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THE ASSIMILATION OF VARIOUS HABITATS IS A RESULT OF THE ADAPTIVE RADIATION OF MOLLUSKS. ECOLOGICAL RADIATION OF MOLLUSKS IN NUTRITIONAL PROCESSES

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Abstract

The importance of fish as a valuable source of protein for human population has indeed been realised and hence rated high for its nutritional value. Fishery biologists often calculate condition factor to determine not only the health status of fish but also advise / suggest the time of harvesting of fish for human consumption. While it is impossible to enrich / enhance the quality of food of marine fish in the wild condition, for fresh water species, especially those which are reared, it is often possible to enrich the feed in order to have impact on the nutritional status of the fish for human consumption. Knowledge of the food and feeding habits of fishes of any water body is thus a prerequisite to improve its fishery potential as also to any program of fishery management. Study of the any program of fishery management. Study of the food and feeding habits of fishes therefore had attracted the attention of fishery biologists almost from the beginning of the present century.

INTRODUCTION

Food is virtually important to every organism as its growth, development, reproduction and other metabolic activities depend on the energy it received from its food. Fishes are no exception to this.

A better understanding of their life history, including growth, shoaling, migrational behaviour, feeding preferences, sexual variations etc., is essential for the efficient management of commercially important fisheries (Sivakumar, 1985). Like mammals and birds, some fishes, especially the marine, make extensive migration in search of food, as the amount of food available in a place may not be the same throughout the year. Even if food is available, its nutritive value may differ from season to season depending upon the prevailing environmental conditions, which control the production of these food organisms.

the Growth and maturation of several fish species, both marine and fresh water, have been found to depend upon the availability and supply of food. The nutritional biology i.e., food preferences, feeding habits along with Ogy in the important feeding intensity of mullets one of the important estuarine fish varieties, in Indian waters, received attention even before Independence of India (Chacko and Venkatraman, 1945) Baskaran (1993) has made a recent attempt to relate the nutritional cycle with the reproductive cycle of two mullets of Muthupet Saline swamp. Michael (1984) attempted a similar study in the estuarine bagrid cat fish, *Mystus gulio* of Kovalam backwaters. Earlier Chandran (1969) made an attempt to study the impact of nutrition on the reproductive cycle of the marine perch *Psammoperca waigiensis* of Palk Bay in the South East Coast of India. There are indeed several studies on food and feeding habits of fishes.

In extensive and semi-intensive aqua-culture systems, it should be remembered, natural food contributes substantially to the nutrition of the cultured species. In composite culture, the species chosen for culture are on the basis of their food preference and feeding habits to enable each one to occupy one particular ecological niche of the water body so that competition for food among them could be avoided. Successful and sustainable aquaculture practices depend upon the provision of nutritionally adequate, environmentally friendly economically viable artificial feeds. Feed is thus the major operational input and feed costs normally range from 30-60% of the operational expenditure in finfish and prawn culture systems. In view of this, artificial feeds should scientifically be formulated, optimally processed and judiciously supplied, considering the specific nutritional needs of the cultivated species and the intensity of culture operation (Paulraj, 1993). Due to the steady rise in human population throughout the world, considerable attention is being given to the problems of increasing protein resources and enhancing the biological value of different food products. Fish, as a fairly valuable item of human nutrition, is gaining greater recognition. The demand for fish as a nutritious food for man is increasing with each passing year. The increasing demand for this proteinic food has made it necessary to exploit more completely and efficiently the water available especially those in land.

Feeding 7 billion people on earth through agriculture on land in an environmental sustainable manner would pose a major problem. Therefore the world is looking at water as a source of food production. Asia has been in the center of fishing and aquaculture activities. India ranks second among the Asian countries in culture and third in capture fisheries. In India more than six million fishermen and fish farmers rely on fisheries for their livelihood. Area available for fish production in India is vast indeed. The marine jurisdictional area alone spans to 2.02m km2 which is 38% of the total (5.3m km2) marine, fresh water and land area of the country. Potential area available for aquaculture stretches to 1.4mha. From these vast areas, 5mt fishes and edible invertebrates are now captured and cultured. Our annual fisheries export is 0.4mt worth 47,000 million rupees. Thus fisheries productive constitute a highly productive sector, a source of valuable food and employment, and a net contributor to the balance of our payment (Pandian, 1999).

