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The Krishna River System Bioresources Study



K. C. JAYARAM

ZOOLOGICAL SURVEY OF INDIA
1995

**RECORDS
OF THE
ZOOLOGICAL SURVEY OF INDIA**

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**THE KRISHNA RIVER SYSTEM :
A BIORESOURCES STUDY**

by

K. C. JAYARAM

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1994*

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**"ALL THE RIVERS ARE SACRED
ALL FLOW TOWARDS THE SEA
ALL ARE LIKE MOTHERS TO THE WORLD
ALL PURGE AWAY SINS "**

- MARKANDEYA PURANA LVII, 30

1. INTRODUCTION

1.1. Rivers of India

From the days of the Vedas many of India's rivers have become sacred in the eyes of the people associated as they are with religious shrines and hermitages adorning their banks, bearing mute testimony to fallen empires and kingdoms and growing cities and civilization. The most ancient Aryandom has been described in the Rig Veda (X. 75.4) as the sacred land watered by the seven *Sindhus (Sapta-Sindhavah)* namely the five rivers of the Punjab together with the Sindhu (=Indus) and another either the Saraswati or the Kabul or the Oxus. Later when Aryandom spread over the whole of India it came to be represented by the seven rivers, Ganga, Yamuna, Godavari, Saraswati, Narmada, Sindhu and Cauvery. The origins of all rivers were correctly surmized as from the prominent parts of the mountains.

The river waters were also generally characterized as being transparent, light, stimulating, tasteful, appetizing, sweet and lukewarm.

Thus interest in India's river system is not of recent origin and the large population of the country depend solely on the river waters for their existence. The river is a primary input into most measures that go towards improving the living conditions and standards of human society. Towards this end the river waters are harnessed for purposes of irrigation, domestic and industrial water supply, hydel generation, navigation, besides aquaculture.

1.2 Resume of River Basin studies in India

In recent years river basin studies in India have been undertaken for several aspects. Rapid industrialization and urbanisation since Independence have made much inroads into the riverine habitats and have threatened with consequences of degradation of their quality and content. Many workers have studied pollution as affecting the Indian rivers Chakraborty *et al.* (1959), Chacko *et al.* (1953), David (1957), Pahwa and Mehrotra (1966), Venkateswarlu (1969) and more recently Chaturvedi (1985), Reddy and Venkateswarlu (1985, 1987), Pandey (1985), Singh (1985), Sangu and Sharma (1985), Chattopadhyay *et al.* (1987), Rao and Rao (1987).

Mostly, these studies have been confined to either physico-chemical parameters, or algae and other biological aspects. Tiwari and Mishra (1985), Chandra (1985) discussed in general, water quality of Indian rivers and impact of river pollution on fisheries. In particular to Krishna river system the studies of Kongovi *et al.* (1987), Ravish and Subramanian (1988), Joshi and Sukumaran (1988), Reddy *et al.* (1988) are valuable. The Central Water Pollution Control Board has published (1990) a State-of-Art of the river in its series River basin Sub-basin Study (ADSORBS No.21). No comprehensive account of this river system in its entirety with a taxonomic account of fin fish, shell fish and water quality has been published till now.

The first comprehensive publication to deal exclusively with fishes of any Indian river system as a whole is that of Francis Hamilton (1822) who described 269 species

of fishes found in the Ganga and its tributaries and illustrated 97 of them. Such a monographic treatment of any other Indian river system did not come out for another hundred and fifty years or more. David (1963) published his investigations on the fish and fisheries of the Godavari and the Krishna river systems and listed 131 species of fish as occurring in River Krishna. His survey, however, was confined only to the middle and lower reaches of the river in Andhra Pradesh. A limnological survey of the Cauvery's lower reaches was made by Sreenivasan (1979). The next comprehensive survey was of the entire Kaveri system published by Jayaram *et al.* (1982). However, piece meal studies of river stretches not in their entirety have been made by some workers both of North and South Indian rivers and areas drained by them. Thus taking the Gangetic river system, Hora (1938) reported on some fish species collected at Sakrigali ghat, Ganga; Menon (1949) on Kosi; Hora (1949) on Rihand in U.P., David (1954) on Hooghly; Motwani and David (1957) on Sone, Bihar; Karamchandani (1962) on Ganga at Dighwara, Bihar; Husain and Tilak (1984) on Ghaghara and Tons in Faizabad District, U.P. The recent publication "The Ganga-A Scientific Study" (Krishna Mutri *et al.* 1991) is a compendium of the Integrated Research Programme on the Ganga carried out by several Universities and Post-Graduate Colleges in the Ganga Basin under Ganga Action Plan. Tilak (1971) reported on the fish fauna of River Tawi in Jammu and Kashmir for the first time. Some of the rivers draining eastern Doons and Kumaon Himalayas, U.P. were dealt with by Hora and Mukerji (1936) and Hora (1937) respectively. The Brahmaputra in Assam was investigated by Motwani, Jayaram and Shegal (1962) and the fish of Assam by Sen (1985); Hora's (1935, 1936) report on fish of Naga hills also pertain to the Brahmaputra drainage ultimately. Sen and Dey (1984) gave a good account of the distribution pattern of fishes found in the Brahmaputra and Barak. The Teesta fishes were dealt with by Jayaram and Singh (1977). The fish of Garo-Kashi hills embracing the present States of Meghalaya, Nagaland and Tripura were dealt with in a few publications by Hora (1921, 1923), Hora and Gupta (1941) and Barman (1988). Sharma and Tombi Singh (1984) reported on the fishes from the Taret river, Manipur.

In respect of South Indian rivers, as stated earlier, the treatise of Jayaram *et al.* (1982) and the limnological study of the Cauvery only in Tamil Nadu by Sreenivasan (1979) are noteworthy. The results of an Integrated Inter-institutional multifaceted Environmental Project on Cauvery sponsored by the Madras Science Foundation and funded by the Department of Environment, Government of India under the direction of the author is under publication elsewhere. Raj (1941) dealt with the Mettur Dam on the Cauvery and its fisheries; Hora (1937 a, 1942) dealt with the fishes of the then Mysore State and Coorg hills drained by the Cauvery. Rajan (1955, 1963) dealt with the fishes of Bhavani and of Pykara which are tributaries to Cauvery. Johnsingh and Vickram (1987) for the first time gave an account of the fishes of Mundanthurai wild life sanctuary, Tamil Nadu drained by rivers Manimutharu, Pambar, Tambaraparni etc.

In respect of Krishna, David's (1963) account is the only one which is of value. Earlier to David, Annandale (1921) reported on the fauna of certain streams in the then Bombay Presidency which included some fish species from Krishna headwaters

in Satara district. Bhimachar and Rao (1941) and Bhimachar (1942) dealing with the fishes of the then Mysore State referred to species found in the Tungabhadra drainage Fraser (1942), Hora and Misra (1942), Suter (1944) reported on fishes of Poona mainly from Mula Mutha river which joins the Bhima. Chacko and Kuriyan (1948) and David (1957) also studied the fishes of the Tungabhadra and Bhadra rivers respectively. Silas (1953) reported on collections made from Mahabaleshwar and Wai. Kulkarni (1952) described the new Schilbeid catfish *Neotropius khavalchor* from Krishna river near Islampur, Kolhapur district. Tonapi and Mulherkar (1963) reported sixty species of fish, many for the first time from Poona. Rossel (1964) reported on some Siluroid fish species found in Bhima. He described *Mystus maydelli* as new which is a juvenile of *Mystus malabaricus*. Tilak and Tiwari (1976) reported the total number of species from Poona as 112, but no locality records were given in their check list.

The most recent investigation on Krishna, somewhat holistic in approach was by a team of Shivaji University, Kolhapur (Anon, 1977) who conducted an expedition covering the entire river during 1975-76. It was mainly organized to survey the agricultural, geographical, archaeological, botanical and engineering aspects of the river and rivershed. The zoological aspects covered some notes on major fisheries and common species by their popular names only. No details as a systematic listing of species, fishing grounds, fishing technologies are given in the report. The botanical aspects highlighted crop pattern and the menace of Parthenium grass. Trivedy *et al.* (1989) investigated the utility of Benthic macroinvertebrates (Molluscs, Insect larvae, Tubifex) in six stations of Krishna as indicators of pollution. Baburao and Yazdani (1979) while discussing the larvicidal fishes for malaria control dealt with some species from Poona. Ghate and Wagh (1991) recently recorded *Macropodus cupanus* for the first time from Mutha Mula. More recently Ghate *et al.* (1992) gave an account of the fish fauna of rivers Mula and Mutha and have recorded 49 species in one year (1991-1992).

There have been references to fish fauna from areas nearby to Krishna system under the mistaken impression that they also contribute to the piscine wealth of the river. Thus Rahimullah's (1943, 1944) fish survey of Hyderabad State has been thought of as pertaining to Krishna. The author has stated very clearly that his survey is only of important reservoirs and tanks in Hyderabad State and Krishna or its tributaries in their fluvial condition has not been taken into consideration. As such these references should not be taken as relevant to Krishna fish fauna.

In respect of Godavari, David's (1963) account dealt with it also. Earlier, Hora and Mukherji (1935), Hora and Misra (1935, 1938), Fraser (1942), Hora and Misra (1942) dealt indirectly with the fish found in Godavari system, and in areas drained by it. Rao (1971, 1976) dealt exclusively with the Gobioids and Clupeoids of the Godavari estuary.

Mahanadi appears to have had a better look by investigators. Hora (1940) reported on the fish from the headwaters of Mahanadi. Job, David and Das (1955) investigated the Mahanadi stretches in Orissa in respect of its fishes whereas Jayaram and Majumdar (1976) did the same in relation to the Hirakud Dam then

under construction. The only account relating to Narmada is that of Hora and Nair (1941).

It is evident from the above that comprehensive studies on the fish faunal resources of our major river systems are sadly lacking.

With this background the present investigations on the Krishna river basin were undertaken having the following objectives:

1. A thorough assessment of the content and quality of the Bioresources (fin fish, shell fish and marginal, submerged aquatic plants only) of the entire Krishna river system.
2. Attempt to identify the pathogens and major pollutants of the riverine system.
3. Study the effect of certain fishing technologies adopted by the fishermen and their impact on the fish populations.
4. Investigate the ecological impact of exotic species introduced, if any.

2. METHODOLOGY

The following methodologies were adopted during the course of the investigation.

2.1 Sampling.

The entire river from its origin near Wai to its confluence with the Bay of Bengal was divided into four sectors based upon their physiographic features for operational convenience.

- | | | |
|--------|-----|-----------------------------------|
| Sector | I | Origin to Kurnool. |
| | II | Kurnool to Nagarjunasagar Dam. |
| | III | Nagarjunasagar Dam to Vijayawada. |
| | IV | Vijayawada to confluence. |

For survey purposes however, and for logistic reasons, two sectors were combined (I & II; III & IV). Each such combined sectors was surveyed twice, once during the postmonsoon period, and the other during the premonsoon period. A final mopping survey of I, II, and III sectors was also carried out. A six seater Standard Motor Van was hired and the various stations (85 in total) were surveyed; the esuarine areas beyond Nagayalanka was visited with the help of motor launch. The stations were selected on the advice and suggestions of the respective state fishery authorities and also on the basis of landings, availability of craft, gear and fishermen. Most of the stations were covered during early morning hours and few were covered both morning and late evening. Some actual spots of fishing like Babladi, Rekulampally, etc. to which the vehicles could not go, were reached by trekking from the nearest motorable point.

Fish collections were made by cast nets, gill nets and wherever possible by

purse seine like nets. Market sampling was also done but it was ensured that no tank fishes were obtained. Local names, fishing practices, catch statistics were obtained by enquiries from fishermen and officials.

All fishes were killed in 9% formaldehyde solution (commercial formalin 37 to 40%) and preserved. Colour, maturity condition etc. were noted in the field itself. In the case of molluscan shells, dead ones were washed and kept dry, while live ones were preserved in formalin. Shell fish as crustaceans were also preserved in formalin. Weights, wherever needed, were taken with the help of a spring balance. A boat was engaged for collecting water and plankton samples.

2.2 Physico-chemical Parameters

Physical:

1. Temperature-By centigrade mercury thermometer.
2. Turbidity - Sechi disc method.
3. pH - By pH indicator paper (Merck make range 5.5 to 9.0).
4. Velocity and water current By float method.
5. Other factors, as width, stretch, meteorological conditions were determined by visual estimation.
6. Depth was determined by the pole used by the boatmen engaged for taking water samples.

Chemical:

1. Dissolved oxygen By Winkler's method.
2. Free carbondioxide By phenolphthalein indicator method.
3. Alkalinity By using Phenolphthalein and methyl orange indicators.
4. Salinity was determined by argentometric method.

2.3 Biological:

Water sampling for plankton:

Samples of water were collected along the shore from middle of the river by towing the net for a measured distance and time and also by filtering a measured quantity of water through the net. 9000 cc of water was filtered through.

Plankton net was made of bolting silk standard grade No.21 xxx with 72 meshes per linear cm. The upper diameter of the net is 28 cm. and the lower diameter receiving the tube is 3 cm. The side length is 84 cm.

Plankton concentrate was preserved in 4% formalin.

Procedures prescribed in APHA Standard Methods, 16th Edition (1985) were followed.

2.4. Pathogens

These were estimated by Karad Science College, Karad and VIMTA Labs, Hyderabad on payment basis. Bacteria were isolated on nutrient agar broth. Water samples were collected in sterilised bottles kept air tight and transported in an ice box to these laboratories within 8 hours of collection.

2.5 Periods of Survey

SECTORS I & II Origin to Nagarjunasagar Postmonsoon period 5th Dec. 1987 to 10th Jan. 1988; Premonsoon period 2nd May 1988 to 6th June 1988.

SECTORS III & IV Nagarjunasagar to Confluence: Postmonsoon period 18th Dec. 1988 to 26th Dec. 1988; 16th Jan. 1990 to 25th Jan, 1990. Premonsoon period 26th June 1989 to July 1989.

SECTORS I, II & III Origin to Vijayawada (Final Mopping Survey) 3rd March 1990 to 20th March 1990.

2.6 PERSONNEL AND DURATION

Principal Investigator		Dr. K.C. Jayaram, D.Sc., F.N.A.Sc. 15.7.1987 to 31.8.1990
Junior Research Fellow: (Zoology)	i.	Shri. N.Bhaskaran, M.Sc., 15.7.1987 to 31.3.1988.
	ii.	Shri. J.Jeya Chandra Dhas, M.Sc., 19.4.1988 to 31.8.1990.
	iii	Shri R.T. Srithar, M.Sc. M.Phil., 21.11.1988 to 31.8.1990.
Junior Research Fellow: (Botany)	i.	Shri. P. Dwarakan, M.Sc., 15.4.1988 to 10.7.1989.
	ii	Shri. S. Rajasekar, M.Sc. M.Phil., 5.9.1989 to 13.7.1990.
Technical Assistant.	i	Shri.B.Hanumantha Rao, B.Sc., 1.9.1988 to 31.5.1990.
Field assistant.	i.	Shri. K. Ravi Kumar. 16.7.1987 to 31.9.1987.
	ii.	Shri B.H.Hanumantha Rao, B.Sc., 1.10.1987 to 31.8.1988.
	iii.	Shri C. Rajendran, M.A., 16.11.1988 to 31.8.1990.
Contingent Labour	i.	Smt. S. Chandrambal 18.7.1988 to 31.8.1990.

2.7. LIST OF SAMPLING STATIONS**

1. River Krishna at Ondishi village, 3km West of Dhom Reservoir, Satara District, Maharashtra State, 7.5.1988; 10.3.1990.
2. Dhom Reservoir on rivers Krishna and Vatali at Vihali village, 8 km West of Wai, Satara District, Maharashtra State, 3.1.1988; 7.5.1988; 9.3.1990.
3. River Krishna at Menavali village near Dhom Reservoir, 8 km West of Wai, Satara District, Maharashtra State, 2.1.1988.
4. Venna Lake at Mahabaleshwar, 53 km West of Wai, Satara District, Maharashtra State, 7.5.1988.
5. Fish Market at Wai, Satara District, Maharashtra State, 6.5.1988; 9.3.1990.
6. River Krishna at Wai, 50 km North of Satara, Satara District, Maharashtra State, 2.1.1988; 9.3.1990.
7. River Venna, a tributary of Rivers Krishna at Kanhera Village near Satara, Satara District, Maharashtra State, 1.1.1988.
8. River Krishna at Mahuli village, near Satara Railway Station, Satara District, Maharashtra State, 1.1.1988.
9. Satara Fish Market, Satara District, Maharashtra State, 1.1.1988; 5.5.1988.
10. River Tarali, a tributary of River Krishna at Umbraj, 32 km South-East of Satara, Satara District, Maharashtra State, 1.1.1988.
11. Koyana Reservoir, 60 km West of Karad, Satara District, Maharashtra State, 10.5.1988.
12. River Koyana at Koyana nagar, 60 km West of Karad, Satara District, Maharashtra State, 31.12.1987.
13. River Koyana at Patan, 37 km West of Karad, Satara District, Maharashtra State, 31.12.1987; 10.5.1988.
14. River Koyana at Marul village, 11 km from Koyana Dam, Satara District, Maharashtra State, 31.12.1987.
15. River Krishna at Rethere, K.H., 13 km from Karad, Satara District, Maharashtra State, 31.12.1987; 9.5.1988.
16. River Krishna at Pachwad, 3 km from Karad, Satara district, Maharashtra State, 31.12.1987.
17. River Krishna at its confluence with River Koyana at Karad, Satara District, Maharashtra State, 10.3.1990.
18. River Koyana before its confluence with River Krishna at Karad, Satara District, Maharashtra State, 10.3.1990.
19. Fish market at Umbraj, South-East of Karad, Satara District, Maharashtra State, 11.5.1988.

** In listing the sampling stations the course and direction of the river from its origin to confluence is taken and not the dates of visit.

20. Karad Fish Market, Satara District, Maharashtra State, 30.12.1987; 11.5.1988; 10.3.1990.
21. Miraj Fish Market, Sangli District, Maharashtra State, 29.12.1987.
22. Fish Market at Pandarpur, catch reported from River Bhima, Solapur District, Maharashtra State, 13.5.1988; 7.3.1990.
23. Fish Market at Sangli town, Sangli District, Maharashtra State, 14.5.1988; 6.3.1990.
24. River Krishna at Mahsal village, 25 km of Sangli, Sangli District, Maharashtra State, 16.5.1988.
25. River Krishna at Haripur ghat, Sangli town, Sangli District, Maharashtra State, 28.12.1987; 14.5.1988; 6.3.1990.
26. River Krishna at Digraj, 13 km south of Sangli town, Sangli District, Maharashtra State, 29.12.1987.
27. River Krishna at Haripur village, 5 km South of Sangli town, Sangli District, Maharashtra State, 28.12.1987; 15.5.1988; 7.3.1990.
28. River Krishna at Bhilwada, 22 km South-West of Sangli town, Sangli District, Maharashtra State, 28.12.1987; 15.5.1988.
29. River Panchaganga at Shivaji pool, Kolhapur, District, Maharashtra State, 6.3.1990.
30. River Ghataprabha below Hidkal dam, 49 km North-East of Belgaum, Belgaum District, Karnataka State, 4.5.1988.
31. River Ghataprabha, a tributary of River Krishna at Bagalkot town, Bijapur District, Karnataka State, 20.5.1988; 11.3.1990
32. Fish Market at Muddebihal, 60 kms. from Bijapur, Bijapur District, Karnataka State, 24.12.1987.
33. Fish market at Jamkhandi, Bijapur District, Karnataka State, 26.12.1987; 18.5.1988.
34. River Krishna at Babaladi, 20 km from Jamkhandi, Bijapur District, Karnataka State, 19.5.1988.
35. River Krishna at Rabkavi, 20 km South-West of Jamkhandi, Bijapur District, Karnataka State, 26.12.1987.
36. River Krishna at Sirguppe, 18 km South-West of Jamkhandi, Bijapur District, Karnataka State, 26.12.1987.
37. Reservoir at Rabkavi barrage at Rabkavi, 20 km South-West of Jamkhandi, Bijapur District, Karnataka State, 26.12.1987.
38. River Krishna at Tintini bridge at Tintini village, 15 km from Deodurg, Raichur District, Karnataka State, 22.12.1987; 21.5.1988.
39. River Krishna at Cinchodi village, 6 km from Jalahalli, Raichur District, Karnataka State, 21.5.1988.

40. River Krishna below Krishna road bridge at Krishna village, 20 km North of Raichur, Raichur District, Karnataka State, 21.12.1987; 25.5.1988.
41. River Krishna at Huvinahadagi village, 11 km from Deodurg, Raichur District, Karnataka State, 22.12.1987; 22.5.1988.
42. River Tungabhadra at Rajolibandha, 40 km south of Raichur, Raichur District, Karnataka State, 24.5.1988.
43. River Tungabhadra at Mantralayam, Kurnool District, Andhra Pradesh, 22.5.1988; 12.3.1990.
44. Fish Market, Gadwal, Mahabubnagar District, Andhra Pradesh, 16.12.1987; 27.5.1988. Catch from River Krishna.
45. Jamunaguda, an irrigation reservoir on River Krishna near Gadwal town, Mahabubnagar District, Andhra Pradesh, 18.12.1987.
46. River Krishna at Bireli village, 10 km from Gadwal, Mahabubnagar District, Andhra Pradesh, 29.5.1988.
47. River Krishna at Jurala dam, 13 km from Gadwal, Mahabubnagar District, Andhra Pradesh, 28.5.1988.
48. River Krishna at Krishna Agraharam, 6 km from Gadwal, Mahabubnagar District, Andhra Pradesh, 17.12.1987; 3.5.1988.
49. River Krishna at Dongadugundam, Rekulampalli village, 9 km from Gadwal, Mahabubnagar District, Andhra Pradesh, 17.12.1987; 28.5.1988.
50. River Krishna at Beechampally, 4 km from Pebbair, 22 km from Gadwal, Mahabubnagar District, Andhra Pradesh, 17.12.1987.
51. River Krishna at Lingalagattu, 8 km below Sunnipenta, Sri Sailam, down stream below the dam and reservoir, Kurnool District, Andhra Pradesh, 11.12.1987; 3.6.1988.
52. Fish market, Kurnool town, catch from River Tungabhadra and also from River Krishna at Nehrunagar, Mutchumari, Kurnool District, Andhra Pradesh, 13.16.12.1987; 31.5.1988; 14.3.1990.
53. River Tungabhadra at Nawab's Bungalow, Kurnool town, Kurnool District, Andhra Pradesh, 30.5.1988; 13.3.1990.
54. River Tungabhadra at Sunkasela, 27 km from Kurnool, Kurnool District, Andhra Pradesh, 31.5.1988.
55. Dindi reservoir on Dindi river, a tributary of River Krishna, Mahabubnagar District, Andhra Pradesh, 4.6.1988.
56. Nagarjunasagar, at Peddamungal, 128 km South East of Devarakonda, Nalgonda District, Andhra Pradesh, 9.12.1987.
57. Peddavagu river, 4 km South-West of Devarakonda, an affluent to the Nagarjuna Sagar, Nalgonda District, Andhra Pradesh, 8.12.1987.
58. Fish market at Devarakonda town, catch from Peddamungal, Nagarjuna Sagar, Nalgonda District, Andhra Pradesh, 8.12.1987.

59. Fish market at Pylon, catch from Nagarjuna Sagar at Kond Kona 10 km from Vijayapuri, Nalgonda District, Andhra Pradesh, 8.12.1987; 6.6.1988.
60. River Krishna at Ekonampet, downstream of Nagarjuna Sagar Dam, 5 km east of Vijayapuri South, Nalgonda District, Andhra Pradesh 7.12.1987; 28.6.1989.
61. River Krishna, Buggavagu reservoir on right bank canal of Nagarjunasagar, Nalgonda District, Andhra Pradesh, 7.12.1987; 20.12.1988; 26.6.1989.
62. River Krishna at Satrashala, 43 km from Macherla, 51 kms. downstream of Nagarjunasagar dam, Guntur District, Andhra Pradesh, 20.12.1988; 27.6.1989.
63. River Chandravahu at Macherla town, a tributary of River Krishna, Guntur District, Andhra Pradesh, 21.12.1988.
64. River Krishna at Pondugala, 13 km from Dacheppalle town, Guntur District, Andhra Pradesh, 21.12.1988; 1.7.1989.
65. River Krishna at Ramapuram, 21 km from Dacheppalle down, Guntur District, Andhra Pradesh, 22.12.1988; 30.6.1989.
66. River Krishna at Bhadrupalem, 13 km from Dacheppalle, 5 km downstream of Ramapuram, Guntur District, Andhra Pradesh, 22.12.1988.
67. River Krishna at Regulagudda, 41 km from Dacheppalle, Guntur District, Andhra Pradesh, 23.12.1988; 29.6.1989.
68. River Naguleru in Dacheppalle town, a tributary of River Krishna, Guntur District, Andhra Pradesh, 23.12.1988; 29.6.1989.
69. Bunder canal of river Krishna at Vijayawada town, Krishna District, Andhra Pradesh, 24.12.1988.
70. Madras canal or Western Main canal of River Krishna branching off at Sitanagaram, Krishna District, Andhra Pradesh, 1.7.1989; 17.1.1990.
71. Eluru canal near Muthyalpet in Vijayawada town, Krishna District, Andhra Pradesh, 18.1.1990.
72. Ryves canal at Karmegapuram, Vijayadawa town, Krishna District, Andhra Pradesh, 19.1.1990.
73. Fish Market at Two town, Vijayawada, Krishna District, Andhra Pradesh, 5.7.1989.; 19.1.1990; 19.3.1990.
74. River Krishna at Vidyadarapuram, Vijayawada town, Krishna District, Andhra Pradesh, 25.12.1988; 3.7.1989.
75. River Krishna at Ibrahimpatnam, 18 km West of Vijayawada on Vijayawada Hyderabad State Highway, Krishna District, Andhra Pradesh, 2.7.1989; 2.7.1990.
76. River Krishna below Kanakadurgamma bridge (Madras-Vijayawada by-pass bridge), Vijayawada town, Krishna District, Andhra Pradesh, 19.1.1990.
77. River Krishna below Prakasam barrage at Vijayawada, Krishna District, Andhra Pradesh, 2.7.1989; 18.1.1990.

78. River Krishna at Puligadda, 84 km east of Vijayawada, Krishna District, Andhra Pradesh, 4.7.1989.
79. River Krishna at Nagayalanka, 10 km South of Avanigudda, Krishna District, Andhra Pradesh, 4.7.1989; 21.1.1990.
80. River Krishna at Gullalamoda, Avanigudda taluk, Krishna District, Andhra Pradesh, 21.1.1990.
81. Edurumondi reservoir on the bank of River Krishna in Yesupuram Island, Avanigudda taluk, Krishna District, Andhra Pradesh, 22.1.1990.
82. River Krishna at Yesupuram, Avanigudda taluk, Krishna District, Andhra Pradesh, 22.1.1990.
83. River Krishna at Elichetlidibba, Guntur District, Andhra Pradesh, 22.1.1990.
84. Fish Market, Machilipatnam, Krishna District, Andhra Pradesh, 23.1.1990.
85. Gilakaladindi (Bundar canal estuary) landing centre at old port, Machilipatnam, Krishna District, Andhra Pradesh, 23.1.1990.

3. THE KRISHNA RIVER

Krishna (meaning the black), like the Godavari and Cauvery flows almost across southern India from West to East. Though the latter two rivers are venerated to a greater extent than Krishna, in respect of the area of its drainage including its two great tributaries the Bhima and the Thungabhadra, it is the largest of the three.

3.1 Geography

The river rises near Mahabaleshwar at Ondishi village near Wai (photos 1,2) at an elevation of 1372 m* from a water spring and about 64 km east of the Arabian Sea. It joins the Bay of Bengal after traversing a distance of 1349 km. Of these, 290 km is in Maharashtra, 483 km in Karnataka and 576 km in Andhra Pradesh. The mean annual discharge of water is 67305 million m³ and its drainage area is 2,68,786 sq.km. of which 26.8% lies in Maharashtra, 43.8% in Karnataka and 29.4% in Andhra Pradesh (Rao, 1979 and CWC). As is common with most Indian rivers its origin is shrouded in mystery. At Old Mahabaleshwar a temple is constructed where, from a closed area with a square tank in the centre, seven cement channels drain, each named Varna, Venna, Gayathri, Savithri, Koyana, Krishna and Bagirathi. The tank water is used for washing clothes and is dirty. No lead channels or spring feed any of these seven contributory pathways. As one travels along the bank of Krishna upstream, at near Ondishi the Sahayadri range of hills converge like a huge dish or a Basin (photo 2) on whose face the force of the SW monsoon lashes and strikes the catchment and consequent run-offs form the channel as Krishna. Further at Dhom reservoir (photos 3,4), the original course of the river is diverted (photos 5,6) to flow through a new channel which joins the natural one a few km downstream of the

*ADSORBS 21 on Krishna basin (1989-90) gives the morphometric features of the river as follows : Elevation 1337 m. Total distance traversed : in Maharashtra 280 km; in Karnataka 440 km; in Andhra Pradesh 720 km; Total 1440 km.

reservoir near Wai. Perhaps this may be the reason for the erroneous citation in many publications that the Krishna river's origin is at Wai.

The river traverses the districts of Satara, Sangli, Kolhapur in Maharashtra; Belgaum, Bijapur, Raichur in Karnataka and Mahabubnagar, Kurnool, Nalgonda, Guntur and Krishna in Andhra Pradesh. (Figs. 1 to 4)

The main tributaries which join River Krishna in the respective states are as follows:

IN MAHARASHTRA (Fig. 5)

- R. *Vatali* at Viahali and Asari villages, 8 km from Wai joins the Krishna to form the Dhom reservoir.
- R. *Venna* origin at Sahayadri range of hills joins Krishna at Satara.
- R. *Koyana* (155 km) origin from Sahayadri range of hills joins Krishna at Karad, Satara district.
- R. *Yerla* origin near about Mol, and joins Krishna near about Bhilwadi.
- R. *Varna* (66 km) origin at Sahayadri range of hills near about Sangameshwar and joins R. Krishna at Haripur, Sangli district.
- R. *Panchaganga* (144 km) origin at Sahayadri range of hills near about Vishalgarh and joins Krishna at Narsobawadi.

Other minor tributaries are Urmodi joining at Bargaon; Tarali, Mand at Umraj and Vasna at Tasgaon. Dudhganga along with Vedganga joins Krishna below Kurundwad.

IN KARNATAKA (Fig. 6)

- R. *Ghataprabha* origin at Western Ghats 283 km long and joins Krishna at Kuchisangam.
- R. *Malaprabha* (meaning "full of mud") similar to Ghataprabha, Origin at the eastern Sahayadri spurs, 306 kms and joins Krishna at 30 km upstream of Narayanpur Dam.
- R. *Tungabhadra* origin at Gangamula, as Tunga and Bhadra 531 km long and joins Krishna 70 km above Sri Sailam. Vedavati is one of the small tributaries.
- R. *Bhima* origin in Western ghats near about Bhimashankar (Maharashtra), 861 kms long, joins Krishna near Devarsugur (Raichur).
- R. *Don* is one of the many minor tributaries.

IN ANDHRA PRADESH (Fig. 7)

- R. *Dindi* origin near about Muhalgidda (Mahabubnagar District) and joins Nagarjunasagar through Dindi reservoir.
- R. *Muniyeru* (196 km) origin near about Mallampalli 235 km long and joins Krishna

near Nandigama.

R. Musi origin in small hills of Western ghat ranges, 240 km long and joins Krishna at Wazirabad, 40 km below Nagarjunasagar Dam.

Rivers Palleru, Peddavagu I, II, Hallia, are all minor tributaries. There are 48 large and small tributaries in Andhra Pradesh alone.

3.2. Geomorphological Features

Krishna provides an interesting example of fluvial geomorphology in the fact that in the course of its passage from the origin to confluence it exhibits all stages of life as youth, maturity and old age.

In Maharashtra the river course is considered to be in the first stage of erosion. From Mahabaleshwar to Wai, the river flows through deep valley, where vertical erosion is more, thus showing its youth stage. The valley it has created is V shaped. Near Mahuli, Satara district, it takes sharp turns within a very short distance, though the terrain is flat. At every turn severe erosion of the banks has taken place with deposition of silt. After Karad the river starts its meandering course as if it is a mature river and at some places the river bed is as wide as 2 metres as in Satara, Satara district. At Kolhapur the region is predominantly underlain by the gneissic rocks of the south, and by the rocks of Dharwar series on the western edge. Near its confluence with the Dudhganga the Krishna has an altitude of about 533 m and at this point it emerges from the heavy rainfall zone along the Western Ghats. A short distance below the junction of Malaprabha, the river drops from the table land of Deccan proper by about 122 m to the level lands of Raichur. Thus the river enters Karnataka expanding more, forming islands as in Babaladi, Regulagadda (A.P.). The river forms an island, circles it and thus OXBO-like lakes are formed abounding in fish life. This shows maturity in early youth stage of the river. After its confluence with Bhima it forms a common boundary of the States of Karnataka and Andhra Pradesh for a length of 42 km.

