	4.02	1.898
11	6.89	3.61	1.909	7.3	4.02	1.816	7.95	4.14	1.921
12	6.48	3.53	1.837	7.3	4.02	1.816	7.38	3.94	1.875
13	6.56	3.53	1.86	6.97	3.69	1.889	7.71	4.02	1.918
14	7.3	3.98	1.835	7.63	4.1	1.86	7.54	3.94	1.917
15	7.71	4.1	1.88	7.54	4.02	1.878	7.54	4.02	1.878
16	6.19	3.36	1.841	6.4	3.44	1.857	7.79	3.94	1.979
17	7.63	4.18	1.824	7.13	3.85	1.851	7.79	4.1	1.9
18	7.09	3.77	1.88	6.64	3.57	1.862	7.71	4.1	1.88
19	6.81	3.69	1.844	7.46	3.94	1.896	7.46	3.85	1.936
20	8.2	4.43	1.852				7.46	3.85	1.936

Table 1: Lengths (L), widths (W) and ratios length/width (W/L) of *Aulonogyrus formosus formosus*, *A. f. knysnanus* and *A. inyanganensis*. Length and width expressed in mm.

Tables 2 - 4: Widths of elytral intervals; all widths measured at 60X and expressed in micrometric units.

Intervals no.	3	4	5	6	8	9	10	11
Ex. no. 1	11.5	9	15	11	6	11	6	8
2	10	9	12	10	7	8.5	7	8
3	10	8.5	13	10	6	8	6	8.5
4	9	8.5	15	11	6	9.5	6	9.5
5	10	9.5	14	10	5.5	10	6	8
6	10	9	13	11	6	8	6	8
7	11	9	15	10	5.5	10	6	9
8	9	8.5	10	9	6	8	6	8
9	11	10.5	13.5	9	6	9	7	8
10	11	9	15	10	5	10	6.5	9
11	10	10	12	10	6	8.5	6	8
12	10.5	9.5	11.5	10	6	7.5	6	8
13	10	10	11.5	10.5	6	8	6.5	8
14	9.5	9.5	14	11	7	9	7	9
15	12	11.5	15	11	6.5	10	6	9
16	10	9	12	11	5	8	6	8
17	11	10	13	11	6	10	7	10
18	8.5	9.5	13	12	7	9	7	8
19	10	10	12	11	6	9	5	9
20	12.5	11.5	14	12	7	9	6.5	10

Table 2: *Aulonogyrus formosus formosus*.

Intervals no.	3	4	5	6	8	9	10	11
Ex. no.								
1	10.5	9	14.5	10	6	9	6.5	8
2	12	8	12	11	6.5	9	7	10
3	11	10	15	12	6	10	7	9
4	10.5	9	13	8	4.5	9	5	8.5
5	12	9	14	11	6	9.5	7	9.5
6	10	8.5	14	10	7	9	6	9
7	11.5	9	13	9.5	6	8	5.5	9
8	11.5	9	12	9.5	5.5	9	5	9
9	11	10	14	12	6	9	7	9.5
10	10	10	13	11	6	8	6	9.5
11	12	9.5	14	10.5	7	9	6	8
12	10	10	17	9	7	10	7	8.5
13	10	12	13	11	6	9	6	8
14	12	9	14	11	7	9.5	6.5	9
15	11.5	9.5	14.5	11	6	10	6.5	9
16	9	8.5	13	9	6	8	6	9
17	12	9	14	10	6	9	6	9
18	10	8.5	14	10	5	9	6.5	9
19	11	9	14	10.5	7	9	8	9

Table 3: *Aulonogyrus formosus knysnanus*.

