CHAPTER 1

BIODIVERSITY OF THE STREAM AND THE RIPARIAN ZONE OF RIVER VISHWAMITRI

Biodiversity represents the very foundation of human existence. Yet by our heedless actions we are eroding this biological capital at an alarming rate. Even today, despite the destruction that we have inflicted on the environment and its natural bounty, its resilience is taken for granted. But the more we learn of the workings of the natural world, the clearer it becomes that there is a limit to the disruption that the environment can endure. Biodiversity is a part of our daily lives and constitutes the resources upon which families, communities, nations and future generations depend. Despite this, recent estimates suggest that more than half the habitable surface of the planet has already been significantly altered by human activities (Hannah and Bowles, 1995) It has also been suggested that we are on to the mass extinction of species (Myers, 1979; Wilson, 1985). These concerns have been coupled with a realization that our knowledge of the diversity and variability of plants, animals, microorganisms and the ecosystems in which they occur is woefully incomplete. In fact, of the estimated 5–50 million species of the world's biota, only 1.7 million have been described to date (Groombridge *et al.*, 2000).

Most studies conducted till date have focused on terrestrial ecosystems, its conservation in protected areas and its socioeconomic dimensions whereas the biodiversity in aquatic ecosystems, especially the freshwaters, where the life first originated, remains mostly neglected. Internationally however, the biodiversity of inland water ecosystems has just started receiving some attention (Gopal, 1997). Freshwaters are home to a tremendous diversity of fish, amphibians, aquatic plants, invertebrates, and microorganisms. Though the wetlands are considered to be highly productive, they are also one of the most fragile and

threatened ecosystems. Freshwater biodiversity is seriously threatened today – a telling indicator of the status of the world's freshwater ecosystems. Yet freshwater biodiversity is amongst the most poorly known on Earth, and there is very little information even on their total biological diversity, much less on the factors regulating it or on its functions. The present investigation therefore, was aimed at understanding the biological diversity of River Vishwamitri.

Further, it is well documented that the fauna that live in the stream are very dependent on the riparian zone for their food and habitat requirements (Manci, 1989, Cummins, 1993). The riparian zone, defined as an ecological complex, is all land directly adjacent to a watercourse including flood plains and wetlands (Parsons, 1991; Walker, 1993). This zone can also be seen as an extension of the river continuum, with an "energy driver association" acting upon the in-stream biology (Cummins, 1993). Further, the zone can be seen as an interface between terrestrial and aquatic systems and is described as a series of ecotones between these systems (Risser, 1990; Walker, 1993). Riparian lands can also include intermittent stream, gullies and dips, which sometimes run with water (Askey-Doran *et al.*, 1996). The riparian zone influences several elements of the habitat, including temperature, cover, and food. The riparian vegetation ranges from emergent aquatic and semi-aquatic plants to terrestrial understorey and canopy species (Parsons, 1991). Loss of vegetative cover and undercut banks can decrease the amount of suitable habitat, thereby reducing stream productivity and carrying capacity. Streambank vegetation also can be an important source of food for aquatic organisms (Manci, 1989). In addition to preventing pollution and sedimentation, the diverse vegetation of the riparian zones provide an environment in which a large variety of fauna is sustained. The riparian zone provides food for all trophic levels of the food web, starting with microbes and continuing to top consumers. The leaf litter that falls into the stream from the vegetation provides organic matter for the multiplication of microbes. The macro-invertebrates would also feed on this leaf litter, and the food web continues up with small fish eating these invertebrates, and larger fish eating those fish. In addition, the fauna that finds shelter in the riparian zone itself are also dependent on this food web, for the vegetation and the invertebrates and fishes. At the same time, the riparian zone also provides the components of this food web with shelter. The strong root systems, for example, allow for overhangs along the banks into which fish take shelter. The densely packed vegetation is also home to numerous birds and mammals. In a stream without the riparian vegetation, these webs and habitats are destroyed. A clear-cut land looses most, if not all of its ability to provide habitat. The fauna either dies or moves away. In the stream, not only are the habitats destroyed but the increase in temperature that results from a lack of shade is detrimental. The food web, in

this way, is destroyed before it begins. With little leaf litter or organic matter of any kind, the microbes and macro-invertebrates cannot find food. This would have a detrimental effect on the fauna living there. Thus the riparian zone plays a major role in maintaining the stream ecosystem. Hence, during the current study effort was also made to comprehend the floristic and faunal diversity of the riparian zone of River Vishwamitri which will act as a baseline data for any future investigation regarding the possible role they play to regulate the carrying capacity of Vishwamitri river.

METHOD

The exploration of the area was undertaken by conducting a trip each month. This included visiting all the five stations regularly and it covered the area in all different seasons i.e. winter, summer and postmonsoon.

During each trip, observations were made pertaining to the vegetation and associated animal diversity. The identification of plants was mainly done by comparing the collected plant parts with the standard herbariums prepared at Department of Botany and also by referring to standard reference books and published articles (Sabnis, 1967; Patel, 1971; Shah, 1983). The area was thoroughly combed for the animals or for indirect evidences of their presence such as trails, molted skins, pellets, droppings etc. Amphibians were collected using bucket traps. Insect traps and pitfall traps were used for collecting insects and spiders respectively. Scoop and dragnets were used to collect fishes. Birds and Mammals were observed in and around the sampling stations using field binoculars (10 x 50).

For identification of the plankton 15L of water was sieved through plankton net. The volume was made up to 100mL. This was preserved with 4% Formalin. Lugol's iodine was added for staining the algae as well as preserving delicate structures like cilia, flagella, etc. This was then concentrated by sedimentation for 5 days. The final volume was made to 10mL. From this 0.5mL was taken on a glass slide for examination under a Leica DMBR Advanced Research Microscope.

The identification of various algae and the animal groups (aquatic and terrestrial) was done using standard reference books and published articles (Blanford and Godwin Austen, 1908; Brunetti, 1912; Fowler, 1912; Preston, 1915; Arrow, 1917; Gude, 1921; Baker, 1922-30; Harding and Moore, 1927; Cameron, 1932; Ali, 1956; Daniel and Shull, 1963; Maxwell, 1971; Kalyanam, 1967; Ali, 1979; Patel and Chhaya, 1979; Nayar *et al.*, 1981; Daniel, 1983; Ali and Ripley, 1983a, 1983b; Jhingran, 1983; Tikader, 1987; Prater, 1990; Ayyar and

Ananthakrishnan, 1991; Daniel and Sekar, 1991; Grewal, 1993; Green, 1996; Gunathilagaraj, 1998; Kunte, 2000).

The animals, which could be collected, especially insects, spiders, fishes, amphibians and reptiles were confirmed by matching with the authentic specimens at the Department of Zoology, M.S. University of Baroda.