Below its confluence with Tungabhadra near Kurnool at Moravakonda, Mutchumari, Nandikotkur taluq, the Krishna runs in a deep gorge through a series of hills for nearly 290 km before emerging into the coastal belt at an elevation of 37 m above sea level. In this gorge lie Gadwal and Sri Sailam and upto Nagarjunasagar several natural rapids and waterfalls forming "Gundams" are present (see figure 8). Of this 290 km, about 100 km. downstream from Sri Sailam is always filled with the backlash of the Nagarjunasagar reservoir, which is a Reserve Forest area.

The bed slope of the river Krishna from its source to its confluence with Bhima at Devarsugur, Raichur district is 1.43 meter per km; and from Bhima confluence to the confluence to Tungabhadra 0.55 m per km, and from confluence of Tungabhadra to mouth of Krishna river 0.58 m per km. (Vij and Shenoy, 1968).

It may be stated here that division of the river into sectors I, II, III & IV for purposes of this survey was done on this basis only. I Origin to Kurnool. II. Kurnool to Nagarjunasagar. III. Nagarjunasagar to Vijayawada. IV Vijayawada to confluence.

The river turns sharply eastwards on reaching the hills of the Eastern ghats and flows for about 161 km between Krishna and Guntur districts before joining the Bay of Bengal. The rate of fall of its channel drops rapidly from an average of a meter to half and eventually as it nears the sea it is as little as 21 to 17 cm. From Prakasam Barrage to Bay of Bengal (Delta, 97 km) the slope is 1 in 3000 to 4000. It carries an enormous mass of silt and during flood time the quantity is sufficient to cover an area of 7.5 sq. km to a depth of 30 cm.

At Vijayawada the Krishna runs through a gap of 1170 meters in width in a low range of genissic hills. The Prakasam barrage is constructed across the river at Vijayawada and the flood velocity is about 10.4 cm per hour. Beyond Vijayawada the river continues as single channel of great width for another 64 km through rich fertile, alluvial delta and bends off to the left a branch at Puligadda, which continuing through Nagayalanka forms the island of Divi. After another run of 34 km from Nagayalanka, it joins the sea beyond Elichetlidiba. The main stream however continues from Puligadda on to the right for another 24 km and breaks up into three branches Hamsladevi, Gullalamoda and Lankevanidibba each separated from one another by two small islands having the above named villages on their banks and covered with jungle (Fig.9). These islands are often affected by high floods and cyclones.

The Krishna is navigable from the sea to about 40 kms upto Nagayalanka. From here upto Prakasam barrage navigation is routed through canals as Bunder, and above the barrage for about 35 km launches can ply.

3.3 Water Flow

As already stated the chief source of the waters of the Krishna is the 610 to 2134 m high hills of Sahayadri range of Western ghats which receive the very heavy SW monsoon rainfall during June to September. Krishna basin belongs to Group I which has an annual run off of more than 20,000 sq.km. catchment area. The maximum discharge of the river is 33,810 cumecs, and the minimum less than 3 cumecs. The total annual mean run off is 57.764 million cu.m. with the rate of flow of 243, 403 m³/km².(Rao, 1979).

The direction of the river flow (Fig.10) is mostly west to east as below :-

North- West to South-East

Krishna Agraharam, Gadwal, Mahabubnagar district, Andhra Pradesh.

North to South

Haripur, Sangli district, Maharashtra.

Babaladi, Bijapur district, Karnataka.

East to West

Satrashala, Pondugala, Guntur district, Andhra Pradesh.

3.4 Dams and barrages across Krishna

A dam or a barrage placed across a river obstructs immediately the free flow of the river and its smooth course. This artificial barrier changes the ecology of the river in the fact that the stored water above the obstruction has to change from a lotic to lentic habitat, with associated changes. For fish there can be no better obstacle than a dam and that too without any fish pass. Krishna river is no exception considering the irrigational and development needs of the area it drains. The various irrigation channels that have been taken out of the reservoir waters reduce habitat and species diversity by converting a natural environment replete with vegetation cover and food organisms into an artificial environment with few or none of these essential requirements for maintenance of fish population (for example the Madras canal of the Telugu Ganga project). Some of the major dams put up across the Krishna and its tributaries are as below.

DHOM DAM (photos 3,4,6). Wai taluq, Satara district, built across the Rivers Krishna and Vatali at Vihali, Asari villages, 8 km west of Wai town. It is an earthen dam in the main gorge and with masonry spillways. Total length 2392.7 m with a maximum height of 50 m. Gross storage is 13.37 T.M.C. and live storage 11.67 T.M.C. Main canal is 134.4 km long. For purpose of construction of the Dam the original course of the River Krishna has been blocked and the river diverted (photos 5,6) to flow through the reservoir sluice gates forming a new channel below. This new channel joins the original one a few km downstream of the reservoir near Wai.

KOYANA DAM (Satara district, Maharashtra). A gravity dam with the crest level of 650.30 m high 807.72 m long and with a capacity of 98.70 T.M.C. The water spread area is 115.35 sq. km and gross storage 98.68 T.M.C. Besides this a 61 m high gravity dam across Bolawadi stream and another 24.4 m high diversion dam across the Vaitarni have been constructed.

NARAYANPUR DAM across the Krishna river at Siddapur village, Muddebihal taluq, Bijapur district, Karnataka. The overflow dam of 459.0 m is of concrete and the non-overflow part of the dam is masonry; 1322.84 m and earthen 7911.64 m making the total length of the dam as 969.48 m, and the height of the dam is 29.72 m. Gross storage is 1.066 T.M.C. and the live storage 0.673 T.M.C.

ALMATTI DAM across the Krishna at Almatti village, Bagewadi taluq, Bijapur district. Of the total length of 1573 m 486.5 m is masonry and 405.0 m is earth. The height of the dam is 47.80 m. The gross storage is 6.43 T.M.C. and the live storage 6.09 T.M.C.

HIPPARGI barrage across the Krishna at Hippargi village, Jamkhandi taluq, Bijapur district. Of the total length of 5460.0 m masonry overflow part is 338.33 m, masonry non-overflow is 441.67 m, and earthen dam 4680.00 m. The gross storage is 7.62 T.M.C. and live storage is 5.82 T.M.C.

SRI SAILAM DAM (Kurnool district, Andhra Pradesh). A gravity dam on the Krishna in stone masonry and concrete measuring 158.5 m long at top, the top of

the dam being EL+30 m. The height above the deepest foundation is 10 m with the crust level as EL+28 m providing a gross storage capacity of 308 T.M.C., the water spreads to an area of 60 sq. km.

NAGARJUNASAGAR DAM (Nalgonda district, Andhra Pradesh). $16^{\circ}34^1N$ $79^{\circ}19^1E$ a deep ravine of 96 km long with abrupt margin at a slope of 45-60⁰ measuring 4863.196 m long, 111.86 m high with a non masonry overflow dam of 987.7 m comprising both right and left flanks. The left earthen dam is 2560.219 m in length and the right one 853.406 m. Gross storage is 399.75 T.M.C. The live storage is 231.73 T.M.C. Besides Krishna, seasonal rivers as Peddavagu, Uppuvagu (tributary of Peddavagu) and Dindi fall into the reservoir (Fig. 11).

Besides the above major dams, the following are also worthy to note.

On River Krishna : Jurala Dam being constructed near Gadwal, Mahabubnagar district, Andhra Pradesh. Prakasam Barage constructed across two hills 1153.66 m matter long, with a sloping back and 319 shutters each 3 m x 2 m. The crest of the anicut is masonry. A big reservoir of water is stored above the barrage with good fishing.

On River Bhima. Bhima Dam near Solapur, Maharashtra.

On River Tungabhadra. Sunkesela Anicut near Kurnool and Rajolibandha Anicut near Raichur.

On River Ghataprabha. Hidkal Dam near Belgaum, Karnataka.

On River Venna. Near Karad, Maharashtra.

On River Varna. Kanher dam near Satara.

On River Dindi. Near Devarakonda, Andhra Pradesh. A masonry dam in the river gorge portion 304.8 m long, the dam is 1511.2 m long. The gross storage is 2609 metric cubic feet.

4. PHYSICO-CHEMICAL PARAMETERS

4.1. Meteorological Conditions

The weather was throughout sunny excepting an overcast sky at Huvinahadagi, Rajolibandha, Krishna bridge at Devarsugur during May 1988. It was drizzling and raining at Macherla in Dec. 1988 and at Ibrahimpatnam in July 1989. Windy conditions were met with at Babaladi, Huvinahadagi, Rajolibandha, Krishna bridge at Devarsugur, at Sunkasula in May 1988, at Lingalagattu, Konda on Nagarjunasagar in June 1988, at Macherla, Ekonampet, Satrashala, Dachepalle in Dec. 1988 at Dachepalle, Regulagudda, Pondugala, Ibrahimpatnam in June-July 1989, at Vijayawada in Feb, 1988 and at Nagayalanka in July 1989.

4.2. Physical Factors

The data collected on various physical and chemical parameters in the premonsoon and postmonsoon periods are given in Tables 4.4 and 4.5 respectively. The water spread of the river varied from 50 to 60 meters at Wai to more than 1.2 km at Vijayawada. The water stretch actually flowing in the river varies from season to season, being as narrow or hardly 5 to 10 m at Wai or even less at Ondishi, to as wide as 1.5 km at Ibrahimpatanam, and about 2 km at Elichetlidibba.

The river bed is pebbly at the upper reaches, with boulderous granite rocks in most of the middle reaches and sandy only at the lower reaches after Pondugala. At Gadwal it cuts across granite rocks, and at Mantralayam, Ekonampet slabs of such stones are seen. The depth of the river varied to hardly a 30 cm at Wai, less at Ondishi to as much as 40 m at Nagarjunasagar. The direction of the river has been mostly west to east or south-east except at places listed elsewhere. The river water at most places was colourless, but at places like Wai, Haripur ghat, Sangli, Pandarpur, Mantralayam, due to pollution by pilgrims and other causes, the colour varied from brownish to turbid sandy colour. At these places the water was not of palatable taste and had an odour varying from decayed vegetable to an acrid acid.

Temperature

Air Temperature ranged more or less uniformly during the pre and post monsoon periods with some exceptions. Krishna at Karad showed a wide variation 24 to 35.5°C respectively. River Nagaleru at Dachepalle and R. Krishna at Vijayawada recorded 20°C during the pre and post monsoon periods respectively. It may be because of weather conditions on that day (27.6.89) at Dachepalle which was windy, otherwise the temperature ranged from 28.8°C to 40.0°C in premonsoon and 23.00C to 35.00C in postmonsoon periods respectively (Fig. 12).

Water temperature also followed the same pattern as air temperature. Krishna at Karad showed 21°C in the postmonsoon period, and at Vijayawada it was 15°C. Barring these, the water temperature ranged from 28.0°C to 33.0°C in premonsoon and 21.0°C to 32.5°C in postmonsoon periods respectively (Fig. 13)

Turbidity is manifest due to abundance of plankton or to the suspension of fine particles of silt. Domestic sewage and some type of industrial wastes commonly make waters more turbid. High turbidity screens out light, alters radiation and interfere with biological production. In the Krishna system we have very clean waters as at Lingalagattu, Sri Sailam to very turbid waters as at Wai, Malaprabha at Hidkal dam etc. the latter area is strewn with remnants of Dam boulders, stone chips, which due to long erosion add to the silt content of the water, the fish catch in these stations is indicative. *Mystus krishnensis* and other prized fish of A1 category were obtained at Lingalagattu whereas trash fish as *Danio* sp. *Chela* sp. were only obtained at Hidkal Dam.

The Zsd transparency at Lingalagattu was 160 cm at Hidkal Dam 15 cm at Wai 9 cm and at Buggavagu 714 cm.

Velocity ranged from 0.05 to 1.0 m per second. Krishna has more or less a slow to fast flow and nowhere it is very slow excepting at places where stagnation is caused (Fig.14). At Kurnool a velocity of more than a meter per second was recorded in premonsoon period on 30.5.1988 which was a windy day and an exception. Categorising the flow the stretches of the river system at certain places can be classified as shown in Table 4.6.

4.3. Chemical Factors

Dissolved Oxygen (DO) The highest concentrations of dissolved oxygen was recorded at Karad during premonsoon period of May 1987 (10.4mg/1) and the lowest 2.5 mg/1 at Haripur ghat, Sangli followed by Wai 3.0 mg/1, Pandarpur 3.4 mg/1 Mantralayam 3.2mg/1. It has already been stated that these centres are polluted; otherwise the Do ranged from 4.2 (Nagayalanka) to 8.1 (Babaladi). In the postmonsoon season, the highest was recorded at Wai (9.6 mg/1) and the lowest 0.28 mg/1 at Haripur ghat, Sangli. The time of collection may have somewhat influenced the concentration, otherwise the range was 4.36 (Nagayalanka) to 7.28 (Kurnool) (Fig.15).

Free Carbon-dioxide (CO₂)

As is the case in running waters, free CO₂ was only in traces, except at Haripur ghat, Sangli 5.3 mg/1 where the river is highly polluted (postmonsoon).

Carbonate alkalinity (CO₃)

During the premonsoon period, the maximum value was at Nagayalanka (27 mg/1) and the minimum 4 mg/1 at Haripur ghat, Sangli. During the postmonsoon season the maximum was in Ghataprabha at Bagalkot (20 mg/1) and the minimum 7 mg/1 in R. Naguleru at Dachepalle. The normal range was 4.0 to 27 in premonsoon and 7.0 to 20 in postmonsoon (Fig.16).

Bicarbonate alkalinity (HCO₃)

This was recorded from almost all stations. The maximum value of 424 mg/1, was at Dachepalle in the premonsoon of June 1989 due to the the influx of the municipal wastes and sewage. The minimum was 30 mg/1 in River Bhima at Pandarpur. In the postmonsoon period the maximum was 640 mg/1 at Haripur ghat, Sangli and the minimum 65 mg/1 at Karad, otherwise in premonsoon period the range was 30 to 381 mg/1 and in postmonsoon period 65 to 440 mg/1. The high and low profiles of the bicarbonate alkalinity during the two seasons are clear. (Fig. 17)

pH value

This has been more or less uniform ranging from 7 to 7.5 in the premonsoon and 7.0 in the postmonsoon period except at Karad where it was 6.0 on 31.12.1987.

Salinity

Salinity was determined from few stations beginning from Prakasam barrage, Vijayawada, Nagayalanka, Yesupuram and Elichetlidibba. As is to be expected it increased towards the sea. (Fig. 18)

