AACL BIOFLUX
Aquaculture, Aquarium, Conservation & Legislation
International Journal of the Bioflux Society

Mendelian laws in aquaculture and cuniculture: simple and efficient

Ruxandra M. Petrescu-Mag[1,2], Ştefil Creangă[2], I. Valentin Petrescu-Mag[2,3,4]

[1] Babes-Bolyai University, Faculty of Environmental Sciences and Engineering, Cluj-Napoca, Romania; [2] Ion Ionescu de la Brad University of Agricultural Sciences and Veterinary Medicine Iaşi, Romania; [3]University of Agriculture Science and Veterinary Medicine of Cluj-Napoca, Cluj, Romania; [4]SC Bioflux SRL, Cluj-Napoca, Romania.
Corresponding author: I. V. Petrescu-Mag, zoobiomag2004@yahoo.com

Abstract. Many aquarists, fish or rabbit breeders have at their disposal for reproduction heterogenic populations as a result of segregation, or due to crossbreeding. In many cases, they must buy new brood stock every 2-3 years due to the fact their old brood stock degenerates visible after several generations. The aim of this paper is to underline that there are some low cost and easy to understand principles available with application in animal improvement and production. Color, size and shape are important traits when we describe a product as a phenotypically uniform line, strain or breed, e.g. the albino African catfish, the red eyed swordtail, the Red Blond guppy, the large chinchilla rabbit, the New Zealand white rabbit. A standardized color, shape and size describe better an animal population and thus the said product is promoted better on the market. Two simple examples of applications will be presented in this paper, the case of purification and maintaining of thermo-resistant guppy fish, and the principle of improvement of body size and maintaining the color pattern in Transylvanian Giant rabbit. The key to success is to know what is (are) the recessive gene(s) for every relevant locus.
Key Words: Mendelian laws, simple, efficient, animal production, purification, standardization.

Introduction. Biotechnologies… the future. Today, an essential tool of the big companies for use in human or animal health improvement, animal or crop production, biodiversity or taxonomy and so on. What about the small crop and animal producers? Are they able to use cutting edge technologies? On what extent they have human resources trained to apply the last knowledge in genetics and biotechnologies? Have they equipments and laboratories in this view? Unfortunately, at least in South-East Europe, the small producers of brood stocks are not equipped well enough for such activities; moreover, their knowledge in genetics is too poor to enterprise animal improvement by themselves.

The aim of this paper is to underline that there are some low cost and easy to understand principles available with application in animal improvement. Color, size and shape are important traits when we describe a product as a phenotypically uniform line, strain or breed, e.g. the albino African catfish *Clarias gariepinus,* the red eyed swordtail *Xiphophorus hellerii*, the Red Blond guppy *Poecilia reticulata*, the large chinchilla *Oryctolagus cuniculus*, the New Zealand white *O. cuniculus*. A standardized color, shape and size describe better an animal population and thus it is promoted better on the market.

Many aquarists, fish or rabbit breeders have at their disposal heterogenic populations as a result of segregation, or due to crossbreeding. Very often, they must buy every 2-3 years new brood stocks as their old brood stock degenerates significantly after several generations. What they do not know is that, in some cases when the phenotypes are encoded by simple or double recessive genes, the old brood stock can be saved using the very simple principles of Gregor Mendel (known as Mendelian Laws).

Our Applications. Two simple examples of applications will be presented here, the case of purification and maintaining of thermo-resistant guppy fish (Fig. 1, left), and the principle of improvement of body size and maintaining the color pattern in Transylvanian

Giant rabbit (Fig. 1, right). The key to success is to know what is (are) the recessive gene(s) for every relevant locus.

