GENERAL INTRODUCTION
presented the data in a separate chapter of the thesis.

Data was collected on the concentrations of proximate biochemical constituents (protein, fat, water, ash) and cholesterol in the 'red' (dark) and 'white' (light) muscles and liver of two species of riverine cat-fishes, Wallagonia attu (Schn.) and Rita rita (Ham.), while the quantitative variations in the nucleic acids were observed in heart, kidney, liver and skeletal muscle of an air-breathing freshwater catfish Clarias batrachus (Linn.). This piece of work brought to light the influence of anatomical heterogeneity on the biochemical data and some physiological characteristics of the tissues, and also cautioned against taking tissue samples from unspecified locations, in attempts to establish the effect of biological factors on chemical composition of fish. As far as the selection of red, white, muscles and liver is concerned, the aim was also to venture into a hitherto controversial field of study and bring forth certain facts remote from scepticism. A survey of literature reveals an unprecedented interest in the biochemical and physiological affinities of the red muscle of fish. Some of the notable contributions including also the ones arousing controversies in this field being those of Matsura & Hashimoto (1954), Braekkan (1956, 1959), Mori et al. (1956), Masukawa et al. (1957), Boddeke et al. (1959), Saito et al. (1959), Barets (1961), Nakano (1961), Wittenberger

For studies on sex-linked biochemical differences in Clarias batrachus, the constituents selected were cholesterol, glycogen, fat, RNA and DNA. Cholesterol and glycogen were analysed in the liver of recovering spent fishes, liver fat was estimated in specimens with gonads in ripening phase, while RNA and DNA were quantitated in the white muscle of recovering spent individuals. The chemical effects of sex differences at one or the other stage of maturation or on a non-seasonal basis have been explained earlier in the light of the relative depletion suffered by the two sexes due to building up of gonads (Belding, 1934; Fera, 1936a,b; Kordyl, 1951; Fontaine & Hatey, 1953; Vinogradov, 1953; Bailey, 1957; Keiz, 1959; Chang & Idler, 1960; Jacquot, 1961; Robertson et al., 1961; Yanni, 1961; Schmidt & Idler, 1962; Herrera & Munoz, 1963; Fisher, 1964; Phillips et al., 1964; Sharratt et al., 1964; Bentley & Follett, 1965; Mc Cartney, 1965, 1966, 1967; Ziecik & Slawinski, 1965; Idler & Truscott, 1966; Plack & Woodhead, 1966; Fagerlund, 1967; Yamashita, 1967). Love (1970)
reviewed these and some other related reports in more detail. However, in view of the inadequacies of the explanations furnished in the various publications, a determined effort was made by the author to enlarge the sphere of the work and this yielded encouraging results.

Biochemical studies on growth of fish and somatic and organ condition included the 1) analyses of quantitative variations in RNA and DNA in the white muscle of freshwater teleost Walgonga attu, popularly referred to as 'freshwater shark' because of its highly predaceous habit, and 2) evaluation of the relationship between RNA concentration in flesh (white muscle) and somatic condition of Claris batahchus as well as that between RNA concentration and liver 'condition' of this teleost, with the objective of determining suitable biochemical indicator(s) of recent growth rates. As a separate but related piece of investigation, the hepato-somatic indices of some species of fishes, namely Mysilus vittatus (Bloch), Puntius sophore (Ham.), Channa punctatus Bloch, and Colisa fasciata (Val.) were worked out mainly to supplement information on liver condition obtained through biochemical observations.

DNA content of the ripe, unspawned and unfertilized eggs of three teleostean species, Mastacembelus armatus (Lacep.), Rita rita (Ham.) and Channa punctatus Bloch was estimated and the data has been interpreted to explain the phylogenetic and
evolutionary relationships of fishes. This was the first ever attempt on cellular DNA content of the eggs, because in the past the DNA content of the red blood cells and sperms was analysed. The present approach, however, appears more convenient, and accurate and less problematical. With the introduction of these biochemical techniques it is hoped the validity of phylogenetic relationships of fishes established by older methods based on morphological characters, will be tested, subjectivity minimized and a better understanding of the exact nature of evolutionary process of different groups of fishes imparted. Since DNA is a genetic material, carrying the inheritance characteristics from generation to generation, it was believed that its use in phylogenetic and evolutionary problems will be more fruitful than the conventional morphological criteria.

It must be evident from the work presented here in the form of a thesis that the main upthrust is on nucleic acids. This is particularly because of the unique roles played by these macromolecules that an understanding of their chemical, physical and biological properties has become an important aspect of biochemistry or chemical biology, and appears a major problem of the present time.

Fairly extensive data on the nucleic acid concentrations in different normal tissues of mammals has been compiled by
Chargaff & Davidson (1955). Some of the more followup studies on mammalian tissues are those of Petersen & Baserga (1965), Anderson & Hollifield (1966), Benjamin & Gellhorn (1966), Braun et al. (1966); Gellhorn & Benjamin (1966), Young & Alexis (1968), Hayashi & Kaymierowski (1972), Duvilanski et al. (1975), Blobel & Potter (1976), Garlic & Burk (1976), Gibb et al. (1976), Stocco et al. (1976), Blokh et al. (1979), Maher et al. (1979), Pankova & Grishanova (1979), Razumorskaya et al. (1979), Terpstra et al. (1979). Besides, work on nucleic acids of birds is also on record (Summers & Fisher, 1962; Anastasova-Kristeva et al. 1975; Desveaux-Chabrol, 1976; Pallak & Fallon, 1976; Shinohara & Piatigorsky, 1976).