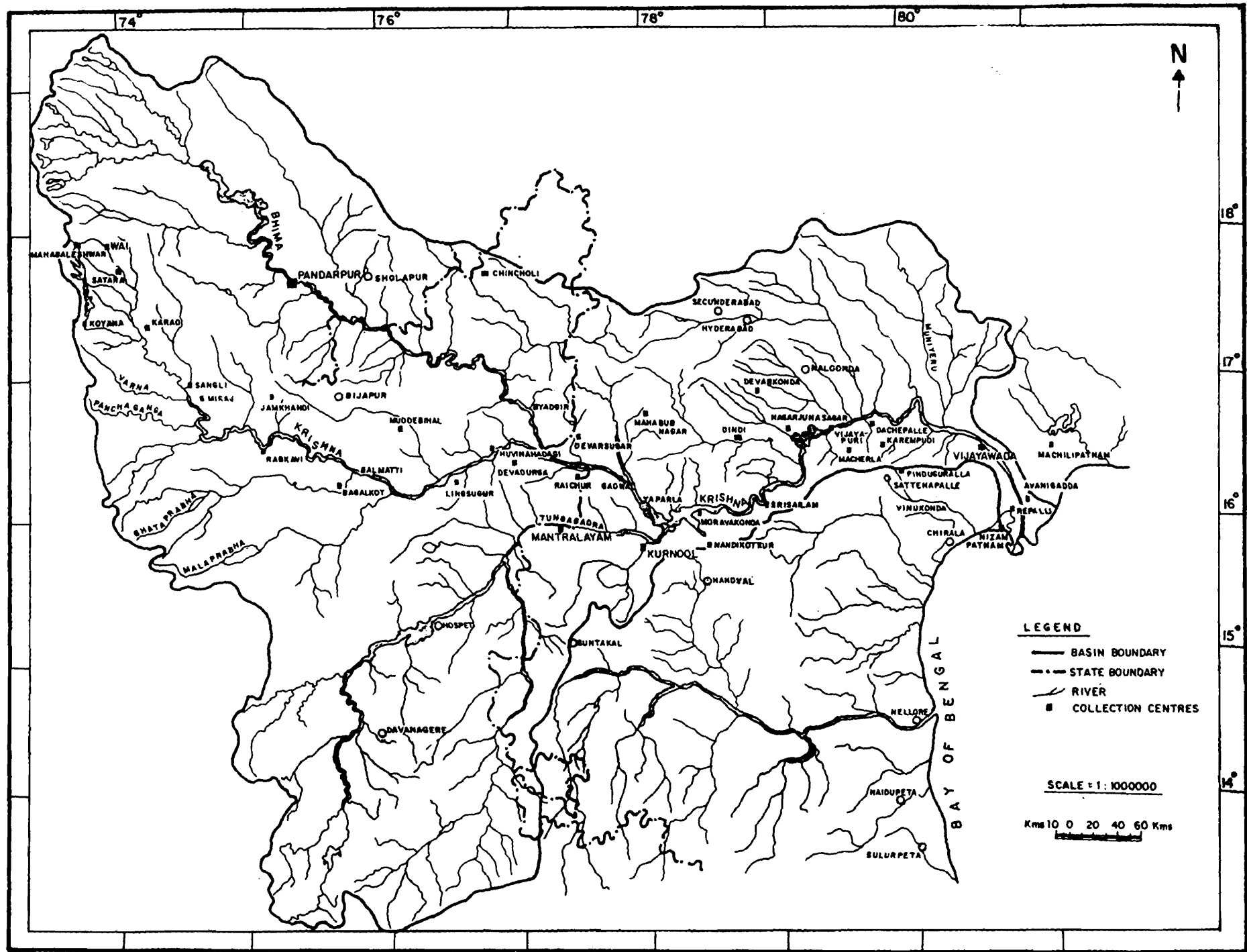


FIG.1 INDEX MAP OF KRISHNA BASIN

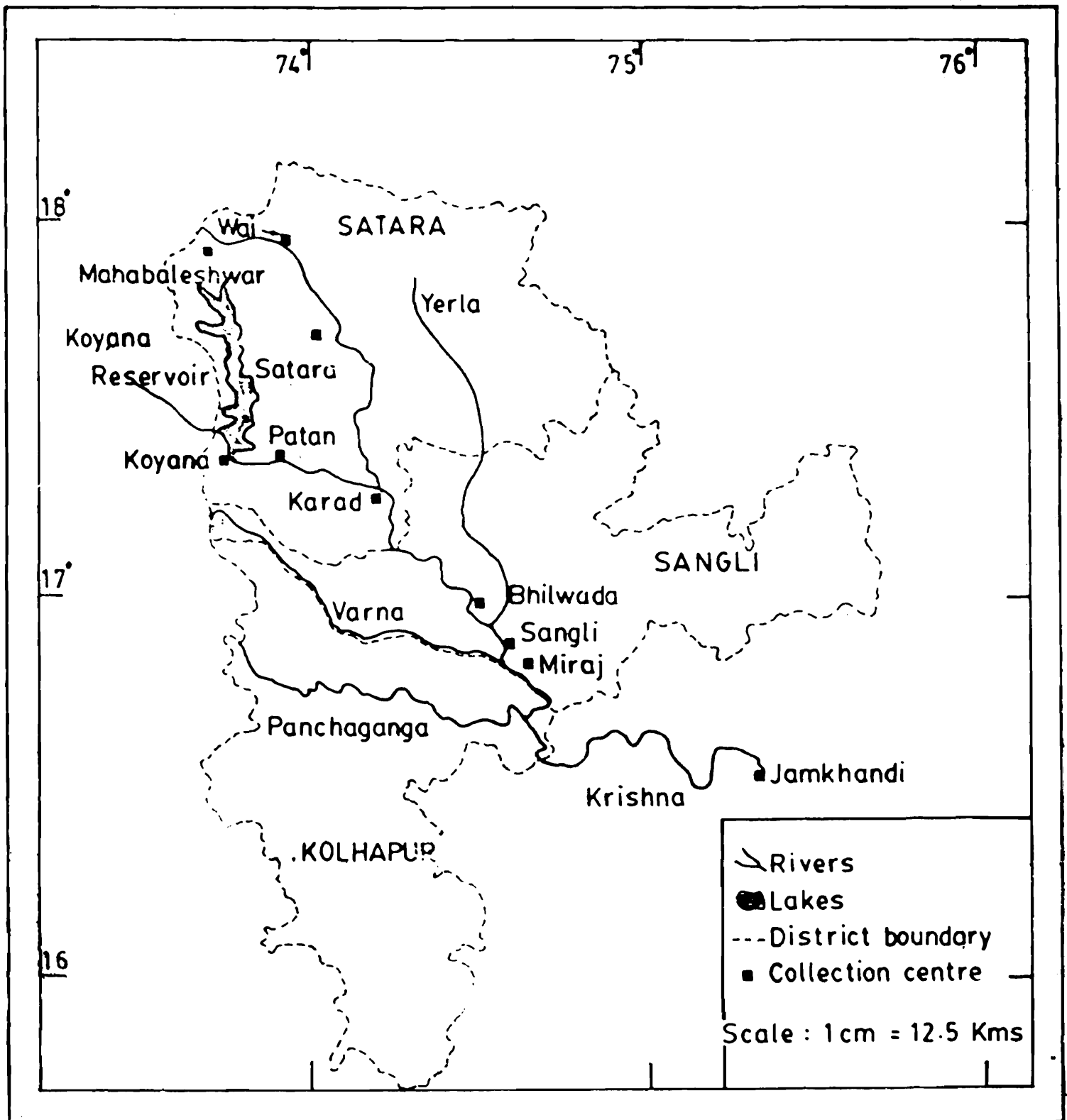


FIG 2 KRISHNA RIVER BASIN – MAHARASHTRA

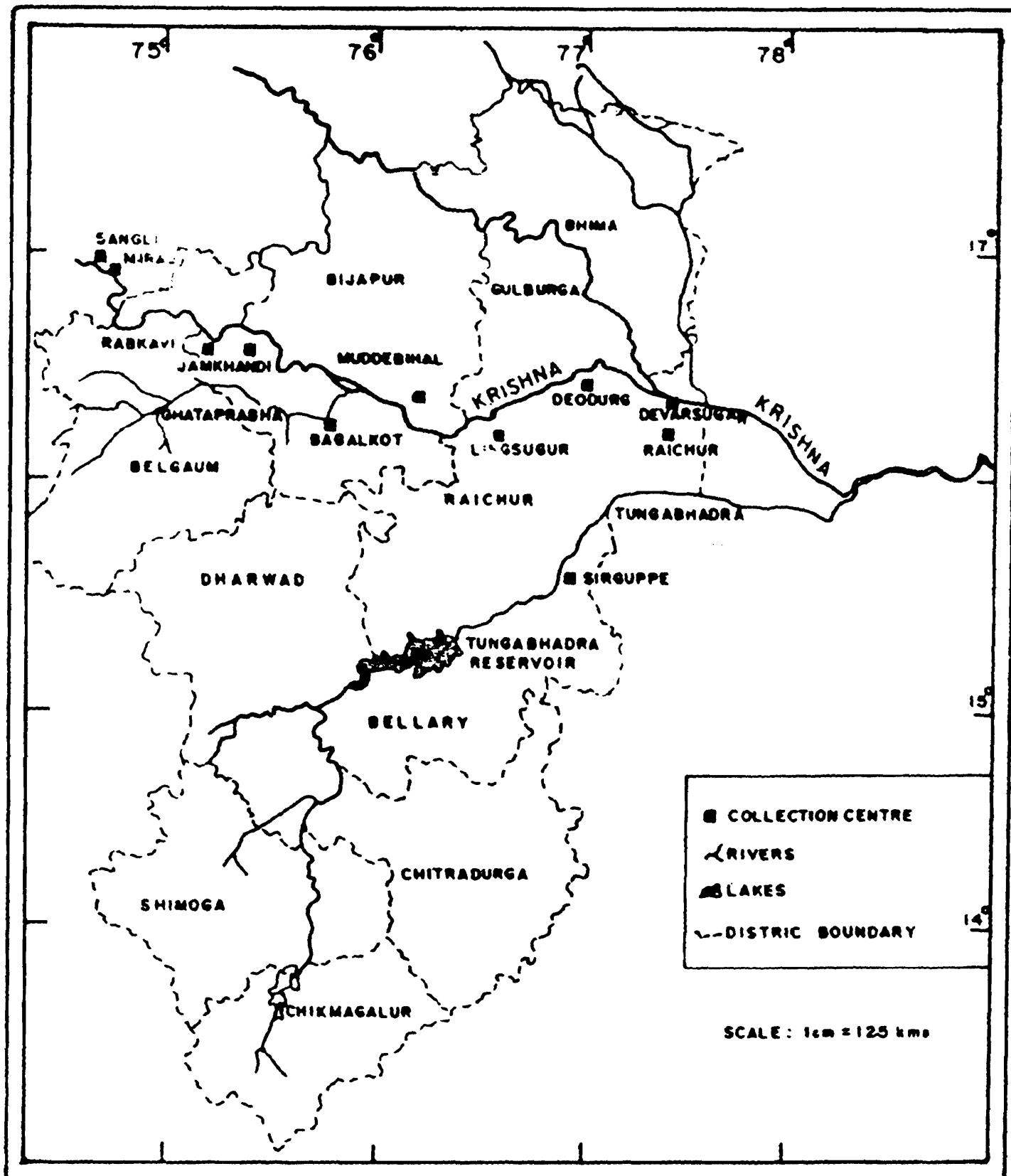


FIG. 3 KRISHNA RIVER BASIN- KARNATAKA

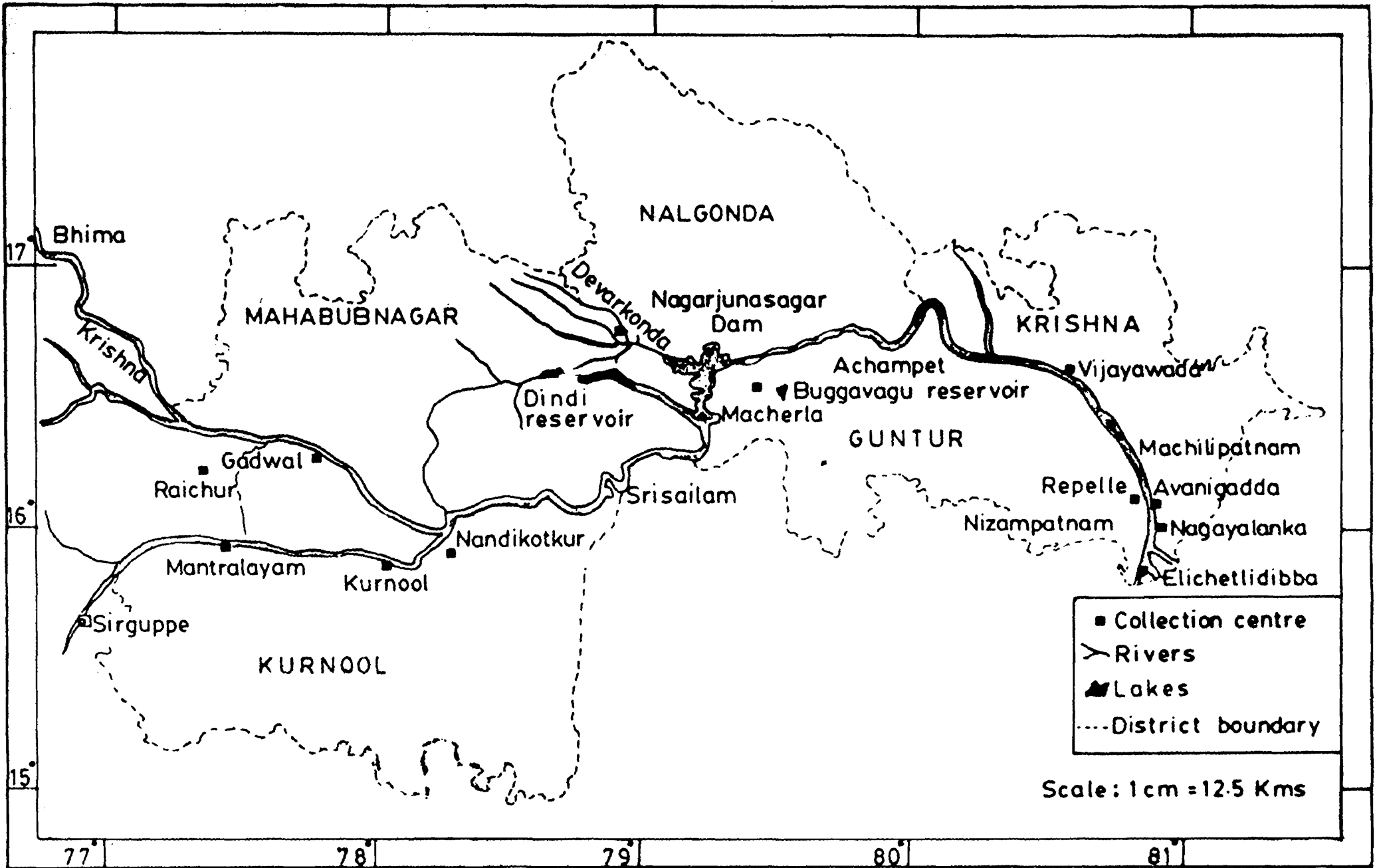


FIG 4 KRISHNA RIVER BASIN – ANDHRA PRADESH

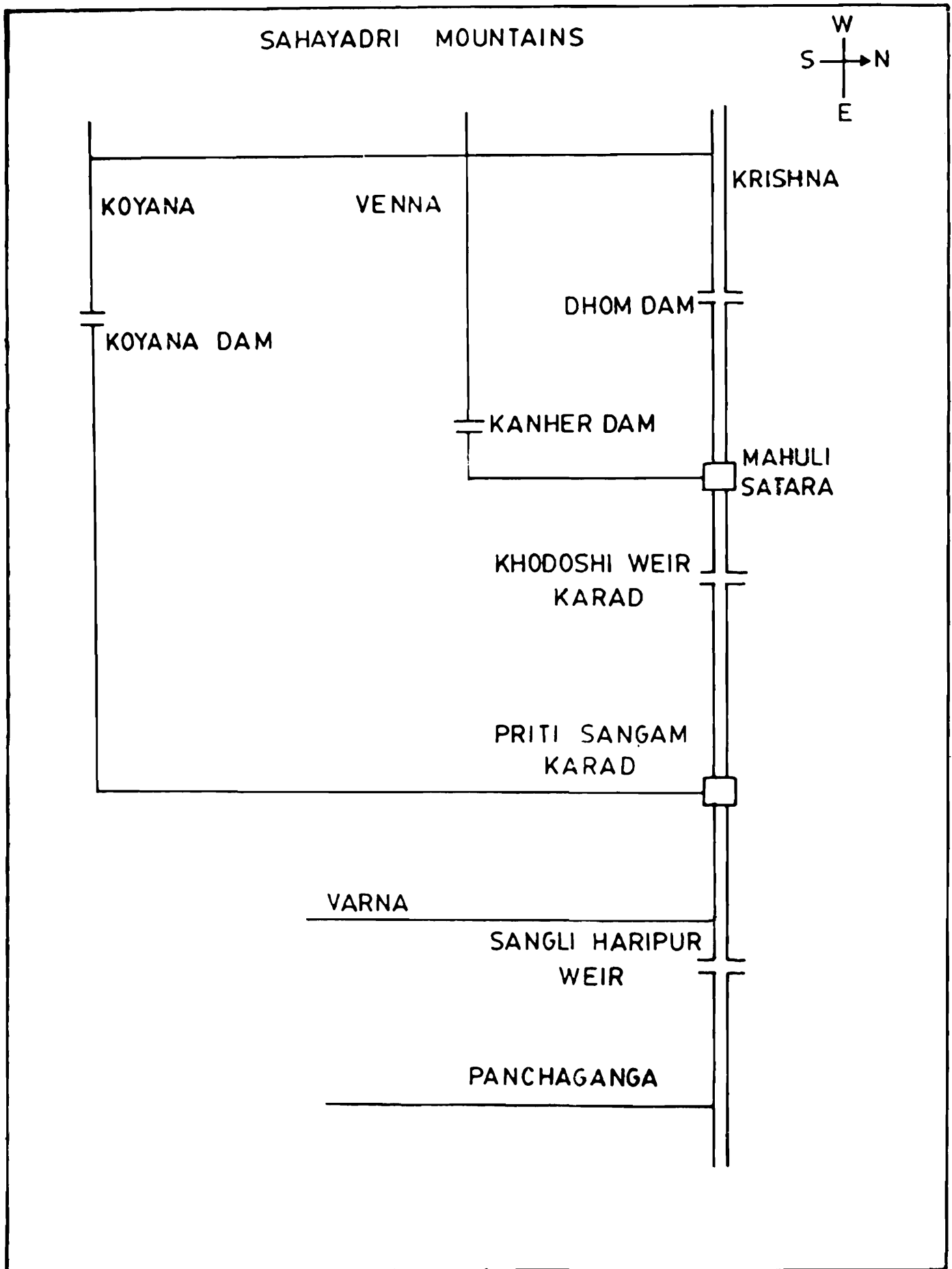


FIG 5 TREE DIAGRAM OF RIVER KRISHNA IN MAHARASHTRA

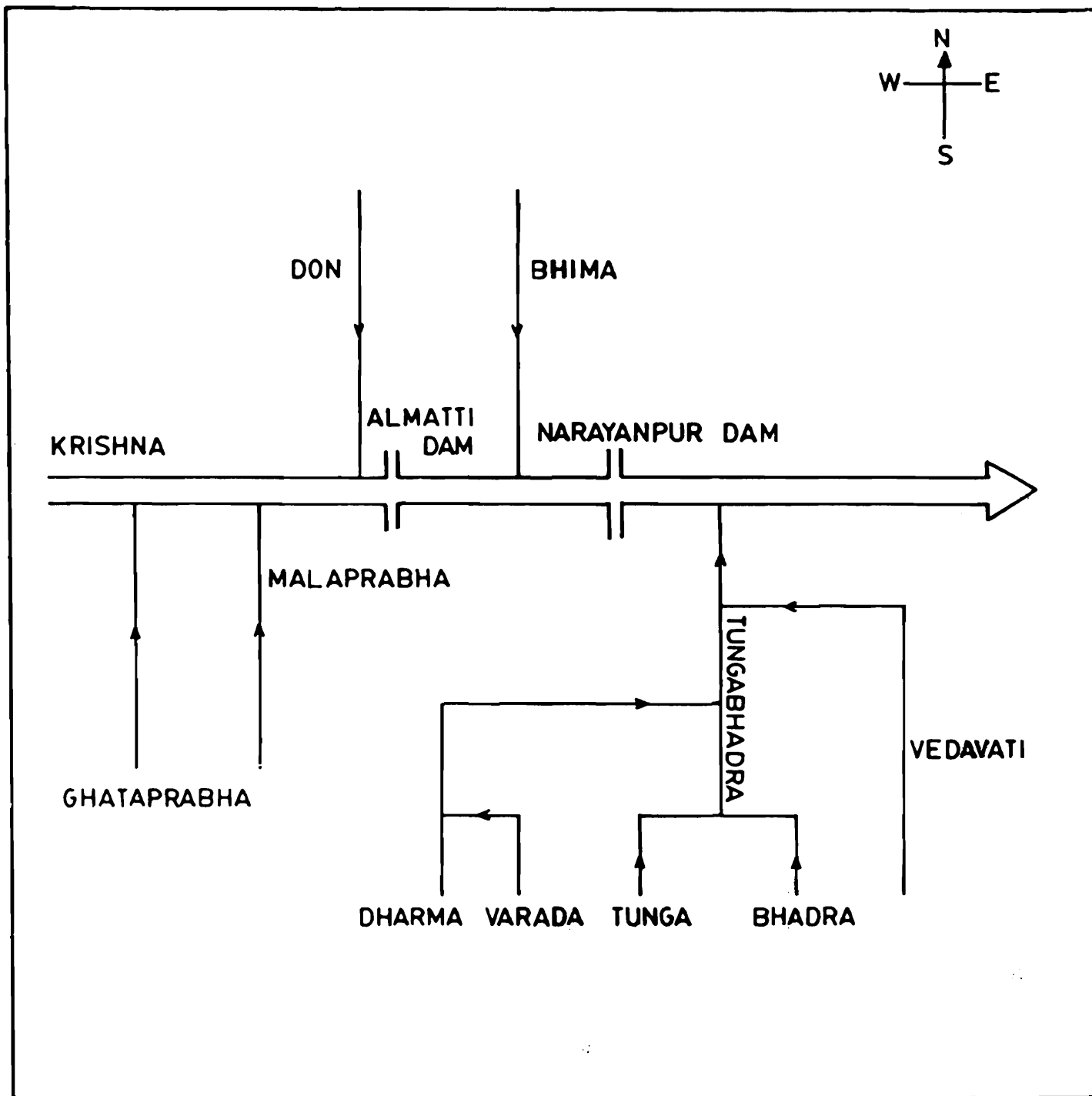


FIG.6 TREE DIAGRAM OF RIVER KRISHNA IN KARNATAKA

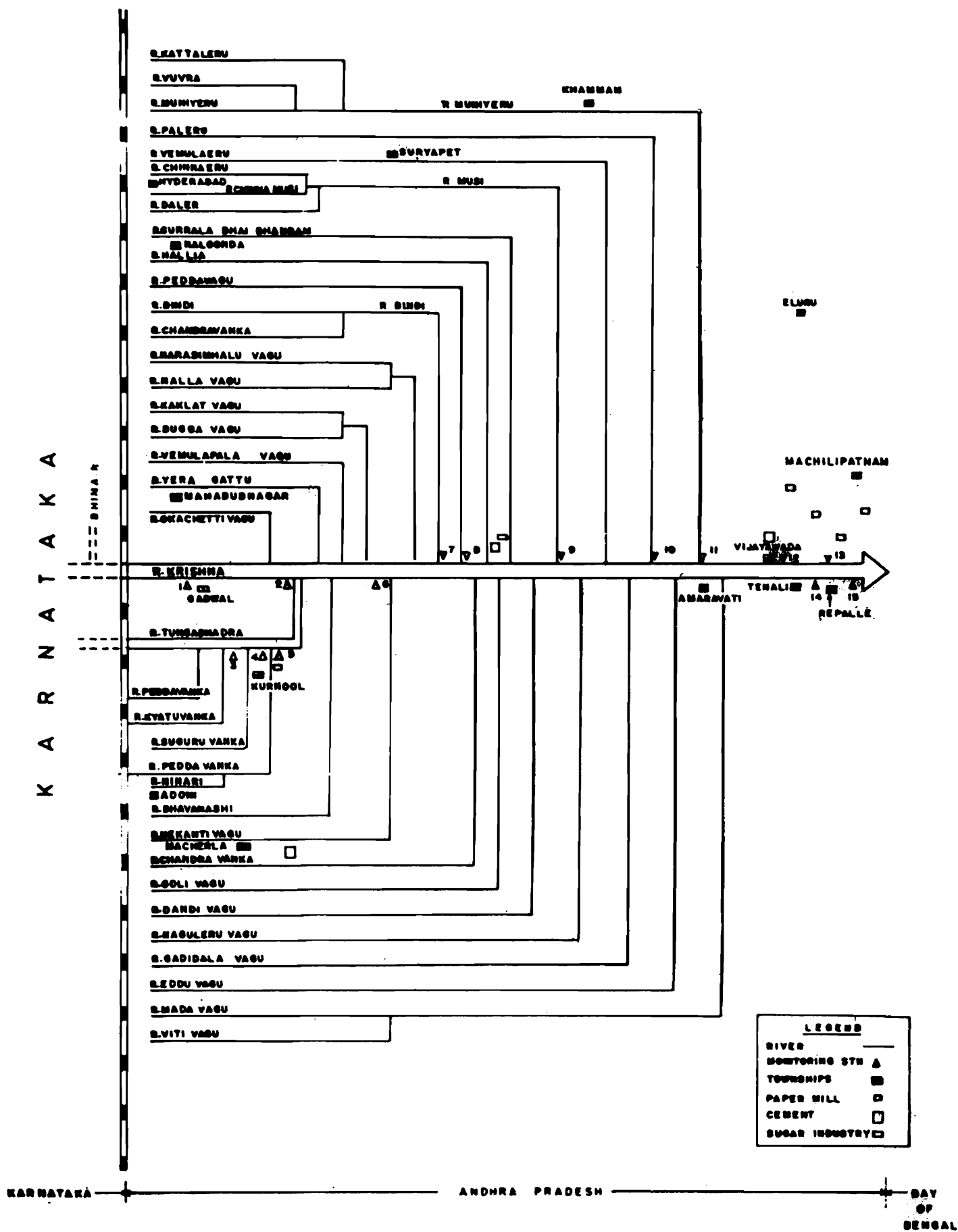


FIG.7 TREE DIAGRAM OF RIVER KRISHNA IN ANDHRA PRADESH

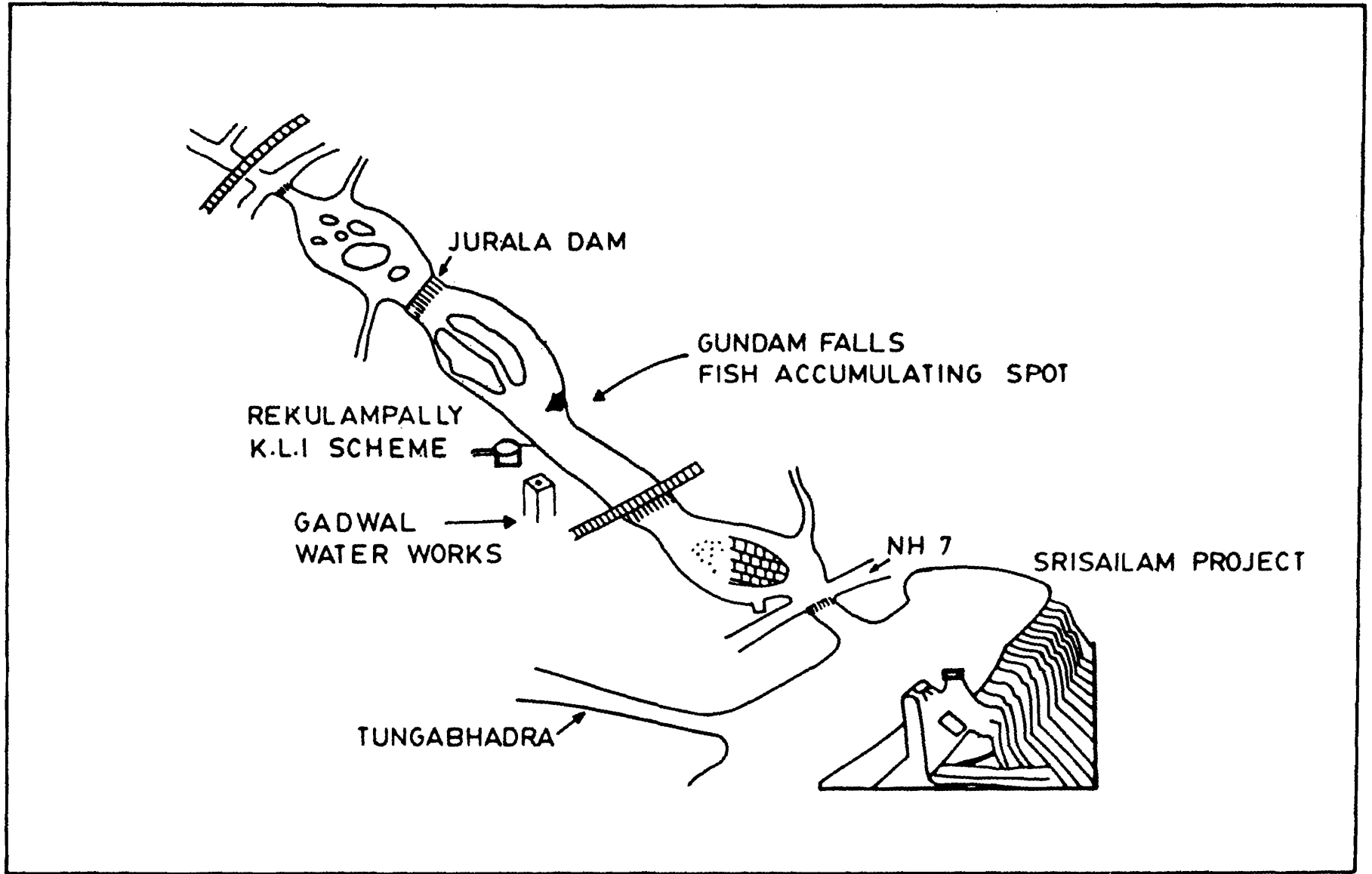


FIG 8 ECOSYSTEM OF RIVER KRISHNA IN MAHABUBNAGAR DISTRICT

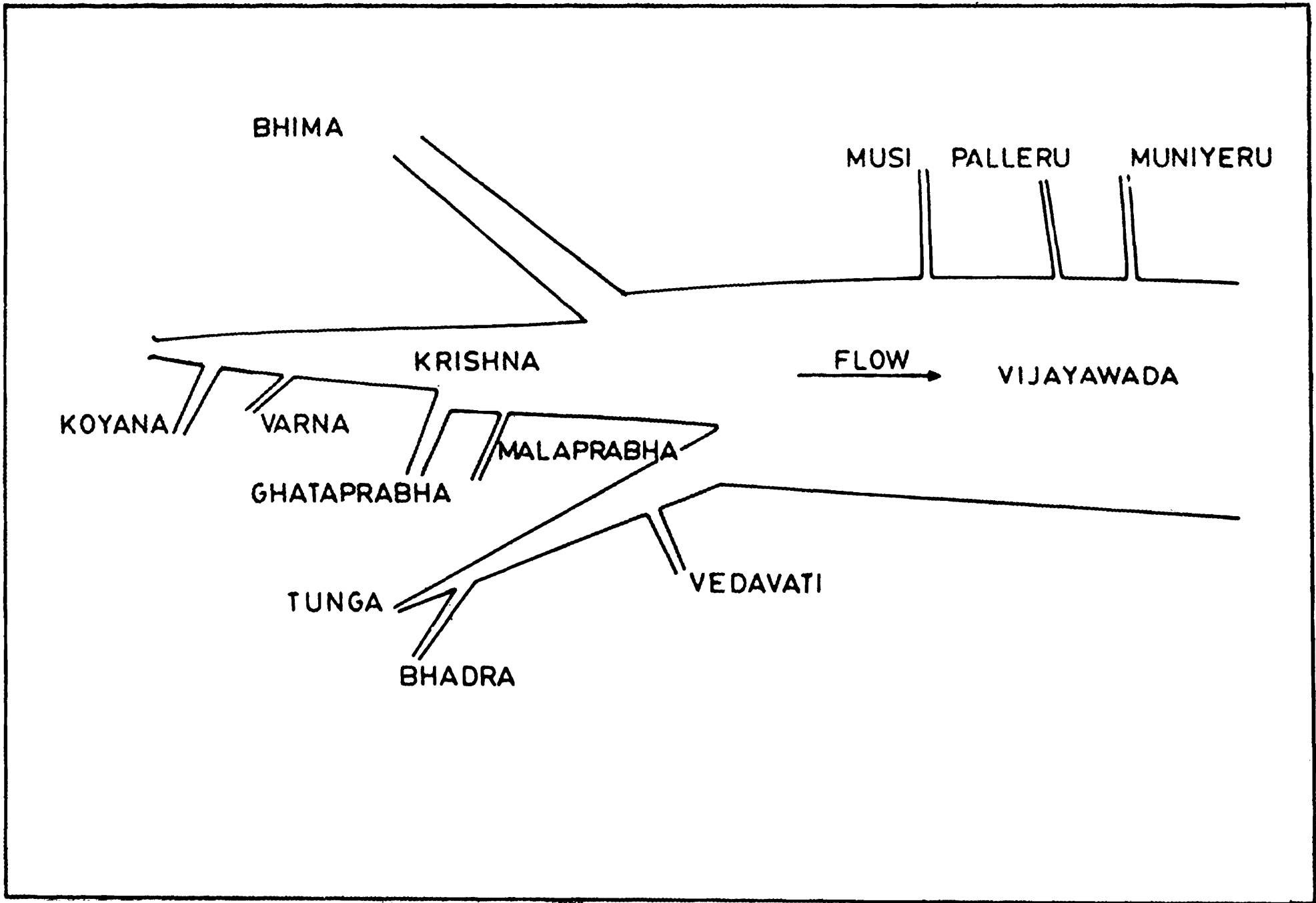


FIG.10 FLOW DIAGRAM OF THE KRISHNA

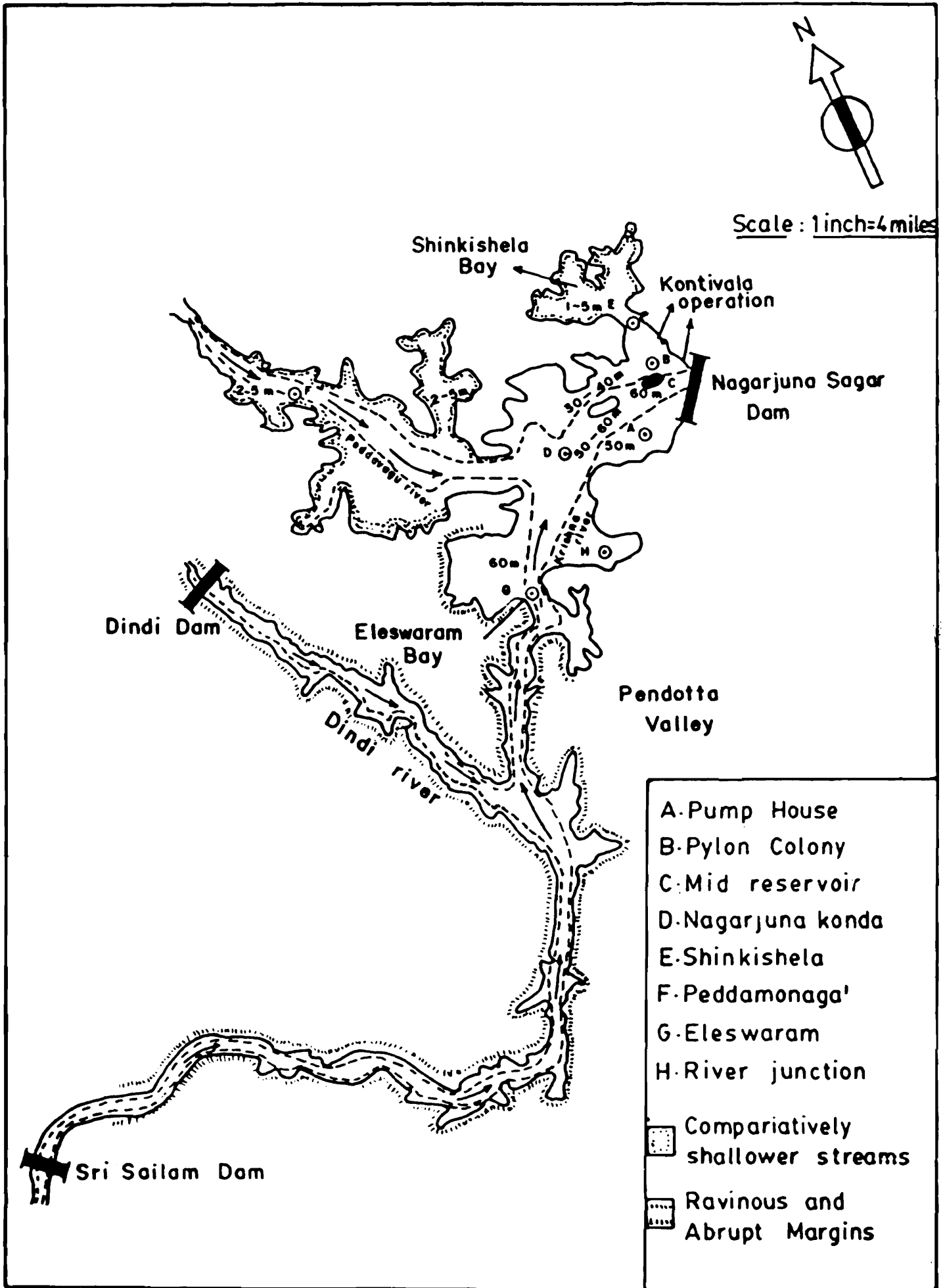


FIG. 11 NAGARJUNA SAGAR RESERVOIR

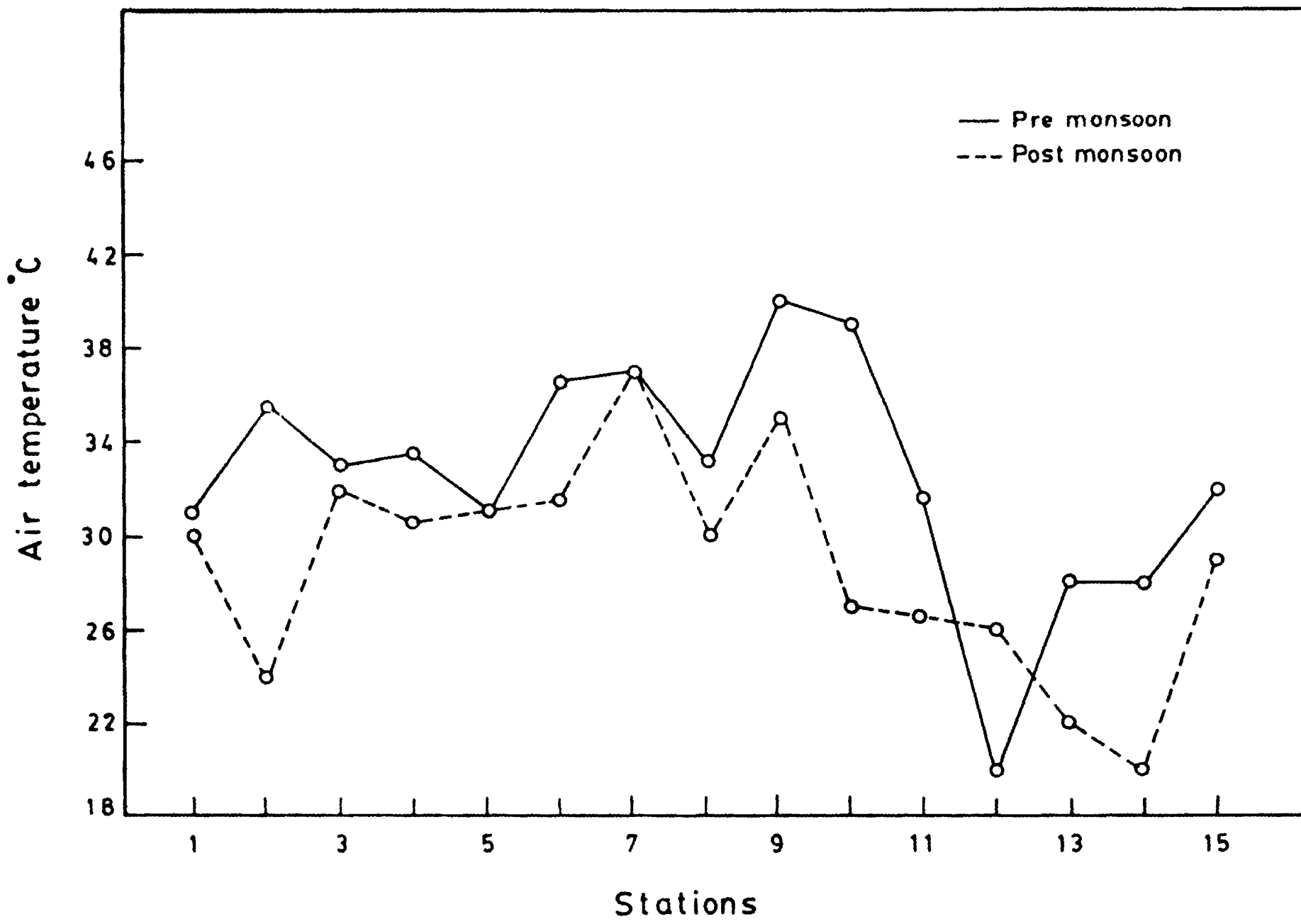


FIG.12 AIR TEMPERATURE RECORDED AT SELECTED STATIONS IN THE KRISHNA BASIN

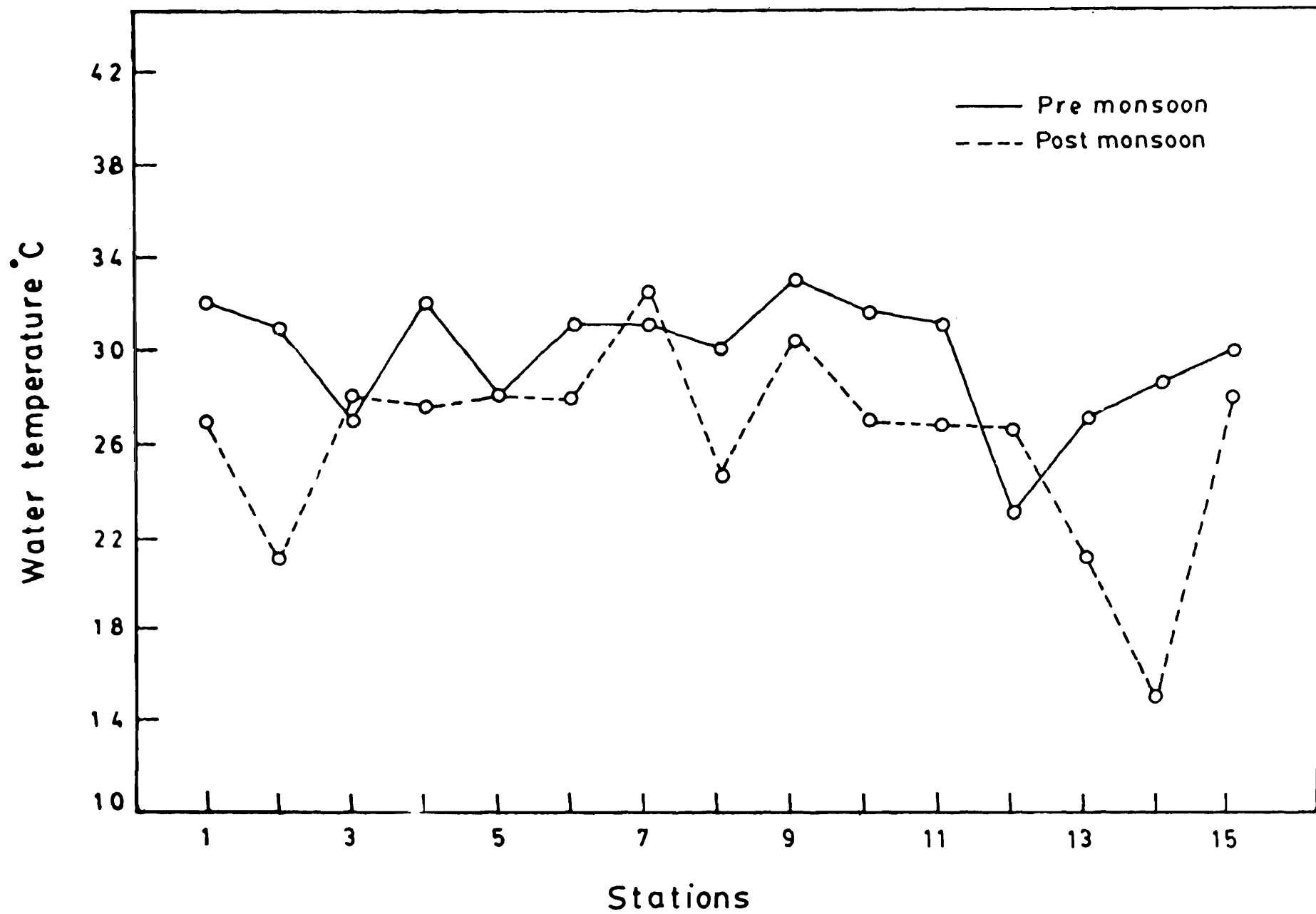


FIG.13 WATER TEMPERATURE RECORDED AT SELECTED STATIONS IN THE KRISHNA BASIN

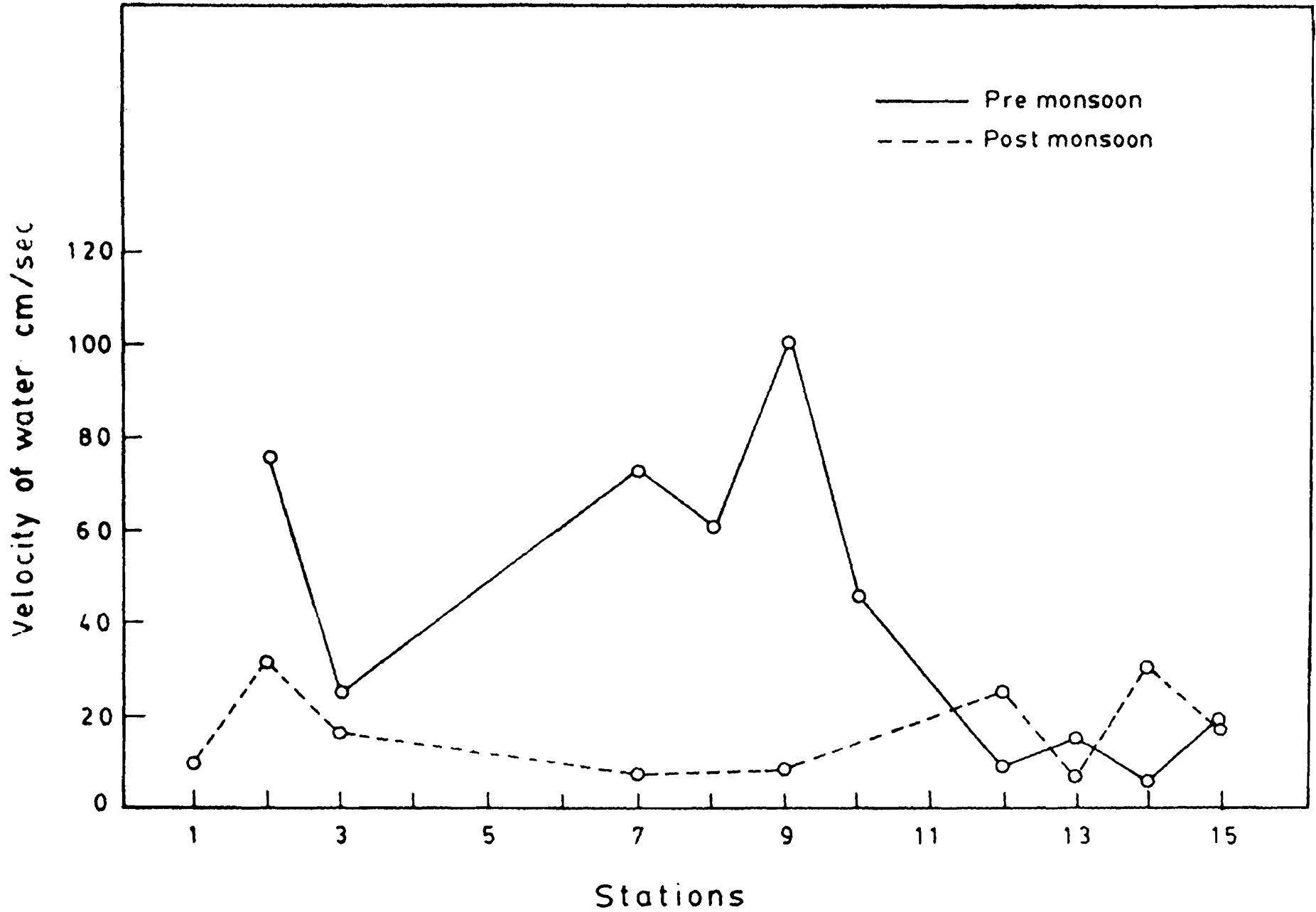


FIG.14 VELOCITY OF WATER CURRENT RECORDED AT SELECTED STATIONS IN THE KRISHNA BASIN

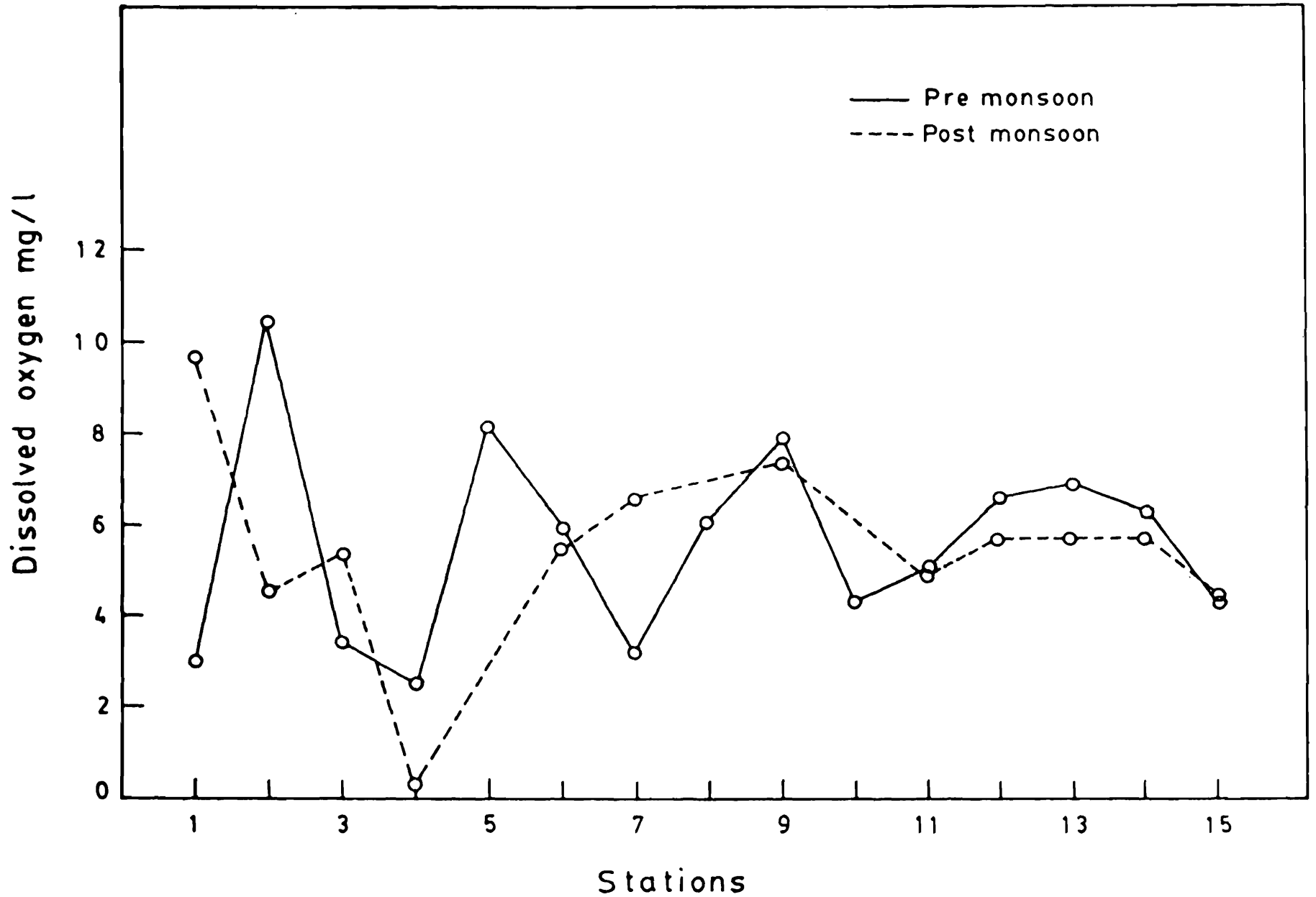


FIG.15 DISSOLVED OXYGEN CONCENTRATION IN KRISHNA RIVER SYSTEM AT SELECTED STATIONS (TABLES 4.4 AND 4.5)