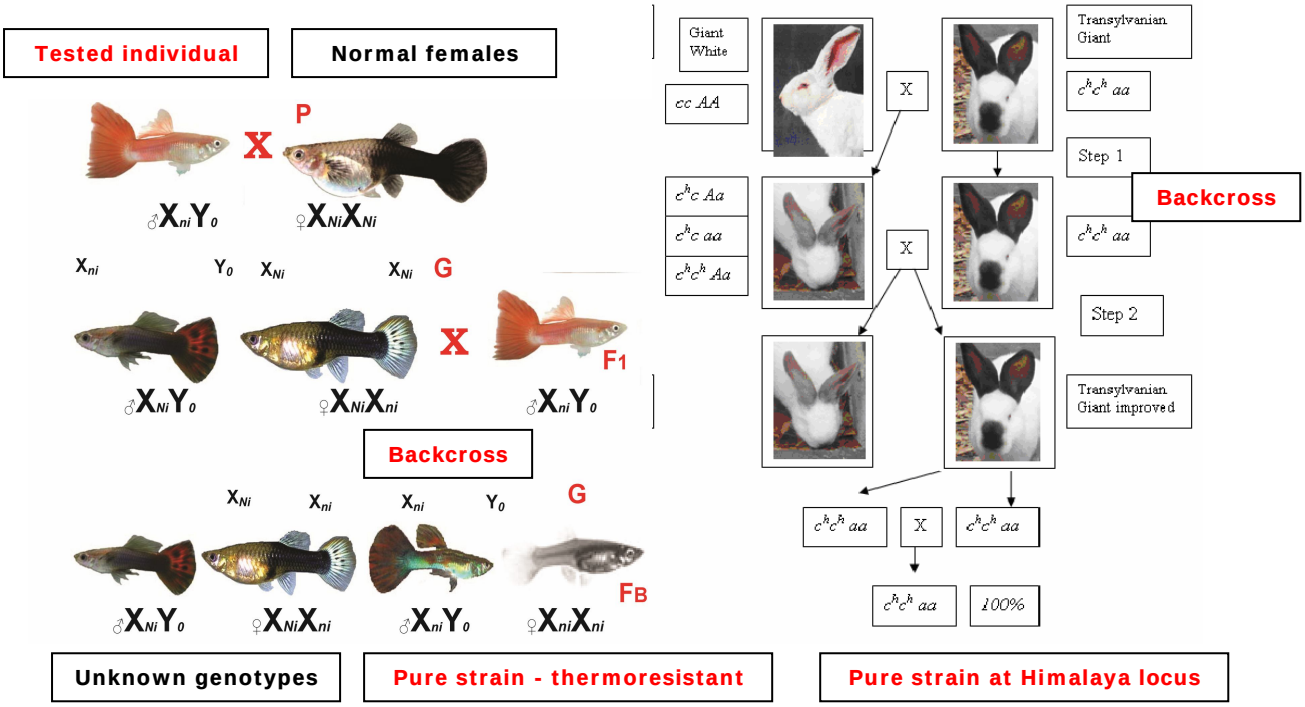

Fig. 1. Procedure for purification and maintaining of thermo-resistant guppy fish (left); principle for improvement of body size and maintaining and/or recovery of the proper color pattern in Transylvanian Giant rabbit using infusion with Giant White rabbit (right).

A homozygote guppy strain for both cold and heat water resistance gene was purified by Petrescu-Mag et al (2007, 2008ab; Fig. 1, left). After the identification of cold and heat resistant males, purification was possible due to the X-linkage of Nigrocaudatus II (*Ni*) which was used as color marker gene. The breeding program of the research was based on a ♂Red Blond X ♀Half-Black Black cross, followed by a backcross of F1 females with the initial Red Blond male.

A similar principle was used during the years 2010-2011 by our team to improve the body size in several populations of Transylvanian Giant rabbits (TGR). TGR breed was created by Petrescu-Mag et al (2009, 2011, 2012ab); this rustic, polyphyletic and productive rabbit breed is large sized, the minimal weight being 4.50 kg, the normal weight 6.00 kg, and the maximum weight 9.00 kg. The body size improvement in TGR was absolutely necessary in some populations with an initial body weight of about 4.6-4.8 kg. Simply hybridization of TGR with the Giant White is not enough due to poor quality as regards the color of body extremities and color pattern diversity resulted due to segregation in F_2 and F_n. Use of F_B (backcross), following after F_1, and selection of best animals in terms of color pattern and body size or weight is the shortest and best solution to obtain perfect animals for exhibition or brood stock.

As regards the purification of qualitative traits in general, a good knowledge of Mendelian laws helps us to maintain many strains, lines, or breeds, such as: the albino African catfish, the red eyed swordtail, the albino swordtails, the red eyed varieties of platyfish (*Xiphophorus maculatus*), the Red Blond guppy, the albino guppy strains, the guppy strains characterised by non-Nigrocaudatus traits as recessive to *Ni* gene, the large chinchilla rabbit, the New Zealand White rabbit, the Himalaya rabbit, the Californian rabbit, the Transylvanian Giant rabbit, the Giant White rabbit, the Viena White rabbit and so forth.

As regards genotype identification using phenotypes, a special attention should be given to genus *Poecilia* because numerous color patterns express in males only (Breden & Stoner 1987; Brooks & Endler 2001; Rodd et al 2002; Alexander & Breden 2004; Tripathi et al 2008; Bourne & Watson 2009; Ţălu et al 2012; Georgescu & Georgescu 2012) so

that lack of a specific color-pattern does not necessarily mean the absence of corresponding gene (Lindholm & Breden 2002; Petrescu-Mag 2009). Such an example is the Red Snakeskin guppy variety: in this fish, the X, Y, none or both allosomes carry the Snakeskin body (*Ssb*) gene but, however, this gene is not expressed in females at all (see Fig. 2.) (Phang et al 1989ab, 1990; Phang & Fernando 1991).

