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Karyomorphological Studies in Three Species of Teleostean Fishes

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The karyomorphometrical analysis of somatic chromosomes of females of three species (*vide infra*) presented in this paper seemed not to have been carried out prior to our preliminary report (Khuda-Bukhsh and Manna 1974 a, b).

Materials and methods

Three living specimens each of *Mystus gulio* (Fam: Bagridae), *Eutropiichthys vacha* (Fam: Schilbeidae) and *Mastacembelus armatus* (Fam: Mastacembelidae) were intramuscularly injected with 0.1% colchicine solution at the rate of 2 ml/100 gm of body weight. After 5 hours their kidneys were separately removed into 1% sodium citrate solution, minced and flushed repeatedly to bring the cells into suspension. Cytological preparations were made according to the acetic alcohol-flame drying-Giemsa technique. The arm ratio and centromeric indices of metaphase chromosomes were determined following Levan *et al.* (1964) on which the morphological types and the chromosome formulae were assigned.

Results

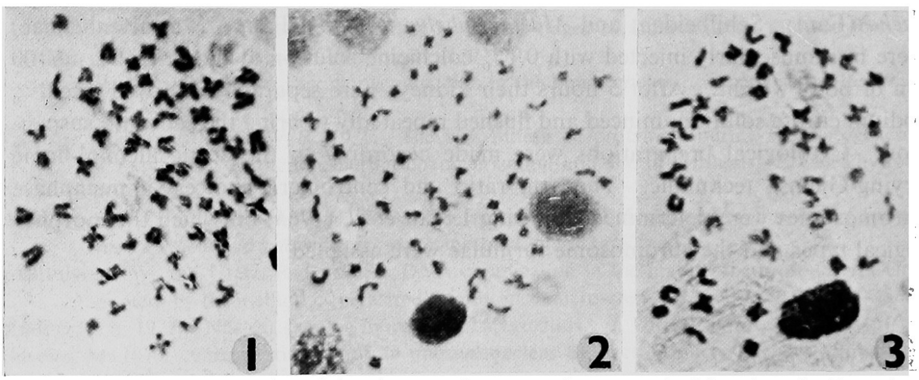
1. *Mystus gulio*

The diploid metaphase complements consisted of 58 fairly small and gradually seriated chromosomes, none of which could be designated as the sex element (PM.1, Fig. 1A). The mean length values of chromosomes determined from six metaphase complements ranged between 1.90 and 0.77 micron from the longest to the shortest chromosome. The maximum difference between any two chromosomes in the serial order was meagrely 0.21 micron (Nos. 28 and 29) while some others measured the same e.g. Nos. 15 and 16; 17 and 18; 20 and 21; 22 and 23; 24–27. The karyomorphometric studies of the arm ratio ('r' value) and centromeric index ('i' value) of each individual chromosome pair yielded 15 pairs of metacentric (Nos. 3–4, 6–9, 11, 13, 15–17 and 19–22), 6 pairs of submetacentric (Nos. 1–2, 5, 12, 14 and 23), 1 pair of subtelocentric (No. 10) and 7 pairs of telocentric (Nos. 18, 24–29) chromosomes (Figs. 1 B–C). Therefore, the chromosome formula of this species has been ascribed as n=15 m+6 sm+1 st+7 T. However, the borderline 'i' values in certain chromosomes caused some limitation to the morphological groupings e.g. the 'i' value of 'm' type chromosomes No. 4 as 38.4 and No. 17 as 38.2 were close to the upper limit of 'sm' type (37.5). Similarly, 'sm' type chromosome No. 23 having the 'i' value of 36.2 was close to the lower limit of 'm' type. Besides them the morphology in the rest was less confusing.

The unfavourable disposition sometimes made the morphology of the chromosomes in different plates little variable (compare chromosome Nos. 12, 13 etc. in Figs. 1 B–C) not only in this species but also in the other two.

