Morphometric and allozyme variation in natural populations and cultured strains of the Nile tilapia *Oreochromis niloticus niloticus* (Teleostei, Cichlidae)

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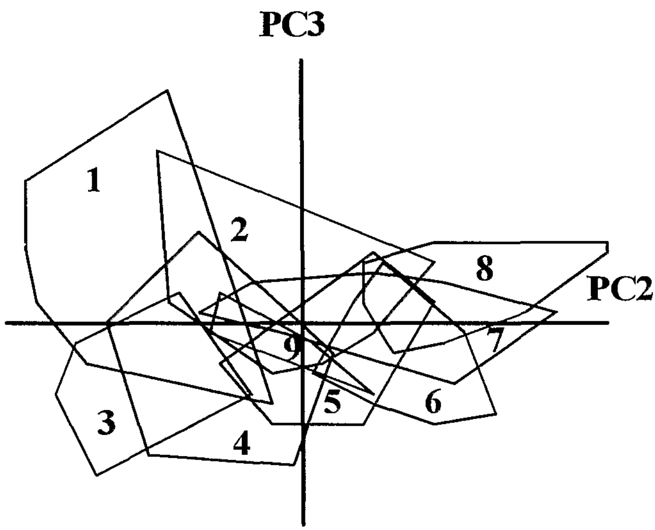
The Nile tilapia, *Oreochromis niloticus* (LINNAEUS, 1758) endemic to Africa has been introduced in many parts of the World for aquaculture purposes. In particular the subspecies *O. niloticus niloticus* is at present one of the most cultured freshwater fishes.

Several authors published on the meristic and morphometric characters of this species (*e.g.* DAGET, 1954 for local populations; TREWAVAS, 1983 for natural populations from the major part of its distribution range; GOURENE and TEUGELS, 1993 for cultured strains). Several others have published on the allozyme variation (*e.g.* BASIAO and TANIGUCHI, 1983; MCANDREW and MAJUMDAR, 1983; SEYOUM and KORNFIELD, 1992 for cultured stocks; ROGNON *et al.*, 1996 for West African natural and cultured populations; AGNESE *et al.*, 1997 for natural populations from allover the distribution range).

Origin	N (morphometry)	Standard Length (mm)	N (allozyme study)
Natural populations			
Dagana, Senegal	18	77.4 - 252.6	63
Selingue, Mali	24	95.0 - 138.5	58
Bamako, Mali	17	73.5 - 219.4	22
Battor, Ghana	7	180.0 - 252.4	7
Lake Chad, Chad	20	140.6 - 279.3	22
N'Djamena, Chari , Chad	17	97.9 - 156.9	30
Cairo, Nile, Egypt	17	136,9 - 246,7	18
Lake Manzalla, Egypt	16	122.1 - 178.0	30
Lake Edward, Uganda	28	152.9 - 223.9	30
Cultured strains			
Bouake strain	29	95.0 - 138.5	55
Volta strain	32	101.0 - 136.8	50
Quarun strain	20	154.7 - 225.5	20

Table 1
List of natural populations and cultured strains examined of *Oreochromis niloticus*.

As part of a multidisciplinary project on the characterisation of species and populations used in aquaculture we examined the morphology and allozyme variation of nine natural populations and three cultured strains of *Oreochromis niloticus*. Origin and sample size of the populations and strains are listed in Table I. For each specimen twenty-five measurements and eight counts were taken. The morphometric results obtained were log-transformed and submitted to principal component analysis using the STATISTICA package. For allozyme studies, standard horizontal gel electrophoresis was carried out to investigate the products of 25 loci. The allozymic data were analysed using the PHYLIP sofware package.



I Figure 1
Plot of a principal component analysis on log-transformed data of 25 metric variables for 142 specimens of *Oreochromis niloticus* originating from 9 natural populations from West Africa, the Nile and Lake Edward. The numbers given in the figure correspond to the following natural populations: Lake edward (1), Bamako (Niger) (2), Lake Manzalla (3), Cairo (Nile) (4), N'Djamena (Chari) (5), Lake Chad (6), Dagana (Senegal) (7), Selingue (Niger) (8), and Battor (Volta) (9).

