This is the first study investigating detailed biological aspects of flat toadfish, *Colletteichthys dussumieri* of Cochin estuary. They have no commercial importance in fisheries but significantly sound management of vegetated coastal resources relies on the basic knowledge on the biology of the species, including information on population structure. The study was undertaken for a period of twenty four months from October 2003 to September 2005. The highlights of the results are as follows:

**Systematics**

A detailed description of *Colletteichthys dussumieri* is furnished along with their synonyms. Discrepancies in meristic (lateral line pores and vertebrae) characters were observed.

**Morphometrics**

Growth variability in fourteen morphometric characters of *C. dussumieri* were evaluated and linear regression analysis was applied to calculate growth rate of each variable in relation to total length. The equations explaining each morphometric variable versus total length of males and females are:
Established correlation coefficients (r) showed positive significant correlation (P<0.01) in both the sexes except for the values for snout length in females (p<0.05). The highest correlation coefficient was observed between total length and standard length (r = 0.996) in male and (r = 0.988) in female. The lowest was between snout length and eye diameter (r = 0.497) in male and snout length and pre-pelvic length (r = 0.339) in female. Comparison of regressions of the characters between male and female showed significant differences in all the characters except for head length, snout length, inter-orbital length and body depth. So the analysis of morphometric variables demonstrated a substantial degree of differences between the sexes concerning either the growth pattern or the rate of change of some variables.
Food and Feeding

Study on food and feeding habits of *C. dussumieri* pointed towards its carnivorous nature. Analysis of its gut content based on frequency of occurrence, index of preponderance and relative gut length measurements revealed that crustaceans mainly prawns and crabs and teleostean fishes make up the bulk of the diet. At times bivalve molluscs were also encountered in gut. It is apparent that composition and preferences of food are the same in both sexes. But observations on the average amount of feeding in both sexes show that males have a little higher feeding intensity than females.

Feeding intensity was high in early maturity stage and was relatively lower in fish with ripening gonads. High feeding intensity was observed in immature and juvenile fish in comparison to the matured ones. The present study indicated that *C. dussumieri* is a stenophagic fish feeding on a few selected organisms despite the presence of large number of organisms in their vicinity. The results revealed that the fish is “Carnivorous-stenophagic-bottom feeder”.

Reproduction

In the light of the morphological and histological changes of gonads, five maturity stages were established in *C. dussumieri* :- (a) immature / resting, (b) maturing virgins / recovering spents, (c) mature / ripening, (d) ripe and (e) spent. The complete demarcation of a group of ova in the mature ovary and gonadosomatic index of *C. dussumieri* gives the impression that individual fish spawns only once in a year between September to January with a peak in October to November.

Size at 1\textsuperscript{st} maturity was 131 mm TL for males and 141 mm TL for females. Size at 50% maturity was estimated to be 182 mm (181-190mm)
TL for males and 151mm (151-160 mm) TL for females, corresponding to ≥2 years old. The overall male: female ratio was 100:89. The Chi-square value did not show any significant difference indicating equal distribution of both sexes.

Fecundity of *C. dussumieri* varied from 150 to 859. The coefficient of correlation of the various statistical relationships derived between fecundity, body length, body weight, ovary length and ovary weight revealed significant relation between fecundity and other body parameters, indicating *C. dussumieri* to be a low fecund fish.

**Age and growth**

Age, growth and mortality of *C. dussumieri*, were determined by examination of the whole sagittal otoliths. Marginal increment analysis of otoliths revealed that increments formed on the otoliths were deposited once a year, translucent formed between September and November coincident with the maximum reproductive peak, while the opaque zone formed mainly from February to June when growth is faster. Maximum age limit for males and females were 9 and 7 years respectively. Males matured at an age of approximately 2 years and females took a little more than 2 years. Fish total length and otolith radius were strongly related in both males (R² = 0.889) and females (R² = 0.815). The von Bertalanffy growth curve was used to describe growth. The parameters were derived from back-calculated length-at-age. Significant differences in growth parameters were found between sexes (in males L∞=351 mm, K= 0.168 and t₀ = -0.81; in females L∞=303mm, K= 0.216 and t₀ = -0.65). Longevity of males was greater than that of the females and males reached larger sizes than females. The growth performance index of the specie falls within the values
mentioned of those estimated for other members of the batrachoid family. Natural mortality rate was found to be higher in females than in males.