It seems from a general survey of literature that the field of fish nucleic acids is still in its virgin stage. Relatively fewer investigations have been made on the nucleic acids in fishes and much more work is needed to correlate vast mass of information. Notable findings can be reviewed here. Love (1958) described the differences in DNA concentration in different locations of the musculature of North Sea Cod (Gadus callarias) and also presented data on the quantitative variations in this nucleic acid related to season and growth. The effect of increase in the number and size of cells on the nucleic acids in the epaxial muscle of rainbow trout (Salmo gairdnerii) during growth was reported by Luquet & Durand (1970). Giurca &
Radulsea (1971) and Giurca (1972) worked out the dynamics of seasonal changes in the RNA and DNA of the pituitary gland and gonad of grass carp, *Ctenopharyngodon idella*. Findings on seasonal changes in the nucleic acids in liver, and red and white muscles of teleostean fishes have also been published (Satomi & Ishida, 1976; Satomi & Tanaka, 1978 a,b).

Creelman & Tomlinson (1959) outlined the results of the analyses of RNA and DNA in different tissues of sockeye salmon (*Oncorhynchus nerka*) at different stages of spawning migration, but did not discuss the underlying mechanisms.

Bulow (1970, 1974) established the relationships between nucleic acid concentrations and growth of fishes and documented the applicability of RNA-DNA ratios in assessing the recent growth rates. Selection of suitable tissues for these biochemical studies was also discussed by Bulow (1971). Haines (1973) pointed out the use of RNA-DNA ratios as measures of long-term growth in fish populations. Bulow et al. (1978) compared two bluegill (*Lepomis macrochirus*) populations by means of the RNA-DNA ratios and liver-somatic index; the data was correlated with the relative food intake and growth rate. Bouche et al. (1970) investigated the influence of fasting and re-nutrition of carp, *Cyprinus carpio* on the nucleic acids of the liver. Information on the nucleic acid content of
rainbow trout tissues under different conditions of nutrition was furnished by Satomi & Nose (1971) and Satomi & Tanaka (1978 a,b). Satomi (1972) described the changes in the amounts of nucleic acids in unit weight of carp tissues during the process of growth, and evaluated the RNA-DNA ratios in fishes reared in fertilized ponds. Buckley (1979a) found that the RNA-DNA ratio was useful for the diagnosis of the starving condition in Winter founder (Pseudopleuronectus americanus) larvae. The same author (1979 b) also determined the changes in total RNA, DNA and protein content during development of Atlantic Cod (Gadus morhua) larvae at different prey densities, to explain the effect of starvation and also the relationships between RNA-DNA ratio, prey density and growth rate.

Literature on the turnover of nucleic acids in freshwater teleosts of Northern India is also growing. Differences in the concentrations of RNA and DNA in the dark and white muscles of minor carp, Barbus stigma (Puntius sophore) were recorded by Jafri & Mustafa (1976a). Mustafa & Jafri (1976a) published quantitative data on RNA and DNA in the two types of muscles of cat-fish Mystus vittatus and their changes during growth of the fish in the pre-maturity phase. Similar studies on major carps, Catla catla, Labeo rohita and Labeo bata were carried out by Mustafa (1977a). The influence of sexual matura-

Clarias batrachus has also been authenticated (Mustafa, 1977b). Mustafa & Jafri (1977) described the pattern of changes in the RNA and protein levels in the flesh of the murrel Channa punctatus by establishing logarithmic relationships. The difference in the nucleic acid concentrations in the trunk and tail regions of the musculature have also been reported by Mustafa (1978b) and Mustafa & Jafri (1978) for cat-fish Heteropneustes fossilis and Channa punctatus, respectively. Through regression models Mustafa (1979) expressed the relation of RNA biosynthesis in Channa punctatus to 'fillet condition factor' on the one hand and to protein synthesis on the other. Sarkar et al. (1979) indicated the changes in nucleic acid and protein content during embryonic development of Heteropneustes fossilis and examined the effect of inhibitors. In the same fish Chaudhuri et al. (1979) referred to the changing pattern of RNA synthesis and RNA polymerases during embryogenesis.

In analyses of nucleic acids at tissue level, the correlation of their concentration with any life process is usually handicapped by lack of any distinction between whether a change has been directly caused by a factor through alteration of pathway in biosynthesis or it is an effect of some other phenomenon induced by that particular factor. As such the role of a biological factor is influencing the chemical make up of
fish tissues can only be doubtfully elucidated. However, an attempt was made in the work on growth of *Wallagonia attu* as well as on the sex-linked differences in nucleic acids in *Clarias batrachus*, to distinguish, as far as possible, the cause and effect relations. The later study was carried out when the fish was in the recovering spent phase, since this stage is characterized by resynthesis of a number of cellular constituents for the recovery from the depletion which occurs due to maturation of gonads. In addition to leading to an insight into the biochemical and physiological differences in the two sexes, the work also brought to light the occurrence of the phenomenon of 'gene de-repression' and pointed out the cytoplasmic influence on gene expression. This is one of the important achievements of the present contribution since little is known about the biochemical or physiological basis of the activation or de-repression of genes at various stages, although it is understood rather vaguely that cytoplasmic stimulating substance must be required in a critical concentration to be effective (Giese, 1973).

Clarification must be made of at least two terms 'content' and 'concentration' which have been extensively used in this thesis. In the literature these terms are often employed wrongly as synonyms. In the present description the term 'content' is used when results are expressed as amounts per cell, whereas the term 'concentration' denotes the amount per unit weight of tissue, as suggested by Leslie (1955).