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Short note/Kurze Mitteilung

New colour genes in the guppy, *Poecilia reticulata* (Peters, 1859)

Neue Farbgene beim Guppy, *Poecilia reticulata* (Peters, 1859)

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Zusammenfassung: Reziproke Verpaarungen vier verschiedener spezifisch gefärbter domestizierter Guppy-Stämme (Caeruleus, Maculatus, Lutino, Metallicus/Pink) mit Stämmen bekannten Erbgangs (Pauper/Grau, Maculatus/Grau, Albino, Gold) ergaben, dass diese Farben auf fünf Farbgenen beruhen, von denen drei autosomal-rezessiv vererbt (Lutino, Pink, Metallicus) und zwei (Moscow, Caeruleus) vom Y-Chromosom kodiert werden.

The guppy, *Poecilia reticulata*, is the first fish species in which a colour gene (*Maculatus*) was discovered strictly linked to the Y-chromosome (Schmidt 1920, Winge 1922a, b, 1927). In the first decades of the last century further phenotypes and colour genes have been described, also since the 1940's some colour genes from domesticated strains have been described (for review see Lindholm & Breden 2002).The present note describes five new colour genes in four strains of guppies bred since many years in aquaria and named herein Caeruleus (latin = sky blue), Lutino (derived from luteus, latin = deep yellow), Metallicus (latin = metallic) and Pink/Moscow.

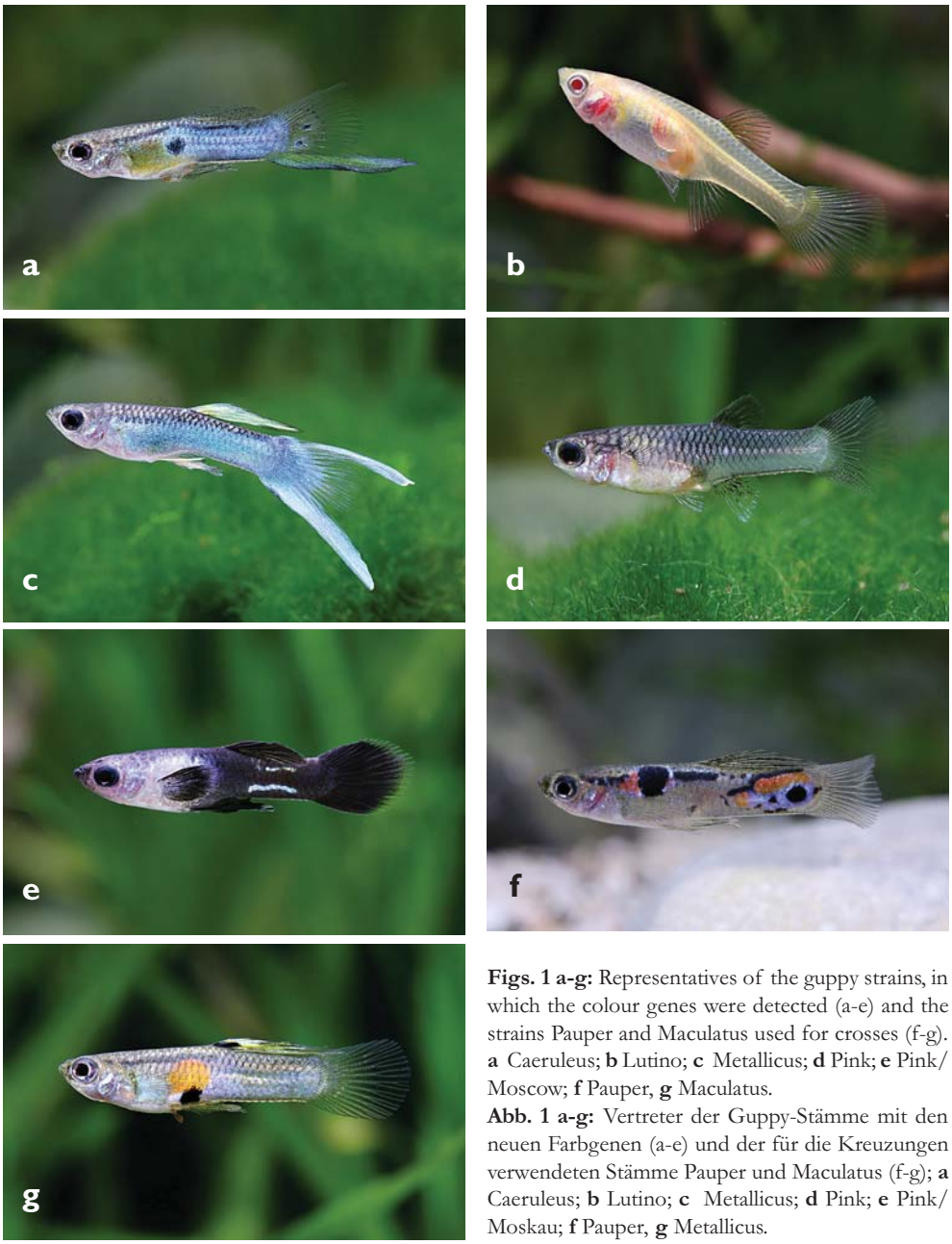
Caeruleus-males have a light blue metallic colour extending from the head to the base of the caudal fin; in the middle of the body a black spot is present and the colour nearby is a little bit greenish. The unpaired fins are slightly white, light yellow with little black spots or transparent (fig. 1 a). Females are uncoloured. Lutino-males have a double sword; the body colour of both sexes is intensely yellow; eyes are dark-red (fig. 1 b). Metallicus-males have a double sword and a body-wide blue-metallic colouring (fig. 1 c). Females are uncoloured. Pink/Moscow-males have a tail like wild guppies. The anterior part up to the middle of the body and the pectoral fins are dark blue. Intensity may slightly change. Body colour of both sexes is similar to the mutant Gold (Goodrich et al. 1944), which, however, is more yellow in the latter and a dark border of scales is largely missing ventrally. Especially juveniles show a pink pectoral region (fig. 1 d).