Intervals no.	3	4	5	6	8	9	10	11
Ex. no.								
1	12	12	14	12	7	11	7	8
2	12	12	14	12	7	10	6	9
3	11	11.5	13	10	5	11	6	8
4	12	11	15	11	6	10	6	9
5	12	11	13	11	7	10	6.5	9
6	11.5	11	13	12	6	10	6	9
7	12	12	13	11	6	10	7	8
8	14	11	13	11	6.5	10	6.5	8.5
9	11	10	14	11	6.5	10	6.5	8.5
10	11	12	13	13	7	10	6.5	8.5
11	11.5	11.5	14.5	10	6.5	10.5	6.5	8.5
12	11.5	11	13	11	6	10	6.5	8
13	12.5	11	15	11	6	9.5	6	8.5
14	12	12	12.5	11	6	10	7	9
15	12	12	14	12	6	9	7	9
16	11	11	14	12	6.5	10	6	8.5
17	11	11	14	11	6.5	10	7	8.5
18	12	12	14	11	6	10.5	7	8.5
19	11	11	12	11	6	9.5	6	8
20	12	11	12.5	11.5	7	10	7	8

Table 4: *Aulonogyrus inyangensis* n.sp.

	3/4	5/6	8/9	10/9	10/11
<i>A. formosus formosus</i>	1.08±0.09	1.26±0.15	0.7±0.10	0.7±0.09	0.7±0.08
<i>A. formosus knysnanus</i>	1.19±0.15	1.35±0.18	0.7±0.08	0.7±0.08	0.7±0.08
<i>A. inyanganensis</i> n.sp.	1.04±0.08	1.20±0.11	0.6±0.06	0.6±0.05	0.8±0.07

Table 5: Mean ratios between widths of elytral intervals (± standard deviation).

<i>A. f. formosus</i>	-	-	-
<i>A. f. knysnanus</i>	ns	-	-
<i>A. inyanganensis</i>	**	**	-
	<i>A. f. formosus</i>	<i>A. f. knysnanus</i>	<i>A. inyanganensis</i>

Table 6: Size (tests employed: Bartlett, Kruskal-Wallis and STP); ns = not significant; \* = 0.05 ≥ P > 0.01; \*\* ≤ 0.01.

	Correlation coefficients: length/width	Regression coefficients: length/width
<i>A. f. formosus</i>	0.98	1.87
<i>A. f. knysnaus</i>	0.91	2.05
<i>A. inyanganensis</i>	0.79	2.35

Table 7: Length/width. Test of homogeneity among correlation coefficients: the correlation coefficients are significantly not homogeneous at P > 0.01.

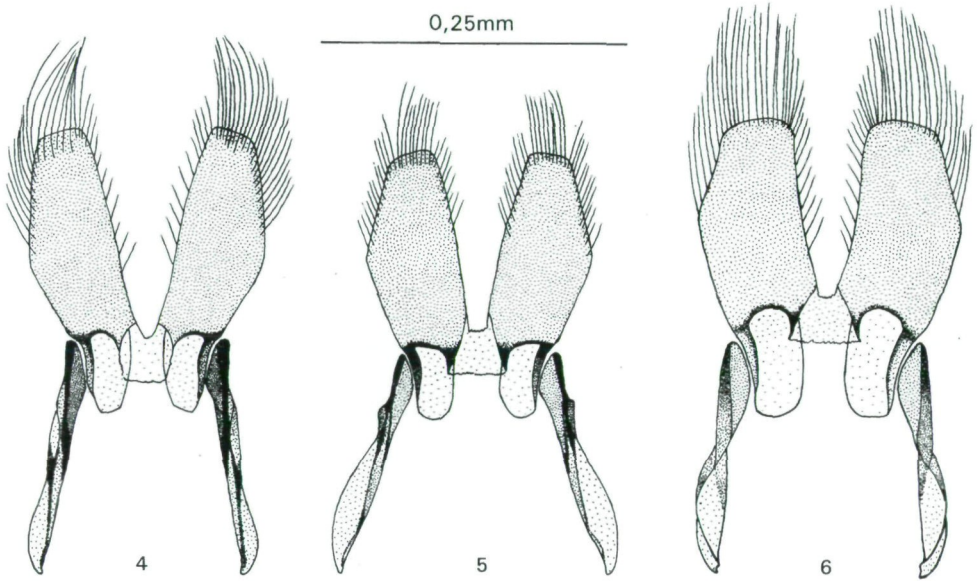
Elytral intervals	df	X <sup>2</sup>
3/4	2	9.0543 *
5/6	2	4.3830 ns
8/9	2	4.8765 ns
10/9	2	5.2837 ns
10/11	2	1.1382 ns
Critical values	X <sup>2</sup> <sub>0.05</sub> [2] = 5.991	X <sup>2</sup> <sub>0.01</sub> [2] = 9.210
		X <sup>2</sup> <sub>0.001</sub> [2] = 13.816