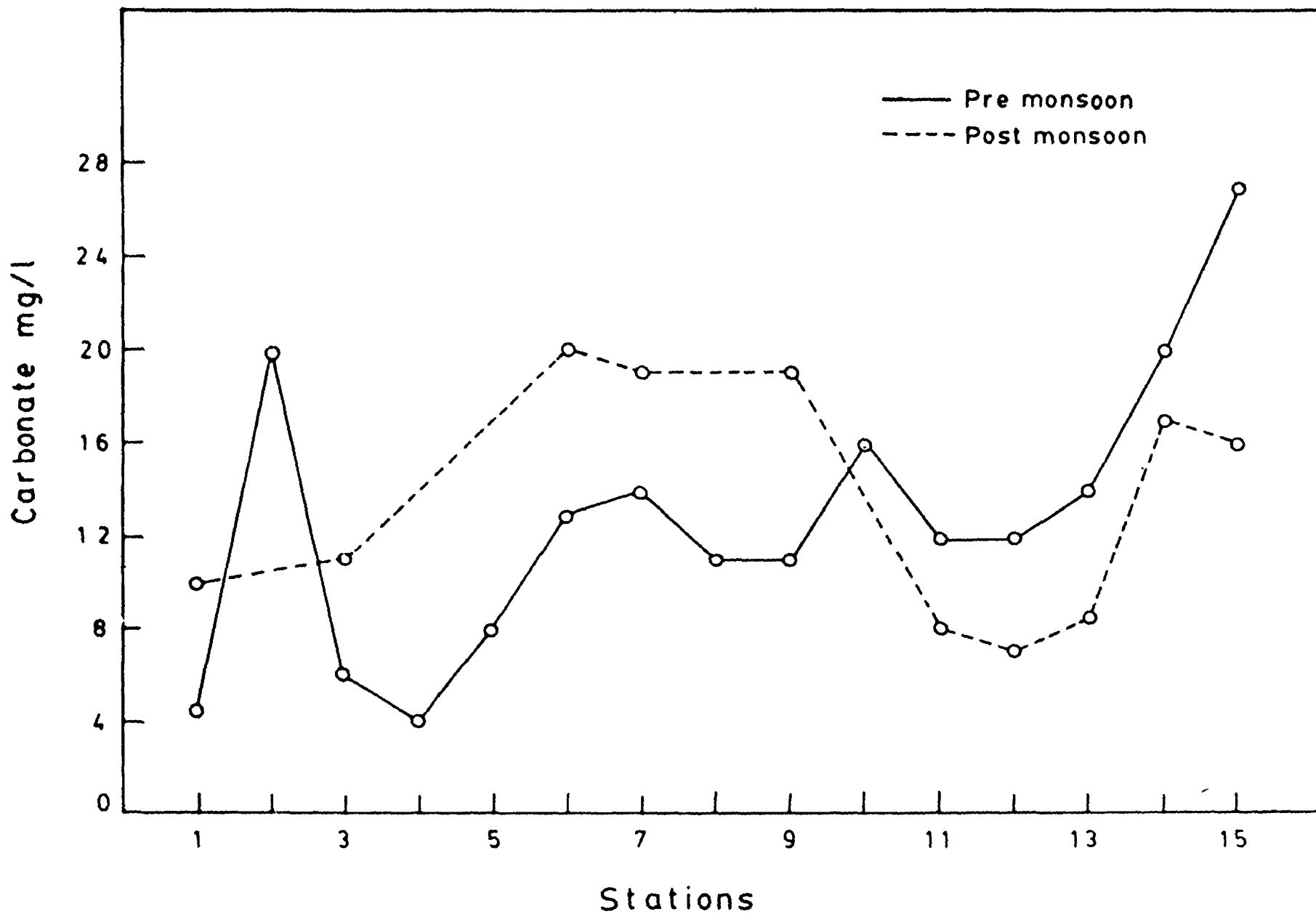


FIG 16 CARBONATE ALKALINITY IN KRISHNA RIVER SYSTEM AT SELECTED STATIONS

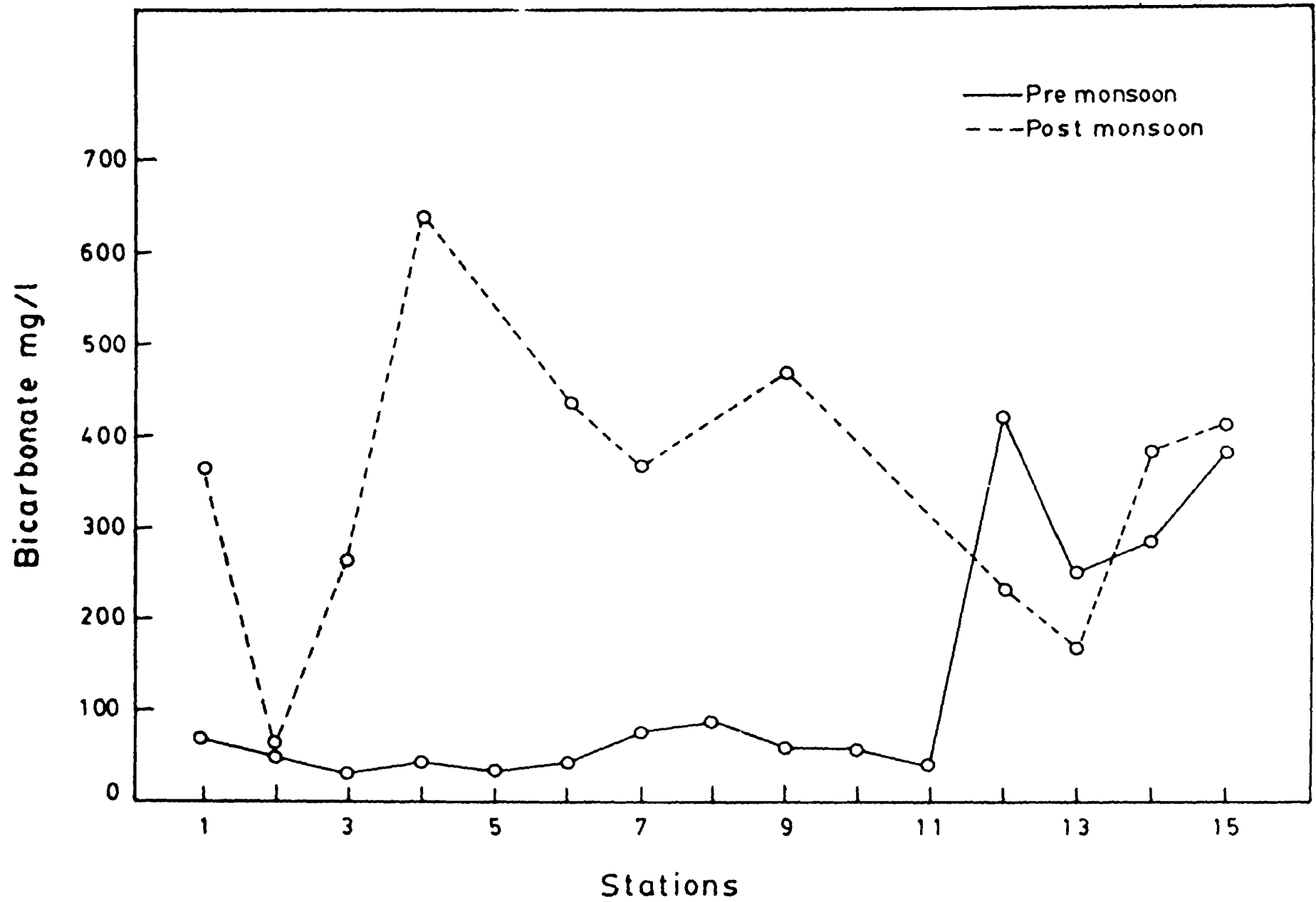


FIG.17 BICARBONATE ALKALINITY IN KRISHNA RIVER SYSTEM AT SELECTED STATIONS

POST MONSOON. JAN, 1990

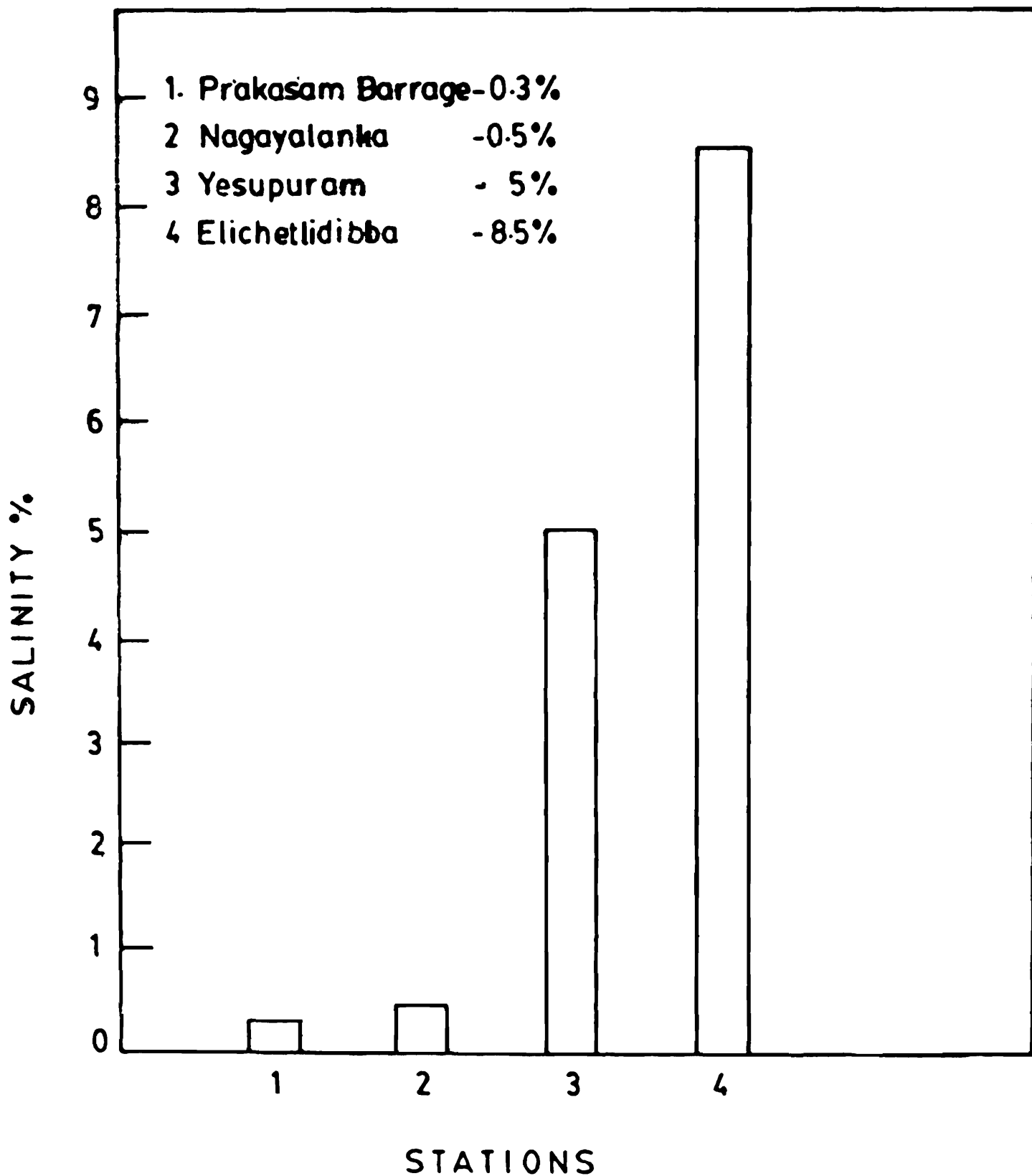


FIG.18 SALINITY IN KRISHNA RIVER
SYSTEM AT SELECTED STATIONS

TABLE 4.4: PHYSICO-CHEMICAL PARAMETERS OF KRISHNA RIVER BASIN DURING PREMONSOON PERIOD

Sl. No.	Stations	Date & Time	PHYSICAL		CHEMICAL				pH
			Temperature Air Water	Velocity cm/sec	DO mg/l	CO ₂ mg/l	Carbo- nate mg/l	Bicarbo- nate mg/l	
1.	River Krishna at Wal	7.5.1988 3 p.m.	31	32		3.0	4.5	70	7
2.	River Krishna at Karad	11.5.1988 4 p.m.	35.5	31	76.2	10.4	20	51	7 to 7.5
3.	River Bhilma at Pandarpur	13.5.1988 9 a.m.	33	27	25.3	3.4	6	30	7
4.	River Krishna at Haripur ghat, Sangli	16.5.1988 11 a.m.	33.5	32		2.5	4	43	7.5
5.	River Krishna at Babaladi	19.5.1988 9 a.m.	31	28		8.1	8	36	7
6.	River Ghataprabha at Bagalkot	20.5.1988 5 p.m.	36.5	31		5.9	13	39	7.5
7.	River Tungabhadra at Mantralayam	22.5.1988 6 p.m.	37	31	73.2	3.2	14	77	7
8.	River Krishna at Krishna Agraharam	29.5.1988 9 a.m.	33	30	61	6.0	11	88	7
9.	River Tungabhadra at Kurnool.	30.5.1988 5 p.m.	40	33	101*	7.8	11	60	7
10.	River Krishna at Lingalagattu	2.6.1988 5.15 p.m.	39	31.5	45.7	4.3	16	56	7 to 7.5
11.	River Krishna at Nagarjunasagar	6.6.1988 8.45 p.m.	31.5	31		5.0	12	47	7
12.	River Naguleru at Dachepalle	29.6.1989 3.5 p.m.	20	28	8.9	6.49	12	424	7
13.	River Krishna at Ramapuram	29.6.1989 3.50 p.m.	28	28	15.2	6.77	14	254	7
14.	River Krishna at Vijayawada	2.7.1989 3.50 p.m.	28	29.5	6.4	6.20	20	281	7
15.	River Krishna at Nagayalanka	4.7.1989 4 p.m.	32	30	19.2	4.20	27	381	7 to 7.5

* Due to wind (exception)

TABLE 4.5. PHYSICO-CHEMICAL PARAMETES OF KRISHNA RIVER BASIN DURING POSTMONSOON PERIOD

Sl. No.	Stations	Date & Time	PHYSICAL			CHEMICAL			pH	
			Tempe- rature Air	°C Water	Velo- city cm/sec.	DO mg/1	CO ₂ mg/1	Carbo- nate mg/1		Bicarbo- nate mg/1
1.	River Krishna at Wal	2.11.1988 3.45 p.m.	30	27	8.9	9.6	10	365	7	
2.	River Krishna at Karad	31.12.1987 8.45 a.m.	24	21	30.48	4.51	0.5	65	6	
3.	River Bhima at Pandarpur	30.12.1987 5.45 p.m.	32	28	16.15	5.3	11	265	7	
4.	River Krishna at Haripur ghat,Sangli	28.12.1987 5.15 p.m.	30.5	27.5		0.28	5.3	640	7	
5.	River Krishna at Babaladi	--								
6.	River Ghataprabha at Bagalkot	26.12.1987 4.30 p.m.	31.5	28		5.36	20	440	7	
7.	River Tungabhadra at Mantralayam	23.12.1987 5 p.m.	37	32.5	7.01	6.49	19	368	7	
8.	River Krishna at Krishna Agraharam	21.12.1987 12 noon.	30	24.5			-			
9.	River Tungabhadra at Kurnool	16.12.1987 5 p.m.	35	30.5	7.62	7.28	19	468	7	
10.	River Krishna at Lingalagattu	11.12.1987 7 a.m.	27	27						
11.	River krishna at Nagarjunasagar	20.12.1988 6.50 a.m.	26.3	26.4		4.81	8		7	
12.	River Nagaleru at Dachepalle	22.12.1988 5.45 p.m.	26	26.2	25.3	5.60	-	7	234	7
13.	River Krishna at Ramapuram	22.12.1988 8.05 a.m.	23	21	6.4	5.64	8.05	168	7	
14.	River Krishna at Vijayawada	18.11.1990 7.15 a.m.	20	15	30.5	5.64	17	384	7	
15.	River Krishna at Nagayalanka	21.1.1990 8.30 a.m.	29	28	17.06	4.36	16	412	7	

TABLE 4.6. Categorization of flow velocity of Krishna River System

1.	<i>Very Slow</i>	<i>0.0 to 0.05 m/sec.</i>
	Premonsoon	Nowhere
	Postmonsoon	
2.	<i>Slow</i>	<i>0.05 to 0.20 m/sec.</i>
	Premonsoon	Dachepalle, Ramapuram, Vijayawada, Nagayalanka, Haripur ghat, Sangli.
	Postmonsoon	Wai, Pandarpur, Mantralayam, Kurnool, Ramapuram, Nagayalanka.
3.	<i>Moderate</i>	<i>0.02 to 0.04 m/sec.</i>
	Premonsoon	Pandarpur.
	Postmonsoon	Karad, Dachepalle, Vijayawada.
4.	<i>Fast</i>	<i>0.4 to 0.7 m/sec.</i>
	Premonsoon	Krishna Agraharm, Lingalagattu.
	Postmonsoon	--
5.	<i>Very Fast</i>	<i>0.7 to 1.0 m/sec.</i>
	Premonsoon	Karad, Mantralayam.
	Postmonsoon	--
6.	<i>Torrent more</i>	<i>more than 1.0 m/sec.</i>
	Premonsoon	Kurnool (exception).
	Postmonsoon	--

5. POLLUTANTS

The waters of River Krishna and its tributaries are utilised for multifarious purposes along the course in which they flow. Mostly the waters are used for community water supply, irrigation, industrial water supply, bathing of human, cattle, washing of clothes with help of detergents and as a recipient or a disposal agent for industrial effluents and town and city sewage. The intensity of use and extent of drawing or discharge depends upon the size of the population and of the industry besides the distance of the water source. Pollution of the river takes place to a varying degree on the manner of transport of the waste material whether it is directly discharged or indirectly. Sewage containing oxidizable organic matter when discharged into the river decomposes through the activity of micro-organisms and exert a demand on Dissolved oxygen in the water thereby reducing the overall quantum. Depending upon the degree of self purification that takes place in the flowing water, the residual pollutant either diminishes or remains constant.

The need for pollution studies in rivers to protect fish life from injurious effects of industrial effluents and sewage contamination have been highlighted by Fowler

(1939) and Bhaskaran (1947), Hora and Nair (1944), Nair (1944), Ganapathi and Alikunhi (1950), Ganapathi and Chacko (1951), David (1957). Bose (1944) and Fowler (1944) suggested methods for utilization of domestic wastes and sewage for fish culture. More recently, Kaphalia *et al.* (1986) demonstrated that freshwater fishes as *Bagarius*, *Wallago attu* etc. which are carnivorous can be used as biological indicators of pesticide contamination in the aquatic environment. Chandra (1985) brought out the impact on Inland Fisheries due to river Pollution. Bhatnagar *et al.* (1989) reported on the damage caused in the brain development of *Labeo gonius* due to water pollution. Khillare and Wagh (1989) studied the effects of Malathion, Sevin and other agricultural pesticides on the biochemical constituents of *Puntius stigma* (= *P. sophore*).

In respect of Krishna system many investigations have been done on the Tungabhadra, the major tributary of the river beginning with David (1957), Reddy and Venkateswarlu (1985), Kongovi *et al.* (1987). Rao and Rao (1987) and Joshi and Sukumaran (1988). Reddy *et al.* (1988) reported on the flourine toxicity in the Nagarjunasagar reservoir which is formed by Krishna.

Krishna is no exception to Indian rivers in being polluted especially when its waters are richly used for cane cultivation and sugar production in Maharashtra, part of Karnataka, paddy and tobacco cultivation in Andhra Pradesh besides several industries.

MAHARASHTRA

Krishna is polluted at Wai, Haripur ghat in Sangli town, and Bhima at Pandarpur where besides urban sewage oil pollution by washing of lorries, tempos, etc. is in vogue. At Pandarpur, a pilgrim town the pollution is of a different nature being mostly of non toxic variety. The self purification capacity of the river is high. In summer months at Wai (see photos 7,8) and Haripur ghat on Krishna the quality of water is poor as shown by the oxygen content of the water. (Pandarpur 3.4 mg/l, Sangli 2.5 mg/l and Wai 3.0 mg/l)

Fish obtained were also of poor quality as *Danio* sp., *Rasbora* sp., *Salmostoma* sp., *Gambusia* sp., etc. *Gambusia* whilst its effectiveness against mosquito larvae is not disputed, it is known however to be destructive not only to fish of similar and smaller sizes but also to larger fishes since it will eat their eggs and young (Berg, 1948-49, Menon, 1965). It thrives in such polluted waters.

The Bhima besides at Pandarpur is also polluted at Yadgir town, whose sewage is discharged into it. During the summer months it is let into some lands to act as soil fertiliser for cultivation. The quality and quantity of the above said sewage and drain water is not known

The Ugar Kagwad sugar factory at Sangli, the innumerable small and big ones such as Krishna Cooperative sugar Factory, Shivnagar; cane crushing mills in and around Karad; the Aristocrat Baggage factory, Maharashtra Scooters Ltd., in Satara discharge their effluents into Krishna. No details about load of pollution and treat-

ment of effluents are available. The Shivnagar factory near Karad has a treatment plant and its effluents are discharged and dried on land, forming thick mats of light brown to pink coloured sediments. The DO of such treated effluents was 1.25 mg/l, pH 6.0. No hydroxides or carbonates were present in the month of May 1988.

In terms of B.O.D load released from urban waste water discharges and industries it has been calculated that 82.9% (0.22 million kg) is contributed by the former and 17.1% (0.04 million kg) by the latter. In the Krishna basin of Maharashtra 0.19 million tones of chemical fertilisers are applied of which 55% consists of Nitrogen, 27% Phosphorous, 18% Potassium. The total consumption of pesticide is 607 tonnes per year of which organochlorine based ones are 456.116 tonnes; organophosphates 25.78; and other types 125.61 (from Basin-Sub basin Inventory of water Pollution, MPCB, 1988).

KARNATAKA

In Karnataka, Tungabhadra is a major tributary contributing a large volume of water to Krishna. The river water is used for bathing, washing, power generation besides irrigation and drinking water supply. A number of industries including pulp, paper and board, iron and steel, sugar and distillaries, polyfibres, chemical and engineering have been established in the Tungabhadra basin. It has been computed that there are 24 large, 25 medium and 69 small scale industries in this area. At Bhadravathi, iron and steel, pulp and paper industries and sugar distillaries are located. At Harihar- Davangere area textile, polyfibre, engineering and sugar industries are located and in the Hospet area, pulp and board, polyfibre, sugar and distillaries, manganese ore mining and processing industries are found.

At Harihar, the polyfibre factory effluent is let into the river 54 km downstream. In terms of B.O.D. load released, in the upstream it ranged from 1.0 to 2.0 mg/l and in downstream 1.0 to 5.0 mg/l. In May 1988 the DO in the downstream stretch of the river was as low as 2.6 mg/l but normally it was around 7.0 mg/l. The factory is estimated to abstract about 35000M³ of water per day from Tungabhadra river and discharge about 33000M³ of waste water per day in a treated condition.

Dempu dairy works at Rabkavi near Jamkhandi discharges its effluents into some channels ultimately joining Krishna. No further details are available.

ANDHRA PRADESH

Rayalaseema Paper Mills Ltd., Kurnool manufactures paper. This mill is situated on the bank of R. Tungabhadra at Kurnool at Gondi marla, near Nawab's Bungalow (photo 9). The sewage and solid wastes are let in near this place. People use the eroded river bank as a public toilet, besides washing cattle, lorries, tempos, etc. A ferry service by a motor launch pollutes the river by its diesel leakage and exhaust. The treated effluents of the paper mills joins the river near Podatha village about 2.5 km from the factory site.

The B.O.D. load is 20 to mg/l, and the effluent discharge at maximum produc-

tion level is about 35,000 m³ to 40,000 m³ per day. Fish specimens collected were of poor quality and stunted size. *Tor neilli* reported by Day (1878) growing to 30 kg is no more available. Sastry and Kamatchiammal (1988) pointed out that paper mill effluents destroy the biota where the food web is disrupted and habitual food organisms are destroyed and thus affect the migratory path of fish.

Besides the above major industry on Tungabhadra, the A.P. Drugs and Pharmaceutical Industries in Hill colony, Vijayapuri North, Nagarjunasagar; the Heavy Water Plant at 10th km on road to Hyderabad from Vijayapuri; and Raasi Synthetics and Chemicals near 10th km on Vijayapuri-Hyderabad Road discharge their effluents into the Nagarjunasagar. The Glass factory in Kurnool town discharges into Andhra canal joining Tungabhadra.

The total organic pollution load in the Krishna basin in Andhra Pradesh is of the order of 0.33 million kilograms of B.O.D. a day, 74.5% (0.25 million kg) contributed by urban sector and 25.5% (0.08 million kg) by the industrial sector. The quantum of chemical fertilizer applied is 0.65 million tonnes of which 69.5% consists of Nitrogen, 23.0% Phosphorous and 7.5% of Potassium. The total consumption of pesticides is 28.74 tonnes of which 1195 tonnes are of organophosphorous compounds, 633 tonnes of organochlorine and others (from Krishna River Basin Inventory of Water Pollution, Andhra Pradesh, APCB, 1987).

At Ibrahimpatnam, the Vijayawada Thermal Power Station releases its hot effluent into the main Krishna. The Physicochemical parameters of the water samples at the main river and also of the effluent do not differ markedly and are within normal limits. Fishermen also reported no ill effects or decline in their catches because of this effluent.

Overall it may be stated that out of 427 industries in the entire basin, chemical and metallurgical industries form a major share 31.38%, engineering industries 22.00%, food industries 23.74%, miscellaneous 13.51%, textile 8.06%, mining 1.31% (from CPCB, ADSORBS 21/89-90).

The urban polluting agencies (non-point sources of pollution) and the major industrial polluting agencies (point sources of pollution) of the Krishna basin are listed in Tables 5.1 and 5.2 respectively.

**TABLE 5.1. URBAN POLLUTING AGENCIES
(NON-POINT SOURCES)**

<i>Sl. No.</i>	<i>Name of Polluting Agency</i>	<i>Location</i>	<i>Products</i>
I MAHARASHTRA			
1.	R. Krishna at Wal, Satara District	Wal.	Urban wastes, sewage, automobile effluents as diesel etc. cattle, human bathing.
2.	Haripur ghat, Sangli.	Sangli Town.	Urban wastes, sewage, automobile effluents as diesel etc. cattle, human bathing.
3.	R. Bhima, Pandarpur.	Pandarpur ghat.	Human and Cattle bathing, Religious offerings.
II ANDHRA PRADESH			
4.	R. Tungabhadra, Nawab's Bungalow, Kurnool.	Kurnool Town.	Urban sewage, oil leakage of motor launch.
5.	R. Tungabhadra, Mantralayam.	Mantralayam.	Pilgrims' religious offerings. Urban sewage.
III KARNATAKA			
6.	R. Ghataprabha, Bagalkot.	Kalloli, Bagalkot town.	Urban wastes, sewage, cattle washings.

TABLE 5.2. MAJOR INDUSTRIAL POLLUTING AGENCIES (POINT SOURCES)

<i>Sl. No.</i>	<i>Name of Factory</i>	<i>Location/Town</i>	<i>Products</i>
I MAHARASHTRA			
1.	Ugar Kagwad Sugar Factory	Sangli	Sugar, Molasses.
2.	Krishna Coop. Sugar Factory, Shilvnagar.	Karad	Sugar, Molasses.
3.	Aristocrat Baggage Factory	Satara	Moulded luggages.
4.	Maharashtra Scooters Ltd.	Satara	Machinery.
II KARNATAKA			
5.	Dempu dairy Works, Rabkavi	Jamkhandi	Milk Products.
6.	Harihar Polyfibres Ltd.	Harihar	Polyester fibre
III ANDHRA PRADESH			
7.	Rayalaseema Paper Mills Ltd.	Kurnool	Paper, Board.
8.	A.P. Drugs and Pharmaceutical Industries.	Vijayapuri North	Drugs.
9.	Raasi Synthetic and Chemicals	Vijayapuri North	Chemicals.
10.	Vijayawada Thermal Power Station	Ibrahimpattam, Vijayawada.	Thermal Power.
11.	K.C.P. Sugar Mills Ltd.	Vyyuru, Vijayawada	Sugar Molasses.

6. PATHOGENS

The high rate of population growth in India and the rapid pace of its industrialization have created problems of disposal of waste waters. Some of the waste waters as that of slaughter house, discarded organic wastes, dead fish, spoiled food remnants, carcasses, etc. harbour pathogenic bacteria and in turn affect the quality of fish life in the river. Such sewage discharges are the main sources of virus transmission into the water environment.

Chaudhuri (1983) reported that out of a total of 7006.74 million liters of water generated in Class I cities, only 37.1% is treated, in Class II cities hardly 5.44% is treated. Singh (1985) reported that urban effluents discharged in Ganga at Bhagalpur carried pathogenic *Salmonella* sp. *Klebsiella* sp. and *Staphylococcus aureus*. Selvanayagam *et al.* (1989) found that in Cooum domestic sewage was the major pollutant. In the downstream pH values were higher due to increased aerobic decomposition.

As already stated Krishna is polluted with urban sewage at Wai, Haripur ghat, Sangli, Bhima at Pandarpur, Ghataprabha at Bagalkot, Tungabhadra at Kurnool and Mantralayam. Water samples were collected and got analysed for presence of pathogenic organisms. (Table 6.1).