RESULT

FLORISTIC DIVERSITY

The floristic component of aquatic biota is dominated by algae in open waters, while the higher plants (macrophytes) dominate the shallow water areas.

I. Algae

DIVISION: CHLOROPHYTA

ORDER: CHLOROCOCCALES

FAMILY: COELASTRACEAE

1. *Coelastrum microporum* Naegeli

FAMILY: HYDRODICTYACEAE

2. *Hydrodictyon reticulatum* (Linn.) Lagerheim
3. *Pediastrum duplex* Meyen
4. *Pediastrum simplex* Meyen
5. *Pediastrum ovatum* (Her.) A. Braun
6. *Pediastrum boryanum*
7. *Pediastrum tetras*
8. *Sorastrum sphaericum*

FAMILY: OOCYSTACEAE

9. *Ankistrodesmus falcatus (Corda)* Ralfs
10. *Tetraedron gracile* (Reinsch) Hansgirg
11. *Selenastrum gracile* Reinsch

FAMILY: SCENDESMACEAE

12. *Actinastrum hantzschii* Lagerheim
13. *Scendesmus acuminatus* (Lagerheim) Chodat
14. *Scendesmus bijugatus* (Turpin) Kuetzing
15. *Scendesmus dimorphus* (Turpin) Kuetzing
16. *Scendesmus quadricauda* (Turpin) Brebisson

ORDER: ZYGNEMATALES

FAMILY: DESMIDIACEAE

17. *Closterium* sp.
18 *Staurastrum* sp
19. *Cosmarium* sp.1

20. *Cosmarium* sp.2
21. *Cosmarium* sp.3

FAMILY: ZYGNEMATACEAE

22. *Spirogyra* sp.

ORDER: ULOTRICHALES

FAMILY: ULOTRICHASCEAE

23. *Ulothrix* sp.

ORDER: OEDOGONIALES

FAMILY: OEDOGONIACEAE

24. *Oedogonium* sp.

CLASS: CHAROPHYCEAE

ORDER: CHARALES

FAMILY: CHARACEAE

25. *Chara* sp.

DIVISION: CYANOPHYTA (Blue-Green Algae)

FAMILY: CHROOCOCCACEAE

26. *Microcystis aeruginosa* Kutz
27. *Merismopedia* sp.

FAMILY: NOSTOCACEAE

28. *Anabaena* sp.

FAMILY: OSCILLATORIACEAE

29. *Lyngbya* sp.
30. *Oscillatoria tenuis* Agardh
31. *Oscillatoria limosa* (Roth) Agardh
32. *Oscillatoria* sp.
33. *Spirulina subtilissima*
34. *Arthrospira* sp.

DIVISION: EUGLENOPHYTA

ORDER: EUGLENALES

FAMILY: EUGLENACEAE

35. *Phacus orbicularis* Hübner
36. *Phacus tortas* (Lemm.)
37. *Euglena acus* Ehrenberg
38. *Euglena oxyuris* Schmarda
39. *Euglena viridis* Ehr.
40. *Lepocynclis* sp.

DIVISION: CHRYSOPHYTA

CLASS: BACILLARIOPHYCEAE

ORDER: BACILLARIALES

FAMILY: COSCINODISCOIDEAE

41. *Coscinodiscus* sp

42. *Cyclotella meneghiniana* Kütz

FAMILY: FRAGILARIACEAE

43. *Fragilaria* sp.
44. *Synedra acus* (Kutz)
45. *Synedra ulna* (Nitzsch)

FAMILY: EUNOTIACEAE

46. *Eunotia* sp.

FAMILY: ACHNANTHACEAE

47. *Achnanthes* sp.
48. *Cocconeis* sp.

FAMILY: NAVICULACEAE

49. *Caloneis permagna* (Bail.) Cleve
50 *Gyrosigma* sp.
51. *Mastogloia* sp.
52. *Navicula gracilis* Ehr.
53. *Navicula* sp.1
54. *Pinnularia* sp.
55. *Stauroneis* sp.

FAMIL: GOMPHONEMACEAE

56. *Gomphonema* sp

FAMILY: CYMBELLACEAE

57. *Amphora ovalis* Kutz
58. *Cymbella aspera* (Ehr)
59. *Cymbella turgidula* Grun

FAMILY: NITZSCHIACEAE

60. *Nitzachia palea* (Kutz.) w. Sm

FAMILY: SURIRELLACEAE

61. *Surirella robusta* Her.

II. Macrophytes

During monsoon the river is in spate and the banks are flooded After monsoon, the water level recedes, exposing the banks throughout. In the month of September the banks are muddy showing sparse vegetation. It is only during October that both the permanent and the ephemeral vegetation of the banks could be studied simultaneously.

i. Trees

FAMILY: SIMAROUBACEAE

1. *Ailanthus excelsa* Roux.

FAMILY: MIMOSACEAE

2. *Acacia nilotica* (L.) Del. *indica* (Bth) Brenan
3. *Pithecellobium dulce* (Roux.) Beth.
4. *Prosopis juliflora*

FAMILY: MORACEAE

5. *Ficus hispida* L.f.
6. *Streblus asper Lour.*

FAMILY: ARECACEAE

7. *Borassus flabellifer* L.
8. *Phoenix sylvestris* (L.) Roxb.

ii. Shrubs

FAMILY: RHAMNACEAE

1 *Zizyphus nummularia* DC.

FAMILY: ASCLEPIADACEAE

2. *Calotropis gigantea* Br.

FAMILY: CONVOLVULACEAE

3. *Ipomoea fistulosa* Mart. ex

FAMILY: VERBENACEAE

4 *Lantana camara* L.

iii. Climbers

FAMILY. VITACEAE

1. *Cayratia carnosa* (Lam) Gagnep.

FAMILY: FABACEAE

2. *Teramnus labialis* (L.) Pers.

FAMILY: CUCURBITACEAE

3. *Coccinia indica* (L.) Voigt
4 *Cucumis callosus* L.
5. *Mukia maderaspatana* (L.) M. Roem.

FAMILY: ASCLEPIADACEAE

6. *Pergularia daemia* (Forsk.) Chiov.

FAMILY: CONVOLVULACEAE

7. *Ipomoea aquatica* Forsk.
8. *Ipomoea nil* (L.)
9. *Ipomoea pes-tigridis* L.

iv. Herbs

FAMILY: CAPPARACEAE

1. *Cleome gynandra* L.
2. *Cleome viscosa L*

FAMILY:Violaceae

3. *Hybanthus enneaspermus* (L.) F. Muell

FAMILY: POLYGALACEAE

4. *Polygala erioptera* DC

FAMILY: ELATINACEAE

5. *Bergia odorata* Edgew.