The known strains used for crosses were Pauper, in which males have a horizontal red spot at the caudal peduncle and a black spot just behind the red one. The body colour is grey (fig. 1 e). And Maculatus, in which males have a red spot in the middle of the body and a black spot at the dorsal fin; the body colour is grey (fig. 1 f). In both strains females are uncoloured and male colouration is determined by loci on the Y-chromosome (Winge 1922b, 1927). To check more thoroughly the strains Lutino and Pink I used the strains Albino and Gold in some crosses.

All strains were kept at 26-27 °C in 120 l tanks, which were planted with *Cryptocoryne moehlmanni*, *Riccia* sp. and *Vesicularia dubyana*. The guppies were fed with *Artemia salina*, *Daphnia* sp., crushed *Spirulina* and high quality flake food.

For each cross two of three males and two of three females were mated and kept in 45 l tanks under similar conditions. The offspring of each breed was raised separately until colouring was fully developed. Tables 1-4 show the guppy strains, the number of crosses and guppy strains (abbreviated), the crosses (males first, females last) and data of the F_1 generation.

Abbreviations: Caeruleus (Ca), Lutino (Lu), Metallicus (Me), Pink/Moscow (Pi/Mo), Pauper (Pa), Maculatus (Ma), Albino (Al)



Figs. 1 a-g: Representatives of the guppy strains, in which the colour genes were detected (a-e) and the strains Pauper and Maculatus used for crosses (f-g). **a** Caeruleus; **b** Lutino; **c** Metallicus; **d** Pink; **e** Pink/Moscow; **f** Pauper, **g** Maculatus.
Abb. 1 a-g: Vertreter der Guppy-Stämme mit den neuen Farbgenen (a-e) und der für die Kreuzungen verwendeten Stämme Pauper und Maculatus (f-g); **a** Caeruleus; **b** Lutino; **c** Metallicus; **d** Pink; **e** Pink/Moskau; **f** Pauper, **g** Metallicus.