In the summer of 1988 (May) the MPN of coliform at Haripur ghat, Sangli was 80 per 100 ml, while at Pandarpur on the Bhima it was 900 to 1600. The same two localities showed a variation of zero at Haripur and 250 at Pandarpur when the early morning samples were analysed, unlike the previous ones which were the evening samples. The pH was highly acidic 3.5 at Haripur ghat, Sangli where the MPN was zero. *Salmonella* was present in all the locations, *Shigella*, *Vibrio* were absent.

In the summer of 1990 (March) Haripur ghat, Sangli on Krishna showed MPN of more than 18,000 with all the 3 pathogens present. Wai on Krishna also presented the same picture.

At Haripur ghat, Sangli, a weir is constructed below which the river is polluted (photo 10) and above which it is deep and clear (photo 11). An analysis of the parameters showed (March 1990) as below:

	Below	Above
	mg/l	mg/l
DO	00.28	5.60
Free CO ₂	53.00	1.00
Bicarbonate	640	280

Such wide fluctuations of MPN of coliform is not unusual and it has been reported that in the Ganga, the variation may be between 3000 to 90, 000. Opinions differ on the dependability of MPN of coliform as an index of pollution.

TABLE 6.1. COLIFORM COUNT AS MPN PER 100 ml.

Sl. No.	Date and Time		Locatton	MPN of Coliform per 100 ml.	Pathogens			Remarks
					Salmonella	Shigella	Vibrio	
1.	9.3.90	9 A.M.	R. Krishna at Wal.	>18,000	+	+	+	
2.	14.5.88	4 P.M.	R. Krishna at Haripur ghat, Sangli.	80	+			
3.	15.5.88	7 A.M.	R. Krishna at Haripur ghat, Sangli.	1600	+			
4.	15.5.88	9 A.M.	R. Krishna at Haripur village 5. Km. from Sangli.	Zero				pH 3.5
5.	8.3.90	7 A.M.	R. Krishna at Haripur ghat, Sangli	>18,000	+	+	+	
6.	12.5.88	6 P.M.	R. Bhima at Pandarpur.	900	+			
7.	13.5.88	9 A.M.	R. Bhima at Pandarpur.	250	+			
8.	14.5.88	6 A.M.	R. Bhima at Pandarpur.	Zero				pH 3.5
9.	8.3.90	6.30 A.M.	R. Bhima at Pandarpur.	>18,000	+	+	+	
10.	11.3.90	5 P.M.	R. Ghataprabha at Bagalkot.	1.5				
11.	12.3.90	5 P.M.	R. Tungabhadra at Mantralayam.	0.75				
12.	14.3.90	6 A.M.	R. Tungabhadra at Kurnool.	0.75				

NOTE Sample Nos. 1 to 9 were analysed by Microbiology Dept., Yeshwantrao Chavan College of Science, Karad 415 110.

Sample Nos. 10 to 12 were analysed by M/s. Vimta Labs, Hyderabad 500 013.

For instance, the Central Water Commission, Poona have recorded faecal coliform MPN from downstream of Harihar polyfibre factory as 2.13 (June, 1988), 2400 for December 1982, January and May 1988. For the same periods, the total coliform MPN was 2400 all through. Likewise, Krishna river at Tintini Bridge (Station No.38) has been stated to have 350 faecal coliform MPN and 540 total coliforms MPN in November 1985 and 2400 both during July and September 1985 (*Namma Parisara* Vol. 1, Nos.3 and 5, 1985).

The poor quality of fish such as *Gambusia*, *Danio* etc at Wai, *Salmostoma* sp., loaches at Haripur ghat, Sangli, almost no catch at Kurnool confirm the undesirable status of the river at these places.

At Dindi reservoir, Andhra Pradesh mortality of *Glossogobius giuris giuris* was noticed in some number during June 1988. Many fishes were found washed ashore with their gills choked. Such of those examples caught alive also died instantly on landing. Water was clear with a DO content of 7.8 mg/l. Guts on dissection were found empty, the water level in the reservoir was about 3 or 4 m at the centre and transparency at 22.5 cm.

7. PLANKTON

Plankton sampling was done in river Krishna on the main, Panchaganga, Bhima and Tungabhadra. Panchaganga was sampled only once in March 1990 but all the other three rivers were sampled during the premonsoon and postmonsoon seasons on specified dates (see list of stations) during the periods detailed on p.

7.1. Zooplankton

It is generally conceded that plankton production is low in lotic systems as compared to lentic habitats. The investigations showed that in general that zooplankton population was greater in premonsoon periods than in postmonsoon. Seasonal fluctuations of zooplankton at different sampling stations is given in Table 7.2

TABLE 7.2 THE SEASONAL FLUCTUATIONS OF TOTAL ZOOPLANKTON (NUMBERS/LITRE) AT THE DIFFERENT SAMPLING STATIONS OF THE KRISHNA SYSTEM (1988-1990)

	Premonsoon	Postmonsoon
R. KRISHNA		
Dhom reservoir	11	8
Wai	6	6
Karad	6	2
Haripur ghat, Sangli	23	13
Jamkhandi	25	15
Gadwal	19	15
Nagarjunasagar	15	8
Ramapuram	17	8
Vijayawada	27	6
Nagayalanka	not covered	27
R. PANCHAGANGA		
Kolhapur	40	Not covered
R. BHIMA		
Pandarpur	8	8
R. TUNGABHADRA		
Kurnool	15	2

The heavy floods carried by the river and the heavy load of silt made the zooplankton fewer in postmonsoon period.

Copepods followed by Rotifers is seen to be dominant. In Copepoda itself Cyclopoid Copepods followed by Calanoid Copepods predominate. In Cladocerans *Ceriodaphnia*, in Rotifers *Brachionus calyciflorus* dominate.

A list of major groups of zooplankton found in the Krishna system is given below.

7.3 Zooplankton population in Krishna River System

Protozoa : CILIATA

Spirostomum sp.

ROTIFERA

- | | |
|-----------------------------------|-----------------------------------|
| 1. <i>Asplanchna sp.</i> | 2. <i>Brachionus calceiflorus</i> |
| 3. <i>Brachionus diversiconis</i> | 4. <i>Brachionus falcatus</i> |
| 5. <i>Brachionus rubens</i> | 6. <i>Brachionus anguillaris</i> |
| 7. <i>Brachionus caudatus</i> | 8. <i>Bosminopsis caudatus</i> |
| 9. <i>Filinia longiseta</i> | 10. <i>Horaella brehmi</i> |
| 11. <i>Keratella tropica</i> | |

CLADOCERA

- | | |
|-----------------------------|-----------------------------|
| 12. <i>Alona sp.</i> | 13. <i>Bosmina sp.</i> |
| 14. <i>Bosmina deiteri</i> | 15. <i>Ceriodaphnia sp.</i> |
| 16. <i>Daphnia carinata</i> | 17. <i>Diaphanosoma sp.</i> |
| 18. <i>Macrothrix sp.</i> | 19. <i>Moina sp.</i> |

COPEPODA

- | | |
|--------------------------------------|--|
| 20. <i>Allodiaptomus raoi</i> | 21. <i>Calanoid copepodids</i> |
| 22. <i>Calanoid nauplii</i> | 23. <i>Chydorus sp.</i> |
| 24. <i>Cyclopoid copepodids</i> | 25. <i>Cyclopoid nauplii</i> |
| 26. <i>Ergasilus sp.</i> | 27. <i>Eucyclops serrulatus</i> |
| 28. <i>Microcyclops varicans</i> | 29. <i>Mesocyclops thermocyclopoides</i> |
| 30. <i>Mescocyclops hyalinus</i> | 31. <i>Nictocra sp.</i> |
| 32. <i>Mychocamptus chathamensis</i> | 33. <i>Onychocamptus chathamensis</i> |
| 34. <i>Paracyclops vagus</i> | 35. <i>Rhirediaptomus indicus</i> |
| 36. <i>Thermocyclops crassus</i> | 37. <i>Tropocyclops prasinus</i> |

OSTRACODA

- | | |
|------------------------------------|-----------------------|
| 38. <i>Stenocypris malcomsonii</i> | 39. <i>Cypris sp.</i> |
|------------------------------------|-----------------------|

Krishna river has the maximum number of Zooplankton species 36 out of the above represented by all groups, compared to Panchaganga, Bhima and Tungabhadra.

It is seen that zooplankton communities were more abundant in the upper reaches of the river than in the lower reaches. The river stretch below Prakasam barrage to confluence was poor in plankton population. Rotifers were scarce and Copepods were represented by Calanoid copepods, Cyclopoid copepods, *Ergasilus sp.*, *Tropocyclops prasinus*; Cladocerans as *Diaphanosoma sp.*, *Bosmina deiteri* etc. were only seen. On the other hand the upper and middle reaches of the river abound in plankton life. *Paracyclops vagus*, *Onychocamptus chathamensis* amongst copepods, were present only in the middle reaches. Of Rotifers, *Brachionus rubens*, *Brachionus anguillaris*, *Brachionus caudatus*, *Brachionus falcatus*, *Bosminopsis caudatus*, *Filinia longiseta*, *Keratella tropica* were absent in the middle reaches. In cladocerans *Alona*

sp. was found in the middle reaches but not in the upper reaches. Ostracods *Cypris* sp. and *Stenocypris malcomsoni* and the Protozoan ciliate *Spirostomus* occurred only in the upper reaches. *Brachionus anguillaris*, *Brachionus rubens*, *Filinia longiseta*, *Keratella tropica* were dominant in the polluted waters at Wai, Haripur ghat, Sangli, Kurnool and subdominant at other places where they occurred. Among the Ostracods, *Stenocypris malcomsoni* and *Cypris* sp. were common in many locations. Generally they were more prevalent in the river where it has come out of the mountains such as Jamkhandi. In Cladocera *Macrothrix* sp., *Moina* sp., *Ceriodaphnia* sp., were the more common ones encountered than others. Copepods dominated the system as is to be expected. *Mesocyclops hyalinus*, *Chydorid* sp., *Thermocyclops crassus* were the more common species seen.

A qualitative analysis of all species as they occurred in different stations is given below.

7.4. STATIONWISE ZOO PLANKTON POPULATION

STATION : DHOM RESERVOIR

Copepod

**Cyclopoid copepod*

Cyclopoid nauplii

Cladoceren

Bosmina sp.

Rotifers

Keratella tropica

STATION : WAI

Copepod

Calanoid copepodids

Cyclopoid nauplii

Tropocyclops prasinus

Rotifers

Brachionus anguillaris

Filinia longiseta

STATION : KARAD

Copepod

Cyclopoid copepod

Thermocyclops crassus

Cladoceren

Ceriodaphnia sp.

Moina sp.

* *Cyclopoid copepodids*, *Cyclopoid nauplii* though listed under species are not separate Taxa but only the stage of the Copepods. For convenience sake they are listed like this.

STATION : SANGLI

Copepods

*Calanoid copepodids**Cyclopoid copepodids**Cyclopoid nauplii*

Ostrocooda

*Stenocypris malcomsoni**Cypris sp.*

Rotifers

*Brachionus calciflorus**Keratella tropica**Horaella brehmi*

Protozoans

Spirostomum sp.

STATION : KOLHAPUR

Copepods

*Cyclopoid copepodids**Cyclopoid nauplii**Mesocyclops hyalinus*

Rotifers

*Brachionus rubens**Brachionus anguillaris**Keratella tropica*

Cladocerans

*Calanoid nauplii**Ceriodaphnia sp.**Daphnia carinata**Macrothrix sp.**Rhirediaptomus indicus*

STATION : PANDARPUR

Copepodids

*Calanoid copepodids**Chydorus sp.**Cyclopoid nauplii*

Rotifers

*Asplanchna sp.**Brachionus calciflorus**Brachionus caudatus**Filinia longiseta*

STATION : JAMKHANDI

Copepods

*Calanoid copepod**Calanoid nauplii**Chydorus sp.*

Ostracoda

*Stenocypris malcomsoni**Cypris sp.*

Rotifers

*Asplanchna sp.**Brachionus calciflorus**Brachionus falcatus**Bosminopsis caudatus**Filinia longiseta*

STATION : GADWAL

Copepods

Calanoid copepodids

Chydrous sp.

Cyclopoid copepodids

Mesocyclops thermocycloides

Cladocereans

Ceriodaphnia sp.

Moina sp.

STATION : KURNOOL

Copepods

Calanoid copepodids

Chydorus sp.

Rotifer

Bosminopsis sp.

Brachionus rubens

STATION : NAGARJUNASAGAR

Copepods

Allodiaptomus raoi

Cyclopoid copepodids

Thermocyclops crassus

Mesocyclops thermocycloids

Cladocerens

Ceriodaphnia sp.

Diaphanosoma sp.

Monia sp.

STATION: SATRASHALA

Copepods

Allodiaptomus raoi

Chydorus sp.

Paracyclops vagus

Thermocyclops crassus

Cladocerens

Alona sp.

Ceriodaphnia sp.

Rotifer

Brachionus calceiflorus

STATION : RAMAPURAM

Copepods

Allodiaptomus raoi

Chydorus sp.

Onychocamptus chathamensis

Thermocyclops crassus

Eucyclops serrulatus

Microcyclops thermocycloids

Cladocereans

Alone sp.

Rotifer

Brachionus calceiflorus

STATION : VIJAYAWADA

Copepods

*Allodiaptomus raol**Chydorus sp.**Cyclopoid copepodids**Eucyclops serrulatus**Nictocra sp.**Thermocyclops crassus**Mesocyclops thermocyclopoides**Tropocyclops prasinus*

Cladocerens

*Alona sp.**Bosmina sp.**Ceriodaphnia sp.**Macriothrix sp.**Moina sp.*

Rotifers

*Brachionus diversicornis**Horaella brehmi*

STATION: NAGAYALANKA

Copepods

*Calanoid copepodids**Cyclopoid copepodids**Tropocyclops prasinus**Ergasilus sp.*

Cladocerens

*Diaphanosoma sp.**Bosmina detteri*

8. PLANKTONIC ALGAE*

Algae play a vital role in the productivity of aquatic ecosystems. They are World-wide in their distribution. Algae of lotic water bodies in India have not been much studied, particularly of the Krishna River system. Reservoirs have been extensively investigated for their planktonic algae but very few rivers have been taken up. Chacko and Sreenivasan (1955) studied the hydrobiology of three major rivers of the then Madras state, which included the Tungabhadra river. Dutta *et al.* (1954), Roy (1955), Shetty *et al.* (1961), studied the plankton of Hooghly and its estuary; Chakraborty *et al.* (199) that of River Jamuna at Allahabad, Bilgrami and Datta Munshi (1980) of a stretch of river Ganges between Barauni and Farakka. Recently Trivedi (1988) gave the algal flora of Krishna, Koyana, Panchaganga and Tungabhadra among others.

Planktonic algae were collected in the same manner as zooplankton. Here, the premonsoon populations were in greater number in the middle reaches than the postmonsoon ones as can be seen from Table 8.1.

*Thanks are due to Prof. V.T.Sridharan, Department of Botany, National College, Tiruchy for kindly going through this chapter.

TABLE 8.1: SEASONAL FLUCTUATIONS OF TOTAL PLANKTONIC ALGAE (NUMBERS/LITRE) AT DIFFERENT SAMPLING STATIONS OF THE KRISHNA RIVER SYSTEM (1988 1990)

	<i>Premonsoon</i>	<i>Postmonsoon</i>
R. KRISHNA		
Dhom reservoir	32	61
Wai	23	34
Karad	17	23
Haripur ghat, Sangli	46	46
Jamkhandi	44	30
Gadwal	39	27
Nagarjunasagar	23	18
Ramapuram	36	29
Vijayawada	34	22
Nagayalanka	Not covered	20
R. PANCHAGANGA		
Kolhapur	11	11
R. BHIMA		
Pandarpur	23	19
R. TUNGABHADRA		
Kurnool	19	29

A list of major algal group found in the Krishna River system is given below. It is represented by Cyanophyceae, Chlorophyceae and Bacillariophyceae. The last group was abundant in most stations where the air temperature was above 29⁰C during the postmonsoon period. Chlorophyceae thrive well between 30⁰ to 32⁰C during summer (premonsoon survey). Significant phytoplankton populations upto 2 meter depth indicate that this upper strata is well lighted. Dominance of Bacillariophyceae seems to be characteristic of most potamoplankton whereas Chlorophyceae is dominant in limnoplankton.

8.2. *Algae of Krishna River System*

CYANOPHYCEAE

- | | |
|------------------------------|---------------------------------|
| 1. <i>Anabaena spiroides</i> | 2. <i>Chroococcus turgidus</i> |
| 3. <i>Microcystis sp.</i> | 4. <i>Merismopaedia elegans</i> |
| 5. <i>Nostoc sp.</i> | 6. <i>Oscillatoria sp.</i> |

7. *Rhaphidiopsis* sp.9. *Tetrapedia* sp.8. *Spirulina* sp.

CHOLOROPHYCEAE

1. *Achnanthes microcephala*3. *Chlamydomonas* sp.5. *Closterium* sp.7. *Closterium moniliferum*9. *Cosmarium granatum*11. *Eudorina* sp.13. *Pandorina* sp.15. *Pediastrum simplex*17. *Spirogyra* sp.19. *Selenastrum* sp.21. *Cladophora* sp.23. *Ulothrix* sp.2. *Carteria globulosa*4. *Chlorella* sp.6. *Closterium acutum*8. *Cladophora* sp.10. *Elakothrix* sp.12. *Golenkenia radiata*14. *Pandorina morum*16. *Merismopedia* sp.18. *Staurostrum* sp.20. *Scenedesmus* sp.22. *Tetrastrum triangulare*24. *Zygnema* sp.

BACILLARIOPHYCEAE

1. *Anomoneis exilis*3. *Cymbella tumida*5. *Cyclotella meneghiniana*6a. *Diatoma* sp.8. *Fragilaria* sp.10. *Meridion* sp.12. *Navicula cuspidata*14. *Nitzschia fonticula*16. *Nitzschia* sp.18. *Surirella* sp.20. *Synedra ulna*2. *Caloneis bacillus*4. *Cymbella aspera*6. *Diatoma elongata*7. *Fragilaria brevistriata*9. *Frustulia rhomboides*11. *Melosira granulata*13. *Navicula* sp.15. *Nitzschia nana*17. *Pinnularia borealis*19. *Synedra* sp.21. *Tabellaria intermedia*

OTHERS

1. *Ceratium* sp.3. *Euglena* sp.2. *Peridinium* sp.4. *Trachilomonas* sp.

Spirogyra sp., *Meridion* sp., *Diatoma* sp., *Fragilaria* sp., are algae clogging the water and filtering sunlight. These are found at Wai, Haripur ghat, Sangli, Tungabhadra at Mantralayam and Rajolibandha, where the river is polluted, stagnant, shallow and infested with weeds. The fish catch from these stations are also poor. *Fragilaria* sp. and *Diatoma* sp. also give a bad odour and pungent taste to the waters at the above places. On the other hand *Zygnema* sp., *Cladophora* sp. and *Ulothrix* sp. occurring in R.Krishna at Haripur village, 5 kms south of Sangli town

are surface water algae which do not clog but float and drift. In this locality a drag net fishing operation yielded a rich and varied catch in May 1988 (Premonsoon), and also in postmonsoon periods of December 1987 and March 1990.

Oscillatoria an exceedingly common Cyanophyceae generally serve as food for fish and other aquatic organisms. Chacko (1970) opined that *Oscillatoria* is the most favoured blue green algae consumed by about 56 species of fishes. However excess of this alga brings about depletion of oxygen resulting in large scale mortality of fish and other aquatic biota. Mortality of some Gobioid fishes occurred in Dindi reservoir (June 1988), but no large scale presence of *Oscillatoria* was noticed. Lalita and Dubey (1987) have indicated that waters which receive the wastes of chemical and textile industries, sewage show more frequent occurrence of *Oscillatoria*.

Zygnema which is present in many locations is common with several species. *Spirogyra* is abundant in the premonsoon period. Found as a bright green floating mass in shallow areas of the river, it is also called the "Water Silk". This has a potential to form a thick cover over the water and in polluted areas as Wai, Haripur ghat, Sangli, Kurnool, it is present in such clogged condition as a mat. *Spirogyra* is generally considered as a pollution indicator. *Ulothrix* sp., *Pediastrum* were found in most stations. *Pandorina*, *Chlamydomonas*, *Chlorella* were found in some locations in the upper reaches only.

Amongst the planktonic algae Chlorophyceae generally dominate in terms of numbers over others followed by Bacillariophyceae.

Palmer (1969) prepared a list of 60 pollution tolerant genera. It is seen that some of the genera listed are present in the polluted stretches. The degree of pollution at the sites is explained by Palmer (1969) and Nygaard (1949) indices. According to Nygaard's compound index a value of above 3 and as per Palmer's algal index TAGPI value of above 15 is indicative of pollution. The presence of some out of the top 8 genera as *Euglena*, *Oscillatoria*, *Chlorella*, *Nitzschia*, *Navicula* alone is sufficient to indicate the pollution status. According to Palmer (1969) a single species of *Euglena* is far more significant than all others as a pollution tolerant form. In *Oscillatoria* a difference in species composition distinguishes the pollution tolerance of 2 or more species.

The following is the Trophic State levels as determined by Nygaard Index.

INDEX	CALCULATION	OLIGOTROPHIC	EUTROPHIC
Myxophycean	<u>Myxophyceae* (Cyanophyceae)</u> Desmideae	0.0-0.4	0.1-3.0
Chlorophycean	<u>Chlorococcales</u> Desmideae	0.0-0.7	0.2-9.0
Diatom	<u>Centric diatoms</u> Pennate diatoms	0.0-0.3	0.0-1.75
Euglenophycean	<u>Euglenophyta</u> Myxophyceae + Chlorococcales	0.0-0.2	0.0-1.0
Compound	<u>Myxophyceae + Chlorococcales +</u> <u>Centric diatoms + Euglenophyta</u> Desmideae	0.01-1.0	1.2-2.5

Palmer's total Algal genus Pollution Index (TAGPI) is as below:

PALMER'S INDEX

Pollution Index	Quality of Water
	<i>POSITIVE</i>
20 or >20	High Organic Pollution
	<i>PROBABLE</i>
15 to 19	Probable evidence of high organic pollution
	<i>NEGATIVE</i>
<15	i. Organic Pollution Not high ii. Sample not representative iii. Some other factor interfering

An analysis of values obtained by Nygaard's and Palmer's indices of some stations is presented in Table 8.3.

From the analysis, it is seen that as per Compound Index alone Dhom, Wai, Karad, Kolhapur and Kurnool are Eutrophic and as per Palmer's Index Wai, Karad, Ramapuram show positive evidence of organic pollution; Dhom, Kolhapur, Pandarpur, Gadwal and Nagayalanka show probable pollution. It is confirmed that the river stretch at Wai, Pandarpur and Kurnool are definitely polluted.

*or Cyanophyta

TABLE 8.3:

POLLUTION INDEX VALUES AS PER NYGAARD AND PALMER OF SOME STATIONS IN KRISHNA RIVER

S.No.	Stations	Nygaard's Index					Palmer's Algal genus pollution Index.(TAGPI)
		Myxophycean	Chlorophycean	Diatom	Euglenophycean	Compound	
1.	Dhom Reservoir	3	3	0.333	0	8	17
2.	Wai	2	1	0.333	0.666	7	21
3.	Karad	2	2	0.666	0.5	8	24
4.	Sangli	0	0	0.2	0	0	9
5.	Kolhapur	2	0	0.666	0	4	17
6.	Pandarpur	0	0	0.333	0.2	0	19
7.	Jamkhandi	0	0	0.333	0.0	0	11
8.	Gadwal	4	1	0.333	0.4	0	17
9.	Kurnool	3	0	0.166	0	4	11
10.	Nagarjunasagar	0	0	0	0	0	9
11.	Satrashala	0	0	2	0	0	12
12.	Ramapuram	0	0	0	0	0	21
13.	Vijayawada	0	0	0.333	0	0	10
14.	Nagalayanka	0	0	0.25	0	0	17

8.4 STATIONWISE ALGAL POPULATION

STATION : DHOM RESERVOIR

Chlorophyceae

*Chlorella sp.**Closterium sp.**Eudorina sp.**Pediastrum sp.**Tetrastrum triangulare**Ulothrix sp.*

Bacillariophyceae

*Caloneis bacillus**Cymbella sp.**Diatoma elongata**Navicula cuspidata**Navicula sp.**Nitzschia nana**Synedra sp.**Tabellaria intermedia*

Cyanophyceae

*Merismopedia elegans**Nostoc sp.**Oscillatoria sp.*

STATION : WAI

Chlorophyceae

*Chlorella sp.**Closterium moniliferum**Eudorina sp.**Pandorina sp.**Spirogyra sp.**Ulothrix sp.**Zygnema sp.*

Bacillariophyceae

*Cymbella sp.**Diatoma elongata**Fragilaria gravistunta**Meridion sp.**Navicula cuspidata**Nitzschia nana**Nitzschia sp.**Tabellaria intermedia*

Cyanophyceae

*Merismopedia elegans**Oscillatoria sp.*

Miscellaneous

*Euglena sp.**Trachelomonas sp.*

STATION : KARAD

Chlorophyceae

Chlorella sp.

Clostrium moniliferum

Navicula cuspidata

Chlamydomonas sp.

Eudorina sp.

Pediastrum sp.

Ulothrix sp.

Zygnema sp.

Cyanophyceae

Merismopedia elegans

Oscillatoria sp.

Miscellaneous

Euglena sp.

Trachelomonas sp.

Bacillariophyceae

Cymbella sp.

Diatoma elongata

Nitzschia

Tabellaria intermedia

STATION : SANGLI

Chlorophyceae

Cladophora sp.

Elakothrix sp.

Golenkenia radiata

Pandorina sp.

Spirogyra sp.

Ulothrix sp.

Zygnema sp.

Cyanophyceae

Chroococcus turgidus

Oscillatoria sp.

Raphidiopsis sp.

Bacillariophyceae

Anamoneis exillis

Diatoma sp.

Fragilaria sp.

Meridion sp.

Nitzschia sp.

Pinnularia borealis

STATION : KOLHAPUR

Chlorophyceae

Chlamydomonas sp.

Closterium acutum

Carteria globulosa

Golenkenia radiata

Cyanophyceae

Anabaena spiroides

Oscillatoria sp.

Bacillariophyceae

Cyclotella sp.

Melosira sp.

Nitzschia nana

Nitzschia fonticula

Synedra sp.

STATION : PANDARPUR

Chlorophyceae

*Pediastrum sp.**Spirogyra sp.**Ulothrix sp.**Zygnema sp.*

Miscellaneous

*Ceratium sp.**Euglena sp.*

Cyanophyceae

*Anabaena spiroides**Microcystis sp.**Nostoc sp.**Oscillatoria sp.*

Bacillariophyceae

*Diatoma elongata**Navicula cuspidata**Nitzschia sp.**Synedra sp.*

STATION : JAMKHANDI

Chlorophyceae

*Pediastrum sp.**Spirogyra sp.**Ulothrix sp.**Zygnema sp.*

Cyanophyceae

*Microcystis sp.**Nostoc sp.**Oscillatoria sp.*

Bacillariophyceae

*Diatoma sp.**Fragilaria sp.**Nitzschia nana**Synedra sp.*

STATION : GADWAL

Chlorophyceae

*Elakothrix sp.**Golenkenia radiata**Pandorina sp.**Staurastrum sp.**Spirogyra sp.*

Miscellaneous

*Euglena sp.**Peridinium sp.**Trachelomonas sp.*

Cyanophyceae

*Anabaena spiroides**Microcystis sp.**Oscillatoria sp.**Tetrapedia sp.*

Bacillariophyceae

*Diatoma sp.**Navicula sp.**Surirella sp.**Synedra sp.*

STATION : KURNOOL

Chlorophyceae

*Achnanthes microcephala**Cosmarium granatum**Pandorina morum**Spirogyra sp.**Ulothrix sp.**Zygnema sp.*

Cyanophyceae

*Anabaena sp.**Nostoc sp.**Oscillatoria sp.*

Bacillariophyceae

*Cymbella tumida**Diatoma sp.**Fragilaria gravistunta**Meridion sp.**Navicula sp.**Synedra phenicentron*

STATION : NAGARJUNASAGAR

Chlorophyceae

Cladophora sp.

Spirogyra sp.

Zygnema sp.

Cyanophyceae

Coelospherium sp.

Microcystis sp.

Nostoc sp.

Oscillatoria sp.

Tetrapedia sp.

Bacillariophyceae

Navicula sp.

STATION : SATRASHALA

Chlorophyceae

Chlamydomonas sp.

Chlorella sp.

Spirogyra sp.

Selenastrum sp.

Ulothrix sp.

Zygnema sp.

Cyanophyceae

Anabaena sp.

Nostoc sp.

Oscillatoria sp.

Spirulina sp.

Bacillariophyceae

Diatoma sp.

Frustulia sp.

Tabellaria sp.

STATION : RAMAPURAM

Chlorophyceae

Cladophora sp.

Chlorella sp.

Scenedesmus sp.

Spirogyra sp.

Cyanophyceae

Anabaena sp.

Microcystis sp.

Oscillatoria sp.

Bacillariophyceae

Nitzschia nana

Navicula sp.

Synedra sp.

STATION : VIJAYAWADA

Chlorophyceae

Chlorella sp.

Eudorina sp.

Pediastrum sp.

Spirogyra sp.

Ulothrix sp.

Zygnema sp.

Cyanophyceae

Microcystis sp.

Nostoc sp.

Bacillariophyceae

Diatoma sp.

Fragilaria sp.

Nitzschia sp.

Navicula cuspidata

STATION : NAGAYALANKA

Chlorophyceae

*Chlorella sp.**Eudorina sp.**Spirogyra sp.**Ulothrix sp.*

Cyanophyceae

*Microcystis sp.**Oscillatoria sp.*

Bacillariophyceae

*Diatoma sp.**Meridion sp.**Navicula sp.**Nitzschia sp.**Synedra sp.*

8.5 Algae known from krishna but not collected

CHLOROPHYCEAE

*Actinastrum hantzschii**Chlorella sp.**Closterium sp. A**Closterium sp. C**Cosmerium variolatum**Elakothrix sp. B**Eudorina sp. A**Golenkenia radiata**Microcoelus sp.**Pediastrum duplex**Scenedesmus armatus**Selenastrum gieta**Staurastrum sp.**Tetraedron sp. B**Tetraedron sp. D**Ankistrodesmus gracilis**Closterium moniliferus**Closterium sp. B.**Cosmerium sp.**Elakothrix sp. A**Elakothrix sp. C**Eudorina sp. B**Kirchneriella sp.**Pandorina sp.**Scenedesmus acutiformis**Scenedesmus arverensis**Spirogyra sp.**Tetraedron sp. A**Tetraedron sp. C**Ulothrix sp.*

CYANOPHYCEAE

*Aphanizomenon sp.**Chroococcus turgidus**Merismopedia viridis**Merismopedia aeruginosa**Phormidium sp.**Spirulina meneghiniana**Arthrospira sp.**Merismopedia elegans**Merismopedia robusta**Merismopedia glauca**Rophidiopsis sp.*

BACILLARIOPHYCEAE

*Achnanthes microcephala**Amphora ovalis**Asterionella formosa**Anomeoneis exilis*

Carteria globulosa
Cymbella bodanica
Cocconeis sp.
Diatoma elongatum
Diatoma vulgaris
Gomphonema sp.
Gyrosigma kutzingii
Melosira sp. B
Meridion sp. A
Melosira varians
Navicula sp. A
Navicula sp. C
Navicula sp. E
N. rostulata
Nitzschia sp. A
Nitzschia sp. C
Nitzschia nana
Pinnularia borealis
Synedra rumpens
Surirella capronoids
Tabellaria intermida

OTHERS

Ceratium hirudinella
Gymnodinium sp.
Phacus sp.
Trachilomonas sp. B

Cymbella sp.
Cymbella meneghiniana
Diatoma sp.
Diatoma hiemalae
Fragilaria sp.
Gyrosigma sp.
Melosira sp.A
Mastogloia balfica
Meridion sp. B
Navicula cuspidata
Navicula sp. B
Navicula sp. D
Navicula cari
Navicula pupula f.rectangularis
Nitzschia sp. B
Nitzschia sp. D
Nitzschia apiculata
Pleurosigma angulatum
Surirella linearis
Roicosphenia curvatia

Euglena sp. A
Peridinium aciculiferum
Trachilomonas sp. A
Trachilomonas hispida

8.6 Algae known from River Tungabhadra but not collected

CHLOROPHYCEAE

Achananthes lanceolata
Cosmarium granatum
Cosmarium subtumidum
Crucigenia rectangularis
Monoraphidium convolution
Scenedesmus armatus

Achananthes microcephala
Cosmarium subcostatom f.minor
Coelastrum combrium
Hydrodictyon reticulatum osmerium
Pandorina morum
Spirogyra sp.