FAMILY: MALVACEAE

6. *Sida acuta* Burm. f
7. *Sida cordifolia* L.

FAMILY: STERCULIACEAE

8. *Melochia corchorifolia* L.

FAMILY: TILIACEAE

9. *Corchorus aestuans* L.
10. *Triumfetta rhomboidea* Jacq.

FAMILY: OXALIDACEAE

11. *Biophytum sensitivum* (L.) DC.
12. *Oxalis corniculata* L.

FAMILY: FABACEAE

13. *Alysicarpus monilifer* (L.)
14. *Crotalaria medicaginea* Lam.
15. *Desmodium gangeticum* (L.) DC.
16. *Desmodium triflorum* (L.) DC.
17. *Goniogyna hirta*
18. *Indigofera astragallina* DC.
19. *Indigofera cordifolia* Heyne ex Roth
20. *Tephrosia purpurea* (L.) Pers.
21. *Tephrosia villosa* (L.) Pers.

FAMILY: CAESALPINIACEAE

22. *Cassia occidentalis* L.
23. *Cassia tora* L.

FAMILY: ONAGRACEAE

24. *Ludwigia perennis* L.

FAMILY: RUBIACEAE

25. *Borreria stricta* (L.f.) F.N. Will
26. *Dentella repens* (L.) Forst

FAMILY: ASTERACEAE

27. *Eclipta prostrata* (L.) L. Mant.

28 *Grangea maderaspatana* (L.)

29. *Launaea procumbens* (Roxb.) R. & R.

30. *Parthenium hysterophorus* L.

31. *Tridax procumbens* L.

32. *Vernonia cinerea* (L.)

33. *Vicoa indica* (L.) DC.

34. *Xanthium strumarium* L.

FAMILY: PLUMBAGINACEAE

35. *Plumbago zeylanica* L.

FAMILY: APOCYNACEAE

36. *Catharanthus pusilla* (Murr.) G. Don

FAMILY: GENTIANACEAE

37. *Enicostemma hyssopifolium* (Willd) Verdoon

FAMILY: BORAGINACEAE

38 *Coldenia procumbens* L.

39. *Heliotropium supinum* L.

40. *Trichodesma indicum* (L.) R. Br.

FAMILY: CONVOLVULACEAE

41. *Convolvulus microphyllus* (Roth) Sieb. Ex Spr

42. *Evolvulus alsinoides* (L.) L.

43. *Evolvulus nummularius* (L.) L.

44. *Merremia gangetica* (L.) Cufod

FAMILY: SOLANACEAE

45. *Datura metel* L.

46. *Solanum nigrum* L.

47. *Solanum surattense* Burm f.

FAMILY: SCROPHULARIACEAE

48. *Lindenbergia murari* (Roxb. Ex D. Don) P. Bruchl

49. *Lindernia ciliata* (Colsm) Pennell

50. *Lindernia oppositfolia* Retz.

FAMILY: ACANTHACEAE

51. *Barleria prionitis* L.

52. *Blepharis maderaspatensis* (L.) Roth

53. *Dipteracanthus prostratus* (Poir.) Nees.

54. *Elytraria acaulis* (L.f.) Lindau

FAMILY: VERBENACEAE

55. *Phyla nodiflora* (L.) Greene

FAMILY: LAMIACEAE

56. *Ansiomeles indica* (L.) O. Ktze

57. *Ocimum canum* Sims

FAMILY· NYCTAGINACEAE

58. *Boerhaavia diffusa* L.

FAMILY: AMARANTHACEAE

59. *Achyranthes aspera* L. var. aspera
60. *Aerva lanata* (L.) Juss.
61. *Alternanthera pungens* Kunth
62. *Alternanthera sessilis* L. DC.
63. *Amaranthus spinosus* L.
64. *Celosia argentea* L
65. *Digera arvensis* Forsk.
66. *Gomphrena celsioides* Mart

FAMILY: POLYGONACEAE

67. *Polygonum plebeium* R. Br.

FAMILY: EUPHORBIACEAE

68. *Acalypha indica* L.
69. *Croton bonplandianum* Baill.
70. *Euphorbia hirta* L.
71. *Euphorbia microphylla* Heyne
72. *Euphorbia prostrata* Ait.
73. *Phyllanthus fraternus* Webster
74. *Phyllanthus virgatus* Forst. f.

FAMILY· COMMELINACEAE

75. *Commelina benghalensis* L.

FAMILY: POACEAE

76. *Cynodon dactylon* (L.) Pers.

v. Emergent or Amphibious Hydrophytes

FAMILY: LANTIBULARIACEAE

1. *Utricularia stellaris* Linn. f.

FAMILY: HYDROCHARITACEAE

2. *Hydrilla verticillata* (L.f.) Royle
3. *Vallisneria spiralis* L.

FAMILY: TYPHACEAE

4. *Typha angustata* Bory & Chaub.

FAMILY: POTAMOGETONACEAE

5. *Potamogeton pectinatus L*

FAUNA OF THE STUDY AREA

Both the riparian as well as the aquatic fauna have been recorded during the present study These areas support a good number of invertebrates and the major terrestrial groups include

insects and spiders. Amongst the aquatic invertebrate fauna the rotifers constitute the dominant group of organisms.

I. Protozoa

SUPERCLASS: RHIZOPODA
CLASS: LOBOSA
ORDER: TESTACEALOBOSA
SUBORDER: EULOBOSA
FAMILY: ARCELLIDAE
1. *Arcella* sp.
FAMILY: CENTROPYXIDAE
2. *Centropyxis* sp 1.
3. *Centropyxis* sp 2
FAMILY: DIFFLUGIIDAE
4. *Difflugia* sp.1.
5. *Difflugia* sp.2
CLASS: CILIATA
ORDER: HOLOTRICHIDA
SUBORDER: TRICHOSTOMINA
FAMILY: PARAMECIDAE
6 *Paramoecium* sp.
ORDER: SPIROTRICHIDA
SUBORDER: HETEROTRICHINA
FAMILY: BURSARIIDAE
7. *Bursaria* sp.
FAMILY: STENTORIDAE
8. *Stentor* sp.
FAMILY: SPIROSTOMIDAE
9. *Spirostomum* sp.
ORDER: PERITRICHIDA
SUBORDER: SESSILIA
FAMILY: EPISTYLIDAE
10. *Opercularia* sp.
FAMILY: VORTICELLIDAE
11. *Vorticella* sp.