Results obtained by a principal component analysis on the morphological data of all natural populations from West Africa, Egypt and Lake Edward are given in figure 1. Two major groups are discerned : all specimens from Egypt (Cairo and Lake Manzalla) and Lake Edward, except one, are located on the negative sector of the second component, while the majority of the specimens from West Africa are located on the positive sector of this component. The latter is mainly defined by the caudal peduncle length, the toothed pharyngeal bone length and width.

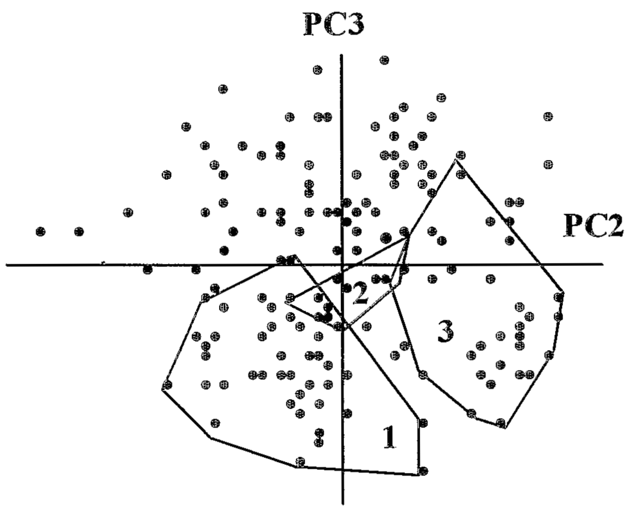


Figure 2
Plot of a principal component analysis on log-transformed data of 25 metric variables for 169 specimens of *Oreochromis niloticus*: (1) Lake Edward, (2) Battor (Volta) and (3) the cultured Bouake strain.

The results of the same analysis with addition of the Bouake strain are illustrated in figure 2. This cultured strain results from an interbreeding between specimens from the Volta basin and Lake Edward. This is however not confirmed by the results obtained as only a slight overlap is noted between the Bouake strain and the Battor (Volta) population; furthermore the Bouake strain is completely separated from the population from Lake Edward.

The results of further analysis with addition of the Volta strain are given in figure 3. Note that the Volta strain, descending from a natural population of the Volta basin, only slightly overlaps with the Battor (= Volta) population. Interestingly, the Volta strain almost completely overlaps with the Bouake strain (not illustrated).

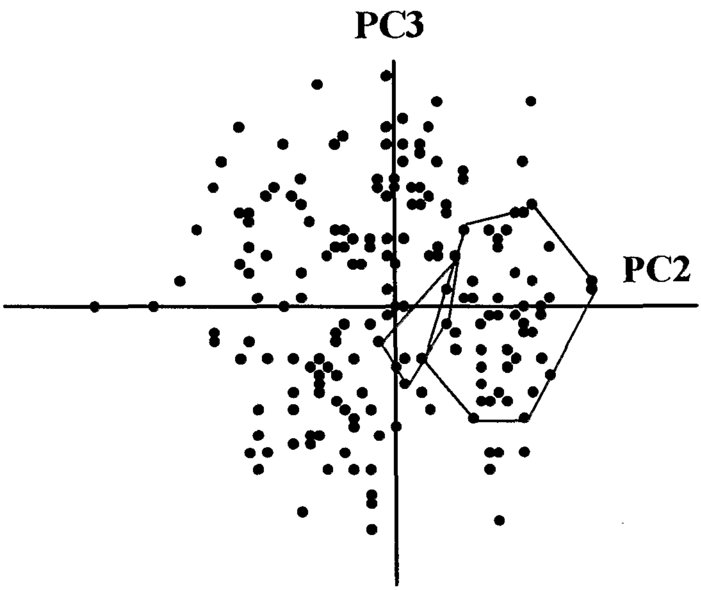


Figure 3
Plot of a principal component analysis on log-transformed data of 25 metric variables for 200 specimens of *Oreochromis niloticus* from the cultured Bouake and Volta strains and 9 natural populations from West Africa, the Nile and Lake Edward: Volta (Battor) (1), Volta strains (2).