CYANOPHYCEAE

Aphanocapsa stagnina
Merismopedia punctata
Oscillatoria chalybea
Oscillatoria ornata
Spirulina major

Merismopedia convoluta
Oscillatoria culcuttensis
Oscillatoria subbervis
Synechococcus cedrorum

BACILLARIOPHYCEAE

Amphora coffeaeformis
Caloneis silicula
Cymbella meneghiniana
Fragilaria brevistriata
Gomphonema sphaerophorum
Navicula sp. A
Cavicula siligria
Surtrella ovata v. minuta
Synedra ulna v. amphicephala

Caloneis incogrita
Cymbella sp.
Cymbella tumida
Gomphonema parvulum
Mastogloia smithi v. amphicephala
Navicula pupula
Pinnularia viridis
Synedra phenicentron
Synedra phenikentron

OTHERS

Euglena oxyuris
Phacus pleuronectus

Euglena polymorpha

8.7 Algae known from Panchaganga river but not collected

CHLOROPHYCEAE

Actinastrum hantzschii
Chlorococum limnetica
Koliella longiseta
Sphaerocystis schroeteri
Staurastrum paradoxym

Carteria globulosa
Chlamydomonas nygaardii
Scenedesmus acuminatus
Staurodesmus triangularia

CYANOPHYCEAE

Anabaena circinalis
Microcystis aeruginosa
Microcystis hesenbergi

Anabaena solitaria
Microcystis glauces
Spirulina gigantea

BACILLARIOPHYCEAE

Cramaphoneis herculena

Fragilaria linearis

Gyrosigma scalproides

Melosira herigii

Synedra pulchella

Fragilaria construens

Gyrosigma sp.

Melosira islandica

Synedra vaucheriae

Stauronies phonicentron

OTHERS

Lepocinclis salina

Mallomonas tonsyrta

Lepocinclis fusiformis

Phacus pyrum

8.8 Algae known from Koyana river but not collected

CHLOROPHYCEAE

Coelastrum microspermum

Oocystis solitaria

Scenedesmus quadricauda

Scenedesmus armatus

Tetrastrum triangulare

Closterium limnaticum

Pediastrum boryanum

Scenedesmus acuminatus

Sphaerocystis schroeteri

CYANOPHYCEAE

Anabaena circinalis

Spirulina meneghinina

Meridium circulare

Chroococcus tuogidus

BACILLARIOPHYCEAE

Anomoconets exilis

Cyclotella antigia

Cocconeis sp.

Navicula sp. A

Synedra sp.

Caloneis antigia

Cyclotella sp.

Melosira sp. A

Navicula brayophile

OTHERS

Euglena sp. A

Phacus sp.

Phacus macrostigma

Trachilomonas sp.

9.1.1. MANGROVE VEGETATION IN THE ESTUARY

Sl. No.	Species	Station Number	Common Name	Uses
	I Family : ACANTHACEAE			
1.	<i>Acanthus ilicifolius</i> L.	85	Etichilla Alchiseddu	Plant used for asthma, Leaves used for rheumatism.
	II. Family : BORAGINACEAE			
2.	<i>Heliotropium curassavicum</i> L.	80	- -	-
	III Family : MYRSINACEAE			
3.	<i>Aegiceras corniculatus</i> (L.) Blanco	83	Dudumara	Bark used for fish poisoning.
	IV. Family : VERBENACEAE			
4.	<i>Avicennia marina</i> (Forsskal)- Vierch.	83	Matta seddu	- -
	V. Family : GRAMINEAE			
5.	<i>Cynodon dactylon</i> (L.) Pers	83	Argumpul	- -
6.	<i>Aeluropus lagopoides</i> (L.) Trin. ex Thwaites	81	- -	Aromatic value
	VI. RHIZOPHORACEAE			
7.	<i>Rhizophora apiculata</i> Blume	85	Uradu seddu	- -
	VII Family : AIZOACEAE			
8.	<i>Sesuvium portulacastrum</i> (L.) L.	80	- -	- -
	VIII Family : CHENOPODIACEAE			
9.	<i>Suaeda maritima</i> (L.) Dymort	81	- -	- -
10.	<i>Suaeda nudiflora</i> Moq.	83	- -	- -

9. VEGETATION AND FLORA ON THE RIVER BANKS OF KRISHNA*

The vegetation and the floristic composition on the banks of the river were observed and studied during the seasonal field exploration tours undertaken. 144 species were collected, details of which are given separately.

In general, the vegetation consists of submerged and floating hydrophytes, herbaceous undergrowth interspersed with occasional shrubs and few trees including mangroves. It is worth pointing out that most of the original vegetation on either side of the river have either been lost or replaced by exotics and cultivares due to human agencies. Only where the river takes its origin and during its early course in Satara district, Maharashtra, trees of evergreen forest are present. Also in the Sri Sailam Reserve Forest area, from near Mutchumari to Sri Sailam, as it is protected, thick forests are seen. Similarly, a good formation of mangroves exists in the estuarine region of Krishna district near Machilipatnam. Majority of the area under the flow of the river are rich cultivable lands. About 75% of the tropical evergreen forest is dominated by Teak species as *Terminalia tomentosa*, *Tectona grandis*, *Adina*, etc.

The common trees that are found among the herbaceous and shrubby undergrowth are *Dalbergia sissoo* which is one of the characteristic members of the riverine vegetation; *Acacia nilotica*, *Pithecellobium dulce*, *Azadirachta indica*, *Ficus religiosa* and *Ficus bengalensis*. *Prosopis glandulosa* is most dominant, occurring among the above species.

The shrubby layer consists of such common plants as *Jatropha glandulifera*, *Crotalaria verrucosa*, *Martynia annua*, *Cassia auriculata*, *Vitex negundo*, etc. *Ipomoea carnea* is a fast spreading shrub, found growing luxuriously among the above species. The dry mixed deciduous forests have stunted and immature varieties of Bamboo type *Dendrocalamus strictus* and *Anogeissus latifolia*. Sparsely seen are fuel trees as *Albizia pebbek*, *Acacia sundra*, *Premna tomentosa*, and *Anogeissus* and Teak type *Anogeissus latifolia*, *Lagerstroemia parviflora*, *Terminalia tomentosa*, *Cleistanthus collinus*.

Derris scandens, *Pergularia extensa*, *Coccinia indica*, *Oxystelma esculentum*, etc. are the few climbers, met within the shrubby vegetation. *Ipomoea pes-caprae* with its handsome pink flowers is a common trailer on the sandy banks, often associated with *Citrullus colocynthis*. A few plants such as *Amaranthus spinosus*, *Polygonum* with 2 species, *Cyperus* with 4 species and *Croton sparsiflorus* are the dominant elements in the shrubby layer. *Acacia latronum*, *Acacia arabica*, *Acacia leucophloea*, *Dichrostachys cinera* and *Randia dumetorium* were also seen. In recent times the allergic weed *Parthenium hysterophorus* is fastly spreading on the banks of the river, especially in Maharashtra and is becoming a pest.

**Thanks are due to Prof.V.K.George, Department of Botany, St.Joseph's College, Tiruchy for kindly going through this chapter and also to Shri P. Dwarakan and Shri S. Rajasekar, Junior Project Fellows (Botany) especially for their assistance in drawing up the lists of plants.

Among the common aquatic plants found in the shallow waters mention may be made of *Eichhornia crassipes*, *Vallisneria spiralis*, *Hydrilla verticillata*, *Potamogeton nodosus*, *Ottelia alismoides*, *Ceratophyllum demersum*, *Aponogeton natans*, etc. *Typha angustata* grows in large populations at several points. Few of the marshy herbs which are subject to flooding during monsoon are several species of *Cyperus* sp., *Scirpus mucronatus*, *Eleocharis congesta*, *Eleocharis geniculata*, *Fimbristylis schoenoides*, *Mariscus* sp., and invariably majority of these species belong to the family Cyperaceae. Other notable plants of the above category are *Heliotropium paniculatum*, *Ammannia baccifera*, *Ammannia octandra*, *Dentella repens*, *Bacopa monnieri*, etc.

The estuarine region of the river harbour a good formation of mangroves near Machilipatnum in Krishna district. In the Avanigadda taluq, the formation is sparse except in some uninhabited islands near the sea. *Rhizophora apiculata* is the most dominant species here. The plant is very characteristic of its arching aerial roots and viviparous germination. Of late these trees are being cut for fuel, thereby resulting in the degradation of mangrove forest. Other prominent members of this forest are *Avicennia marina* with its peculiar breathing roots called 'pneumatophores' *Aegiceras corniculatus*, *Acanthus ilicifolius*, etc. Herbaceous members are *Sueda maritima*, *Heliotropium curassavicum*, *Sesuvium portulacastrum*, *Aleuropus lagopoides*, etc. (see 9.1.1, p.66)

Some of the plants collected during the above survey are discussed and others are enumerated systematically in the following pages.

1. Family MALVACEAE

Abutilon indicum (L.) Sweet.

A shrub occurring at Ekonampet (stn. no.60) and Dachepalle (stn.no.68), this plant was seen in the dry river bed in summer months. It is propagated easily through postmonsoon floods. Seeds have laxative properties. In Telugu it is called 'Tutturubenda'

2. Family CONVULVACEAE

Ipomoea carnea Jacq.

A common weed widely spread throughout Krishna basin found upto high flood level. Introduced from S. America, it is an amphibious plant with a succulent stem and fleshy watery leaves, toxic to livestock. Ecologically it is a notorious plant, because it absorbs and transpires huge amount of water in it.

3. Family EUPHORBIACEAE

Acalypha indica L.

A short herb occurring at the margins of the river bank. Leaf shows mosaic pattern of phyllotaxy. In Andhra Pradesh it is called Kuppachettu, and has medicinal value.

***Euphorbia hirta* L.**

A prostrate herb found above the flood level in dry areas. Collected in Eluru canal (stn.no.71) of river Krishna. Decoction of the plant used for bronchial affections and asthma.

4. Family HYDROCHARITACEAE***Hydrilla verticillata* (L.f.) Royle**

Found in the Krishna basin, along the river banks and submerged during high flood monsoon period. It is a submerged hydrophyte, with long stem covered with leaves and roots arising from the nodal region. Plants are generally anchored to the bottom of the river. Suitable for indoor and out-door aquaria and is considered to be a good oxygenator; it is eaten by fishes and used as green manure.

5. Family NYCTAGINACEAE***Boerhavia diffusa* L.**

It was encountered at Regulagudda (stn. no. 67) and Ibrahimpatnam (stn.no. 75) in the Krishna basin. The plant is a prostrate glabrous diffusely branched annual herb. In Andhra Pradesh it is called 'Punarnava' Its tap root portion is used as a diuretic and also in anaemia. Active constituent is Punarnavine, an alkaloid.

6. Family LEGUMINOSAE***Tephrosia purpurea* (L.) Pers.**

An erect perennial shrub growing upto one meter height and is fast spreading through monsoon floods. This weed is common along the Buggavagu reservoir (stn.no.61), Prakasam barrage (stn.no.77) at Vijayawada and at Dachepalle (stn.no.68). It is used as a green natural manure for agricultural crops.

7. Family COMPOSITAE***Tridax proumbens* L.**

A spreading prostrate herb with dissected leaves occurring below Prakasam barrage at (stn.no.77) Vijayawada. This plant is seen usually in dry river bed in summer months and easily propagated through Achenes of feathery pappus.

8. *Grangea maderaspatana* (L.) Poiret

A prostrate herb with heterogamous head inflorescence flower yellow. A common weed usually grown along the margins of river bank. Encountered at

Satrashala (stn no.62) and Pondugala (stn.no.64). In telugu it is called "save". Juices of the leaves applied for ear-ache.

9. Family : ZYGOPHYLLACEAE

Tribulus terrestris L.

A creeping herb with yellow flower and spiny fruit found in Ibrahimpatnam (stn.no.75). The seeds are of medicinal value.

10. Family : AMARANTHACEAE

Achyranthes aspera L.

A subshrubby plant with spike inflorescence, seeds having hard seed coat; it is drought resistant. Specimens collected above high flood level in dry areas at Prakasam barrage (stn.no.77). In Andhra Pradesh it is called 'Uttereni' Plant is used for diuretic purposes.

11. Family : CAPPARIDACEAE

Cleome viscosa L.

A viscous plant with 3 to 5 foliate leaves, flower of yellow colour. A common weed found upto high flood level at Sitanagaram at northern side of Prakasam barrage (stn.no.77).

12. Family : MARSILIACEAE

Marsilea quadrifolia L. It is cosmopolitan in distribution. It is an aquatic pteridophyte found at Nawab's bungalow (stn.no.53). It is widely used in the trade as an aquatic ornamental plant for pools and aquaria.

In relation to water level the hydrophytes are grouped into following groups.

I SUBMERGED HYDROPHYTES

Plants which grow below the water surface and are not in contact with atmosphere, generally anchored to the bottom of the rivers. e.g. *Vallisneria spiralis* (Stn.no.5,40,43,53,55,61), *Hydrilla verticillata* (stn.no.22,24,25,31,43,54,55).

II FLOATING HYDROPHYTES

Plants that float on the surface or slightly below the surface of water. They may/may not be rooted in the soil. They are divided into two subclasses.

a) Free floating hydrophytes

Plants floating freely on the surface of water, but not rooted in the mud e.g. *Elchhornia* spp. (stn.no.24,25,53,54,61).

b) Floating but rooted hydrophytes

Some submerged plants are rooted in muddy substrate but their shoot float on or above the surface of water. e.g. *Nymphaea nouchelli* (stn.no.61).

III AMPHIBIOUS HYDROPHYTES

Plants adapted to both aquatic and terrestrial modes of life e.g. *Ipomoea carnea* (stn.no.15,41,47,71).

9.1. LIST OF PLANT SPECIES OF THE KRISHNA RIVER BASIN

I. THE FOLLOWING PLANTS OCCUR ALONG THE RIVER BANKS AND ARE SUBJECT TO HIGH FLOODING DURING THE MONSOON MONTHS.

Sl. No.	Species	Station Number	Uses
↳ I	Family : CYPERACEAE		
1.	<i>Cyperus articulatus</i> L.	25,61,75	--
2.	<i>Cyperus compressus</i> L.	47,68	--
3.	<i>Cyperus difformis</i> L. (Mat grass)	40,60	
4.	<i>Cyperus rotundus</i> L.	74,77	--
5.	<i>Cyperus malaccencis</i> Lam.	62,68	--
6.	<i>Cyperus pangorei</i> Rottb.	68	used for mat making
7.	<i>Cyperus corymbosus</i> Rottb.	38	--
8.	<i>Cyperus pilosus</i> Vahl.	40	--
9.	<i>Fimbristylis bisumbellata</i> (Forsskal) Bubani Kadu Kori	75	--
10.	<i>Fimbristylis schoenoides</i> (Retz.) Vahl.	64,60	--
11.	<i>Eleocharis acutangula</i> (Roxb.) Schultes	72	--
12.	<i>Eleocharis geniculata</i> (L.) Roemer and Schultes	64	--
13.	<i>Eleocharis congesta</i> D. Don	39	--
14.	<i>Scirpus mucronatus</i> L. Bull -rush	40	--

15.	<i>Mariscus cyperinus</i> (Retz.) Vahl	55	--
16.	<i>Scleria hebecarpa</i> Nees.	25	--

HYDROPHYTES

II Family : HYDROCHARITACEAE

17.	<i>Vallisneria spiralis</i> auct. non L.	5,40,43,53,55,61	--
18.	<i>Eichhornia crassipes</i> (C.Martius) Water hyacinth Solms Laub.	24,25,53,54,61	--
19.	<i>Hydrilla verticillata</i> (L.f.) Royle	22,24,25,31, 43,54,55	--
20.	<i>Ottelia alismoides</i> (L.) Pers.	61	--

III Family : POTAMOGETONACEAE

21.	<i>Potamogeton pectinatus</i> L.	55	--
22.	<i>Potamogeton nodosus</i> Poiret	61,82	--

IV Family : CERATOPHYLLACEAE

23.	<i>Ceratophyllum demersum</i> L.	61	--
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V Family : TYPHACEA

24.	<i>Typha angustata</i> Bory & Chaub Water grass	5,22,62,77	--
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VI Family : APONOGETONACEAE

25.	<i>Aponogeton natans</i> (L.) Engl & K.Krause	19	--
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II THE FOLLOWING OCCUR ONLY ON THE RIVER BANK, IN DRY AREAS.

VII Family: POLYGONACEAE

26.	<i>Polygonum barbatum</i> L. Back wheat	2,5,25,38,43 45,54,77	--
27.	<i>Polygonum glabrum</i> Willd.	15,19,31,39,53,60	--
28.	<i>Polygonum flaccidum</i> Meissner	40	--

VIII Family : GRAMINEAE

29.	<i>Alloteropsis cimicina</i> (L.) Stapf	75	--
30.	<i>Pennisetum americanum</i> (L.) Leeke Pearl Millet	68	Grains edible
31.	<i>Setaria intermedia</i> (Roth) R & S Kangn	5	--

32.	<i>Setaria verticillata</i> (L.) P. Beauv.	17	--
33.	<i>Digitaria adscendens</i> (Kunth) Henrard	19	--
34.	<i>Eriochloa procera</i> (Retz.) C.E.Hubb.	42	--
IX Family : ACANTHACEAE			
35.	<i>Dipteracanthus patulus</i> (Jacq.) Nees	64	--
36.	<i>Justicia prostrata</i> (C.B. Clarke) Gamble	70,74	--
X Family : BORAGINACEAE			
37.	<i>Heliotropium paniculatum</i> R.Br.	68	--
38.	<i>Heliotropium curassavicum</i> L.	65,78	--
39.	<i>Heliotropium ovalifolium</i> Forsskal	27,72,74	--
40.	<i>Heliotropium indicum</i> L.	64,82	--
XI Family : COMMELINACEAE			
41.	<i>Commelina diffusa</i> Burm. f.	61,75	--
42.	<i>Commelina nudiflora</i> L. Kankaoa	74	Medicinal value, Leaves used for poulticing sores.
XII Family : EUPHORBIACEAE			
43.	<i>Phyllanthus virgatus</i> Forster f.	62	Medicinal value.
44.	<i>Croton sparsiflorus</i> Morong	72	--
XIII Family : FICOIDACEAE			
45.	<i>Mollugo nudicaulis</i> Lam.	68	Medicinal value, Leaves applied to boils to draw out pus, plant used in allergy and whooping cough.
XIV Family : LABIATAE			
46.	<i>Ocimum basilicum</i> L.	62	--
XV Family : LYTHRACEAE			
47.	<i>Ammannia octandra</i> L.f.	64	--
48.	<i>Ammannia baccifera</i> L.	65	Medicinal value
49.	<i>Nesaea brevipes</i> Koehne	74	--
XVI Family : CAPPARIDACEAE			
50.	<i>Cleome viscosa</i> L. Hulhul	77	Medicinal value

XVII Family : MALVACEAE			
51.	<i>Urena lobata</i> L.	61	--
52.	<i>Sida cordata</i> (Burm. f.) Borssum waalkes	71	--
53.	<i>Sida acuta</i> (Burm.f)	77	--
54.	<i>Abutilon indicum</i> (L.) Sweet	60,68	--
55.	<i>Malvastrum coromandelianum</i> (L.) Garcke	60	--
XVIII Family : NYCTAGINACEAE			
56.	<i>Boerhavia diffusa</i> L.	75,67	Medicinal value. Root used as diuretic, laxative, expectorant in asthma, antidote to snake venom.
XIX Family : PEDALIACEAE			
57.	<i>Pedallium murex</i> Linnaeus	61	--
58.	<i>Martynia annua</i> Linnaeus	15	--
XX Family : RUBIACEAE			
59.	<i>Oldenlandia umbellata</i> Linnaeus	74	--
60.	<i>Dentella repens</i> (L.) Forster & Forster f.	82	--
XXI Family : SOLANACEAE			
61.	<i>Solanum surrattense</i> Burm. f.	60,7,68	--
62.	<i>Solanum trilobatum</i> Linnaeus	76	Medicinal value. Root and leaves bitter, so prescribed for consumptive cases. Berries and flowers given for cough.
63.	<i>Physalis minima</i> Linnaeus	72	Medicinal value.
XXII Family : SCROPHULARIACEAE			
64.	<i>Bacopa monnieri</i> (L.) Pennell	27,60,61	--
65.	<i>Scoparia duclis</i> Linnaeus	75	Medicinal value Plant infusion used in ague.
66.	<i>Verbascum chinense</i> (L.) Santapau	78	--

XXIII Family : CONVULVULACEAE

67. *Ipomoea pes-caprae* (L.) R.Br. 81 --
 68. *Ipomoea carnea* Jacq. 15,41,47,71 --

XXIV Family : VERBENACEAE

69. *Phyla nodiflora* (L.) E.Greene 61,82 Medicinal value. Plant used in stoppage of bowels and pain in knee joints.

XXV Family : POLYGALACEAE

70. *Polygala arvensis* Willd. 77 --

XXVI Family : ZYGOPHYLLACEAE

71. *Tribulus terrestris* L. 75 Fruits used for gout, Kidney diseases

III THE FOLLOWING PLANTS ARE FOUND HIGH ABOVE FLOOD LEVEL AND ARE UNAFFECTED BY FLOOD WATERS

HERBS

XXVII Family : AMARANTHACEAE

72. *Gomphrena decumbens* auct. 62 Ornamental value
 non. Jacq.
 73. *Gomphrena globosa* L. 70 --
 74. *Aerva lanata* (L.) Juss 70 --
 75. *Achyranthes aspera* L 77 Plant Medicinal value. used as a pungent purgative, diuretic in dropsy, piles, boils, skin eruptions.
 76. *Amaranthus spinosus* L. 15,12,19, 27,62 Medicinal value -Leaves and roots given to children (after boiling) for laxative, and applied as emollient.
 77. *Alternanthera sessilis* (L.) R.br.ex Dc. 5,65 --
 78. *Alternanthera triandra* Lam. 27,78 --

XXVIII Family : COMPOSITAE

79.	<i>Eclipta alba</i> (L.) Hassk.	68	Medicinal value. Leaves used for scorpion sting, and for eye diseases.
80.	<i>Eclipta prostrata</i> (L.)	60	Medicinal value.
81.	<i>Grangea maderaspatana</i> (L.) Poiret	62,64	Medicinal value. Juice of leaves employed as instillation for ear ache.
82.	<i>Vernonia cinerea</i> (L.) Less	74	--
83.	<i>Tridax procumbens</i> L.	77	--
84.	<i>Parthenium hysterophorus</i> L.	19,25,31,42,70, 72,76,77,	--
85.	<i>Blumea</i> spp.	76	--

XXIX Family : EUPHORBIACEAE

86.	<i>Phyllanthus rheedii</i> Wight	64,68	--
87.	<i>Phyllanthus urinaria</i> L.	19	--
88.	<i>Acalypha indica</i> L	47,71	Medicinal value. Root used as cathartic and as laxative.
89.	<i>Euphorbia hirta</i> L.	71	Medicinal value plant used in diseases of children in worms, bowel complaints
90.	<i>Chrozophora rottleri</i> (Geiseler) Adr. Huss.	27	--

XXX Family : CONVULVULACEAE

91.	<i>Evolvulus alsinoides</i> (L.) L.	61,68	Medicinal value. Leaves made into cigarettes smoked in chronic bronchitis and asthma.
92.	<i>Merremia emarginata</i> (Burm.f.) Hallier.f.	62	--
93.	<i>Cressa cretica</i> L.	82	--

XXXI Family : CRUCIFERAE			
94.	<i>Brassica juncea</i> (L.) Cosson. Indian Mustard herb	79	Seed edible
XXXII Family : ACANTHACEAE			
95.	<i>Peristrophe bicalyculata</i> (Retz) Nees	72,74	Medicinal value Plant macerated in an infusion of rice and said to be antidote to snake poison.
XXXIII Family : AIZOACEAE			
96.	<i>Glinus oppositifolius</i> (L.) A.DC.	74	--
XXXIV Family : LABIATAE			
97.	<i>Leucas stricta</i> Benth.	72	--
SHRUBS			
XXXV Family : EUPHORBIACEAE			
98.	<i>Breynia vitis-idaea</i> (Burm.f.) C. Fisher	62	--
99.	<i>Acalypha alnifolia</i> Klein ex. Willd.	72	--
100.	<i>Jatropha glandulifera</i> Roxb.	53	Roots used for children suffering from abdominal enlargements.
XXXVI Family : MELASTOMACEAE			
101.	<i>Memecylon grande</i> Retz.	60	--
XXXVII Family : CAESALPINIOIDEAE			
102.	<i>Cassia auriculata</i> L.	60,65	Medicinal value. Bark and root used as astringent. Root used in skin disease, leaves and fruits anthelmintic.
103.	<i>Cassia obtus</i> (roxb.) Wight & Arn.	65	--
104.	<i>Cassia occidentalis</i> L.	70	Seed and Leaves used externally in skin diseases
XXXVIII Family : PAPILIONOIDEAE			
105.	<i>Tephrosia purpurea</i> (L.) Pers.	61,68,77	Medicinal value. Also a natural manure.
106.	<i>Crotalaria verrucosa</i> L.	70	--

107.	<i>Crotalaria juncea</i>	79.	Natural manure.
XXXIX	Family : LABIATAE		
108.	<i>Hyptis suaveolens</i> (L.) Poit.	81	Plant used in parasitical cutaneous diseases.
XL	Family : PAPAVERACEAE		
109.	<i>Argemone mexicana</i> L.	5,15,75	Root used for chronic skin diseases.
XLI	Family : VERBENACEAE		
110.	<i>Vitex negundo</i> L.	5,19,31, 60,70	Medicinal value. Leaves used as vermifuge, headache and catarrh.
TREES			
XLII	Family : RHAMNACEAE		
111.	<i>Ziziphus jujuba</i> (L.) Geertner	67	Timber value & Fruit edible.
XLIII	Family : PAPILIONOIDEAE		
112.	<i>Dalbergia sissoo</i> Roxb.	60,68	Timber value. Decoction of leaves used for gonorrhoea. Roots used as astringent.
XLIV	Family : MIMOSOIDEAE		
113.	<i>Pithecellobium dulce</i> (Roxb.) Benth,	72,76	Timber value and Fruit edible.
114.	<i>Acacia arabica</i> (Lam.) Willd. Babul Kikar	47	Timber value and Economic value for gum.
115.	<i>Acacia nilotica</i> (L.) d Del.	64,74	--
116.	<i>Prosopis cineraria</i> (L.)	54	--
117.	<i>Prosopis glandulosa</i> Torrey	42,53,55,71, 79,80,81,82.	Timber value.
118.	<i>Mimosa pudica</i> L.	74	Leaves and roots used in piles and fistula.
XLV	Family : MORACEAE		
119.	<i>Ficus bengalensis</i> L.	68,74	Fruit edible and Timber value.
120.	<i>Ficus religiosa</i> L.	68	Fruit edible and Timber value.

XLVI Family : BIGNONIACEAE			
121.	<i>Tecoma stans</i> (L.) Kunth	70	Medicinal value and Root considered remedy for snake bites and for scorpion sting.
XLVII Family : MELIACEAE			
122.	<i>Azadirachta indica</i> Adr. Juss Neem tree	65,68	Leaves used for poultice applied to boils. Bark, gum, leaf and seed used for snake and scorpion sting and economical value.
XLVIII Family : TAMARISCACEAE			
123.	<i>Tamarix gallica</i> L.	41	--
XLIX Family : MYRTACEAE			
124.	<i>Syzygium cumini</i> (L.) Skeels Jamun	4	Fruit edible, seeds used in diabetes.
CLIMBERS			
L Family : ASCLEPIADACEAE			
125.	<i>Pergularia extensa</i> (Jacq.) N.E.Br.	74	Medicinal value. Juice of leaves used as expectorant in catarrhal affections, Root bark mixed with cow's milk for purgative in rheumatic cases.
126.	<i>Oxystelma esculentum</i> (L.f.) ex-Schultes.	71	--
LI Family: CUCURBITACEAE			
127.	<i>Citrullus colocynthis</i> (L.) Schrader	60,65,74	Medicinal value. Fruit and seed used for purgative. Root used for jaundice, urinary diseases and rheumatism.
128.	<i>Citrullus lanatus</i> (Thunb.) Matsum & Nakai	64	--

129.	<i>Coccinia indica</i> Wight and Arn.	68	Juice from leaves and roots used in diabetes.
130.	<i>Mukia mederaspatana</i> (L.) M.Roemer	72	--
LII	Family : PASSIFLORACEAE		
131.	<i>Passiflora foetida</i> L.	65	Leaves applied on the head for giddiness and headache.
LIII	Family : MIMOSOIDEAE		
132.	<i>Acacia cacsia</i> (L.) Wild.	27,38,47	--
PTERIDOPHYTES			
LIV	Family : MARSILIACEAE		
133.	<i>Marsilea quadrifolia</i> L.	53	--

10. FAUNA OTHER THAN FISH SHELL FISH

10.1. MOLLUSCA*

Molluscs form a dominant constituent in any river fauna. Many species serve as food for Catfishes as *Pangasius*, *Rita* etc. Some of them are economically used. Shells of Bivalves are used in shell button industry in North Bihar. They are prolific and abundant in any place they occur. Hora (1952, 1953) advocated culture of *Pangasius* to control molluscs. Some species play as hosts for trematodes causing *Schistosomiasis* in man.

Viviparid molluscs are dominant followed by Thiaridae and Planorbidae. *Bellamya bengalensis typica* is most common. 566 examples were collected of all the species.

The Krishna survey obtained 30 species of mollusca of which *Parreysia* (*Parreysia*) *favidens* var. *deltae* and *Parreysia* (*Radiatula*) *pachysoma* have not been so far recorded from South India. The former species is known from West Bengal and the latter from Eastern India, Bangladesh and Burma. the occurrence of these species in River Krishna, at Rabkavi, Jamkhandi, Karnataka; Haripur, Sangli; Digraj, Maharashtra are first new records.

* The assistance rendered by Dr. N.V. Subba Rao, Joint Director, Zoological Survey of India in identifying the mollusc species is gratefully acknowledged.

Corbicula peninsularis is known by its type from Bombay. The find of additional material from Sangli, Maharashtra is of interest.

Parreysia (Parreysia) cylindrica is known from Yenna river, Krishna watershed at Medha. The collection of this species from Rekulampally, Gadwal, Andhra Pradesh and Satara, Maharashtra is of interest.

It is worth recording here that out of the 30 species of molluscs nine are known to harbour Cercariae infesting mammals and birds. In most of the localities where these occur water is used for washing and bathing cattle. Intense infections are carried to cattle because of these mollusca harbouring Cercariae (Table 10.1.1.).

The species collected with the total number of specimens in brackets is given below.

Phylum MOLLUSCA

Class GASTROPODA

Order ARCHAEOGASTROPODA

Family NERITIDAE

1. *Neritina (Dostia) violacea* (Gmelin) Kurnool. (9)

Order MESOGASTROPODA

Family PILIDAE

2. *Pila virens* (Lamarck)

Satara, Jamkhandi. (7)

Family VIVIPARIDAE

3. *Bellamyia bengalensis* f. *typica* (Lamarck)

Umbraj, Miraj, Sangli, Mahsal, Digraj, Bagalkot, Jamkhandi, Babaladi, Raichur, Krishna bridge, Mantralayam, Krishna Agraharam. (75)

4. *Bellamyia bengalensis* f. *Annandale* (Kobelt)

Pachwad, Umbraj, Sangli, Haripur, Jamkhandi, Babaladi, Rabkavi, Krishna Agraharam, Rekulampally, Lingalagattu, Nawab's bungalow, Nagarjunasagar. (160)

5. *Bellamyia bengalensis* f. *eburnea* (Annandale)

Muddebihal, Rabkavi, Sunkasela, Nagarjunasagar. (10)

6. *Bellamyia dissimilis* (Mueller) Jamkhandi, Raichur, Krishna Agraharam, Dindi reservoir. (7)

Family BITHYNIDAE

7. *Gabbia orcula* var *producta* (Nevill)

Rabkavi, Lingalagattu, Nawab's bungalow, Nagarjunasagar. (12)

8. *Digoniostoma cerameopoma* (Benson)
Nagarjunasagar. (1)
9. *Digoniostoma pulchella* (Benson)
Konda, Nagarjunasagar. (5).
Family THARIDAE
10. *Thiara (Tarebia) lineata* (Gray)
Mahsal, Digraj, Muddebihal, Rabkavi, Mantralayam, Kurnool, Sunkasela,
Nagarjunasagar. (17)
11. *Thiara (Thiara) scabra* (Mueller)
Ondishi, Pachwad, Umbraj, Mahsal, Haripur, Bhilwada, Bagalkot, Muddebihal,
Rabkavi, Krishna Agraharam, Lingalagattu, Nawab's bungalow, Sunkasela,
Nagarjunasagar. (61)
12. *Thiara (Stenomelania) torulosa* (Bruguiere)
Kurnool, Mantralayam. (7)
13. *Thiara (Melanoides) tuberculata* (Mueller).
Satara, Pachwad, Umbraj, Haripur, Muddebihal, Jamkhandi, Rabkavi, Nawab's
bungalow, Nagarjunasagar. (37)
Family POTAMIDIDAE
14. *Telescopium (Telescopium) telescopium* (Linnaeus).
Nagayalanka. (5)
Order BASOMATOPHORA
Family LYMNAEIDAE
15. *Lymnaea (Pseudosuccina) acuminata f. rufens* (Gray)
Dhom reservoir, Rabkavi, Nawab's bungalow. (4)
16. *Lymnaea (Pseudosuccina) luteola f. typica* (Lamarck)
Dhom reservoir, Rethere. (16)
Family PLANORBIDAE
17. *Gyraulus convexiusculus* (Hutton)
Rabkavi, Cinchodi village (Raichur). (4)
18. *Indoplanorbis exustus* (Deshayes)
Mahuli, Pachwad, Pandarpur, Rabkavi, Krishna bridge (Raichur), Nawab's
bungalow, Dindi reservoir. (50)

Order STYLOMMATOPHORA

Family ARIOPHANTIDAE

19. *Cryprozona ligualata* (Ferussac)

Satara. (1)

Class BIVALVIA

Order ARCOIDA

Family ARCIDAE

20. *Anandara granosa* (Linnaeus)

Nagayalanka.(1)

Order UNIONOIDA

Family UNIONIDAE

21. *Lamellaxis gracile* (Hutton)

Pandarpur.(1)

22. *Lamellidens marginalis* (Lamarck)

Mahsal, Miraj, Bhilwada, Babaladi, Krishna bridge, (Raichur), Dindi reservoir.
(10)

23. *Parreysia favidens* var *marcens* (Benson)

Miraj, Mahsal, Bhilwada, Muddebihal, Babaladi, Krishna bridge. (8)

24. *Parreysia (p) favidens pinax* (Benson)

Mahsal. (5).