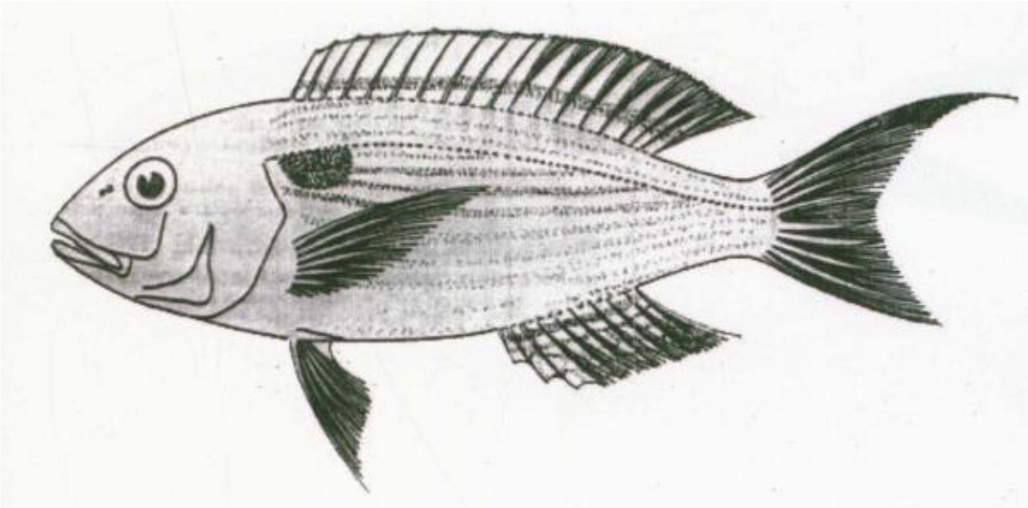
As in all other animal species, the primary function of food in fish is to satisfy energy requirements for maintenance, growth and reproduction. Energy is stored in the chemical structures of complex molecules such as carbohydrates, proteins and lipids of feed materials. Thus proteins, lipids and carbohydrates are the nutrients that furnish the required energy for maintenance, activity, moulting (Crustaceans), growth and reproduction.

It is therefore necessary to examine the nutritionally important biochemical constituents in various tissues qualitatively and quantitatively. Estimation of total proteins, carbohydrates and lipids, will show the relative concentration of these components in different organs. The difference in concentration of the biochemical components may vary from one organ to another in the same fish as also in the same organ in different seasons. Literature reveals that in addition to liver, muscle of fish acts as a storage organ of nutrients (Bauley, 1952; Hoar, 1953; Ramaswamy, 1953, 55 and Sekharan, 1949,50,55) and if so the nutritive materials stored in the muscle must have been derived from the food consumed. Natrajan and Sreenivasan (1961) have reported the impact of proximate and mineral composition on the nutritive value of the economically important marine and fresh water fishes of India.

Studies on the nutritional value of both marine and fresh water fish and pertinent more so relating it to food and feeding habits of the species concerned. Despite several studies available on the food and feeding habits of fishes of different habitats, as also the nutritional value in term of biochemical composition of fishes from varied habitats, seldom an attempt has been made to relate the food and feeding habits of fish with its nutritional value.