II. Rotifers

CLASS: DIGONONTA
ORDER: BDELLOIDEA
FAMILY: PHILODINIDAE
1. *Rotaria neptunia* (Ehrenberg)

CLASS: MONOGONONTA

ORDER: COLLOTHECACEA

FAMILY: ATROCHIDAE

2. *Cupelopagis vorax* (Leidy)

ORDER: FLOSCULARIACEA

FAMILY: HEXARTHRIDAE

3. *Hexarthra mira*

FAMILY - FLOSCULARIDAE

4. *Lacinularia* sp.1

FAMILY: FILINIIDAE

5. *Filinia longiseta* (Ehrenberg)
6. *Filinia opoliensis* (Zacharias)

FAMILY:TESTUDINELLIDAE

7. *Testudinella patina* (Hermann)

ORDER:PLOIMIDA

FAMILY: DICRANOPHORIDAE

8. *Dicranophorus australiensis* Koste & Shiel.
9. *Encentrum* sp. 1

FAMILY: ASPLANCHNIDAE

10. *Asplanchna brightwelli* (Gosse)
11. *Asplanchna sieboldi*

FAMILY: TRICHOTRIIDAE

12. *Trichotria tetractis*

FAMILY: BRACHIONIDAE

13. *Platyias quadricornis* (Ehrenberg)
14. *Plationus patulus* (Müller)
15. *Keratella procurva* (Thorpe)
16. *Keratella tropica* (Apstein)
17. *Brachionus angularis* Gosse
18. *Brachionus bidentata* Anderson
19. *Brachionus calyciflorus* Pallas
20. *Brachionus caudatus* Barrois & Daday
21. *Brachionus diversicornis* (Daday)
22. *Brachionus falcatus* Zacharias
23. *Brachionus forficula* Wierzejski
24. *Brachionus quadridentatus* Hermann
25. *Brachionus rubens* Ehrenberg
26. *Anuraeopsis coelata* De Beauchamp
27. *Anuraepsis fissa* (Gosse)

FAMILY: COLURELLIDAE

28. *Colurella obtusa* Gosse

29. *Colurella unicata* O. F. Muller
30. *Lepadella ovalis* (O. F. Muller)
31. *Lepadella patella* (O. F. Muller)
32. *Lepadella acuminata* (Ehrenberg)
33. *Lepadella rhomboides* (Gosse)

FAMILY: MYTILINIDAE

34. *Mytilina ventralis* (Ehrenberg)

FAMILY: EUCHLANIDAE

35. *Euchlanis dilatata* Ehrenberg
36 *Euchalanis meneta* Myers
37. *Euchalanis oropha* Gosse

FAMILY: LECANIDAE Bartos

38. *Lecane inopinata* Harring & Myers
39. *Lecane bulla* (Gosse)
40. *Lecane closterocerca* (Schmarda)
41. *Lecane crenata* Harring
42. *Lecane elachis* (Harring & Myers)
43. *Lecane hamata* (Stokes)
44. *Lecane pyriformis* (Daday)
45. *Lecane quadridentata* (Ehrenberg)
46. *Lecane stenroosi* (Meissner)
47. *Lecane arcula* Harring
48. *Lecane curvicornis* (Murray)
49. *Lecane crepida* Harring
50. *Lecane inermis* (Bryce)
51. *Lecane nana* (Murray)
52. *Lecane leontina* (Turner)
53. *Lecane luna* (O. F. Müller)
54. *Lecane papuana*
55. *Lecane ungulata* (Gosse)

FAMILY: TRICHOCERCIDAE

56. *Trichocerca brazieliensis* (Murray)

FAMILY: NOTOMMATIDAE

57. *Scaridium longicaudum* (O. F. Müller)
58. *Cephalodella misgurunus*

FAMILY: SYNCHAETIDAE

59. *Polyarthra* sp. Ehrenberg

III. Molluscs

CLASS· GASTROPODA
SUBCLASS: PULMONATA
ORDER: BASOMMATOPHORA
FAMILY: LYMNAEIDAE
1. *Lymnaea* sp.

FAMILY: PLANORBIDAE
2. *Planorbis exustus* (Deshayes)

CLASS: PELECYPODA
SUBCLASS: LAMELLIBRANCHIA
ORDER: SCHIZODONTA
FAMILY: UNIONIDAE
3. *Unio* sp.

IV. Annelids

CLASS: OLIGOCHAETA
ORDER: OPISTHOPORA
FAMILY: GLOSSOSCOLECIDAE
1. *Pontoscolex corethrurus* – Earthworm

FAMILY: MEGASCOLECIDAE
2. *Metaphire posthuma* – Earthworm
3. *Eudichogaster barodensis* - Earthworm

CLASS: HIRUDINEA
ORDER: ARHYNCHOBDELLIDA
FAMILY: HIRUDINAE
4. *Hirudinaria* Sp. - Leech

V. Arthropods

CLASS: CRUSTACEA
ORDER: CLADOCERA
FAMILY: SIDIDAE Baird
1. *Pseodosida bidentata* Herrick
2. *Diaphanosoma senegal* Gauthier

FAMILY: DAPHNIIDAE
3. *Ceriodaphnia cornuta* Sars
4. *Daphnia lumholtzi* Sars
5. *Scapholeberis kingi* Sars
6. *Simocephalus exspinosus* (Koch)

FAMILY: MOINIDAE
7. *Moina micrura* Kurz
8. *Moinodaphnia macleayi* (King)

FAMILY: CHYDORIDAE

9. *Alona* sp.

ORDER: OSTRACODA

10. *Cypris* sp.

ORDER: COPEPODA

11. *Cyclops* sp. 1

12. *Oithonina* sp.1

CLASS: INSECTA

SUB-CLASS: APTERYGOTA

ORDER: THYSANURA

FAMILY: LEPISMATIDAE

13. *Lepisma saccharina* (Fabr.) - Silver fish

SUBCLASS: PTERYGOTA

ORDER: EPHEMEROPTERA

FAMILY: EPHEMEROPTERIDAE

14. *Ephemera* sp. – Mayfly

ORDER: ODONATA

SUBORDER: ANISOPTERA

FAMILY: AESHNIDAE

15. *Anax* sp.

16. *Aeshna* sp.

SUBORDER: ZYGOPTERA

FAMILY: LESTIDAE

17. *Orlestes* sp.