25. *Parreysia favidens deltae* (Benson)

Mahsal, Babaladi, Krishna bridge, (4)

26. *Parreysia cylindrica* Annandale and Prashad.

Marul village, Umbraj, Krishna village (Raichur), Dindi reservoir.(11)

27. *Parreysia (Radiatula) caerulea* (Lea)

Umbraj, Mahsal, Digraj, Krishna bridge. (7)

28. *Parreysia (Radiatula) pachysoma* (Benson)

Miraj, Bhilwada, Muddebihal, Babaladi, (12)

Order VENEROIDEA

Family CORBICULIDAE

29. *Corbicula straitella* Deshayes Sangli, Mahsal, Bagalkot, Rabkavi. (10)30. *Corbicula peninsularis* Prashad

Umbraj, Sangli, Mahsal, Rekulampally, Nawab's bungalow, Sunkasela. (9)

TABLE. 10.1.1 *Gastropods (Snails) of the Krishna River System which are possible carriers of cercarial infection*

Sl. No.	Name of Species	No. of exs.	Carrier of Cercarial Infection
1.	<i>Neritina (Dastia) violacea</i>	9	Not known
2.	<i>Pila virens</i>	7	No
3.	<i>Bellamya dissimilis</i>	7	No
4.	<i>Gabbia orcula producta</i>	12	Not known
5.	<i>Thiara scabra</i>	61	Yes
6.	<i>Thiara torulosa</i>	7	No
7.	<i>Thiara lineata</i>	17	No
8.	<i>Lymnea luteola</i>	16	Yes
9.	<i>Gyraulus convexiusculus</i>	4	Yes
10.	<i>Indoplanorbis exustus</i>	50	Yes

10.2. CRUSTACEA

Macrobrachium malcolmsonii and *M. lamariei* are the two common species of Prawns occurring in the river system. At Macherla a considerable catch was seen exported during the postmonsoon survey in December, 1988. Mainly sent to Calcutta, the catch was from below the Nagarjunasagar reservoir at places as Ekonampet and Buggavagu. Mostly seasonal these were not seen much during the premonsoon period of 1987. Several Islands in Avanigadda below Nagayalanka have taken to prawn farming. *Penaeus indicus* and *P. monodon* are cultivated. An yeild of 100 to 200 kg per acre is reported.

Freshwater crabs *Paratelphusa (Paratelphusa) jacquamontii* were common throughout the stretch. At Miraj, Maharashtra; Jamkhandi, Karnataka; Kurnool, Vijayapuri, Andhra Pradesh these were sold in markets in some quantity. The

appendages are broken mercilessly even when the animal is alive. These are locally consumed as the catch is not of sufficient quantity.

Some data of landings of Prawns and Crabs in Krishna estuary are given in Table 10.2.1.

TABLE 10.2.1. Landing data of Prawns and Crabs in Krishna estuary

	1986	1987	1985-86	1986-87
	(In Tonnes)			
All Species	7008	7614	6988	7017
Penaeids only	9538	9537	9340	9537
Non penaeids, Crabs and other crustaceans	1842	2155	1739	2155

MATERIAL COLLECTED
CRUSTACEA : PRAWNS

Date	Species	Loc.	ex.	Size in mm	
				min	max
28.06.1984	<i>Macrobrachium dobsoni</i>	Ekonampet	2	38	48.5
31.05.1988	<i>Macrobrachium lamaritii</i>	Sunkasela	25	31	59
21.01.1990	<i>Macrobrachium malcolmsonii</i>	Nagayalanka	2	58.5	153.5
30.06.1989	<i>Macrobrachium malcolmsonii</i>	Ramapuram	3	165.5	170
31.05.1988	<i>Macrobrachium scabriculum</i>	Sunkasela	1		51.5
22.01.1990	<i>Penaeus indicus</i>	Ethurumondi	12	43.5	103.5
		Reservoir			
		Yesupuram			
22.01.1990	<i>Penaeus monodon</i>	Yesupuram	2	120	150
22.01.1990	<i>Metapenaeus monoceros</i>	Yesupuram	2	38	48.5

CRABS

DECAPODA : PORTUNIDAE

Scylla serrata (Forsskal) - 10 exs.

POTAMONIDAE

Paratelphusa (Paratelphusa) jacquamontii Rathban -22 exs.

10.3. REPTILIA

Crocodilus palustris (Lesson)

A single example (photo 12) caught at Babaladi during fishing operations indicates its occurrence in the river sporadically. It is harmful to fisheries.

11. FISHING TECHNOLOGIES

River fishing is intensive only at some centres in each of the three states through which the river flows. As there is no licensing system for river fishing, fishermen move up and down the river stretches depending upon the availability of fish in "gundams" "pools" and stagnant areas dispersed sporadically. Fish are caught regularly in water impoundments caused by dams, barrages or weirs. Thus at Dhom, Koyana (Maharashtra), Almatti, Rabkavi, Rajolibandha (Karnataka), Sri Sailam, Nagarjunasagar, Sunkasela, Vijayawada, (Andhra Pradesh) regular fishing to a profitable extent is carried out by fishermen who form individual groups or as fishermen co-operative society members. Migratory fishermen as in Dhom (from Andhra Pradesh) and at Sri Sailam (from Tamil Nadu) are also seen. At Haripur, Sangli, Rabkavi and Vijayawada for instance, the barrages put up across the river form a large reservoir like area from where fishermen obtain heavy catch of Rohu, Mrigal, Catla, *Aorichthys seenghala* and others. The overflow from these barrages form a good fishing ground for smaller species as *Danio*, *Salmostoma*, *Mystus*, etc. by cast net.

Fishermen and women as a distinct caste are found all over. In Avanigadda taluk, in 13 villages, there were 4520 fishermen, 4713 fisherwomen, of whom only 2260 were active. (Data supplied by Inspector of fisheries, Nagayalanka). At Rethere K.H (Maharashtra) 92 fishermen of Bhoi caste live. Fishing is mainly restricted to certain periods on an average of 280 days in a year, the flood season being avoided. The month of "Sraavan" is being observed as closed period on religious beliefs. The fishermen take other manual labour as agriculture during such periods. David (1963) estimated 365 fishermen of Tungabhadra in a length of about 107 km above Sunkasela, 90 below (upto Kurnool) and 150 upto the confluence with Krishna. In Satara district, 24 fishermen co-operative societies with 479 members in 17 villages along the Krishna river are in existence. These are at Patan, Koyana, Umbraj, Rethere, Bhuyachiwadi, Wai, Kaner, Karad, Narayanwadi, Kole, Atke, Masur, Slrode, Kirpe, Kapil, Sere and Kese. These societies landed 360, 540, 660 metric tonnes of fishes in the years 1984-85, 1985-86 and 1986-87 respectively. On an average a fisherman catches 2 or 3 kg per day.

Mostly cast nets, gill nets, bamboo traps, are used for catching fish. Many fishermen own their nets, the fibre being synthetic yarn. At Haripur, 5 km from Sangli (Maharashtra) a purse seine like net called "odap" is used. Five or six gill nets of 2.5 to 5.0 cm mesh size, each with a height of about 2 or 3 meters, and 15 meter long are tied up in such a manner to form a vertical wall across the width of the river. The two ends of the net are tied with coir ropes and floats either of plastic jerry can or of empty tins are tied. Sinkers are made of stone or lead pieces. The drag ropes which will remain in water are tied with green leaves as foliage (photo 13), which serve as attractive baits. The net is set with the help of two boats and well is formed inside. While slowly dragging the nets (photo 14) the fishermen splash the water to make a loud noise. Invariably a good haul of fish is obtained. A similar practice was seen in Babladi, Jamkhandi (Karnataka) (see photos 15 to 18). Generally

10 to 15 fishermen join in such an operation and the dragging is done twice a day at selected places of the river. Lessee contractors engage the fishermen on a daily wage basis of Rs.20/- to Rs.25/- per day. At Nagayalanka, near Yesupuram a larger net is used in such a dragging operation in the estuary. The net is 400 fathoms long, 8 meter in height, 1" mesh made of monofilament Nylon. Plastic floats of red colour are used. Two boats and 10 to 15 (average 14) fishermen are engaged in the work. Between the tides the dragging is done for an hour once a day. The catch varies from 50 to 300 kg.

Small species as *Noemacheilus*, *Botia*, *Chela*, *Salmostoma* are thrown away in Maharashtra. In Karnataka, *Osteobrama cotio cunma* were discarded in large numbers irrespective of size as not saleable in the market.

The fishermen use plantain stems as boats to swim about or tie around them two empty tins or sit afloat a tyre. The catch is taken away in cycles, vans, tempos to nearby marketing centres. Middlemen are always the chief agents to benefit. At Nagayalanka fish below 1 kg were purchased by these men @ Rs.15/-. A good quantity is iced at Nagayalanka and sent by lorries to Howrah.

Gill nets called Eduvala 3x3 cm mesh and a meter wide are used in Rabkavi, Huvinahadagi, Sunkasela, Lingalagattu, Nagarjunasagar, Ramapuram, Pondugala, Regulagadda, Ibrahimpatnam. The nets are drift set overnight and the catch collected next day early morning.

At Dhom reservoir, Satara district, a single species fishing is practised. Groups of fishermen from Rajahmundry, Andhra Pradesh migrate to Dhom on the service of a middleman. Each group consists of 10 people, men and women, and they use a close mesh 0.5 cm size over 30 m long, 3 m wide purse seine like drag net, which is operated in the reservoir. The fishing is done for 15 days in a month, for seven or eight months in a year. The operation is carried out 4 or 5 times a day and 800 to 1000 kg of *Salmostoma* species locally called "Amla" are caught and sun dried (see photo 19). 95% of the catch comprises only of this. This fishing is being carried on since 1980 and the dry fish are sold @ 5/- a kg. About 80% of water is lost because of drying. No other species come in this net in such large numbers. It is worth recording that as is usual with newly constructed reservoirs no major carps or catfishes or any other Cyprinid is obtained when the mesh size is so small. The fishery of *Salmostoma* species in the Deccan region is an annual one and the species is very prolific. The stock that survives builds up the population every year probably with a small fluctuation. This problem needs intense study.

Cast nets are extensively used throughout, the size and mesh, varying from place to place. At Pondugala, Guntur district, the net is large but the river is infested with weeds. After every operation they dry the net (see photo 20) on the bank to get rid of the weeds. At Gadwal, Rekulampally where the river flows through gorges, rocks and boulders (photos 21,22,23,24), the net is of medium size, handy and very efficient for the fishermen to throw them perched from precipitous rocks to reach the water below(see photos 25,26). At Beechampally, Lingalagattu (Sri Sailam) where the water is shallow over a boulderous bed, the net is small, easily thrown over from

a coracle (see photos 27,28). Bamboo traps called "Mavulu" are in vogue at Buggavagu reservoir of Nagarjunasagar mainly to catch crabs and catfishes (see photo 29). This is practised at Dindi reservoir, Satrashala, where the diversion of the river to irrigation channels are blocked with these traps.

Dynamiting pools, isolated river stretches, etc. are on increase. Nagarjunasagar reservoir areas, Sri Sailam, Dindi, Babaladi, Rabkavi, Mahsal are places where during the period of the visit fishes were offered by the fishermen from such a haul. Near Mutchumari (Nandikotkur) the backlash of Sri Sailam reservoir fills up the river and the area is a Reseve Forest. Tribal men and women poach fish illegally by such practices and sell them at Kurnool fish market.

Poisoning with roots is not that prevalent excepted Wai where the tribals resort to this for getting *Glyptothorax*, *Botia*, *Garra*, *Noemacheilus* species which attach themselves to crevices and boulders. At Wai, Karad fish markets many examples of *Garra mullya* are seen.

Coracles made of buffalo hide over a bamboo frame are extensively used. At Digraj (Dec. 1987) a round coracle like craft made of metal was very efficient in crossing the narrow river (150 ft. wide). Canoes made of wood are used in lower reaches below Vijayawada. At Nagayalanka area out of 340 crafts 9 are mechanised; 83 navas are of 18 feet long, 35 of 21 feet, 160 of 27 feet and 53 of 36 feet. Total nets in use are 22224 the break up of which is as below:

(May 1989)

Stake nets	996	Gill nets	17989
Cast nets	1542	"Alivi vala"	105
"Konte vala"	296	Others	1296

STRETCHES OF RIVER MAINLY USED FOR FISHING

MAHARASHTRA

Of the 290 km stretch of the river in the state nearly 165 km are used for fishing. The centres are as below:

1. River Krishna at Haripur 5 km from Sangli town.
2. River Krishna at Bhilwada 22 km from Sangli upstream.
3. River Krishna at Digraj 13 km upstream from Sangli town.
4. River Krishna at Miraj 13 km from Sangli town.
5. River Krishna at Pachwad 3 km near Karad.
6. River Krishna at Rethere 13 km from Karad.
7. River Koyana at Marul village, 11 km from Koyana Dam.
8. River Koyana at Patan 37 km from Karad.
9. River Krishna at Mahuli village near Satara Railway Station 5 kms from Satara.

10. River Krishna at Wai 50 km from Satara.
11. River Krishna at Menavali village near Dhom Reservoir.
12. River Krishna at Vatali at Asari vilalge 8 kms from Wai.
13. River Panchaganga at Shivaji pool, Kolhapur.

KARNATAKA

The river, as already stated, is hedged in between Sri Sailam and Dhom reservoir and the fishing areas are few. The following are the centres.

1. R. Ghataprabha at Bagalkot (poor fishing).
2. Muddebihal, 60 kms Bijapur catch from Almatti and Narayanpur dam.
3. R. Krishna at Rabkavi, 20 km southwest of Jamkhandi.
4. R. Krishna at babaladi, 20 km from Jamkhandi.
5. R. Krishna at Huvinahadagi, 11 km from Deodrug.
6. R. Tungabhadra at Rajolibandha, 40 kms South of Raichur.
7. R. Tungabhadra at Mantralayam (poor fishing).
8. Fishing centres further down Tungabhadra were not covered.

ANDHRA PRADESH

The river extends to 576 km but intense fishing activity is limited to 150 to 200 km only. No fishing is legally allowed beyond Mutchumari as it falls under Sri Sailam Reserve Forest Area. Stretches which are used for fishing and the centres areas below.

1. R. Krishna at Rekulampally, Gadwal.
2. R. Krishna at Jurala Dam, 13 km frm Gadwal.
3. R. Krishna at Lingalagattu, Sri Sailam.
4. R. Krishna at Mutchumari, Nandikotkur, Kurnool.
5. R. Tungabhadra at Sunkasela.
6. R. Krishna at Ekonompet 5 km east of Vijayapuri.
7. R. Krishna at Satrashala, 43 km from Macherla.
8. R. Krishna at Pondugala, 13 km from Dacheppalle.
9. R. Krishna at Ramapuram, 21 km from Dacheppalle.
10. R. Krishna at Bhadrupalem 13 km from Dacheppalle.
11. R. Krishna at Regulagadda 41 km from Dacheppalle.
12. R. Krishna and its canals at Vijayawada.
13. R. Krishna at Nagayalanka and below upto Yesupuram.

The reservoirs (listed on p. 15-16) have their own fishing.

Some data of fishermen, craft, tackle, fish production (total and group wise) are presented in Tables 11.1 and 11.2 respectively.

TABLE 11.1. Data as gleaned from Fisheries Statistics of Andhra Pradesh Fisheries Dept. (1988)

SI No	Districts	Mahbubnagar	Kurnool	Nalgonda	Guntur	Krishna
Data particulars	I	II	III	IV	V	
1. Number of marine fishing villages					16	29
2. Number of landing centres (Marine)					9	26
3. Number of marine fishermen					3960	4658
4. Fishermen Population						
Males	6125	1269	8765	6655		13,005
Females	5783	967	8683	6057		11,778
Children	8133	1160	10,997	8229		16,583
5. Active Fishermen						
Full Time	964	901	2166	4652		6992
Part Time	4836	137	1870	1916		3777
Occasional				473		790
6. Fishing Craft						
Mehanised				202		159
Non-Mechanised Navas				700		294
7. Fishing Tackle						
Drag Nets	1431		1048	6190		6948
Gill Nets	242	153	1203	448		2663
Cast nets	2944	678	3007	2046		3755
Trawl nets	293		81	437		772
8. Fish production (In Tonnes 1987)						
Marine				10469		4054
Inland	6747	797	5845	1394		3069
Total	6747	797	5845	11863		7123
1987-88 (In Tonnes)						
Marine				10600		2393
Inland	6982	825	6042	1445		3169
Total	6982	825	6042	12045		5562
9. Cooperative Societies 1986-87	208	51	159	97		188

TABLE 11.2: SPECIES WISE INLAND FISH PRODUCTION IN KRISHNA BASIN OF ANDHRA PRADESH

Group	1986	1987	1985-86	1986-87
	IN TONNES		IN TONNES	
Carps	41089	44643	40970	41140
Catfishes	9445	10262	9417	9456
Murrel	16205	17607	16158	16285
Mullets	2393	2601	2386	2316
Hilsa	2437	2647	2480	2440
Miscellaneous	21843	23733	21780	21871

12. FISH FAUNA

Investigations on the fish fauna of the entire Krishna river system or for that matter either of Krishna, of Tungabhadra or of Bhima, from their origin to confluence have not been attempted so far. The only noteworthy study is of David (1963) who undertook a survey of the middle and lower reaches of Krishna and Godavari in the Andhra Pradesh region only during February - March 1958. The area covered by him was from Moravakonda to Vijayawada on Krishna from Hospet to Kurnool on Tungabhadra and none on Bhima. The work done on Krishna earlier to David has already been reviewed.

David (1963) listed 132 species from the Krishna river system alone, of which 38 species were based on earlier records and 94 collected by him. *Barilius evezardi* was rediscovered from Krishna after Day's (1872) description. *Labeo pangusia* was suspected to be occurring in Thungabhadra also, based on a personal communication (David). *Schismatorhynchus nukta* is marked with an asterik (David, 1963) indicating that he obtained specimens but the river system is not indicated. *Collsa fasciatus* along with *Anabas testudineus* is recorded from Collair lake but the latter species only is marked as occurring in Krishna also.

It has been found from the present investigation that Krishna and its tributaries harbours 195 species of fishes under 93 genera and 46 families. Of these, 154 species are represented by specimens and only 41 species could not be collected during the surveys because of their non-occurrence in those locations at the time of our visit or other reasons which are discussed in detail later. A systematic list of fish fauna is given in the following pages.

12.1. SYSTEMATIC LIST OF FISHES KNOWN FROM THE KRISHNA RIVER SYSTEM

CLASS OSTEICHTHYES (Bony Fishes)

SUB CLASS ACTINOPTERYGII

COHART I. TAENIOPAEDIA

SUPERORDER CLUPEOMORPHA

Order CLUPEIFORMES

Family I Clupeidae

Subfamily Pristigasterinae

Genus ***Ilisha*** Richardson1. *I. kampeni* (Weber and de Beaufort)

Subfamily Alosinae

Genus ***Hilsa*** Regan2. *H. ilisha* (Hamilton)Genus ***Gudusia*** Fowler3. *G. chapra* (Hamilton)

Subfamily Dorosomatinae

Genus ***Nematalosa*** Regan4. *N. nasus* (Bloch)

Family II Engraulidae

Subfamily Engraulinae

Genus ***Setipinna*** Swainson5. *S. phasa* (Hamilton)Genus ***Stolephorus*** Lacepede6. *S. commersonii* Lacepede7. *S. indicus* (van Hasselt)Genus ***Thryssa*** Cuvier8. *T. mystax* (Schneider)

SUPERORDER ELOPOMORPHA

Order ELOPIFORMES

Family III Elopidae

Genus ***Elops*** Linnaeus9. *E. machnata* (Forsk.)

Family IV Megalopidae

Genus ***Megalops*** Lacepede

10. *M. cyprinoides* (Broussonet)

Order ANGUILLIFORMES

Family V Anguillidae

Genus *Anguilla* Shaw

11. *A. bengalensis bengalensis* (Gray & Hardwicke)
12. *A. bicolor bicolor* (McClelland)

COHART II ARCHAEOPHYLACES

SUPERORDER OSTEOGLOSSOMORPHA

Order OSTEOGLOSSIFORMES

Family VI Notopteridae

Genus *Notopterus* Lacepede

13. *Notopterus notopterus* (Pallas)

COHART III EUTELEOSTEI

SUPERORDER PROTACANTHOPTERYGII

Order GONORHYNCHIFORMES

Family VII Chanidae

Genus *Chanos* Lacepede

14. *Chanos chanos* (Forsk.)

SUPERORDER OSTARIOPHYSI

Order CYPRINIFORMES

Family VIII Cyprinidae

Subfamily Cultrinae

Genus *Chela* Hamilton.

15. *C. (Chela) cadius* Hamilton
16. *C. (Chela) laubuca* (Hamilton)

Genus *Salmostoma* Swainson

17. *S. acinaces* (Valenciennes)
18. *S. boopsis* (Day)
19. *S. clupeoides* (Bloch)
20. *S. novacula* (Valenciennes)
21. *S. horai* (Silas)
22. *S. longicauda* Srithar and Jayaram
23. *S. phulo phulo* (Hamilton)

Subfamily Rasborinae

Genus *Esomus* Swainson

24. *E. barbatus* (Jerdon)
25. *E. danricus* (Hamilton)

Genus **Danio** Hamilton

26. *D. aequipinnatus* (McClelland)
27. *D. devario* (Hamilton)
28. *D. malabaricus* (Jerdon)
29. *D. (Brachydanio) rerio* (Hamilton)

Genus **Rasbora** Bleeker

30. *R. daniconius daniconius* (Hamilton)
31. *R. rasbora* (Hamilton)

Genus **Aspidoparia** Heckel

32. *A. morar* (Hamilton)

Genus **Amblypharyngodon** Bleeker

33. *A. melettina* (Valenciennes)
34. *A. mola* (Hamilton)

Genus **Barilius** Hamilton

35. *B. barila* (Hamilton)
36. *B. barna* (Hamilton)
37. *B. bendelisis bendelisis* (Hamilton)
38. *B. canarensis* (Jerdon)
39. *B. evezardi* Day
40. *B. gatensis* (Valenciennes)

Subfamily Cyprininae

Genus **Oreichthys** H.M. Smith

41. *O. cosuatis* (Hamilton)

Genus **Puntius** Hamilton

42. *P. amphibius* (Valenciennes)
43. *P. carnaticus* (Jerdon)
44. *P. chola* (Hamilton)
45. *P. curmuca* (Hamilton)
46. *P. dorsalis* (Jerdon)
47. *P. filamentosus* (Valenciennes)
48. *P. jerdoni* (Day)
49. *P. kolus* (Sykes)
50. *P. lithopidos* (Day)

51. *P. fasciatus* (Jerdon)
52. *P. melanostigma* (Day)
53. *P. narayani* (Hora)
54. *P. parrah* Day
55. *P. sahayadriensis* Silas
56. *P. sarana sarana* (Hamilton)
57. *P. sophore* (Hamilton)
58. *P. terio* (Hamilton)
59. *P. ticto ticto* (Hamilton)

Genus **Rohtee** Sykes

60. *R. (Rohtee) ogilbii* Sykes

Genus **Osteobrama** Heckel

61. *O. belangeri* (Valenciennes)
62. *O. cotio cunma* (Day)
63. *O. neilli* (Day)
64. *O. vigorsii* (Sykes)

Genus **Thynnichthys** Bleeker

65. *T sandkhol* (Sykes)

Genus **Schismatorhynchus** Bleeker

66. *S. (Nukta) nukta* (Sykes)

Genus **Labeo** Cuvier

67. *L. ariza* (Hamilton)
68. *L. boga* (Hamilton)
69. *L. boggut* (Sykes)
70. *L. calbasu* (Hamilton)
71. *L. dussumieri* (Valenciennes)
72. *L. fimbriatus* (Bloch)
73. *L. goniuis* (Hamilton)
74. *L. kawrus* (Sykes)
75. *L. nigrescens* Day
76. *L. pangusisa* (Hamilton)
77. *L. porcellus* (Heckel)
78. *L. potail* (Sykes)
79. *L. rohita* (Hamilton)
80. *L. sindensis* (Day)

Genus **Tor** Gray

81. *T. khudree* (Sykes)
82. *T. mussullah* (Sykes)
83. *T. neilli* (Day)

Genus **Cirrhinus** Oken

84. *C. cirrhosa* (Bloch)
85. *C. fulungee* (Sykes)
86. *C. mrigala* (Hamilton)
87. *C. reba* (Hamilton)

Genus **Osteochilus** Gunther

88. *O. (Osteochilichthys) nashii* (Day)
89. *O. (Osteochilichthys) thomassi* (Day)

Genus **Catla** Valenciennes

90. *C. catla* (Hamilton)

Genus **Parapsilorhynchus** Hora

91. *P. tentaculatus* Annandale

Subfamily Garrinae

Genus **Crossocheilus** van Hasselt

92. *C. latius latius* (Hamilton)

Genus **Garra** Hamilton

93. *G. bicornuta* Rao
94. *G. gotyla stenorhynchus* (Jerdon)
95. *G. mullya* (Hamilton)

Family IX Psilorhynchidae

Genus **Psilorhynchus** McClelland

96. *P. balitora* (Hamilton)

Family X Cobitidae

Subfamily Botinae

Genus **Botia** Gray

97. *B. lohachata* (Chaudhuri)
98. *B. striata* Rao

Subfamily Cobitinae

Genus **Lepidocephalus** Bleeker

99. *L. (Lepidocephalichthys) guntea* (Hamilton)
100. *L. (Lepidocephalichthys) thermalis* (Valenciennes)

Family XI Homalopteridae

Subfamily Noemacheilinae

Genus **Noemacheilus** van Hasselt

- 101. *N. (Noemacheilus) anguilla* Annandale
- 102. *N. (Acanthocobitis) botia aureus* Day
- 103. *N. (Schistura) denisonii denisonii* Day
- 104. *N. (Indoreonectes) evezardi* Day
- 105. *N. (Acanthocobitis) moreh* (Sykes)
- 106. *N. (Noemacheilichthys) rueppelli* (Sykes)
- 107. *N. (Schistura) striatus* Day

Order SILURIFORMES

Family XII Bagridae

Genus **Rita** Bleeker

- 108. *R. gogra* (Sykes)
- 109. *R. kuturnee* (Sykes)

Genus **Mystus** Scopoli

- 110. *M. armatus* (Day)
- 111. *M. bleekeri* (Day)
- 112. *M. cavasius* (Hamilton)
- 113. *M. gulio* (Hamilton)
- 114. *M. krishnensis* Ramakrishnaiah
- 115. *M. malabaricus* (Jerdon)
- 116. *M. tengara* (Hamilton)
- 117. *M. vittatus* (Bloch)

Genus **Aorichthys** Wu

- 118. *A. aor* (Hamilton)
- 119. *A. seenghala* (Sykes)

Family XIII Siluridae

Genus **Ompok** Lacepede

- 120. *O. bimaculatus* (Bloch)
- 121. *O. pabo* (Hamilton)

Genus **Wallago** Bleeker

- 122. *W. attu* (Schneider)

Family XIV Schilbeidae

Subfamily Schilbeinae

Genus **Pseudeutropius** Bleeker

123. *P. atherinoides* (Bloch)

Genus **Proeutropiichthys** Hora

124. *P. taakree* (Sykes)

Genus **Neotropius** Kulkarni

125. *N. khavalchor* Kulkarni

Genus **Eutropiichthys** Bleeker

126. *E. goongwaree* (Sykes)

127. *E. vacha* (Hamilton)

Genus **Silonia** Swainson

128. *S. childreni* (Sykes)

Family XV Pangasiidae

Genus **Pangasius** Valenciennes

129. *P. pangasius godavarii* David

Family XVI Sisoridae

Genus **Bagarius** Bleeker

130. *B. bagarius* (Hamilton)

Genus **Nangra** Day

131. *N. itchkeea* (Sykes)

132. *N. viridescens* (Hamilton)

Genus **Glyptothorax** Blyth

133. *G. lonah* (Sykes)

134. *G. madraspatanum* (Day)

135. *G. trewavasae* Hora

136. *G. conirostrae poonaensis* Hora

Family XVII Clariidae

Genus **Clarias** Scopoli

137. *C. batrachus* (Linnaeus)

138. *C. dussumieri dussumieri* (Valenciennes)

Family XVIII Heteropneustidae

Genus **Heteropneustes** Muller

139. *H. fossilis* (Bloch)

Family XIX Ariidae

Genus **Arius** Valenciennes

140. *A. arius* (Hamilton)

141. *A. jella* Day

SUPERORDER ATHERINOMORPHA

Order ATHERINIFORMES

Family XX Hemiramphidae

Genus ***Hyporhamphus*** Gill

142. *H. limbatus* (Valenciennes)

Family XXI Belonidae

Genus ***Xenentodon*** Regan

143. *X. cancila* (Hamilton)

Family XXII Cyprinodontidae

Genus ***Oryzias*** Jordon & Snyder

144. *O. melanostigma* (McClelland)

Family XXIII Poeciliidae

Genus ***Gambusia*** Poey

145. *G. affinis patruelis* (Baird & Girard)

Genus ***Lebistes*** Filippi

146. *L. reticulatus* (Peters)

Family XXIV Platycephalidae

Genus ***Platycephalus*** Bloch

147. *P. crocodilus* Tilesius

148. *P. indicus* (Linnaeus)

SUPERORDER ACANTHOPTERYGII

Order CHANNIFORMES

Family XXV Channidae

Genus ***Channa*** Scopoli

149. *C. gachua* (Hamilton)

150. *C. marulius* (Hamilton)

151. *C. punctatus* (Bloch)

152. *C. striatus* (Bloch)

Order PERCIFORMES

Family XXVI Centropomidae

Genus ***Lates*** Cuvier

153. *L. calcarifer* (Bloch)

Family XXVII Chandidae

Genus ***Ambassis*** Cuvier

154. *A. commersonii* (Cuvier)

Genus **Chanda** Hamilton

155. *C. nama* (Hamilton)

156. *C. ranga* (Hamilton)

157. *C. thomassi* (Day)

Family XXVIII Teraponidae

Genus **Terapon** Cuvier

158. *T. jarbua* (Forsk.)

Family XXIX Sillaginidae

Genus **Sillago** Cuvier

159. *S. sihama* (Forsk.)

Family XXX Carangidae

Genus **Alepes** Swainson

160. *A. para* (Cuvier)

Genus **Carangoides** Bleeker

161. *C. jordani* (Nichols)

Genus **Caranx** Lacepede

162. *C. carangus* (Bloch)

Genus **Scomberoides** Lacepede

163. *S. lysan* (Forsk.)

Family XXXI Leiognathidae

Genus **Leiognathus** Lacepede

164. *L. brevirostris* (Valenciennes)

165. *L. equulus* (Forsk.)