Table 8: Ratios of widths of elytral intervals. Bartlett's test; ns = not significant; \* = 0.05 ≥ P > 0.01.

Ratios of elytral intervals	Taxa	Significativity
3/4	<i>A. formosus formosus</i> vs <i>A. formosus knysnanus</i>	*
	<i>A. formosus formosus</i> vs <i>A. inyanganensis</i>	ns
	<i>A. formosus knysnanus</i> vs <i>A. inyanganensis</i>	**
5/6	<i>A. formosus formosus</i> vs <i>A. formosus knysnanus</i>	ns
	<i>A. formosus formosus</i> vs <i>A. inyanganensis</i>	ns
	<i>A. formosus knysnanus</i> vs <i>A. inyanganensis</i>	*
8/9	<i>A. formosus formosus</i> vs <i>A. formosus knysnanus</i>	ns
	<i>A. formosus formosus</i> vs <i>A. inyanganensis</i>	ns
	<i>A. formosus knysnanus</i> vs <i>A. inyanganensis</i>	ns
10/9	<i>A. formosus formosus</i> vs <i>A. formosus knysnanus</i>	ns
	<i>A. formosus formosus</i> vs <i>A. inyanganensis</i>	*
	<i>A. formosus knysnanus</i> vs <i>A. inyanganensis</i>	ns
10/11	<i>A. formosus formosus</i> vs <i>A. formosus knysnanus</i>	ns
	<i>A. formosus formosus</i> vs <i>A. inyanganensis</i>	ns
	<i>A. formosus knysnanus</i> vs <i>A. inyanganensis</i>	ns

Table 9: Ratios between widths of elytral intervals. (Tests employed: Kruskal-Wallis and STP for ratio 3/4, ANOVA and T' for the other ratios); ns = not significant; \* = 0.05 ≥ P > 0.01; \*\* = P ≤ 0.01.





Figs. 4 - 6: Gonocoxae and tergal halves IX, dorsal view, of: 4) *Aulonogyrus formosus formosus* (South Africa, Cape Province, Cape Peninsula); 5) *Aulonogyrus formosus knysnanus* (South Africa, Cape Province, stream between Prince Albert Pass and Knysna); 6) *Aulonogyrus inyanganensis* sp.n. (Zimbabwe, Inyangana National Park, Mt. Inyangani).

These analyses can be summarized as follows: *A. inyanganensis* is significantly bigger than *A. formosus* and *A. knysnanus*, while there is no significant difference in size between *A. formosus* and *A. knysnanus*. It must be noted that the population of *A. inyanganensis* is much more uniform under this viewpoint, as it is evidenced by the much smaller variance; this is probably due to the fact that *A. inyanganensis* is an endemic population occupying a very restricted range, while the other two taxa are formed by many populations, occupying far wider ranges. As for the body shape, it seems to become progressively more elongated passing from *A. formosus* to *A. knysnanus* and then to *A. inyanganensis*; the difference is significant between *A. inyanganensis* and the other two species, only weakly significant between *A. formosus* and *A. knysnanus*. As for the elytral intervals, the analyses revealed a significant difference between the ratios of elytral intervals 3 and 4, and a less significant difference between the ratios of intervals 5 and 6; in both cases, the most significant difference is between *A. knysnanus* and *A. inyanganensis*, while the difference between *A. knysnanus* and *A. formosus* is less significant and there is no significant difference between *A. formosus* and *A. inyanganensis*. No significant differences between the three taxa exist according to the ratios of intervals 8 - 11, with the exception of a weakly significant difference between the ratios of intervals 10 and 9 of *A. formosus* and *A. inyanganensis*.

