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Recent Trends in Systematic Ichthyology

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Conventional taxonomy though of value in certain groups, the changed concept in respect of many families of fishes has necessitated the employment of better techniques for determining the phylogeny and inter-relationships. Employment of osteological, neurological, myological, cytotaxonomic and biochemical methods which has proved useful is discussed. Statistical analysis gives only a clue to the heterogeneity or otherwise of the population and is of no use in determining any taxonomic rank of identifiable nature. Much work remains to be done in serological and biochemical taxonomy in respect of fishes.

Key Words: **Recent trends, Systematic ichthyology**

Introduction

The modern concept of binomial nomenclature came into being from the 10th edition of *Systema Naturae* by Carolus Linnaeus (1758), wherein for the first time a consistent usage and practice of giving two names for any animal, one to indicate the genus and the other for the specific combination was adopted.

Systematic Ichthyology is no exception to the tumult of changes and confusion that the entire subject of Zoological Taxonomy underwent. It was not nomenclatural problems alone that contributed to the confused conditions in fish systematics of earlier years. The selection of characters and the methodology adopted for description of taxa caused greater instability and confusion than anything else. The variability of populations and concepts of dynamism of species were never looked into. The typological concept of Linnaean times, though may hold good for certain less known groups even now, was centred round the type-specimen and was absolutely non-dimensional. Very little significance was attributed to geographic variations. Many species and even genera were established on the basis of single specimens, which in reality might be the extreme limit of a varying population. Description of taxa was inadequate and lacked much essential comparable data and were zoologically poor. The individual, rather than the population, became the central point and it naturally led to many technical questions of conventional nomenclature. Even the style and content of descriptions differed from author to author without any uniformity, so much so the comparison by later workers of the very same species collected from elsewhere became well nigh impossible and impracticable. Teleostean classification for instance up to and including not only Berg's (1940) work, but also a very large part of the work of Bertin and Arambourg (1958) has been arrived at primarily by methods that are essentially typological in nature. Orders and then higher taxa were defined first and their origin speculated subsequently in the light of known fossil evidences.

Huxley (1940) propounded the New Systematics, which made a big breakthrough and laid the foundation for the modern present-day computer-oriented (McAllister 1976) Systematics. The New Systematics is a synthesis of recent approaches in biogeography, ecology, cytology, physiology and population genetics. The species came to be defined biologically, and the description took into cognisance the ecological, genetic and geographical factors. The species, as a living, viable unit of the population, alone came to be realised as the only systematic category that can be seen, sampled, tested and experimented. Adequate samples of the population from as many habitats as possible of its known range with all its parameters, were taken as series for study. Most taxonomic work was done infraspecifically. Allopatry and sympatry of a population became very important. Modern taxonomy made the closest contact with population genetics and ecology—the two disciplines which became the indispensable part in the training and work of every taxonomist.

Keeping pace with the new concept of species, the variations met within the population and the diverse ways to study and determine the extent of these variations and the taxonomic rank that could be given have become the absorbing task of the present-day worker.

Variations

A taxonomist encountering a species of a few specimens is in reality, only, examining a sample of the population of that particular species. It is virtually impossible to examine the entire population except in the case of a palaeontological sample of a near extinct species. In all these, the character he is examining is subject to many variations.

Variations are of two major kinds, genetic and nongenetic. The latter adapts the individual, while the former adapts the population and the species as a whole. There are 11 kinds of variations under the first category and six under the second.

Nongenetic variations: The metamorphosis of Leptocephali into full-grown eels is an example of this kind of variation. The presence or absence of well developed horny tubercles (Pearl organs) in *Puntius kolus*, with associated differences in body features is a form of sexual dimorphism. The adaptive modifications of hill-stream fishes such as *Glyptothorax*, *Pseudechensis*, *Noemacheilus* are ecophenotypic. Teratological examples of many fish species reported are traumatic variations.

Genetic variations: Under the genetic category sexual dimorphism plays a dominant role. Hora (1937) showed that at breeding time adult specimens of *Puntius mahecola* and *Puntius filamentosus* show sexual dimorphism. The male representing the *filamentosus* type has the anterior 4 or 5 branched rays of the dorsal fin prolonged and the snout covered with a patch of large tubercles; the female lacks these two characters and represents the *mahecola* type. In view of this, *mahecola* which was for a long time considered a separate species is now synonymised with *filamentosus* (figure 1).

