Introduction

Early development of an animal is important phase of its development as the animal’s basic body pattern is formed during early development. Thus, it is interesting and important phase, also in analytic and experimental developmental biology. Early development, especially of vertebrates is a complex process, involving a variety of morphogenetic movements performed by embryonic cells and tissues, in three-dimensional space of the embryo. Well known developmental biologist, Lewis Wolpert (1991), describing the complexity, writes:

"Movements occur simultaneously, over many parts of the embryo with sheets of cells streaming past each other, contracting and expanding. It taxes the minds of determined embryologists to try and visualize, what is going on".

Amphibian eggs have been used as the most convenient of eggs of all vertebrates, for experimental works, especially those experiments which involve the operations on the embryos. *Rana pipiens* was the main model system in older days, and *Xenopus laevis* nowadays, of many different species of anurans used in different parts of the world. Information on descriptive embryology of these species is well available in literature. (Ref.: Rugh, 1951; Hausen and Riebesell, 1991; Nieuwkoop and Faber, 1994). Unfortunately, either of these species is not in use in Indian laboratories or description of early developmental anatomy of the any of the species commonly available here, is not published so far. This is the reason, for having done the present research work.

Descriptive embryology of amphibians certainly is well studied in older days only. Powerful techniques of molecular biology are now being applied to the classical problems of embryonic development that were studied by an older generation (Wolpert, 1991). Thus,
again a research in descriptive embryology of an amphibian seems to be a less useful research. But, it is very difficult, due to the complexity of the early developmental process, to experiment on embryo of a species, just by referring description of embryo of another species, however close the species may be. It is a common knowledge that species-specific differences start in the fertilized egg itself, and continue as an epigenetic process, throughout the development of the animal. Same organ rudiments of two closer species never appear same in their structure and in their position, in three-dimensional space of the embryo, although both of the embryos are said to remain in the same stage, with respect to the types of organ rudiments they contain. Knowledge of structure and position of an organ rudiment in a particular species, at a particular stage of its development is needed, if that organ rudiment is to be recognized in course of experimentation. Also, as Rugh (1951) writes, while parts of the embryo are isolated for detailed study, one must of necessity re-assemble those parts into a constantly changing three dimensional whole. Thus, early development of the toad *Bufo melanostictus* (Schn.) is studied in the present research work, as a prerequisite for further experimental work on its early development. *B. melanostictus* was selected for the present research work, as it is commonly available throughout India.

In the present research work, a complete table of normal developmental stages of *B. melanostictus* based on external features of its embryos and larvae, is prepared, and with reference to earlier of these stages (i.e., from two-cell stage to advanced neural tube stage) internal features of the developing embryos are studied. Based on external features of developmental stages, tables of normal developmental stages of some of the Indian anurans, including *B. melanostictus* (Schn.) have been published (Ramaswami and
Lakshman, 1959; Khan, 1965; Bhati, 1969; Agarwal and Niazi, 1977; Roy and Khare, 1978; Mehta, 1983; Sekar, 1990; Mohanty et al., 1996). But of no one’s internal features are studied. Normal table of development of the toad *B. melanostictus* (Schn.), prepared by Khan (1965) follows the pattern of Nieuwkoop and Faber, used for staging the development of *Xenopus laevis*. But, duration of the stages, which is also an important factor in consideration of embryonic development, is not given, by Khan.

In the present research work, Gosner’s pattern (Gosner, 1960) of staging is followed, as it is a more generally practiced way of staging. The larval and metamorphic stages of Gosner series illustrate the sequence of external changes that are most easily observed during metamorphosis of a typical anuran which has aquatic larval stages (Dent, 1968).

The observations done in the present research work, have been presented in the thesis, into two main parts, as follows.

**Part (A).** Gosner series of developmental stages of the toad *Bufo melanostictus* (Schn.).- Embryos and larvae of the toad are staged following Gosner’s pattern of staging. Main external features of the embryos and larvae of all stages (i.e., from 1 – 46) are mentioned. Duration of each stage, under the laboratory conditions, at normal room temp. of 24.5°C is given. Camera lucida drawings of specimens of all stages (except stages 1 and 2) are presented. Normal size of an embryo or larva of each stage is mentioned. Metamorphosis of the toad completes at about 48th day of egg laying.

**Part (B).** External and internal features of the embryos of the toad, *Bufo melanostictus* (Schn.), from two-cell stage to advanced neural tube stage. The stages are selected according to the stages of Gosner series. Observations on each stage are given separately, under the heading of stage number and name of the respective stage. External and internal
features of the embryos again are separately given, in each stage. (Although, the external 
features are mentioned in first part, more detailed description is given here). Description of 
internal features is supplemented with photomicrographs.

In general, early development of _B. melanostictus_ followed the typical pattern of 
moderately telolecithal eggs, with holoblastic cleavage pattern. Its external and internal 
features of development resembled more, the development of _Rana pipiens_ than of 
_Xenopus laevis_. Till completion of the gastrula process, no portion of blastoderm 
(especially, towards the marginal zone of the egg) can be demarcated, as a portion 
belonging to the ectoderm, mesoderm or endoderm. Also, mesoderm and endoderm cannot 
be recognized in the involuted portion of the marginal zone. Only two layers, stretching 
outer layer and involuted inner layer, remain visible in gastrula stages. Likewise, the terms 
outer layer and inner layer are used in the description of the gastrula stages.