Data in table 2 indicate an autosomal-recessive inheritance for the ground colour Lutino. Autosomal-recessive characters in *P. reticulata* follow the Mendelian rules (KIRPICHNIKOW 1987), however, Lutinos did not reach the theoretical proportion, i.e. 1:4 (Lu 2) pairing with siblings) or 1:1 (Father/daughter pairing) (Lu 3). Deviations may be attributed to the relative small number of offspring. In guppy populations with a mixed age distribution the yellow offspring was selectively feed by the adults. Also prenatal lethal factors cannot be excluded as discussed e.g. for albinotic guppies (HASKINS & HASKINS 1948; see also KIRPICHNIKOW 1987).

Results listed in table 1 indicate that Caeruleus is y-linked.

Table 3 shows that Metallicus appears to have an autosomal-recessive inheritance, although the theoretical proportions could not be obtained, e.g. 1:2.67 (Metallicus: Pauper) in Me 2 instead of 1:3, and 1: 2.71 (Metallicus: males with other colour patterns) instead of 1:3 in Me 5.

Results in table 4 indicate that Moscow is y-linked, whereas the body colour Pink has an autosomal-recessive inheritance, which was questioned previously (e.g. LUCKMANN 1990, FOERSTER 1993).

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Tab. 1: Crosses with Caeruleus.
Tab. 1: Kreuzungen mit dem Stamm Caeruleus.

Ca 1	Pa x Ca	28 males Pa (53.85%)	0 males Ca (0.0%)	24 females, uncoloured (46.15%).
Ca 2	F1 from Ca 1	53 males Pa (52.47%)	0 males Ca (0.0%)	48 females, uncoloured (47.53%).
Ca 3	Father (Pa) x F1 from Ca 1	11 males Pa (57.89%)	0 males Ca (0.0%)	8 females, uncoloured (42.11%).
Ca 4	Ca x Pa	0 males Pa (0.0%)	28 males Ca (59.57%)	19 females, uncoloured (40.43%).
Ca 5	F1 from cross Ca 4	0 males Pa (0.0%)	44 males Ca (73.4%)	16 females, uncoloured (26.6%).
Ca 6	Father (Ca) x F1	0 males Pa (0.0%)	50 males Ca (49.01%)	52 females, uncoloured (50.99%).
Ca 7	Ma x Ca	15 males Ma (50.0%)	0 males Ca (0.0%)	15 females, uncoloured (50,0%).
Ca 8	F1 from Ca 7	36 males Ma (51.4%)	0 males Ca (0.0%)	34 females, uncoloured (48,6%).
Ca 9	Father (Ma) x F1 from Ca 7	190 males Ma (39.33%)	0 males Ca (0.0%)	293 females, uncoloured (60.67%).
Ca 10	Ca x Ma	0 males Ma (0.0%)	83 males Ca (49.7%)	84 females, uncoloured (50.3%).
Ca 11	F1 from cross Ca 10	0 males Ma (0.0%)	76 males Ca (47.5%)	84 females, uncoloured (52.5%).
Ca 12	Father (Ca) x F1 from Ca 10	0 male Pa (0.0%)	12 males Ca (48%)	13 females, uncoloured (52%).

Tab. 2: Crosses with Lutino.
Tab. 2: Kreuzungen mit dem Stamm Lutino.