Here is an attempt to relate the food and feeding habits with chemical composition of body parts of two species of fish along with their nutritional value as human food. One is an marine species, the thread fin bream, ***Nemipterus japonicus*** commonly found in the South East Coast of India, regularly captured and available in the market as a common man's food while the other, is a fresh water cultured variety of Indian major carp ***Labeo rohita***. These two difier remarkably in the habitat as also in their feeding habits. The former is a carnivorous fish while the later is herbivorus and both are believed to be bottom feeders in their respective habitats. But as an item of food they share a common commercial value; one is wild and the other, cultured. Comparison highlights contrast; occasionally it could also established commonality. The following pages bring forth new information or new insight on fish as a nutritious diet for humans especially for the aged- more so for those who have cardio-vascular complaints.

Nemipterus japonicus



Nemipterus japonicus

Rates of reproductive output

Reproductive output rates, measured as the biomass of offspring hatching or being born in a year, are first and foremost tied to the size of the mother (Fig. 13). Compared across the amniote taxa the allometric slopes are somewhat dissimilar. They are shallowest in marsupials (slope: 0.179, $R^2 = 0.152$, $n = 43$, $\lambda = 0.941$) followed by birds (slope: 0.549, $R^2 = 0.558$, $n = 978$, $\lambda = 0.893$), steeper in placental mammals (slope: 0.689, $R^2 = 0.694$, $n = 467$, $\lambda = 0.805$), and steeper still in turtles (slope: 0.816, $R^2 = 0.771$, $n = 75$, $\lambda = 0.142$) and squamates (slope: 0.806, $R^2 = 0.633$, $n = 1053$, $\lambda = 0.753$). The intercepts are also dissimilar: 0.602 in birds, 0.115 in placental mammals ($p = 0.420$), -0.714 in marsupials, -0.396 in turtles, and -0.319 in squamates. These values, however, suggest more overlap than the differences imply, as shallow slopes are associated with high intercepts. Thus, the regression lines intersect at values close to 1 kg, where all classes are species-rich (Fig. 13). At somewhat smaller sizes, where most diversity resides in all taxa (except turtles), birds and mammals are somewhat more productive than squamates and, especially, turtles. That said, there is great overlap between all three major groups across the range of sizes where squamates, birds and mammals are most diverse (approximately 10–3000 g).

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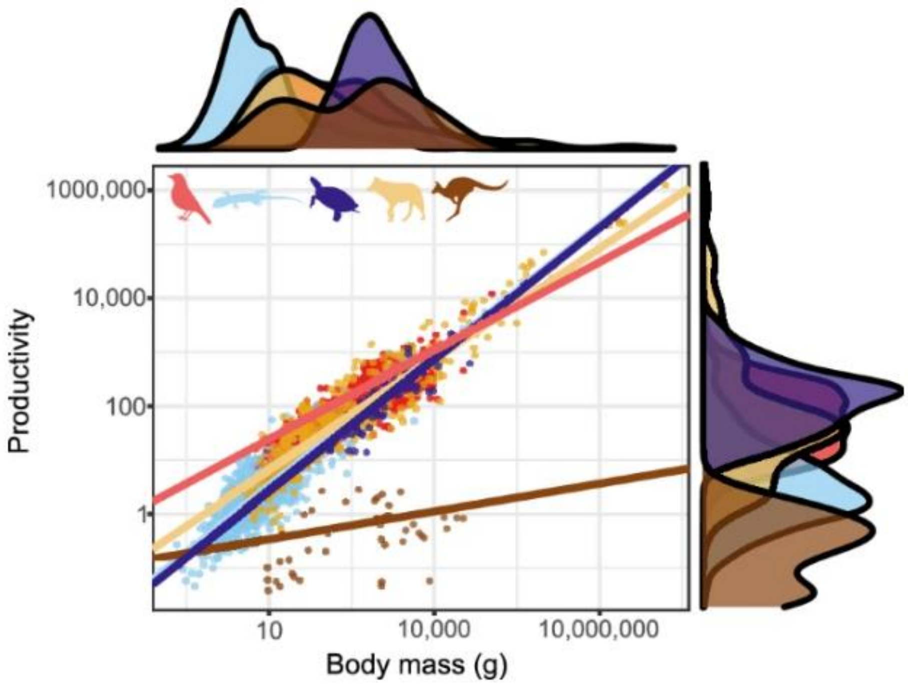