2. *Eutropiichthys vacha*

As in *M. gulio*, the diploid metaphase complements in *E. vacha* consisted of 58 small gradually seriated chromosomes (PM. 2, Fig. 2 A). The mean length values ranged between 1.73 and 0.65 micron from the longest to the shortest chromosome. The maximum size difference between any two chromosomes in serial order was only 0.15 micron (Nos. 2–3) while in others the difference was nil (e.g. Nos. 9–10, 12–13, 21–22) or meagrely 0.01 micron (Nos. 8–9, 13–14, 14–15, 18–19) and so on. The karyomorphometrical studies (Figs. 2 B–C) for arm ratio and the centromeric index revealed the chromosome formula of *E. vacha* as n=5 m (Nos. 3, 8, 10, 13 and 15)+10 sm (Nos. 1–2, 4–6, 9, 12, 14, 17 and 20)+6 st (Nos. 7, 11, 16, 21, 14 and 26) +2 t(Nos. 18–19)+6 T (Nos. 22–23, 25 and 27–29) against n=15



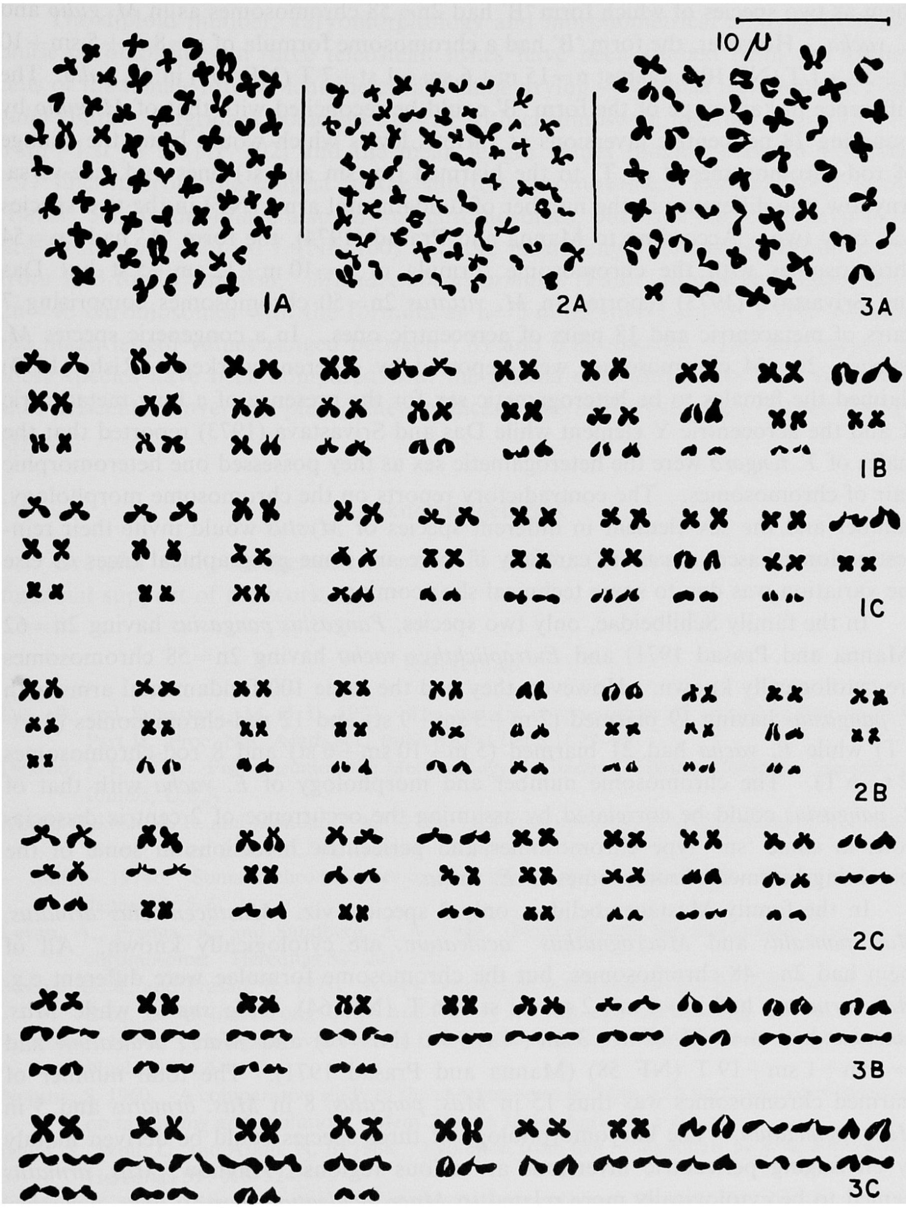
PM. 1–3. Photomicrographs of female metaphase complements. 1, *M. gulio*. 2, *E. vacha*. 3, *M. armatus*.