The results of an analysis with addition of the Quarun strain are given in figure 4. Noteworthy here is that in this figure most of the specimens belonging to cultured strains are located on the negative sector of the third component, which is merely defined by the lower jaw length, body depth and pelvic fin length, while the majority of the natural populations are situated on the positive sector of this component.

In conclusion the morphometric analysis of the natural populations from West Africa did not enable us to indicate clearly marked differences between them. According to TREWAVAS (1983), natural populations from the Lower Nile system in Egypt belong to the same subspecies *O. niloticus niloticus* as those from West Africa. Morphologically, however, the majority of the specimens from both geographical region can be distinghuised from each other. Moreover the Nile specimens are morphologically closer to the Lake Edward specimens, which, following TREWAVAS (1983), belong to the subspecies *O. niloticus eduardianus*.

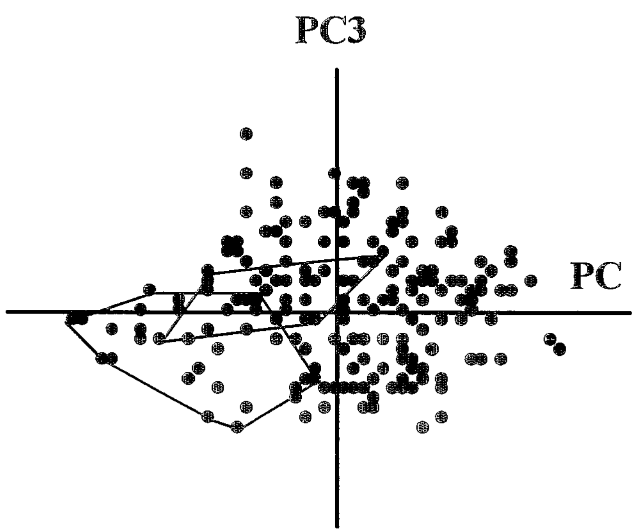


Figure 4
Plot of a principal component analysis on log-transformed data of 25 metric variables for 220 specimens from Bouake strain, Volta strain, Quarun strain and from 9 natural populations from West Africa, Lake Edward and the Nile; Quarun strain (1), Cairo and Lake Manzalla populations (2).

The morphometric results are confirmed by the allozyme study. Thirteen of the 25 loci were polymorphic and domestic strains did not show lower H and P values than natural populations, indicating that they did not loose genetic polymorphism. The genetic relationships between the different samples studied is given in figure 5. The populations are clustered in two major groups: the West African natural populations (Dagana, Selingue, Bamako, N'Djamena, Chad and Volta) with one domestic strain (Volta) and the Nile drainage natural populations (Manzalla, Cairo and Lake Edward) with two domestic strains (Quarun and Bouake).

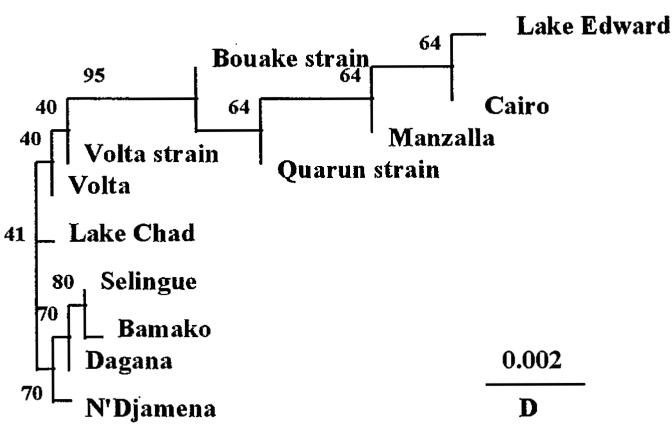


Figure 5
Consensus unrooted tree produced by PHYLIP for 9 natural populations and 3 cultured strains of *Oreochromis niloticus*. Number at each node indicates the percentage obtained using bootstrapping.

An overall comparison of all natural populations and all cultured strains examined, showed important morphological differences between both. It is thus obvious that the external morphology is considerably influenced by the environmental conditions in captivity. Factors such as lack of current in ponds, undoubtedly affect the external morphology this being expressed for example in the reduction of the body depth. In how far captivity conditions affect the growth rate and thus the aquaculture productivity is the subject of further investigation.

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