Allometry of yearly biomass productivity of amniotes. Red: birds; blue: squamates; purple: turtles; yellow: placental mammals; brown: marsupial mammals. Solid lines are regression slopes from PGLS analyses. Both axes are in $\log_{10}$ scale

The overall patterns are quite similar across the three major amniote clades (Squamata, Aves and Eutheria) for most traits (Fig. 14), while members of the Metatheria and Testudines share similar values in some traits but differ markedly in others

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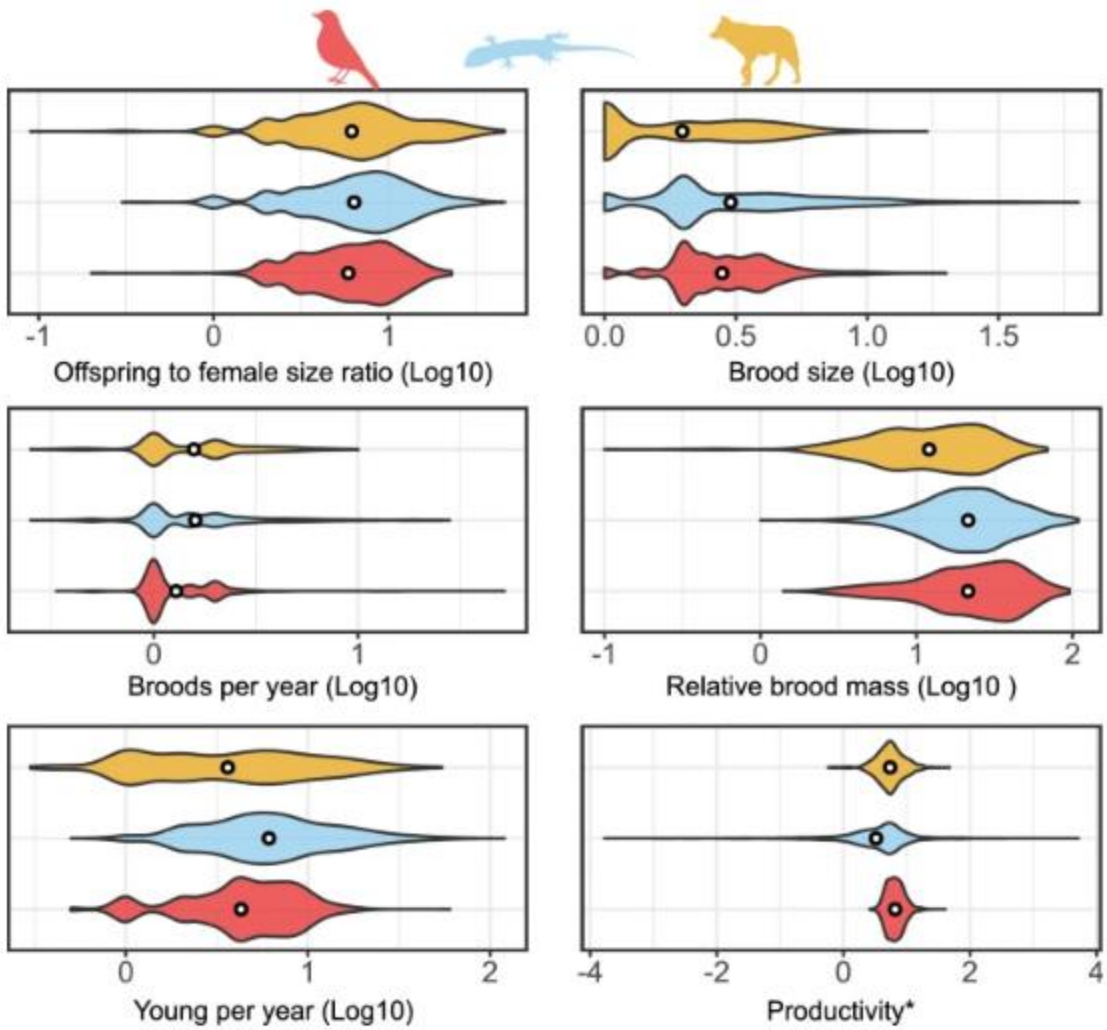