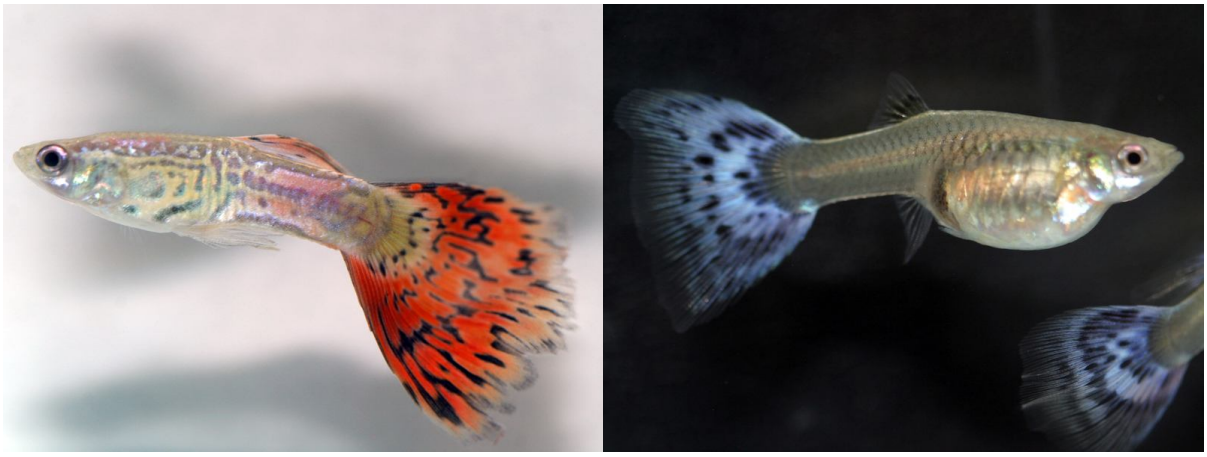

Fig. 2. Red Snakeskin guppy (*P. reticulata*): male (left) and female (right) (Photo: Mircea Roşca).

Example of Failure in Livestock Management by not Applying Mendelian Laws. The white of Debrecen rabbit breed failed to become a European breed by standardization. Although numerous and old enough, this breed is still too heterogenic in coat color: some animals are completely white and albino (cc), others are Himalaya like colored (c^hc^h), while most of them look like an c^hc albino heterozygote, with poor and greyish drawing on extremities. Standardization needs first of all a clear phenotypic description of the breed and a homogenous population. Besides color coat, body shape and size must also be identical and this can be done even empirically, by rabbit breeders.

Final Remarks. Mendelian laws: just for the sake of knowledge? They are very useful in practice, but unfortunately too little used, although they do not require special equipment. Should we buy anything? Yes, breeds, lines and strains which are characterized by traits encoded by dominant genes. If not pure breeds, they will always segregate, and a new brood stock is cheaper than the progeny testing program; moreover, color is the result of the interaction of many non-allelic genes, situated at many loci.

Acknowledgements. This work was co-financed from the European Social Fund through Sectorial Operational Programme Human Resources Development 2007-2013, project number POSDRU/I.89/1.5/S62371 "Postdoctoral School in Agriculture and Veterinary Medicine Area". Secondary, it was supported by the project 590/13.09.2012 (National Plan II, Capacities - Bilateral Cooperation between Romania and Wallonia).

References

Alexander H. J., Breden F., 2004 Sexual isolation and extreme morphological divergence in the Cumaná guppy: a possible case of incipient speciation. J Evol Biol 17:1238-1254.

Bourne G. R., Watson L. C., 2009 Receiver-bias implicated in the nonsexual origin of female mate choice in the pentamorhic fish Poecilia parae Eigenmann, 1894. AACL Bioflux 2(3):299-317.

Breden F., Stoner G., 1987 Male predation risk determines female preference in the Trinidad guppy. Nature 329:831-833.

Brooks R., Endler J. A., 2001 Direct and indirect sexual selection and quantitative genetics of male traits in guppies (*Poecilia reticulata*). Evolution 55:1002-1015.

Georgescu B., Georgescu C. E., 2012 *Poecilia reticulata* as a valuable biological indicator of endocrine disruption. Poec Res 2(1):15-19.

Lindholm A., Breden F., 2002 Sex chromosomes and sexual selection in poeciliid fishes. Am Nat 160:S214-S224.