ORDER: ORTHOPTERA

SUBORDER: ENSIFERA

FAMILY: TETTIGONIIDAE

18. *Holochlora albida* - Long-horned Grasshopper

FAMILY: GRYLLIDAE

19. *Gryllus domesticus* - House cricket

20. *Oecanthus indicus* (Sauss.) - Tree cricket

FAMILY: GRYLLOTALPIDAE

21. *Gryllotalpa africana* (Pal.B) - Mole Cricket

SUBORDER: CAELIFERA

FAMILY: ACRIDIDAE

22. *Cytacanthacris ranacca* - Short-horned Grasshopper

ORDER: PHASMIDA

FAMILY: PHASMATIDAE

23. *Carausius sp.* - Stick insect

ORDER: DERMAPTERA

FAMILY: LABIDURIDAE

24. *Labidura bengalensis* - Earwig

ORDER: DICTYOPTERA
SUBORDER: BLATTARIA
FAMILY: BLATTIDAE
25. *Blatta germanica* (Linn.) - Cockroach
26. *Periplaneta americana* (Linn.) - Cockroach
SUBORDER: MANTODEA
FAMILY: MANTIDAE
27. *Mantis religiosa* - Praying Mantis
ORDER: ISOPTERA
FAMILY: TERMITIDAE
28. *Microtermes obesi* - Termite
ORDER: HEMIPTERA
SUBORDER: HETEROPTERA
FAMILY: PYRRHOCORIDAE
29. *Dysdercus* sp - Red Cotton bug
FAMILY: CORIXIDAE
30. *Corixa hieroglypha* - Water boatman
FAMILY: NOTONECTIDAE
31. *Enithares templetoni* (Kirby) - Back Swimmer
FAMILY: GERRIDAE
32. *Gerris spinole* (Leith.) - Waterstrider
33. *Gerris tristan* - Pond Skater
FAMILY: HYDROMETERIDAE
34. *Hydrometra vittata* (Stal.) - Marsh treader
FAMILY: BELOSTOMATIDAE
35. *Belostoma indica* (Duff.) - Giant Water bug
FAMILY: NEPIDAE
36. *Ranatra filiformis* (Fabr.) - Water Scorpion
ORDER: COLEOPTERA
SUB-ORDER: ADEPHAGA
FAMILY: CARABIDAE
37. *Anthia sexguttata* (Ho.) - Six spotted Beetle
38. *Pheropsophus* sp. - Bombardier Beetle
FAMILY: DYSTISCIDAE
39. *Cybister confussus* (Shp.)
SUBORDER: POLYPHAGA
FAMILY: COCCINELLIDAE
40. *Chilomens sexmaculata* (Fabr.) - Lady-bird Beetle
ORDER: DIPTERA
SUBORDER: CYCLORRHAPHA
FAMILY: MUSCIDAE
41. *Musca domestica* (Linn.) - House Fly

FAMILY: CULICIDAE

42. *Anopheles* sp. - Mosquito

43. *Culex* sp. - Mosquito

ORDER: LEPIDOPTERA

SUBORDER: DITRYSIA

FAMILY: DANAIDAE

44. *Euploea core core* - Common Crow Butterfly

45. *Danaus crysippus crysippus* - Plain Tiger Butterfly

46. *Danaus genutia genutia* - Striped Tiger Butterfly

FAMILY: HESPERIIDAE

47. *Borbo cinnara* - Rice swift

FAMILY: NYMPHALIDAE

48. *Symphaedra nais* - Baronet Butterfly

49. *Precis orithya* - Blue Pansy Butterfly

50. *Precis hierta hierta* - Yellow Pansy Butterfly

51. *Hypolimnas misippus* - Danaid Eggfly Butterfly

52. *Precis almana almana* - Peacock Pansy Butterfly

53. *Melanitis leda* - Common Evening Brown

FAMILY: PAPILIONIDAE

54. *Papilio demoleus* - Lime Butterfly

FAMILY: PIERIDAE

55. *Catopsilia crocale* (Cr.)- Common emigrant Butterfly

56. *Eurema hecabe simulata* - Common Grass Yellow Butterfly

57. *Delias eucharis* - Common Jezebel Butterfly

ORDER: HYMENOPTERA

SUBORDER: APOCRITA

FAMILY: APIDAE

SUBFAMILY: APINAE

58. *Apis dorsata* (Fabr.)

59. *Apis indica* (Fabr.)

SUBFAMILY: XYLOCOPINAE

60. *Xylocopa aestuans* (Linn.) - Carpenter bee

FAMILY: EUMENIDAE

61. *Eumenes esuriens* (Fabr.) - Potter Wasp

FAMILY: FORMICIDAE

62. *Componotus compressus* (Fabr.) - Black Ant

63. *Oecophylla smaragdina* (Fabr.) - Red Ant

CLASS: ARACHNIDA

ORDER: ARANEA

FAMILY: ERESIDAE

64. *Stegodyphus sarasinorum* (Karsch) - Social Spider

FAMILY: SALTICIDAE

65. *Myrmarachne* sp. - Ant-like Spider

66 *Phidippus* sp.

FAMILY: CLUBIONIDAE

67. *Chiracanthium* sp. - Sac Spider

FAMILY: LYCOSIDAE

68. *Hippasa pisaurina* - Funnel web Spider

69. *Lycosa* sp. - Wolf Spider

70. *Evippa* sp. - Wolf Spider

71. *Pardosa birmanica* - Wolf Spider

FAMILY: TETRAGNATHIDAE

72. *Tetragnatha andamensis* - Long-jawed Spider

FAMILY: ARANEIDAE

73. *Argiope anasuja* - Garden Spider

74. *Argiope ameula* - Garden Spider

75. *Cyrtophora citricola* (Stoliczka) - Orb-Web Spider

76. *Neoscona mukerjei* - Orb-Web Spider

77. *Neoscona theis* Orb - Web Spider

VI. Fishes

CLASS: ACTINOPTERYGII

ORDER: SILURIFORMES

FAMILY: BARIDAE

1. *Mystus cavasius* (Hamilton, 1882)

ORDER: CYPRINIFORMES

FAMILY: CYPRINIDAE

2. *Rasbora daniconius* (Hamilton 1822)

VII. Amphibians

CLASS: AMPHIBIA

ORDER: ANURA

FAMILY: BUFONIDAE

1. *Bufo melanostictus* Schneider - Common Indian Toad
2. *Bufo stomaticus* (Lutken) - Marbled Toad

FAMILY: RANIDAE

3. *Hoplobatrachus tigerinus* (Daudin) - Bull Frog
4. *Limnonectes limnocharis* (Boie) - Cricket Frog
5. *Euphlyctis cyanophlytis* (Schneider) - Skipper Frog

VIII. Reptiles

CLASS· REPTILIA

ORDER: SQUAMATA

SUBORDER: SAURIA

FAMILY: GEKKONIDAE

1. *Hemidactylus flaviviridis* Rüppell - Northern House Gecko

FAMILY: AGAMIDAE

2. *Calotes versicolor* (Daudin) - Common Garden lizard
3. *Sitana ponticeriana* Cuvier - Fan throated lizard

FAMILY: SCINCIDAE

4. *Mabuya carinata* (Schneider) - Common skink
5. *Riopa punctata* (Gmelin) - Snake skink