Violin plots depicting the distribution of life history traits in the three major amniote clades. Means are represented as solid white points. Productivity expressed as the ratio of productivity (brood size × brood frequency × offspring size) over adult body size to standardize for body size. Red: birds, blue: squamates, yellow: placental mammals. (See Additional file 2: Figure S1 for graphs that also include marsupials and turtles)

Table 4. 1 Summary table comparing life history distribution across amniotes

From: Different solutions lead to similar life history traits across the great divides of the amniote tree of life

	Characteristics of distribution
Body mass	All unimodal and right skewed Squamata < Aves < < Mammals
Offspring/female size	Offspring/female size ratio approximately the same across placental mammals, birds and squamates (7–8%) marsupials < < < turtles < < birds ≈ placentals ≈ squamates
Brood size	Mode is 1 in mammals, 2 in birds and squamates
Reproductive frequency	The overall mode and distribution of reproductive frequency is extremely similar across amniote groups
Relative brood mass	All unimodal and right skewed. But no placental mammal has a relative brood mass higher than 70%. Small in turtles, very small in marsupials
Yearly fecundity	Distribution of reptiles and birds very similar (right skewed distribution with a mode of 4–6 young). Mammalian mode is 1–2 offspring per year
Reproductive output	Similar overall in squamates, birds and mammals (low intercepts associated with steep slopes), low intercept in turtles, very low intercept, and shallow slope in marsupials

DISCUSSION

Amniotes are distinct from anamniote vertebrates in their physiology and reproduction physiology. The evolution of the cleidoic egg has put them on a path that enables successful reproduction on land. It allows the embryos to develop, grow, and exchange gasses with the environment without extensive risk of desiccation. The evolution of the extraembryonic membranes of amniotes may be imposing a constraint on the lower limit of amniote egg—or embryo sizes . This constraint is probably absent in our anamniote kin and thus anamniotes' eggs are often much smaller, even in large bodied species.

Amniotes then diversified into endotherms (twice), shelled ectotherms (once), and a major lepidosaur/squamate radiation that retained the primitive position of ectothermy without a shell. Endotherms evolved complex and prolonged thermal and food provisioning for their young, and often complex social systems, that reptiles mostly did not. Viviparity evolved multiple times, and within mammals takes two very distinct forms. All this, and more, certainly influenced the reproductive and life history characteristics of amniote taxa. Surprisingly, however, our hypotheses, that these major transitions will manifest in substantial quantitative differences between clades, were mostly refuted.

Conclusion

Vertebrate zoologists often identify themselves as herpetologists, ichthyologists, ornithologists, or mammologists. Therefore, studies within classes are common, whereas cross-taxon, especially cross-class studies are rare (but see e.g.,). In biogeography and conservation, however, studies of terrestrial vertebrates are relatively common, as maps for all four classes and conservation statuses for (nearly) all amphibians, birds and mammals are thought to be available (though completeness varies). In terms of traits, however, the scarcity of cross-taxon studies therefore means we often have little feel for the similarities—or differences across taxa. We hope we have shown here that there is little reason why this should be the case. For us, the similarities were much more impressive than the differences that the fundamental divisions of physiology, locomotion, parental care, and sociality suggested would be the case. We hypothesize that the evolution of the cleidoic egg was the most influential step setting amniotes apart from anamniotes. Whether the differences between these two groups stretches to more than differences in clutch and offspring sizes remains to be explored. We hope studies across amniote, tetrapod, and vertebrate clades (and even across vertebrates and invertebrates) will become much more common.

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