Lu 1	Lu x Grey	0 males Lu (0.0%)	87 males Grey (49.43 %)	0 females Lu (0.0%)	89 females Grey (50.57 %).
Lu 2	F1 from cross Lu1	22 males Lu (9.36%)	83 males Grey (35.32%)	25 females Lu (10.64%)	105 females Grey (44.68%).
Lu 3	Father (Lu) x F1 from cross Lu 1	52 males Lu (16.0 %)	90 males Grey (27.69%)	82 females Lu (25.23%)	101 females Grey (31.08%).
Lu 4	Grey x Lu	0 males Lu (0.0%)	74 males Grey (51.39 %)	0 females Lu (0.0%)	70 females Grey (48.61 %).
Lu 5	F1 from Lu 4	70 males Lu (15.08%)	175 males Grey (37,72%)	47 females Lu (10.13%)	172 females Grey) (37.07%).
Lu 6	Father (Grey) x F1 from Lu 4	0 males Lu (0.0%)	49 males Grey (61.25%)	0 females Lu (0.0%)	31 females Grey (38.75%).
Lu 7	Lu x Al	0 males Lu (0.0%)	52 males Grey (58.43%)	0 females Lu (0.0%)	37 females Grey (41.57%).
Lu 8	F1 from cross Lu 7	16 males Lu (8,47%)	19 males Al (10.05%)	60 males Grey (31.75%)	0 males Lu/ Al (0.0%)
		17 females Lu (8.99%)	15 females Al (7.94%)	61 females Grey (32.27%)	1 female Lu/Al (0.53%) .

Tab. 3: Crosses with Metallicus.
Tab. 3: Kreuzungen mit dem Stamm Metallicus.

Me 1	Pa x Me	50 males *Pa* (52.08%)	0 males *Me* (0.0%)	24 females, uncoloured (47.92%).	
Me 2	F1 from Me 1	64 males *Pa* (34.23%)	24 males *Me* (12,83%)	99 females, uncoloured) (52,94%).	
Me 3	Father (*Pa*) x F1 from Me 2	39 males *Pa* (44,83%)	0 males *Me* (0,0%)	48 females, uncoloured (55.17%).	
Me 4	*Me* x *Pa*	0 males *Pa* (0,0%)	0 males *Me* (0,0%)	54 males showing other colour patterns (42.86%)	72 females, uncoloured (57.14%).
Me 5	F1 from Me 4	0 males *Pa* (0.0%)	24 males *Me* (13,26%)	65 males showing other colour patterns (35.91%)	92 females, uncoloured (50.83%).
Me 6	Father Me x F1 from Me 4	0 males *Pa* (0.0%)	58 males Me (29.74%)	45 males showing other colour patterns (23.08%)	92 females, uncoloured (47,18%).

Tab. 4: Crosses with Pink/Moscow.
Tab. 4: Kreuzungen mit dem Stamm Pink/Moscow.

Pi/Mo 1	Pi/Mo x Pa	46 Grey males Mo (60.53%)	0 males Pi/Mo (0.0%)	30 Grey females, uncoloured (39.47%)	0 males Pi (0.0%).
Pi/Mo 2	F1 from Pi/Mo 1	103 grey males Mo (36,14%)	37 males Pi/Mo (12,98%)	115 Grey females, uncoloured (40.35%)	30 females Pi , uncoloured (10,53%).
Pi/Mo 3	Father Pi/Mo x F1 from Pi/Mo 1	46 Grey males Mo (21.30%)	44 males Pi/Mo (20,37%)	65 Grey females, uncoloured (30.09%)	61 females Pi ,uncoloured (28.24%).
Pi/Mo 4	Grey Pa x Pi/Mo	40 Grey males Pa (46.51%)	0 males Pi (0.0%)	46 Grey females, uncoloured (53.49%)	0 females Pi (0.0%).
Pi/Mo 5	F1 from Pi/Mo 4	58 Grey males Pa (33.33%)	19 males Pi/Pa (10.92%)	65 Grey females, uncoloured (37.36%)	32 females Pi, uncoloured (18.39%).
Pi/Mo 6	Father Grey Pa x F1 from Pi/Mo 4	44 Grey males Pa (48.35%)	0 males Pi (0.0%)	47 Grey females, uncoloured (51.65%)	0 female P (0.0%).
Pi/Mo 7	Pi /Mo x Go	7grey males Mo (38.89%)	11 grey females, uncoloured (61.11%).		