The most common type of individual variation relates to slight genetic differences which exist between individuals. It is a common fact that no two individuals in a population of sexually reproducing fishes are exactly alike, genetically or morphologically. This fact or realisation is one of the

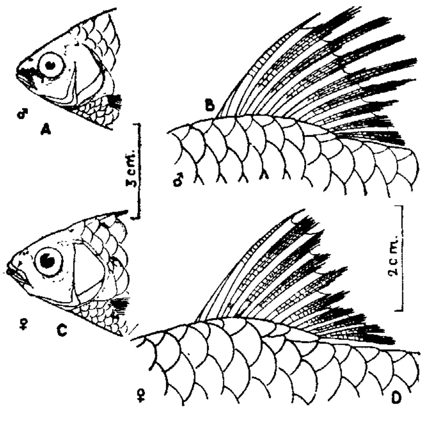

Figure 1 Sexual dimorphism in *Puntius filamentosus* (Val.). *A*, Head of the male showing tubercles on the snout; *B*, Dorsal fin of the male showing filamentous prolongation; *C*, Head of the female [previously known as *P. mahecola* (Val.)] without tubereles on the snout; and *D*, Dorsal fin of the female without filamentous prolongation

outstanding contributions of population genetics. The differences are slight and are often not discovered unless special techniques are employed. The study of this variation is one of the foremost tasks of the taxonomist. No single specimen of a sample is "typical" of the character of a population. Such studies of variations have necessitated the employment of diverse techniques in modern days unlike the earlier times when they were compared with the type-specimen and described as a new taxa not realising the fact that differences are bound to exist in such populations. In fact non-cognisance of such a fact alone contributed much to the abuse of taxonomy and its being viewed with disfavour and contempt by many.

Recent Trends

In view of the fact that the variations within a species in a series of individuals are often minute, such as the proportions of the body depth, head length etc., which may vary only to an extent of 0.5 to 1.0 mm in a sample of say 50 individuals, much confusion results in determination, and differentiation of species. For example *Mystus bleekeri* Day and *Mystus vittatus* (Bloch) are two species found almost all over India, though originally *vittatus* was thought to be confined to south India and *bleekeri* to north India. Most of the morphometric and meristic characters of both the species intergrade. The colour bands often are more or less similar in both the species; the only difference being in the extent of the adipose fin and the relative lengths of the maxillary barbel, which characters are highly variable in these fishes, associated as they are with growth.

A second example is provided by *Glyptothorax anamaliensis* Silas and *Laguvia ribeiroi* Hora. The two species are allopatric in the sense that there is a clear geographical isolation between the two. *G. anamaliensis* as the name indicates is found in the Anamalai hills, Tamil Nadu, whereas *L. ribeiroi* is found in Madhya Pradesh, eastern U.P., Bihar and W. Bengal. They are generically different but in nature have a striking superficial resemblance. Both, however, live in identical ecological habitats of cool, moderately fast freshwater streams.

Batasio batasio and *Mystus vittatus* provide another similar instance but here they share the same ecological niche in the sense that though *M. vittatus* is widely distributed it coexists in the same niche wherever *B. batasio* is found.

The above examples of sympatric and allopatric populations fortunately have a specific or generic level of differentiation between them. But difficulty is often felt when the characters are generalised and clear cut differences are hard to see. Even with statistical analysis, the results though significant, cannot be readily applied by the museum taxonomist or the fishery biologist.

Pillay (1951) for instance morphometrically analysed and compared *Puntius chrysopoma*, *P. caudimarginatus*, *P. pinnauratus*, *P. oatesii*, *P. sewelli*, *P. myitkyinae* and *P. binduchitra* with the widely distributed *P. sarana*. His study indicated that *P. binduchitra* differed from *P. sarana* to an extent of 75% and he opined that the former could be a subspecies of the latter. But in actual taxonomic practice this subspecies is unidentifiable by any external clear-cut character since it is neither geographically separate nor morphologically distinct enough to be of easy diagnosis. Jayaram (1960) similarly analysed the populations of *Rita chrysea* Day inhabiting the Mahanadi river and considered them as heterogenous; but no taxonomic rank could be given because the significance was only statistical.

