Photographic Image Analysis for Morphometric Studies of Tilapia*

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Biologists have long employed morphometry as a tool in identification, grouping of populations and stock identification of fish. For tilapias, studies have been made on the variability of morphometric characters in Egyptian species (Libosvarsky and Bishara 1986). Truss morphometrics, where the body shape is divided into a series of 'cells' each of which contains information on the shape and size of the fish, were used by Brzeski and Doyle (1988) for *Oreochromis mossambicus/urolepis hornorum* sex differentiation. Recent work on *O. niloticus* has been reported by Eknath et al. (1991).

We have developed a computerized approach to the collection of morphometric data using image analysis and a digitizing tablet with 21 landmark points on tilapias (Fig. 1). This technique provides accuracy, speed of sampling and a permanent record and is an alternative to measurements of live fish with calipers.

For photodocumentation, we used an SLR camera equipped with a 50 mm lens; and an aperture setting of f5.6 with speeds of 1/30 to 1/60 seconds for high contrast film (Kodalith, ASA 25). This type of film turns black objects to white and vice versa which highlights the body outline of the fish. Slides are preferred to prints because they can be projected to a digitizing tablet for measurements. The camera is mounted vertically on a copy stand 50 cm above a board (Fig. 2). With this arrangement, three fish, a phototag, date, species and sample numbers fit into the frame.

Samples from eight strains of *O. niloticus* kept at the Philippine Bureau of Fisheries and Aquatic Resources (Eknath et al. 1991) were anesthesized in a basin of water with a few drops of a working solution of chlorobutanol (30% ethyl alcohol + 70% chlorobutanol). The specimens are positioned on a styropore board with the fins fastened using dissecting needles and the left side uppermost.

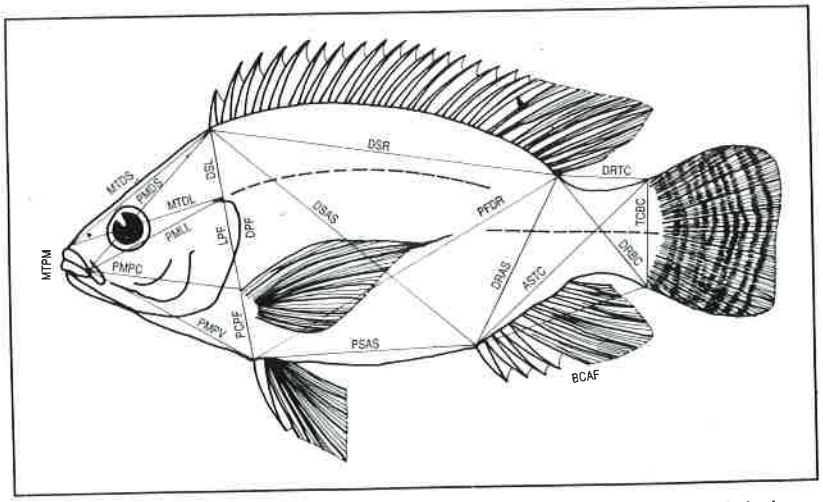

Fig. 1. Truss network of 21 landmark points on the body outline, measured during morphometric characterization of eight test strains of *Oreochromis niloticus*.

Fig. 2. Photodocumentation of test strains of *Oreochromis niloticus* for morphometric characterization. (Photo by O. Espiritu Jr.)