The conclusion that can be drawn from this statistical analysis is that there are significant (though small) differences between the three populations in the above mentioned characters; this, nonetheless, does not mean that the characters themselves may be employed for practical diagnostic purposes, since, as can be seen from the tables of measurements, all the characters so far considered overlap to a greater or lesser extent, so that it is not possible to separate single specimens of the three taxa solely on the basis of these characters. For diagnostic purposes, I have therefore employed other characters, shown in the following key. It is evident that, while a series of good characters separate *A. inyanganensis* from both *A. formosus* and *A. knysnanus*, it is



much more difficult to distinguish *A. formosus* from *A. knysnanus*, the only reliable character being small differences in the aedeagus. I therefore agree with P. Brinck that *A. knysnanus* can no longer be considered a distinct species.

### Key for the identification of *Aulonogyrus formosus formosus*, *A. formosus knysnanus* and *A. inyanganensis* sp.n.

The following key can be inserted into the key provided by BRINCK (1955b) for the identification of the *Aulonogyrus* (*Afrogyrus*) of the Ethiopian region by substituting couplet 46.

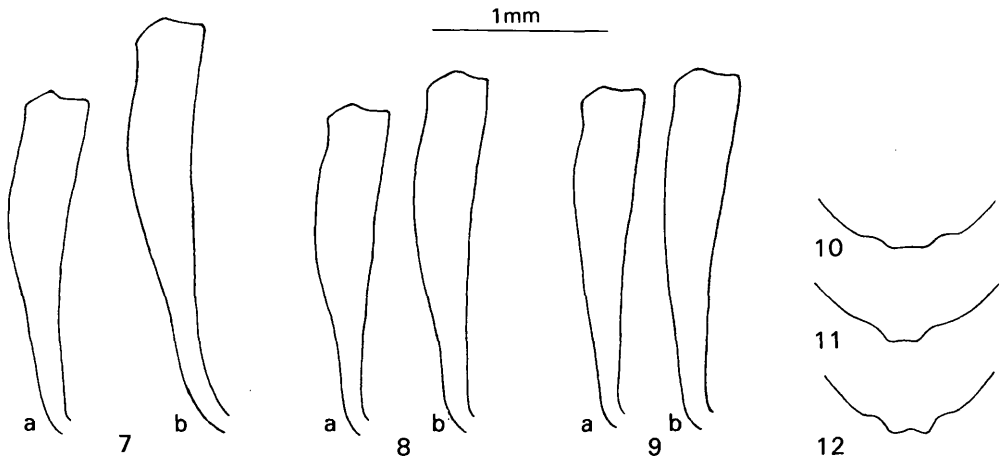
46. Protibiae distinctly and entirely infuscated, with external border strongly sinuous (Figs. 7a, 7b, 8a, 8b). ♂: median lobe of aedeagus without or with a very weak constriction before the tip; notch at the tip of the median lobe weakly pronounced. Parameres rather slender, transversely or obliquely truncate (Figs. 1, 2). ♀: small protrusion at the posterior tip of fused gonocoxosternites terminating with an almost straight, only weakly concave border (Figs. 10, 11). Gonocoxae relatively slender (Figs. 4, 5) ..... 46a
- Protibiae only weakly infuscated, the infuscation being represented only by a weak and indistinct brown patch, more clearly visible on the ventral side; external border of protibiae much less sinuous, especially at the base (Figs. 9a, 9b). ♂: median lobe of aedeagus with a distinct constriction before the tip and a strongly pronounced notch at the tip. Parameres distinctly stouter and wider, regularly rounded at the tip (Fig. 3). ♀: small protrusion at the posterior tip of fused gonocoxosternites terminating with a distinctly concave border (Fig. 12). Gonocoxae stouter and wider (Fig. 6) ..... *A. inyanganensis* sp.n.
- 46a. Aedeagus without any constriction before the tip (Fig. 1) ..... *A. formosus formosus*
- Aedeagus with a very weak constriction before the tip (Fig. 2) ..... *A. formosus knysnanus* stat.n.