Hora et al. (1939) investigated the variations exhibited by *Puntius ticto* and considered *P. punctatus* from south India and *P. stoliczkanus* from Burma as synonyms of *ticto*. Menon (1964) studied the genus *Garra* and adduced evidences for the establishment of different subspecies. Even here it may be stated that he had to group the species into complexes and then only separate them.

Thus statistical treatment no doubt is of value in infraspecific studies, but it cannot be utilised by the museum workers or field scientist.

Osteological Investigations

Emphasis as such is now being given to characters based on the basic structure of fish forms since not much, if not very little, variations are seen in such characters, especially in adult populations.

Vertebral counts have been utilised in differentiating genera and species (Weitzman & Cobb 1975, Jenkins & Lachner 1971). Fin ray counts and their frequency distribution in a large series have often helped separating closely related species. Schultz (1944) studied the caudal fin branched ray counts and found that a definite correlation did exist in a number of genera. It was seen that in many siluroid genera the upper caudal fin lobe had seven branched rays and the lower one eight rays (figure 2). This was more or less constant so much so that the groups of species or even genera could be differentiated on the strength of the frequency distribution of the counts of the caudal fin rays alone. Jayaram (1960) found that of all the Bagrid genera, *Rita* alone had seven or eight rays in the pelvic fin unlike other genera which have only six rays. On the basis of this he was able to separate the genus *Rita* under a separate subfamily Ritinae. Menon (1977) also similarly adopted the number of caudal fin rays in classifying the *Cynoglossus* species. Amongst the fin rays which are considered useful, are the anal, pelvic and caudal; the pectoral fin rays are not much investigated which otherwise appear to be a promising tool for differentiation. The division of species on the basis of the occipital process length, pectoral spine serrations, nature of the median groove on the head, are all known and need no elaboration (see Hora 1951, Jayaram 1977, 1977*a*, Jayaram & Bhimachar 1967) The skull characters and weberian apparatus modifications for differentiating genera and species have also been adopted. Tilak (1964) for instance found on the basis of such studies that *Pangasius* is fit to be kept separate as a family contrary to some view that it should be considered as belonging to Schilbeidae.

Myology

More and more evidences are adduced to break the typological concept of earlier workers and newer trends are being established. Areas and techniques previously not contemplated or known are being taken up