m+6 sm+1 st+7 T for *M. gulio*. As seen in *M. gulio*, in *E. vacha* also the 'i' values of 'sm' type chromosomes as 37.02 in No. 2, 36.11 in No. 4, 36.39 in No. 17 were close to the lower limit of 'm' type (37.5) and 26.43 in No. 5 and 26.92 in No. 20 were close to the upper limit of 'st' type (25.0). The 'i' values of 37.73 in 'm' type No. 10, 12.89 in 'st' type No. 21 and 10.83 in 't' type No. 18 were also close to the limit of some other morphological types which made the morphological groupings an arbitrary one.

3. *Mastacembelus armatus*

The diploid metaphase complements in *M. armatus* consisted of 48 small chromosomes (PM. 3, Fig. 3 A), the mean length of which ranged gradually between 1.81 and 0.89 micron from the longest to the shortest one. The maximum difference between any two chromosomes was 0.10 micron (Nos. 2–3 and 23–24) while it was nil (Nos. 3–4 and 12–13) or meagrely 0.01 micron (Nos. 6–7, 7–8, 14–15 and 16–17) and so on. The study of the arm ratio and centromeric index of chromosomes

(Figs. 3 B–C) yielded the chromosome formula as n=5 m (Nos. 1–5)+2 sm (Nos. 6–7)+1 st (No. 8)+16 T (Nos. 9–24) which was strikingly different from that of *M. gulio* and *E. vacha*. Among the 'm' type chromosomes, the 'i' value of 39.4 in No. 5 was close to the upper limit of the 'sm' type.



Figs. 1–3. 1A, metaphase (2n=58) from kidney of female *M. gulio*. 1B–C, karyotypes of *M. gulio*. 2A, metaphase (2n=58) from kidney of female *E. vacha*. 2B–C, karyotypes of *E. vacha*. 3A, metaphase (2n=48) from kideny of female *M. armatus*. 3B–C, karyotypes of *M. armatus*.

Discussion

In the family Bagridae, out of only 6 species cytologically investigated (see Nogusa 1960, Denton 1973) 4 belonged to *Mystus*, all reported from India. Later Manna and Prasad (1974) found forms 'A' and 'B' of *M. vittatus* and suspected them as two species of which form 'B' had 2n=58 chromosomes as in *M. gulio* and *E. vacha*. However, the form 'B' had a chromosome formula of n=8 m+5 sm+10 st+5 t+1 T (NF 104) against n=15 m+6 sm+1 st+7 T (NF 102) in *M. gulio*. The difference in karyotype of the form 'B' could be reconciled with that of *M. gulio* by assuming 28 pericentric inversions at various levels which would bring the change of rod-chromosomes (t or T) to the biarmed (m, sm and st) ones and vice-versa. Anyhow, the difference in the number of fundamental arms (NF) in the two species was only two. According to Manna and Prasad (1974), the form 'A' had 2n=54 chromosomes with the chromosome formula of n=10 m+12 sm+5 st but Das and Srivastava (1973) reported in *M. vittatus* 2n=50 chromosomes comprising 7 pairs of metacentric and 18 pairs of acrocentric ones. In a congeneric species *M. tengara*, 2n=54 chromosomes were reported by different workers. Rishi (1973) claimed the females to be heterogametic sex for the presence of a long metacentric X and the acrocentric Y element while Das and Srivastava (1973) reported that the males of *T. tengara* were the heterogametic sex as they possessed one heteromorphic pair of chromosomes. The contradictory reports on the chromosome morphology, number and the sex element in different species of *Mystus* would invite their reinvestigation to ascertain more carefully if there are some geographical races or else the variation was due to some technical shortcomings.