### Ecological considerations

*Aulonogyrus formosus formosus* and *A. formosus knysnanus* have similar ecological requirements; they inhabit clear streams with cold, fast running water at relatively low altitudes (always below 1500 m; most of my specimens were collected at altitudes between sea level and 500 m); they show a strong preference for streams shaded by bushes or boulders. *Aulonogyrus inyanganensis* inhabits streams in high altitude mountain steppe, but except for this the ecological requirements seems to be very similar, including the preference for shaded situations. One peculiarity of behaviour of the new species is that, contrary to the other two taxa, I never saw it whirling at the surface of the water; the swarms were always observed diving under water, in the deepest part of the pools; this behaviour, however, might perhaps be influenced by the season, since I collected the specimens during the dry (cold) season.

### Zoogeographical considerations

*Aulonogyrus formosus formosus* is an endemic South African subspecies restricted to the southern part of the Cape Province. BRINCK (1955a) gives an extensive list of records, most being concentrated in the southwestern part of the province. The list also includes a number of records from the southeast, as far east as Grahamstown, but recently P. Brinck (1995, in litteris) informed me that, after reexamination of the beetles, these eastern records must be attributed to *A. formosus knysnanus*. On the basis of this information and of the records known for the latter subspecies, the distribution of the three taxa can be summarized by the map shown in Fig. 13, with *A. formosus formosus* occupying the southwestern corner of the Cape Province, *A. formosus knysnanus* occupying the southeastern one and *A. inyanganensis* living more to the north on the eastern highlands of Zimbabwe. The record of *A. formosus* ssp. from Potchefstroom, Transvaal, needs confirmation (as already stated by BRINCK 1955b), since it is based on a single female and might represent yet another taxon.



Figs. 7 - 9: Left protibia (a: ♂, b: ♀) of: 7) *Aulonogyrus formosus formosus* (South Africa, Cape Province, Cape Peninsula); 8) *Aulonogyrus formosus knysnanus* (South Africa, Cape Province, stream between Prince Albert Pass and Knysna); 9) *Aulonogyrus inyanganensis* sp.n. (Zimbabwe, Inyanga National Park, Mt. Inyangani).

Fig. 10 - 12: Posterior tip of fused gonocoxosternites of 10) *Aulonogyrus formosus formosus* (South Africa, Cape Province, Cape Peninsula); 11) *Aulonogyrus formosus knysnanus* (South Africa, Cape Province, stream between Prince Albert Pass and Knysna); 12) *Aulonogyrus inyanganensis* sp.n. (Zimbabwe, Inyanga National Park, Mt. Inyangani).

It is evident that *A. inyanganensis* is separated from the other populations of the *A. formosus* complex by a distributional gap of about 1000 km from the population at Potchefstroom and by about 2000 km from the main distribution of the complex. This supports the theory that undiscovered populations might exist in the intervening area, which is on the other hand unlikely because of the following reasons: a) researches in the mountains south of the Inyanga area did not produce any species of yellow-margined *Aulonogyrus* with the exception of *A. rhodesianus*; b) *A. formosus formosus* and *A. formosus knysnanus* live at relatively low altitudes, always below 1500 m, while *A. inyanganensis* lives above 2000 m. *Aulonogyrus inyanganensis*, living much more to the north than the other two taxa, must inhabit streams at higher altitude to find suitable ecological conditions. Southward from Inyanga, the mountains become progressively lower, and we must reach the northernmost slopes of the Drakensberg Range, about 750 km to the south, to find again high mountains and a habitat which might be suitable for species of the *A. formosus* complex. We may therefore assume that *A. inyanganensis* is completely isolated from the other populations of the *A. formosus* complex, which confirms its specific status.