SUBORDER: SERPENTES

FAMILY: TYPHLOPIDAE

6. *Typhlina bramina* (Daudin) - Blind snake

FAMILY: UROPELTIDAE

7. *Eryx johni* (Russell) - John's Earth Boa

FAMILY: COLUBRIDAE

8. *Ptyas mucosus* (Linn.) - Rat snake

Xenochrophis piscator (Schneider) - Checkered keelback

ORDER: CROCODILIA

FAMILY: CROCODYLIDAE

9. *Crocodylus palustris* Lesson - Marsh Crocodile

IX. Birds

CLASS: AVES

ORDER: PELECANIFORMES

FAMILY: PHALACROCORACIDAE

1. *Phalacrocorax niger* (Vieillot) - Little cormorant

ORDER: CICONIFORMES

FAMILY: AREIDAE

2. *Ardeola grayii* (Sykes) - Pond Heron
3. *Bubulcus ibis* (Linnaeus) - Cattle Egret
4. *Egretta intermedia* (Wagler) - Median Egret

FAMILY: CICONIDAE

5. *Mycteria leucocephala* (Pennant) - Painted stork
6. *Anastomus oscitans* (Boddaert) - Openbill stork

ORDER: ANSERIFORMES

FAMILY: ANATIDAE

7. *Dendrocygna javanica* (Horsfield) - Lesser whistling teal

ORDER: FALCONIFORMES

FAMILY: ACCIPITRIDAE

8. *Elanus caeruleus* (Desfontaines) - Black winged kite
9. *Milvus migrans* (Boddaert) - Common Pariah kite
10. *Accipiter badius* (Gmelin) - Shikra

ORDER: GALLIFORMES

FAMILY: PHASIANIDAE

11. *Pavo cristatus* Linnaeus - Common peafowl

ORDER: GRUIFORMES

FAMILY: RALLIDAE

12. *Amaurornis phoenicurus* (Pennant) - White breasted water hen

ORDER: CHARADRIIFORMES

FAMILY: RECURVIROSTRIDAE

13. *Himantopus himantopus* (Linnaeus) - Black winged stilt

FAMILY: CHARADRIIDAE

14. *Vanellus indicus* (Boddaert) - Redwattled lapwing
15. *Vanellus malabaricus* (Boddaert) - Yellow wattled lapwing
16. *Rostratula benghalensis* (Linnaeus) - Painted snipe
17. *Tringa tetanus* (Linnaeus) - Redshank
18. *Tringa nebularia* (Gunnerus) - Greenshank
19. *Tringa glareola* Linnaeus - Spotted sandpiper
20. *Tringa hypoleucos* Linnaeus - Common sandpiper
21. *Charadrius dubius* Scopoli - Little ringed plover
22. *Calidris minuta* (Leisler) - Little stint

ORDER: COLUMBIFORMES

FAMILY: COLUMBIDAE

23. *Columba livia* Gmelin - Blue rock pigeon
24. *Streptopelia decaocto* (Frivaldszky) - Ring dove
25. *Streptopelia chinensis* (Scopoli) - Spotted dove
26. *Streptopelia senegalensis* (Linnaeus) - Little brown dove

ORDER: PSITTACIFORMES

FAMILY: PSITTACIDAE

27. *Psittacula krameri* (Scopoli) - Rose-ringed parakeet

ORDER: CUCULIFORMES

FAMILY: CUCULIDAE

28. *Eudynamys scolopacea* (Linnaeus) - Koel
29. *Centropus sinensis* (Stephens) - Coucal

ORDER: STRIGIFORMES

FAMILY: STRIGIDAE

30. *Athene brama* (Temminck) - Spotted owlet

ORDER: APODIFORMES

FAMILY: APODIDAE

31. *Apus affinis* (J.E. Gray)- House swift
32. *Cypsiurus parvus* (Lichtenstein) - Palm swift

ORDER: CORACIIFORMES

FAMILY: ALCEDINIDAE

33. *Alcedo atthis* (Linnaeus) - Small blue kingfisher
34. *Halcyon smyrnensis* (Linnaeus) - Whitebreasted kingfisher

FAMILY: MEROPIDAE

35. *Merops orientalis* Latham - Small green bee-eater

FAMILY: CORACIIDAE

36. *Coracias benghalensis* (Linnaeus) - Blue jay

FAMILY: UPUPIDAE

37. *Upupa epops* Linnaeus - Hoopoe

ORDER: PICIFORMES

FAMILY: CAPITONIDAE

38 *Megalaima haemacephale* (Muller) - Coppersmith

ORDER: PASSERIFORMES

FAMILY: ALAUDIDAE

39. *Mirafra assamica* Horsfield - Bush lark
40. *Mirafra erythroptera* Blyth - Redwinged bush lark
41. *Galerida cristata* (Linnaeus) - Crested lark
42. *Calandrella cinerea* (Gmelin) - Short toed lark
43. *Eremopteris grisea* (Scopoli) - Black bellied finch lark

FAMILY: HIRUNDINIDAE

44. *Hirundo concolor* Sykes - Dusky crag martin
45. *Hirundo smithii* Leach - Wire tailed swallow

FAMILY: LANIIDAE

46. *Lanius excubitor* Linnaeus - Grey Shrike
47. *Lanius vittatus* Valenciennes- Baybacked shrike
48. *Lanius schach* Linnaeus - Rofousbacked shrike

FAMILY: DICRURIDAE

49. *Dicrurus adsimilis* (Bechstein) - Black Drongo

FAMILY: STURNIDAE

50. *Sturnus roseus* (Linnaeus) - Rosy pastor
51. *Sturnus pagodarum* (Gmelin) - Brahminy myna
52. *Acridotheres tristis* (Linnaeus) - Indian Myna
53. *Acridotheres ginginianus* (Latham) - Bank myna

FAMILY: CORVIDAE

54. *Dendrocitta vagabunda* (Latham) - Tree pie
55. *Corvus splendens* (Vieillot) - House crow

56. *Corvus macrorhynchos* Wagler - Jungle crow

FAMILY: PYCNONOTIDAE

57. *Pycnonotus cafer* (Linnaeus) - Red vented bulbul

FAMILY: MUSCICAPIDAE

58. *Turdoides caudatus* (Dumont) - Common Babbler
59. *Turdoides malcomi* (Sykes) - Large grey babbler
60. *Turdoides striatus* (Dumont) - Jungle babbler
61. *Rhipidura aureola* Lesson - White browed fantailed flycatcher
62. *Prinia socialis* Sykes - Ashy wren warbler
63. *Orthotomus sutorius* (Pennant) - Tailor bird
64. *Saxicola caprata* (Linnaeus) - Pied bush chat
65. *Saxicola torquata* (Linnaeus) - Collared bush chat
66. *Saxicola leucura* Blyth - White tailed stone chat
67. *Copsychus saularis* (Linnaeus) - Magpie robin
68. *Saxicoloides fulicata* (Linnaeus) - Indian Robin