In the family Schilbeidae, only two species, *Pangasius pangasius* having 2n=62 (Manna and Prasad 1971) and *Eutropiichthys vacha* having 2n=58 chromosomes are cytologically known. However, they had the same 100 fundamental arms with *P. pangasius* having 19 biarmed (7 m+3 sm+9 st) and 12 rod-chromosomes (3 t+9 T) while *E. vacha* had 21 biarmed (5 m+10 sm+6 st) and 8 rod-chromosomes (2 t+6 T). The chromosome number and morphology of *E. vacha* with that of *P. pangasius* could be correlated by assuming the occurrence of 2 centric dissociations in some 'sm' type chromosomes and pericentric inversions in some of the remaining biarmed chromosomes in *E. vacha*.

In the family Mastacembelidae, only 3 species, viz. *Mastacembelus armatus*, *Mas. pancalus* and *Macrognathus aculeatum*, are cytologically known. All of them had 2n=48 chromosomes, but the chromosome formulae were different e.g. *Mas. armatus* had n=5 m+2 sm+1 st+16 T (NF 64), (*vide supra*) while *Mas. pancalus* had n=1 M+7 m+3 sm+4 st+9 t (NF 78) and *Macr. aculeatum* had n=4 m+1 sm+19 T (NF 58) (Manna and Prasad 1971). The total number of biarmed chromosomes was thus 15 in *Mas. pancalus*, 8 in *Mas. armatus* and 5 in *Macr. aculeatum*. The karyomorphology of three species could be derived mainly by envisaging pericentric inversions at various regions. Anyhow, *Mas. armatus* seemed to be cytologically more related to *Macr. aculeatum* than to *Mas. pancalus*.

Fortyeight rod-like chromosomes have been suggested by several authors (Denton 1973, Ohno *et al.* 1968 etc.) as the primitive karyotype for fishes. If the karyotypes of the 3 species under study were to be derived from the so-called primitive one with 48 rods, the pericentric inversion along with centric fission and/or fusion seemed to have played a significant role in their evolution.

Summary

The diploid number, karyomorphology and morphometrical analysis of metaphase chromosomes in three teleostean fishes have been studied from the kidney cells of the female after colchicine-citrate-flame drying — Giemsa technique. *Mystus gulio* (Fam: Bagridae) possesses 2n=58 with chromosome formula as n=15 m+6 sm+1 st+7 T (NF 102) and the mean length values ranging between 1.90 and 0.77 micron from the longest to the shortest chromosome. *Eutropiichthys vacha* (Fam: Schilbeidae) have also 2n=58 chromosomes, but with the formula of n=5 m+10 sm+6 st+2 t+6 T (NF 100) and the mean length values of chromosomes from 1.73 to 0.67 micron. *Mastacembelus armatus* (Fam: Mastacembelidae) have 2n=48 chromosomes with the formula as n=5 m+2 sm+1 st+16 T (NF 64) and the mean length values ranged between 1.81 and 0.89 micron. The karyotypes of these species have been compared with the related ones and it has been suggested that pericentric inversion played the significant role in the evolution of their karyotypes.

Acknowledgements

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