It can be hypothesized that *A. inyanganensis* originated when populations of the *A. formosus* complex migrated northwards during a period of cooler climatic conditions and then remained isolated on high mountains when climate became warmer; this was not an isolated event, since on the eastern highlands of Zimbabwe we find three other endemic Gyridae (*A. caffer selindanus*, *A. rhodesianus* and *Orectogyrus mirabilis arnoldi*) which are connected to taxa living more to the south (*A. caffer caffer* AUBE, *A. abdominalis* AUBE and *Orectogyrus mirabilis mirabilis* REGIMBART respectively, although in the case of *A. rhodesianus* - *A. abdominalis* the distributions partially overlap).

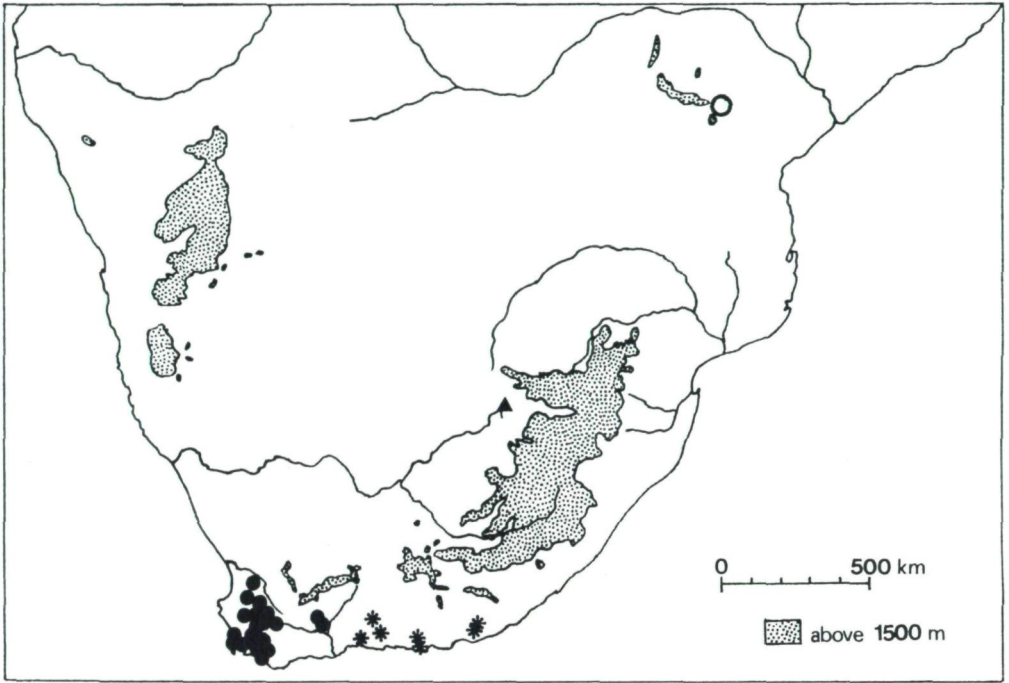


Fig. 13: Distribution of *Aulonogyrus formosus formosus* (black circle), *A. formosus knysnanus* (asterisk) and *A. inyanganensis* sp.n. (white circle). The black triangle indicates the population of the *A. formosus* complex from Potchefstroom, Transvaal, known from a single female of uncertain specific status.



Fig. 14: Type locality of *Aulonogyrus inyanganensis* sp.n.: a pool of Nyamziwa River in the mountain steppe zone on the western slopes of Mt. Inyangani, 2350 m.

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