FAMILY: MOTACILLIDAE

69. *Anthus novaeseelandiae* Gmelin - Paddyfield pipit
70. *Motacilla flava* Linnaeus - Yellow wagatil
71. *Motacilla alba* Linnaeus - White wagtail
72. *Motacilla cinerea* Tunstall - Grey Wagtail

FAMILY: NECTARINIIDAE

73. *Nectarinia asiatica* (Latham) - Purple sunbird

FAMILY: PLOCEIDAE

74. *Passer domesticus* (Linnaeus) - House sparrow
75. *Ploceus philippinus* (Linnaeus) - Baya weaver bird
76. *Lonchura punctulata* (Linnaeus) - Spotted munia
77. *Lonchura malabarica* (Linnaeus) - White throated munia

X. Mammals

CLASS: MAMMALIA

ORDER: LAGOMORPHA

FAMILY: LEPORIDAE

1. *Lepus nigricollis* - Black-napped hare

ORDER: RODENTIA

FAMILY: SCIURIDAE

2. *Funambulus pennati* - Palm squirrel
3. *Bandicota benghalensis* - Indian mole rat

ORDER: CARNIVORA

SUBORDER: FISSIPEDIA

FAMILY: FELIDAE

4. *Felis chaus* - Jungle cat

FAMILY: VIVERRIDAE

5. *Viverricula indica* - Small Indian civet

FAMILY: CANIDAE

6. *Canis aureus* - Golden jackal

FAMILY: HERPESTIDAE

7. *Herpestes edwadsii* - Mongoose

ORDER: PRIMATES

SUB-ORDER: HAPLORHINI

INFRA-ORDER: CATARRHINI

8. *Presbytis entellus* - Hanuman langur

DISCUSSION AND CONCLUSION

The total algal flora of India has never been estimated although detailed systematic accounts of a few representative groups were published long ago (Desikachary, 1959; Philipose, 1967; Ramanathan 1964; Randhawa, 1959, Venkataraman, 1961). A preliminary estimate puts the Indian algal flora at about 1800 species of which about two-thirds are the blue-green algae (Gopal, 1997). The algal flora of River Vishwamitri has been explored before by Sharma (1985) who described about 30 species of algae. In the present study of River Vishwamitri, algae are represented by Chlorophyta, Cyanophyta, Chrysophyta and Euglenophyta. Chlorophyta is represented by 25 species belonging to nine familes Nine species of Cyanophyta were present in the river, which belonged to three families. Chyrsophyta was represented by twenty species belonging to nine families. Euglenophyta had only one family with six species. Thus a total of 61 different species of algae were found from River Vishwamitri.

The riparian zone of River Vishwamitri had relatively poor tree diversity. Only eight tree species belonging to four different families were found during the present study. Family Mimosaceae was represented by three species while family Moraceae and Arecaceae by two species each and family Simaroubaceae was represented by a single species. Four species of shrubs were located belonging to four different families. Nine species of climbers were also located, which belonged to five families. Family Cucurbitaceae and Convolvulaceae were the dominant climber families, which were represented by three species each. As expected the shrubs dominated the riparian vegetation. There were 29 families of shrubs having as many as 76 species. The dominant herb families were Amaranthaceae and Fabaceae, each represented by nine species. Other important herb families were Asteraceae and Euphorbiaceae, represented by 5 species each, Acanthaceae and Convolvulaceae represented by four species each. Family Boraginaceae, Solanaceae and Scrophulariaceae had three species each. Apocynaceae, Capparaceae, Caesalpinaceae, Lamiaceae, Malvaceae,

Oxalidaceae, Rubiaceae, Tiliaceae were all represented by two species each. While families Commelinaceae, Elatinaceae, Gentinaceae, Graminae Nyctaginaceae, Onagaraceae, Plumbaginaceae, Polygalaceae, Polygonaceae, Sterculiaceae, Verbenaceae, Violaceae were represented by a single species each.

Five species of aquatic hydrophytes were observed in the Vishwamitri River. Out of these four species *Potamogeton pectinatus, Typha angustata, Utricularia* sp. and *Vallisneria spiralis* are emergent hydrophytes while *Hydrilla verticillata* is a submerged hydrophyte. Majority of waterbodies are partly or wholly covered by one or more macrophytes (Varshney and Rzoska, 1973). These macrophytes play an important role in energy input, nutrient budget and recycling of nutrients in the water bodies (Howard-Williams and Junk, 1977; Mickle and Wetzel, 1978; Rana and Nirmal Kumar, 1988)

With a few heavy showers in the month of July the river swells considerably and inundates the herbaceous layer completely, with the result the ephemeral vegetation is totally destroyed. During this period of monsoon there is a fluctuation in water level and whichever plants present are subjected to periodic flooding. Similar to the observations of Sabnis (1967), *Cynodon dactylon* survives in spite of the flooding and forms the dominant community of such mud flats. This state continues till the months of October – December, when the water level decreases. The mud flats then lose the excessive moisture content with the result the herbaceous species, which form the main component of the ephemeral vegetation of the herbaceous layer, begins to come up.

The faunal component of River Vishwamitri is represented by a good number of species. Planktonic protozoa (mainly flagellates and ciliates) play a significant role in the food web as primary consumer in aquatic ecosystems. They are also known to help in natural recovery of putrified sewage water. Protozoans may be conveniently used for environmental biomonitoring, particularly in evaluating water quality (Das, 1998).

The rotifers formed the dominant component as far as the aquatic system was concerned, having fifty-nine species belonging to 23 genera and 17 families. Out of the 17 families, sixteen were Monogononts while only one family belonged to the Digononta.

A total of 183 species belonging to 53 genera and 22 families of Molluscans have been recorded from India (Subba Rao, 1998) Gastropods and bivalves, two groups of freshwater molluscs were found in the present study. They are filter feeders, phytophagous or detritivorous and occupy second trophic level in the food chain. Aquatic gastropods such as *Limnaea* and *Planorbis* are the chief source of food for birds such as herons, lapwings and sandpipers.

All over the world Annelid population comprises of approximately 12,700 species belonging to 1,470 genera and 128 families in the world out of which as many as 840 species under 312 genera and 80 families, forming 6.6% of the global annelid species occur in India. The aquatic oligochaete fauna is poorly known in India and most of the species are recorded from littoral zones of small freshwater bodies (Julka, 1998). In present study, three species of earthworms and one species of leech have been recorded from the loose and moist soil of the riparian zone of River Vishwamitri. It is well known that earthworms are economically important since they help in increasing aeration and maintain the fertility of the soil. They also form the food material for various birds and animals. Thus constituting an important link in the foodchain.