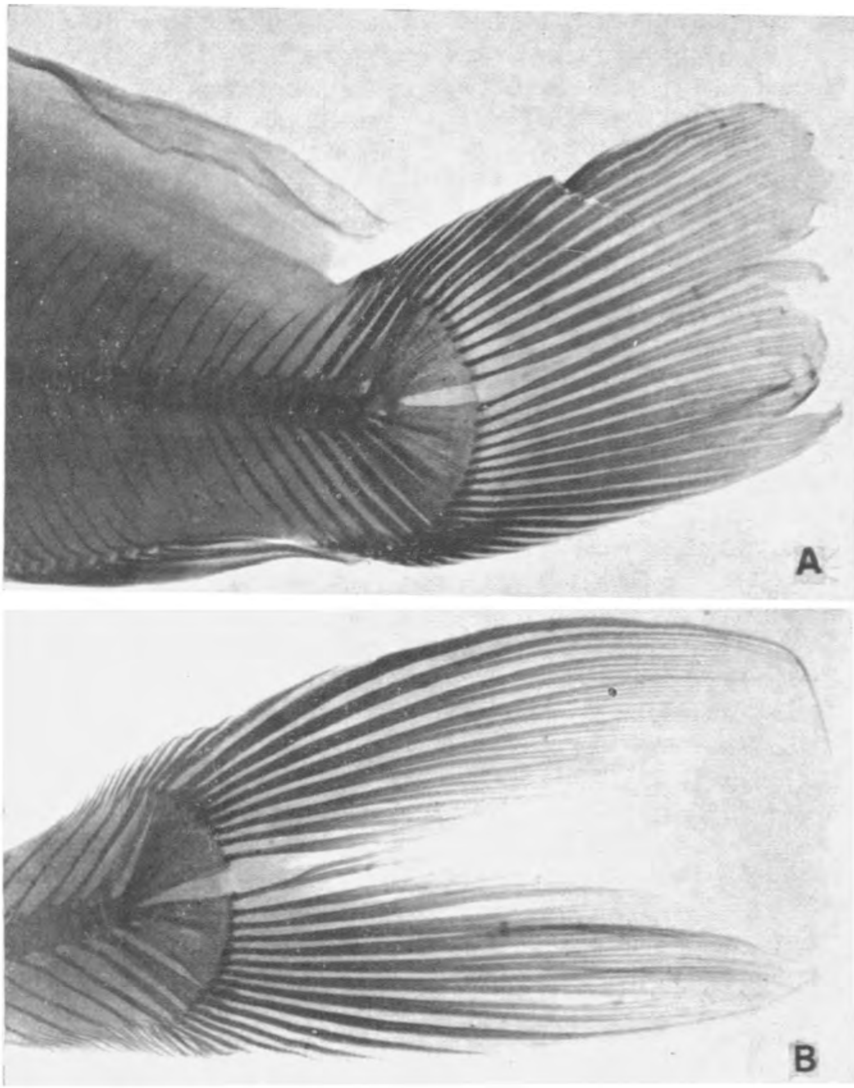

Figure 2 X-ray photographs of caudal fin to show constancy in branched rays—7 in upper lobe and 8 in lower lobe. *A*, *Auchenoglanis biscutatus* (Val.) USNM 86638; and *B*, Bagridae USNM 176322 (*Courtesy USNM, Fish Division*)

and very profitable results have been achieved. Modern classification especially of higher taxa is based on evolutionary trends. For determining these trends the build of the skull and the associated musculature are investigated. Greenwood et al. (1966) in their treatise, classified the teleosts into three major divisions on cranial architecture, viz. specialisation of the jaws, the anterior vertebrae and neurocranium. The pattern of the branchial skeleton has been utilised as one of the group characters to distinguish the superorder Osteoglossomorpha. An example of the excellent usage of the myology in fish classification is the monograph by Winterbottom (1974) on the classification of Tetraodontiformes. Methods to be followed in fish phylogeny have been admirably summarised by Hennig (1956) and Brundin (1966, 1968).

Lateral line Sense Organs, Nerve Patterns

The lateral line sense organs, sensory pores, the facial nerve patterns in teleosts have been taken into consideration for determining phylogenetic status of genera. Nerves, nerve endings, and the sensory pores are stained by the Sihler technique (Williams 1943, Freihofer 1966, Frasser & Freihofer 1971). Springer and Freihofer (1976) determined the ordinal status of *Pholidichthys* as belonging to Perciformes since it has a *Serranus*-type pattern of the recurrent facial nerve. Taylor (1969) revised the catfish genus *Noturus* utilising in part the arrangement of the sensory canal system in the different species. The number of cephalic sensory pores and lateral line tubes in the blenny *Omobranchus* was studied by Springer and Gomon (1975). This method can be employed for differentiation of genera and species.

Cytotaxonomy

Present-day knowledge about the chromosome number and their morphology in fishes is meagre. Karyological information on diverse groups of fishes may not only lead to a solution of several complex problems both at the family and generic level, but also in tracing the phylogeny of the class as a whole. Amongst the various workers, Post (1965), Scheel (1966) have contributed significantly. Scheel (*op. cit.*) demonstrated that the chromosome number varies considerably within all four major genera of Rivulinae, a subfamily in Cyprinodontidae, in contrast to the very stable chromosome number found by other authors in other subfamilies of Cyprinodontidae and Poecilidae. In India Srivastava and Das (1969) have studied the somatic chromosomes of *Mystus vittatus* and *Aorichthys seenghala*.

Biochemical Systematics

Classical cytogenetic methods were quickly assimilated as compared to biochemical techniques. Partly because of the emergence of new research tools and partly because of a relentless and natural trend towards molecular biology, the importance of biochemical methods has not been much appreciated. The main drawback in employing biochemical methods is the superficiality of comparing chromatograms and drawing naive interpretations.

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