**Length-weight relationship and condition factor**

The length–weight relationship was calculated separately for males and females.

Male: \[ \log W = -4.646 + 2.96 \log L \]
Female: \[ \log W = -4.372 + 2.85 \log L \]

The correlation coefficients ‘r’ 0.953 for male and 0.934 for female were found to be significant (p< 0.001) in both instances indicating good correlation between length and weight. Covariance analysis for length-weight relationships of male and female fishes revealed that there exists a significant variation in this aspect between male and female fishes. By testing (students ‘t’ test) the regression coefficients against the isometric value of 3, it was found that for males the growth pattern agrees with the isometric growth formula while in the case of the females the cubic formula was not found to be a proper representation of the length-weight relationship.

The seasonal variation in Kn values of males and females showed almost similar trend. Sex-wise analysis of Kn values revealed that the mean Kn values in males (1.032 and 1.017) were higher than those of females (0.996 and 0.979) for both the years. The ponderal index (K) showed the same trend as that of relative condition factor. Feeding activity and reproductive cycle are the main factors influencing the condition of the species. The relative condition of fish shows seasonal variation, with males generally being in better condition than the females.
The growth of males is quiet satisfactory and the overall growth performance of males show better growth in relation to weight increment than females.

**Biochemical composition**

Sex-wise seasonal variation in the proximate composition of the muscles of *C. dussumieri* were estimated. On fresh weight basis, percentage protein ranged from 15.90 - 20.84%, lipids from 1.31-2.06%, moisture 76.2 - 82.70% and carbohydrate from 0.15-0.48% in males. While in females, protein ranged from 15.63 - 19.74%, lipid 1.32 - 2.14%, moisture 75.95 - 83% and carbohydrate 0.14 - 0.43%. The results revealed that moisture content was inversely related to protein and lipid content. A highly significant parallel relationship exists between lipid and protein contents for both male and female sexes. The carbohydrate does not contribute much to the reserve in the body. According to the present results, the oil content recorded was less than 5% (1.31% – 2.14%) and the maximum protein content recorded was 20.84%. Despite the low economic value of batrachoid fishes, it could be concluded that *C. dussumieri* can be referred to as high protein and low-oil bony fish. Variations in proximate composition in present study seem to be governed by spawning cycle and feeding activity.

It is a well known fact that the knowledge on fish biology particularly morphometry, food and feeding habit, reproduction, age and growth, length-weight relationship, condition factor etc. is of utmost importance, not only to fill up the lacuna of our present day academic knowledge but also in the utility of the knowledge in increasing the technological efficiencies of the fishery entrepreneurs for evolving judicious pisciculture management. Poor understanding of the biology of fishes in a fishery management could lead to dramatic changes in the biological attitudes and
Summary and Conclusion

productivity of species (Smith et al., 1991). It is, therefore, essential that an appropriately weighted and conservative approach be adapted for the management of *C. dussumieri* of Cochin estuary. It is also paramount and essential in the long term that morphometric, meristic and genetic data be gathered quickly and disseminated on the specific populations, upon which assessments are made, in order to track changes which will affect the stability of the population over time. The genetics of fish oocytes is at present a much neglected yet vital area of study. Hence, studies focusing on the molecular mechanisms controlling oocyte growth and development are to be initiated. Information on early embryonic and larval development and organogeny is of critical importance in understanding the basic biology of a particular species and their dietary needs and environmental preferences (Borcato et al., 2004). Consequently, studies on the detailed embryonic and larval development of *C. dussumieri* are indispensable. Further studies are required on the ethno- medicinal value of the species with regard to asthma cure. The present study provides the first baseline data on various aspects of biology of *Colletteichthys dussumieri* of Cochin estuary.

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