Insects form the predominant group of terrestrial invertebrates in riparian zone of River Vishwamitri. Fifty one species of insects (figure 1.1) have been recorded, most of which are terrestrial. However, some species such as *Cybisters* sp., *Gerris spinole, Hydrometra vittata, Ranatra* sp., etc. which are aquatic, were also recorded. Many terrestrial insects have their larval stages in water. Thus larval stages of insects such as mayflies, mosquitoes etc. were also found from the water samples. The success of insects lies in their ability to adapt themselves to a wide range of conditions. Insects play an important role in the food link and occupy the third trophic level in the food web.

Spiders are the second largest group (figure 1.1) of invertebrates recorded in the riparian zone. Fourteen species of spiders belonging to five families were encountered in the present study. The probable reasons for this diversity in riparian zone could be the presence of diverse microhabitats present in the riparian zone. Small depressions on the wet ground provides hiding place to the ground dwellers (both ground hunters and ground weavers), whereas vegetation around the banks provides enough space for the weavers to snare their webs for catching their prey and also provides hunting grounds to the foliage hunters. Since the insect population in the study area was also high, the availability of large prey base could be one of the reasons for the survival of this spider community in the riparian zone

In the aquatic zone, crustaceans, form one of the major group of Arthropods. Global estimates of crustacean species diversity vary between 35,000 and 36,000. In India 2934 species have so far been reported representing about 8.2% of the total global crustacean species. This diversity is mainly contributed by marine crustaceans (94.85%). The work in India has been mainly concentrated on freshwater crustaceans (Venkatraman and Krishanmoorthy, 1998). In the present study one species of ostracod, two species of copepods and nine species of cladocerans belonging to four different families were identified as part of the zooplankton.

A total of 62 fishes have been recorded from the freshwaters of Baroda (Ranade, 1952). However, the fish diversity of the river Vishwamitri is very low. The two species that have been recorded were found in the upper half of the river. The reason the lower stretches of the river do not support any fish life could be attributed to the fact that the values of dissolved oxygen are very low. It is well known that levels of dissolved oxygen below 4-5 milligrams per liter affect fish health and levels below 2 milligrams per liter can be lethal to fish. As dissolved oxygen levels in water drop below 5.0 mg/L, aquatic life is put under stress. The lower the concentration, the greater the stress. Oxygen levels that remain below 1-2 mg/L for a few hours can result in large fish kills. This could be the reason for very low fish diversity in the river.

A total of five amphibian species (figure 1.2) belonging to families Ranidae and Bufonidae were found in the study area. The obligate dependence on water and moist surroundings has led a large number of anurans to inhabit this area, which is an ideal habitat for anurans, as it provides practically everything that an anuran needs for its survival.

Ten species of reptiles were recorded in the riparian zone of River Vishwamitri. These included four species of snakes and five species of lizards. Crocodiles were also recorded from the river during the present study. Though the river does not support a healthy population of fish a good number of crocodiles have been recorded. And a majority of these have been recorded from the middle stretch of the river where biotic interference is maximum. A preliminary observation has revealed that the crocodiles mostly depend on the stray dogs, pigs and the cattle for its source of food. It is believed that when the Vishwamitri River, was in spate in 1995, some of the crocodiles, which were present in the Ajwa reservoir, were swept into the river and since then have been surviving there.

The river and the riparian zone together support a good diversity of bird species. A total of seventy-seven bird species have been recorded during the present investigation. These belonged to thirty different families, thus constituting the largest group of vertebrates. Family Muscicapidae was the largest avian family with a total of eleven species. The members of this family are mostly terrestrial. The second largest family was Charadriidae with a total of nine species and most of them being waders. Majority of the bird species recorded in the present study are resident, however, a few species of migratory birds such as the wagtails, Rosy pastor, sandpipers, snipes etc. were also seen.

A few mammalian species were recorded during the present study. Eight species belonging to six different families were found (figure 1.2).

FIGURE 1. 1 Composition of major invertebrate groups recorded from the study area.

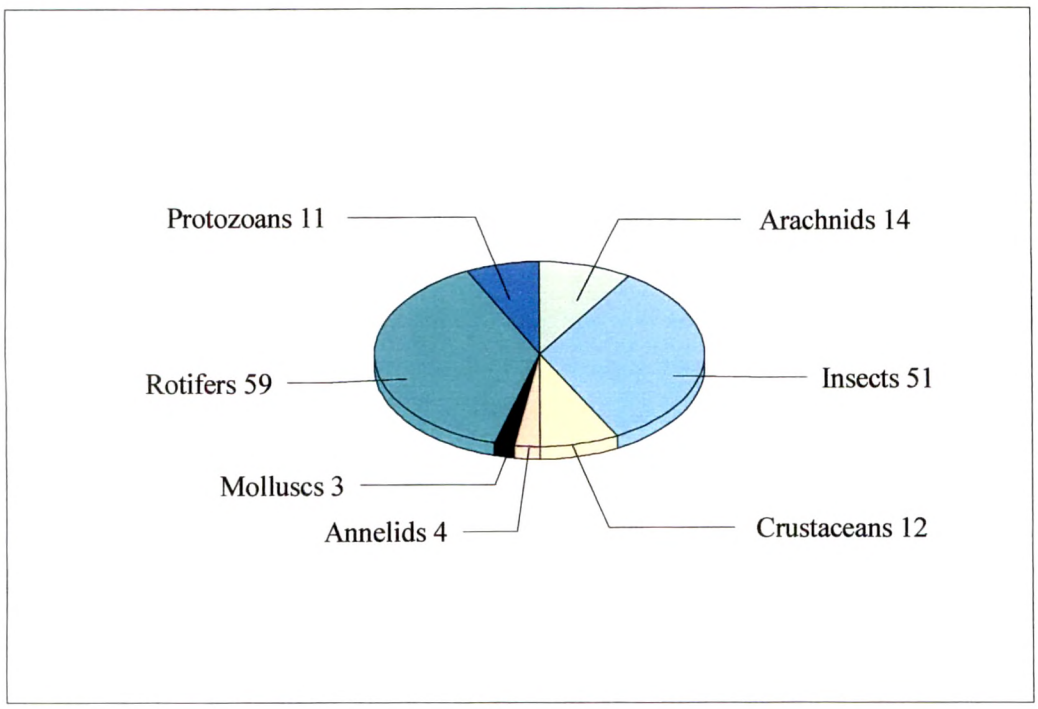

FIGURE 1. 2 Composition of major vertebrate groups recorded from the study area.