Petrescu-Mag I. V., 2009 Winge's sex-linked color patterns and SDL in the guppy: genes or gene complexes? AACL Bioflux 2(1):71-80.
Petrescu-Mag I. V., Bud I., Petrescu-Mag R. M., Sisea C., Bura M., Grozea A., Botha M., Coşier V. (Inventors), 2007 Protocol for obtaining of a cryoresistant ornamental guppyfish, with applicability in guppyculture. BOPI 5/29.05.2009, p.25 (submitted to OSIM: 09.11.2007 - A/00774). Awarded: 26.09.2012, patent no. 123452. Assignee: University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca.
Petrescu-Mag I. V., Bud I., Pamfil D. C., Petrescu-Mag R. M., Grozea A., Bura M., Gorgan D. L., Păsărin B., Bănățean-Dunea I., Lozinsky L. R., Hărşan R., Csep L., Sisea C., Coşier V., Botha M., Petrescu D. C. (Inventors), 2008 Process for obtaining a line of ornamental guppy fish resistant to hyperthermia. Derwent Innovation Patent Number: RO125530-A2. Assignee: University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca.
Petrescu-Mag I. V., Boaru M. A., Hărşan R., Petrescu-Mag R. M., 2008 Genetic basis of resistance to stress in fishes. Molecular and classical investigations in a few model organisms. AACL Bioflux 1(1):99-110.
Petrescu-Mag I. V., Petrescu-Mag R. M., Botha M., Oroian I., 2009 Transylvanian Giant Rabbit originates from Arieș and Someș Areas (Transylvania, Romania). Transylv Rev Syst Ecol Res 7:187-192.
Petrescu-Mag I. V., Petrescu-Mag R. M., Păsărin B., Pop D., Botha M., Gîlcă V., Bud I., Hoha G., Creangă Ş., 2011 Proposal of standard for the judgement of the exhibition Transylvanian Giant Rabbit. ABAH Bioflux 3(1):39-41.
Petrescu-Mag I. V., Petrescu-Mag R. M., Viman O., Botha M., Hoha G., Grun E., Creangă Ş., 2012a The Giant of Transylvania: Standard for arbitration in rabbit exhibitions. Rabbit Gen 2(1):1-4.
Petrescu-Mag R. M., Oroian I. G., Vesa Ş. C., Petrescu-Mag I. V., 2012b Himalaya: an evolutionarily paradoxical phenotype in rabbits (*Oryctolagus cuniculus*). Rabbit Gen 2:15-17.
Phang V. P. E., Ng L. N., Fernando A. A., 1989a Inheritance of the snakeskin color pattern in the guppy, *Poecilia reticulata*. J Hered 80:393–399.
Phang V. P. E., Ng L. N., Fernando A. A., 1989b Genetics of the color of the yellow snakeskin variety of the guppy, *Poecilia reticulata*. Singapore J Pri Ind 17:19–28.
Phang V. P. E, Fernando A. A., Chia E. W. K., 1990 Inheritance of the color patterns of the blue snakeskin and red snakeskin varieties of the guppy, *Poecilia reticulata*. Zool Sci 7:419–425.
Phang V. P. E., Fernando A. A., 1991 Linkage analysis of the X-linked green tail and blue tail color genes in the guppy, *Poecilia reticulata*. Zool Sci 8:975–981.
Rodd F. H., Hughes K. A., Grether G. F., Baril C. T., 2002 A possible non-sexual origin of mate preference: are male guppies mimicking fruit? Proc R Soc Lond B 269:475-481.
Tripathi N., Hoffmann M., Dreyer C., 2008 Natural variation of male ornamental traits of the guppy, *Poecilia reticulata*. Zebrafish 5(4):265-278.
Ţălu Ş., Petrescu-Mag I. V., Păsărin B., 2012 Investigation on acute toxicity of lindane in guppies, *Poecilia reticulata* Peters, 1859. Poec Res 2(1):9-14.

Received: 29 October 2012. Accepted: 22 November 2012. Published online: 26 November 2012.
Authors:
Ruxandra Mălina Petrescu-Mag, Ion Ionescu de la Brad University of Agricultural Sciences and Veterinary Medicine Iași, Mihail Sadoveanu Alley 8, 700489 Iași, Romania, European Union, e-mail: pmalina2000@yahoo.com
Ştefil Creangă, Ion Ionescu de la Brad University of Agricultural Sciences and Veterinary Medicine Iași, Mihail Sadoveanu Alley 8, 700489 Iași, Romania, European Union.
Ioan Valentin Petrescu-Mag, Ion Ionescu de la Brad University of Agricultural Sciences and Veterinary Medicine Iași, Mihail Sadoveanu Alley 8, 700489 Iași, Romania, European Union, e-mail: zoobiomag2004@yahoo.com

How to cite this article:
Petrescu-Mag R. M., Creangă Ş., Petrescu-Mag I. V., 2013 Mendelian laws in aquaculture and cuniculture: simple and efficient. AACL Bioflux 6(2):111-114.