Photointerpretation was done using a 2200 opaque high resolution digitizing tablet (Jandel Scientific Digitizing Tablet Model 2210 Eastman Kodak Company, USA) positioned vertically on a wall. The image was projected by a slide projector (Model BZAR Eastman, USA). The images were analyzed using a four-button cursor to set the landmark points and to measure distances. The tablet was linked to a microcomputer. We used a Computer Aided Monoscopic Analysis (CAMA) program developed at the Biochemistry and Genetics Laboratory of the Marine Science Institute of the University of

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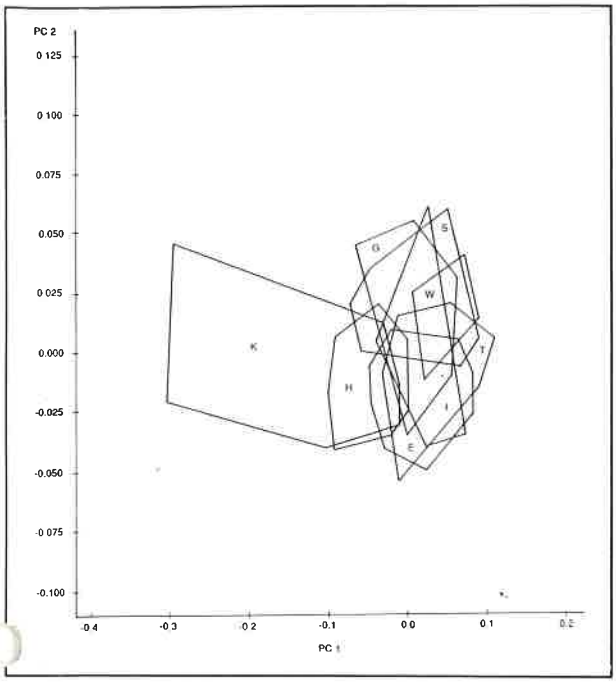

Fig. 3. Plot of first two axes from a principal component analysis of 21 morphometric characters of mixed sexes of *Oreochromis niloticus* strains: E = Egypt; G = Singapore; H = Ghana; I = Israel; K = Kenya; S = Sénégal; T = Thailand; W = Taiwan.

the Philippines designed to do linear measurements of objects on a photographic image. The program gives good accuracy for each measurement session since it verifies the plane of projection of the image. The data are filed as Lotus 123 worksheets and are log-transformed to reduce homoscedasticity of variances. To correct for size effects, each observed distance is divided by its estimate. Corrected size measurements were analyzed multivariately under the Principal Component Analysis and was performed using the Statistical Analysis System (SAS) software.

A typical result (Fig. 3) shows the separation of Kenya strain *O. niloticus* from a cluster of 'Philippine' and African strains. This indicates that overall shape of Kenya strain is different from the rest of the strains, being shorter and having a streamlined body (Eknath et al. 1991). The overlapping pattern of separation among the strains (except Kenya) indicate that these strains are weakly differentiated. The greater segregation of the Kenya strain from others supports its subspecific status: *O. niloticus vulcani*, the other strain being *O. n. niloticus* (Trewavas 1983).

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Growth Performance in Fishes: Rigorous Description of Patterns as a Basis for Understanding Causal Mechanisms*

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Abstract

The origins and features of the growth performance index ϕ' are reviewed, emphasizing its ability to express the underlying common characteristics of a *family* of growth curves. Some other aspects of ϕ' are discussed, notably its correlation, in fishes, with functioned morphology (e.g., gill surface area for respiration) and its conceptual links with *auximetric grids*, another device proposed by the author for growth comparisons of fishes.

Introduction

The Random House Dictionary defines *comparison* as "the considering of two things with regard to some characteristic that is common to both, as the likening of a hero to a lion in courage". The growth curves of fishes even of the same species and population can be very different, and comparing them is indeed difficult. This is because growth relates *two* variables, (i) size and (ii) time.

Therefore, when two growth curves e.g., are to be compared, at least *four* numbers are implied, which when left unconsidered, can quickly lead to contradictions. For example, Kinne (1960) wrote, upon comparing the growth curves of guppies:

"The results indicate that the differences in growth rate established in young fish do not persist throughout life. Initially slow-growing fishes may surpass initially fast-growing fishes, and finally reach a greater length-at-age."

Pauly (1979) attempted to deal with this and similar problems. One of the key results was that, given von Bertalanffy growth curves, when one plots, for many different fish species, population-specific values of logK against their corresponding values of

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