166. *L. splendens* (Cuvier)

Family XXXII Lutjanidae

Genus **Lutjanus** Bloch

167. *L. johni* (Bloch)

168. *L. lutjanus* Bloch

Family XXXIII Gerreidae

Genus **Gerres** Cuvier

169. *G. filamentosus* Cuvier

170. *G. limbatus* Cuvier

Family XXXIV Sciaenidae

Genus **Daysciaena** Talwar

171. *D. albida* (Cuvier)

Family XXXV Scatophagidae

Genus **Scatophagus** Cuvier

172. *S. argus* (Linnaeus)

Family XXXVI Nandidae

Genus **Nandus** Valenciennes

173. *N. nandus* (Hamilton)

Genus **Pristolepis** Jerdon

174. *P. malabarica* (Gunther)

Family XXXVII Cichlidae

Genus **Etroplus** Cuvier

175. *E. maculatus* (Bloch)

176. *E. suratensis* (Bloch)

Family XXXVIII Mugilidae

Genus **Mugil** Linnaeus

177. *M.cephalus* Linnaeus

Genus **Liza** Jordon and Swainson

178. *L. macrolepis* (Smith)

179. *L. parsia* (Hamilton)

180. *L. tade* (Forsk.)

Genus **Rhinomugil** Gill

181. *R. corsula* (Hamilton)

Family XXXIX Psettodidae

Genus **Psettodes** Bennett

182. *P. erumei* (Schneider)

Family XL Cynoglossidae

Genus **Cynoglossus** Hamilton

183. *C. bilineatus* (Lacepede)

184. *C. lida* (Bleeker)

185. *C. semifasciatus* Day

Family XLI Gobiidae

Subfamily Gobinae

Genus **Awaous** Valenciennes

186. *A. stamineus* (Valenciennes)

Genus **Glossogobius** Gill

187. *G. giuris giuris* (Hamilton)

Subfamily Apocryptinae

Genus ***Pseudapocryptes*** Bleeker

188. *P. lanceolatus* (Bloch & Schneider)

Family XLII Gobioididae

Subfamily Trypaucheninae

Genus ***Trypauchen*** Valenciennes

189. *T. vagina* (Bloch & Schneider)

Family XLIII Anabantidae

Genus ***Anabas*** Cuvier

190. *A. testudineus* (Bloch)

Family XLIV Belontiidae

Subfamily Macropodinae

Genus ***Macropodus*** Lacepede

191. *M. cupanus* (Valenciennes)

Order MASTACEMBELIFORMES

Family XLV Mastacembelidae

Genus ***Macrogathus*** Lacepede

192. *M. aculeatus* (Bloch)

Genus ***Mastacembelus*** Scopoli

193. *M. armatus armatus* (Lacepede)

194. *M. pancalus* (Hamilton)

Order TERAODONTIFORMES

Family XLVI Tetraodontidae

Genus ***Tetraodon*** Linnaeus

195. *T. fluviatilis* Hamilton

12.2. ANALYSIS OF FISH FAUNA

Criteria for assessing the quality of a fish differ from area to area of our country besides the components of the fish itself. Thus, whilst murrels are a delicacy in the Telengana region of Andhra Pradesh, it is not so in W. Bengal where "Rohu" "Mrigal" are preferred. In the hill districts of West Coast as Konkan, Catfishes are preferred: down below in Kerala and coastal Tamil Nadu, and Andhra Pradesh sea fishes are in demand. Even in fresh fish some prefer the pond or tank reared ones whereas others desire the river fish.

Componentwise fish quality is also assigned by its bony contents, oily nature, capability to remain alive out of water, fibre composition etc. Many prefer the oil sardine but those in inland areas may shun its uses. *Pangasius pangasius*, *Wallago attu*, *Bagarius bagarius* which are considered foul feeders, are not uniformly accepted by all in the country.

In general it may be taken that a fish which has the maximum quantity of organic matter can be classified as a quality fish. Such fish should have a rapid growth rate and should be able to use the available natural food resources efficiently. A fish which can convert decaying organic matter or algae directly into edible fish flesh is superior to others. This is the reason for classifying herbivorous and detritus feeding fishes which are non- predacious as quality ones.

In respect of the Krishna fish, for purposes of grading, the maximum size to which the concerned species is known to grow can alone be taken. Weight of fish is a function of its length, although in Nature the body proportions of fish continually change with ageing. Further, in a study as the present one, where samples were taken at a location only once on a particular date, computation of length weight relationship is not practicable. Hence the maximum known length alone is taken as grading criteria.

David (1963) classified the fish into three categories based on size, major forms 500 mm and above, medium size, 250-450 mm and small sized below 250 mm. I have divided the Krishna fish into four categories: Quality A. 300 to 900 mm, quality B 200 to 300 mm. C. 150 to 200 mm and D below 150 mm. In the survey it was seen that fishes even of 20 cm. and above fetched a good price and those 30 to 50 cm were really highly priced, mostly being sold as cut pieces at places like Karad, Miraj, Muddebihal, Kurnool, Nagarjunasagar, Vijayawada. In interior areas of Karnataka (Jamkhandi, Raichur) and Andhra Pradesh (Gadwal, Macherla, Nagayalanka) fishes of even 15 cm and below are purchased though an individual specimen of most species may not have a good flesh content. Thus, in view of the prevailing market conditions, I have grouped the fish into four categories instead of three as was done by David.

On the basis of the above criteria, species obtained in the survey and falling under different categories are listed with their maximum known size and size range. It may be mentioned that the maximum known sizes have been recorded from data

published by Day (1878), Hora and Pillay (1962), Misra (1962), Badola and Singh (1981) and Tilak and Sharma (1982). The size range recorded are of specimens actually collected or seen during the survey. Large sized specimens of fishes as major carps, some catfishes as *Aorichthys aor*, *A. seenghala*, *Bagarius bagarius*, *Wallago attu* etc. were measured and data taken; but these were not preserved.

As is to be expected Cyprinidae with 83 species followed by Siluroids with 36 species dominate the faunal composition. All other families trail behind with single digit species, the maximum claimed by Homalopteridae.

On this basis it is seen that 63 species come under Category A, 15 under B, 30 under C and 46 species under D. (154 collected, 41 missing, total 195).

12.2.1. CATEGORY A

Species which attain a size of 300 to 900 mm and above (1 to 3 feet and above)

Species	Known Maximum size mm	Size Range obtained mm
A₁ 900 mm (3 feet) and above		
Family CHANIDAE		
1. <i>Chanos chanos</i>	914	207
Family CYPRINIDAE		
2. <i>Labeo calbasu</i>	914	400-805
3. <i>Labeo rohita</i>	960	96-207
4. <i>Tor khudree</i>	1447	33-205
5. <i>Cirrhinus mrigala</i>	914	91-222
6. <i>Catla catla</i>	1828	627-943
Family BAGRIDAE		
7. <i>Aorichthys aor</i>	1828	350
8. <i>Mystus krishnensis</i>	1650	131-336
Family SILURIDAE		
9. <i>Wallago attu</i>	1828	252
Family SISORIDAE		
10. <i>Bagarius bagarius</i>	1524	300
Family CHANNIDAE		
11. <i>Channa marullius</i>	1219	162-265
12. <i>Channa striatus</i>	914	109
Family CENTROPOMIDAE		

13. <i>Lates calcarifer</i>	914	101-109
Family SCIAENIDAE		
14. <i>Daysciaena albida</i>	900	127
Family MUGILIDAE		
15. <i>Mugil cephalus</i>	914	40-208
A₂ 600 to 899 (2 to 3 feet)		
Family ELOPIDAE		
16. <i>Elops machnata</i>	812	96-149
Family MEGALOPIDAE		
17. <i>Megalops cyprinoides</i>	600	170
Family NOTOPTERIDAE		
18. <i>Notopterus notopterus</i>	609	74-250
Family CYPRINIDAE		
19. <i>Puntius carnaticus</i>	600	59-185
20. <i>Labeo pangusia</i>	600	74-112
Family SCHILBEIDAE		
21. <i>Silonia childreni</i>	635	118-247
Family MUGILIDAE		
22. <i>Liza macrolepis</i>	600	60-124
Family MASTACEMBELIDAE		
23. <i>Mastacembelus armatus armatus</i>	609	34.5-321
A₃ 300 to 599 mm (1 to 2 feet)		
Family ANGUILLIDAE		
24. <i>Anguilla bicolor bicolor</i>	553	193-667
Family CYPRINIDAE		
25. <i>Puntius jerdoni</i>	457	44-197
26. <i>Puntius kolus</i>	304	43-239
27. <i>Puntius sarana sarana</i>	304	48-188
28. <i>Schismatorhynchus nukta</i>	304	74-148
29. <i>Labeo boga</i>	304	70-133.5
30. <i>Labeo fimbriatus</i>	457	99-415
31. <i>Labeo nigrescens</i>	450	165
32. <i>Cirrhinus cirrhosa</i>	457	83-177
33. <i>Cirrhinus fulungee</i>	304	83-109

34. <i>Cirrhinus reba</i>	304	53-250
35. <i>Osteochilus thomassi</i>	304	132-214
36. <i>Garra mullya</i>	350	34-117
Family BAGRIDAE		
37. <i>Rita gogra</i>	304	78-304
38. <i>Mystus cavasius</i>	457	52-198
39. <i>Mystus gulio</i>	500	75-131
40. <i>Aorichthys seenghala</i>	400	311
Family SILURIDAE		
41. <i>Ompok bimaculatus</i>	304	117-243
Family SCHILBEIDAE		
42. <i>Proeutropichthys taakree</i>	450	96
43. <i>Eutropiichthys vacha</i>	304	279
Family CLARIIDAE		
44. <i>Clarias batrachus</i>	457	200
Family ARIIDAE		
45. <i>Arius arius</i>	465	137-140
46. <i>Arius jella</i>	310	115-240
Family HEMIRAMPHIDAE		
47. <i>Hyporhamphus limbatus</i>	304	101-125
Family BELONIDAE		
48. <i>Xenentodon cancila</i>	304	146-266
Family PLATYCEPHALIDAE		
49. <i>Platycephalus crocodilus</i>	375	148-230
50. <i>Platycephalus indicus</i>	314	175
Family CHANNIDAE		
51. <i>Channa punctatus</i>	304	69-191
Family TERAPONIDAE		
52. <i>Terapon jarbua</i>	325	50-100
Family SILLAGINIDAE		
53. <i>Sillago sihama</i>	304	151-167
Family CARANGIDAE		
54. <i>Scomberoides lysan</i>	500	97
Family LUTJANIDAE		
55. <i>Lutjanus lutjanus</i>	300	89
Family SCATOPHAGIDAE		
56. <i>Scatophagus argus</i>	300	36-70

Family CICHLIDAE		
57. <i>Etroplus suratensis</i>	300	73-157
Family MUGILIDAE		
58. <i>Liza parsia</i>	400	60-124
59. <i>Liza tade</i>	470	195
60. <i>Rhinomugil corsula</i>	457	57-187
Family PSETTODIDAE		
61. <i>Psettodes erumei</i>	400	85-94
Family GOBIIDAE		
62. <i>Glossogobius giuris giuris</i>	304	87-184
Family MASTACEMBELIDAE		
63. <i>Macrornathus aculeatus</i>	375	113-198

Some of these species call for comments.

A₁ CATEGORY

900 mm and above (above three feet)

Chanos chanos, the Milk fish is a herbivorous marine and estuarine fish of which a single male example 420 mm long was obtained at Pulligadda near Avanigadda during premonsoon period of July 1989. While larvae of 12 to 15 mm are reported to occur in great quantities from March to August, adults are said to be comparatively scarce at this period. Suitable for cultivation in fresh and brackishwater ponds, culture of this in the estuarine areas of Krishna does not appear to be very prevalent.

Major carps: *Catla catla*, *Cirrhinus mrigala*, *Labeo calbasu* and *Labeo rohita*

"Catla", "Mrigal" were obtained more in the middle and lower reaches upto Vijayawada than elsewhere in the upper reaches. Specimens of Catla were caught from the river at Huvinahadagi (stn. 41), Pondugala (stn.64), Ramapuram (stn.65) and Bhadrupalem (stn.66). Mrigal specimens were caught from the river at Pondugala, Eluru canal (stn.71), Ryves canal (stn. 72), and Ibrahimpatnam (stn.75). The presence of mrigal in the polluted waters of Eluru canal shows its adaptability. Being an omnivorous bottom feeder the occurrence of mrigal in these waters seem to be not unusual. It was obtained in Edurumondi reservoir in Yesupuram Island (stn. 81) also which is a rain fed artificial impoundment connected to Krishna periodically and stocked with Rohu and Calbasu.

Tor khudree, the Khudree Mahseer of Deccan, is confined to upper reaches only. Represented by 33 examples ranging in size from 33 to 205mm, it is very common in Satara and Sangli districts of Maharashtra. The eastern-most limit where the species occurs is Sri Sailam reservoir beyond which it has not been obtained.

Evidently the Sri Sailam dam acts as a barrier besides the fact that below Sri Sailam the terrain is also not very suitable for this species for its natural occurrence. Large scale transplantation of fry and fingerlings obtained by artificial hatching is in vogue following the researches of Kulkarni and his associates (Kulkarni, 1988, Ogale and Kulkarni, 1987). This could be attempted in reaches below Sri Sailam upto Vijayawada in suitable locations as Satrashala, and Ramapuram in Andhra Pradesh.

Catfishes *Aorichthys aor*, *Bagarius bagarius* and *Wallago attu* grow to 5 or 6 feet and the latter two are carnivorous whilst the former is an omnivore. These are present throughout the river except below Prakasam barrage. Representative examples were only taken. In Karad, Miraj, Jamkhandi, Kurnool, Dachepalle, Vijayawada these are extensively sold as cut pieces. At Kurnool, a large example of *Bagarius bagarius* was seen in the fish market, but the tribals cut it into pieces the specimen was obtained from the Sri Sailam Reserve forest area near Nehru Nagar and Mutchumari (near Nandikotkur) where the backlash of Sri Sailam Reservoir provides a rich fishing ground for poachers who dynamite the river stretches illegally.

Mystus krishnensis: Among the catfishes, *Mystus krishnensis*, the element confined to Tungabhadra and Krishna rivers calls for attention. It is a giant *Mystus* species, the largest of all Indian *Mystus* growing to 35 to 45 kg in weight. Its presence in the Tunghabhadra reservoir was first noticed in 1972. On the advice of the author, Dr. Ramakrishnaiah of Central Institute of Capture Fisheries described it as a new species (1987). It occurs only in the middle reaches below Sri Sailam and Nagarjunasagar reservoir, upto Pondugala. It does not extend to Vijayawada, nor has it been so far obtained in the upper reaches. Fishermen ascribed that the village is named as Pondugala after the local name of this fish; but no specimens were obtained there. It forms a good fishing in Nagarjunasagar and Tunghabhadra reservoirs. A specimen of 25 kg weight was obtained at Gadwal (photo 30). Catches are sent to Calcutta from Macherla and Sri Sailam by road and rail.

The sizes recorded so far are as below (after Govind and Rajagopal, 1975).

Tungabhadra River specimens (Below the Dam).

4.8.1965	1650 mm TL	58.50 kg.
28.5.1965	1250 mm TL	11.00 kg.
19.2.1965	1130 mm TL	14.00 kg.

Tungabhadra Reservoir specimens

27.3.1964	1420 mm TL	29.024 kg.
23.1.1965	1214 mm TL	20.000 kg.

Murrels *Channa marulius* were collected from Haripur ghat, Sangli, Pandarpur, Ghataprabha at Bagalkot and Buggavagu reservoir from stagnant areas. The first three locations are polluted, shallow, infested with weeds and it is no wonder murrels were obtained from there. No specimens were obtained from clear waters or from below Prakasam barrage, Vijayawada.

"Bekti" *Lates calcarifer*. A typical fish of estuary, five examples were obtained from the Krishna estuary at Nagayalanka, Gullalamoda and Yesupuram. The last locality has the saline intrusion more than the first one (Salinity 0.45, 5.0, 5.0 mg/l on 21st January, 1990 respectively). Though it is supposed to ascend the rivers atleast upto 100 km. no specimens were seen anywhere else.

The mullet *Mugil cephalus* is a marine fish entering estuaries, backwaters and rivers. 13 examples were collected in the Krishna estuary from Pulligadda, Nagayalanka and Yesupuram.

Daysciena albida, the Croaker, constitutes an important fishery in the Hooghly estuary and its presence in the Krishna estuary at Gullalamoda is noteworthy.

A₂ CATEGORY

(600 to 899 mm: two to three feet).

Elops machnata, the Ten Pounder, is a marine fish but lives in brackishwater also comfortably. Four examples were collected from Gilkaladindi fish landing center, Machilipatnam.

Megalops cyprinoides, the Indian Tarpon, is primarily a marine fish, but enters freshwater and gets acclimatized to such habitats. Predatory in habits it is reared only in our country. A single example was collected from Edurumondi reservoir, on Yesupuram Island which, as already stated, is an artificial rain fed reservoir connected to the Krishna.

Notopterus notopterus the 'Barber's knife' is known to grow upto 2 feet in length, unlike its cousin *N. chitala* growing to beyond 4 feet. Examples were obtained mainly from the middle reaches of the river at Kurnool, Sunkasela, Huvinahadagi. The westernmost limit in Krishna appears to be the Bhima at Pandarpur. The fish is not much prevalent in the upper reaches.

Puntius carnaticus, the carnatic carp not recorded by David (1963), is found in the Krishna in the stretch from Karad upto Satrashala. Though we did not get material from Vijayawada and above, it is likely to occur in these areas also. A purely freshwater river fish, it is an omnivore consuming higher plants, algae, crustaceans, fish recluse etc; some examples had the stomach fully gorged indicating its voracious feeding habit.

Labeo pangusia: David (1963) recorded this species for the first time in Godavari and suspected its presence in Krishna on the basis of a personal communication from Dr.Y.R. Tripathi. We have 13 examples from Krishna below Prakasam barrage, Western main canal and Eluru canal, Vijayawada. No specimens were obtained from the upper or middle reaches of Tungabhadra. This is the first record from River Krishna proper.

Silonia childreni is often confused with *Silonia silundia* which is mostly of North Indian waters. *S. childreni* is confined to the peninsular rivers Godavari, Krishna and Cauvery. Five examples of *S. childreni* were obtained from Babaladi, Gadwal, Vijayawada and also from Puligadda and Avanigadda (118-247 mm SL, July 1989) where its presence indicates its tolerance to slight saline waters also. The species seems to be rather scarce in the upper reaches. It is a voracious feeder and is harmful to fisheries.

A₃ CATEGORY

(upto 599 mm; one to two feet).

It will be seen that this category of fish species is dominant in the Krishna river system, as is always with other rivers also. Most of these species growing between 30 to 60 cm (1 to 2 feet) are obtained in good numbers unlike the other categories and thus the total weight is compensated.

Anguilla bicolor bicolor the short finned eel is reputed to attain a large size in India; they are eaten only by the very poor and as such not much of a demand though in several Asian and European countries it is a luxury table fish. Mostly caught in earthen pots with a bait inside it, we obtained two examples from Machilipatnam market, catch reported to be from the Bunder canal estuary. Culture of this species is being perfected by the Central Marine Fisheries Research Institute, Cochin.

Puntius kolus called "Kholishi" "Kudishi" is dominant in the upper reaches especially in Satara district Maharashtra. Constituting an important item relished a good fishing exists during the winter months. Though prevalent upto Ibrahimpatnam, Vijayawada, the landings are more in the upper reaches than in the middle and lower ones. At Bhilwadi, Satara district, out of the catch of about 12 kg of fish from one cast net, 4.25 kg were of *P. kolus*. Bright golden red in colour in life the same is attributed to its habitat.

Puntius jerdoni: Unlike *P. kolus* this is mostly confined to upper reaches extending up to Muddebihal in Bijapur district, Karnataka. Originally known from South Canara it grows upto 45 cm in length and is relished along with other carps. Hora and Misra (1942) demonstrated that *Barbus* (= *Puntius*) *dobsoni* Day, *B. jerdoni maciveri* Annandale, and *B. pulchellus* are all synonymous with this species.

Puntius sarana: One of the most common fish of our waters, this was obtained from the entire river stretch upto below Prakasam barrage. Menon (1963) separated the subspecies on the basis of lateral line scale counts and as per this criteria the population in Krishna is referred to as *P. sarana sarana*. This is a medium sized barbel rarely reaching a length of 30 cm or more. It is a voracious feeder, consuming decaying macro-vegetation, molluscan shells, worms, insects and filamentous algae.

Labeo species: *L. boga*, *L. fimbriatus* and *L. nigrescens* are caught along with other carps and catfishes. Of these *L. fimbriatus* is more common and widely distributed in the river than the other two. *L. boga* was obtained in the upper and

middle reaches upto Gadwal; *L. nigrescens* at Babaladi (middle reach) and *L. fimbriatus* in the entire river stretch including an example from Puligadda, near Nagayalanka. At Puligadda the saline influence of the estuary is not much in evidence (0.9%) as in Nagayalanka (4.8%) at the time of collection on 14th July, 1989. A specimen caught at Regulagudda, Guntur district on 29.6.89 weighed about 2 kg; fishermen confused it with *L. calbasu* calling it a red variety.

Cirrhinus cirrhosa, *fulungee*, and *reba* are interesting in the sense that the white carp *C. cirrhosa* is known to spawn in river sections with a rapid flow of water, but two examples were obtained at Eluru canal and Vijayawada where at both the stations the river is more or less stagnant like a big pool. *C. fulungee* is known from Poona and Deccan in Karnataka; our specimens from Bagalkot (R. Bhima) and Karad (R. Krishna) confirm its distribution. *C. reba* is widely distributed and is obtained in large numbers wherever it occurs.

Osteochilus thomassi, the Nagendrum fish is fairly common above the Nagarjunasagar Dam and is extensively caught. It is much valued and at Gadwal, Rekulampally a good haul (7 specimens of total weight 42 kg) of this fish was obtained. It is utilized to a limited extent for stocking ponds in Andhra Pradesh. It breeds in rivers from June to September and is a plankton feeder, subsisting mainly on algae and some copepods.

Rita gogra, the bagrid with its yellow coloured body, strong spines and with mucous secretion, lives out of water for considerable time. At Jamkhandi fish market specimens caught overnight were kept in earthen pots, the fish remaining alive because of cutaneous respiration. Fishermen break away the spines as they are serrated. This along with *R. kuturnee* of B category is found only upto Nagarjunasagar reservoir and not further below. Between the two *R. gogra* attains greater weight.

Sillago sihama known as Whiting was collected from Nagayalanka and Machilipatnam. These ascend the estuaries and are occasionally caught in rivers also; they are esteemed light and wholesome food.

Scatophagus argus: Though attaining 30 cm in length, this fish is not favoured as food. It enters backwaters and rivers and is more of ornamental aquarium value. Our specimens were from Edurumondi reservoir, Yesupuram Island and Machilipatnam.

Etroplus suratensis, the Pearl spot, is a common backwater perch found along both the east and west coasts of S. India. It is easily acclimated to freshwater and breeds in tanks and ponds. It is found in shallow creeks, backwaters and canals where there is luxuriant growth of aquatic vegetation. We obtained examples from the middle to lower reaches (Sri Sailam to Vijayawada and Nagayalanka).

Being deep bodied with spines it does not fall an easy prey to predators. Parental care of the young is known.

Liza parsis and *Liza tade* have been obtained in the estuarine area of Krishna as is to be expected. Of the two, the former is more common than the later.

Rhinomugil corsula is well established in the Krishna system in all the three reaches, upper, middle and lower; it does not extend below Praksam barrage, Vijayawada. Its occurrence in the Cauvery river was highlighted by Menon and Jayaram (1977) and its occurrence in Krishna is also a new record. *R. corsula* normally occurs in small quantities in the river Ganges, the Hooghly Matlah estuary, along the Midnapore coast, in the Mahanadi estuary and in the Chilka lake.

12.2.2. CATEGORY B

Species which attain a size of 200 to 300 mm
(8" to 12" or upto 1 foot)

Species	Maximum size Known mm	Size obtained mm
I Family CLUPEIDAE		
1. <i>Nematalosa nasus</i>	220	115-157
II Family CYPRINIDAE		
2. <i>Salmostoma longicauda</i>		45-70
3. <i>Rasbora daniconius daniconius</i>	203	55-109
4. <i>Barilius bendelisis bendelisis</i>	220	59-133
5. <i>Osteobrama vigorsii</i>	228	73-164
6. <i>Labeo potail</i>	250	118-246
7. <i>Labeo sindensis</i>	200	296
III Family BAGRIDAE		
8. <i>Mystus vittatus</i>	200	55-66
IV Family SILURIDAE		
9. <i>Ompok pabo</i>	241	230
V Family CHANNIDAE		
10. <i>Channa gachua</i>	203	51-113
VI Family CARANGIDAE		
11. <i>Alepes para</i>	205	187
VII Family LEIOGNATHIDAE		
12. <i>Leiognathus equulus</i>	254	52-55

VIII Family GERREIDAE

13. *Gerres filamentosus* 200 67-127

IX Family GOBIIDAE

14. *Pseudapocryptes lanceolatus* 200 40-125

X Family GOBIOIDIDAE

15. *Trypauchen vagina* 220 87-92

15 species under 10 families with Cyprinidae dominating, come under this category and comments on a few important ones are given below.

Salmostoma longicauda : This new species described by Srithar and Jayaram (1990) is dominant in the Dhom reservoir. Along with *S. novacula*, these "chilwas" are locally called "Amli". A catch of 800 to 1000 kg per fishing lasting about 2 weeks in a month, 4 or 5 times a day bring in these species. This selective fishing is restricted to Dhom reservoir only and the fish are dried (see photo 19) and sold @ 5/- per kg. About 80% of water is lost in drying.

Labeo sindensis: Day (1872) described this species from Sind, Lahore, Haridwar and also the Deccan at Poona. David (1963) did not record this species. An example 296 mm long was collected by us from Nagarjunasagar. This is a new record from Krishna.

Osteobrama vigorsii is confined to the Krishna and Godavari river systems. We obtained specimens from Sangli and Gadwal, and no material below Sri Sailam.

Channa gachua is one of the smallest members of the genus rarely exceeding 200 mm but its distribution is wide. It is found even in mountain brooks and display the hardiness of its relatives and is sold as live fish. We obtained specimens from the upper reaches only from Wai, Karad, Kolhapur and Pandarpur on the Bhima. The colouration is variable, though dull.

12.2.3. CATEGORY C

Species which attain a size of 150 to 200 mm
(6" to 8")

Species	Maximum size Known mm	Size obtained mm
I Family CLUPEIDAE		
1. <i>Ilisha kampeni</i>	160	74
II Family ENGRAULIDAE		
2. <i>Stolephorus commersonii</i>	120	93-101
3. <i>Thryssa mystax</i>	180	65-67

III Family CYPRINIDAE		
4. <i>Salmostoma clupeoides</i>	152	48-173
5. <i>Salmostoma novacula</i>	187	43-187
6. <i>Danio aequipinnatus</i>	152	26-72
7. <i>Danio malabaricus</i>	152	38-56
8. <i>Aspidoparia morar</i>	177	57-82
9. <i>Puntius amphibius</i>	152	61
10. <i>Puntius dorsalis</i>	150	88
11. <i>Puntius filamentosus</i>	150	57-84
12. <i>Puntius parrah</i>	150	29-33
13. <i>Rohtee (Rohtee) ogilbii</i>	152	46-108
14. <i>Osteobrama cotio cunma</i>	150	48-202
15. <i>Osteobrama neilli</i>	150	89
16. <i>Labeo ariza</i>	187	26-213
17. <i>Labeo boggut</i>	190	65-211
18. <i>Labeo kawrus</i>	180	145
19. <i>Osteochilus (Osteochilichthys) nashii</i>	165	107-134
20. <i>Garra gotyla stenorhynchus</i>	152	76-95.5
IV Family BAGRIDAE		
21. <i>Mystus malabaricus</i>	150	96-126
V Family SCHILBEIDAE		
22. <i>Neotropius khavalchor</i>	60	90-130
VI Family SISORIDAE		
23. <i>Glyprothorax lonah</i>	150	42-80
VII Family CHANNIDAE		
24. <i>Ambassis commersonii</i>	150	38-85
25. <i>Chanda thomassi</i>	165	46
VIII Family CARANGIDAE		
26. <i>Carangus carangus</i>	150	34
IX Family LUTJANIDAE		
27. <i>Lutjanus johni</i>	165	77-89
X Family NANDIDAE		
28. <i>Nandus nandus</i>	177	88
29. <i>Pristolepis malabarica</i>	150	150

XI Family TETRAODONTIDAE

30. *Tetraodon fluviatilis* 165 107-150

30 Species under 11 families with Cyprinidae dominating come under this category. Most of them are small with very little flesh content individually, but they are sold cheap in bulk and are consumed by poorer sections of the community everywhere. One species calls for comments.

Osteobrama cotio cunma : This is a common species in Babaladi, Karnataka and a good quantity of almost 5% to 10% of the catch comprise of this species. Unfortunately fishermen throw away the fish discarding it as unfit for consumption evidently based on local demand and preferences. A similar practice was seen at Haripur, Sangli also. But this resource could be profitably used as bone meal after drying. The species is found in the entire stretch of the river upto Vijayawada

12.2.4. CATEGORY D

Species which do not attain a size above 150 mm
(6 inches)

Species	Maximum size Known mm	Size obtained mm
I Family ENGRAULIDAE		
1. <i>Stolephorus indicus</i>	145	59-63
II Family CYPRINIDAE		
2. <i>Salmostoma acinaces</i>	125	58-85
3. <i>Salmostoma boopsis</i>	125	53-116
4. <i>Salmostoma horai</i>	128	91-139
5. <i>Danio devario</i>	100	30-129
6. <i>Amblypharyngodon melettina</i>	90	46-50
7. <i>Amblypharyngodon mola</i>	75	47-63
8. <i>Barilius barila</i>	102	43-102
9. <i>Barilius barna</i>	125	40-73
10. <i>Barilius evezardi</i>	125	59-65
11. <i>Puntius chola</i>	125	32-66
12. <i>Puntius melanostigma</i>	100	64-102
13. <i>Puntius narayani</i>	50	45-61
14. <i>Puntius sahayadriensis</i>	65	20-40
15. <i>Puntius sophore</i>	127	25-87
16. <i>Puntius ticto ticto</i>	102	12-62

17. <i>Labeo porcellus</i>	145	127-128
18. <i>Parapsilorhynchus tentaculatus</i>	40	29-32
19. <i>Garra bicornuta</i>	100.5	85-112
III Family PSILORHYNCHIDAE		
20. <i>Psilorhynchus balitora</i>	55	29-30
IV Family COBITIDAE		
21. <i>Botia lohachata</i>	62	40-48
22. <i>Botia striata</i>	70	77.5
23. <i>Lepidocephalus (Lepidocephalichthys) guntea</i>	100	38-47
V Family HOMALOPTERIDAE		
24. <i>Noemacheilus (N.) anguilla</i>	50	30-41
25. <i>Noemacheilus (Schistura) denisoni</i>	73.5	27.5-40
26. <i>Noemacheilus (Acanthocobitis) moreh</i>	74	48
27. <i>Noemacheilus (Noemacheilichthys) ruppelli</i>	75	28-74
28. <i>Noemacheilus (Schistura) striatus</i>	50	29-69
VI Family BAGRIDAE		
29. <i>Rita kuturnee</i>	140	41-140
30. <i>Mystus bleekeri</i>	100	75-110
VII Family SCHILBEIDAE		
31. <i>Pseudeutropius atherinoides</i>	125	105-150
VIII Family SISORIDAE		
32. <i>Nangra itchkeea</i>	60	29-48
33. <i>Glyptothorax madraspatanum</i>	125	57
IX Family CYPRINODONTIDAE		
34. <i>Oryzias melanostigma</i>	38	20-25
X Family POECILIDAE		
35. <i>Gambusia affinis patruelis</i>	38	12-30
36. <i>Lebistes reticulatus</i>	38	20
XI Family CHANDIDAE		
37. <i>Chanda nama</i>	76	25-66
38. <i>Chanda ranga</i>	102	27-72
XII Family CARANGIDAE		
39. <i>Carangoides jordonii</i>		118-128
XIII Family LEIOGNATHIDAE		
40. <i>Leiognathus brevirostris</i>	110	74
41. <i>Leiognathus splendens</i>	127	42-60

XIV Family GERREIDAE		
42. <i>Gerres limbatus</i>	114	62-99
XV Family CICHLIDAE		
43. <i>Etroplus maculatus</i>	76	40-77
XVI Family CYNOGLOSSIDAE		
44. <i>Cynoglossus bilineatus</i>	255	90
45. <i>Cynoglossus lida</i>		103-105
46. <i>Cynoglossus semifasciatus</i>	115	51

46 species under 16 families fall under this category. Most of these are small and are of no food value. Many are used in aquaria as ornamental fishes as they are brightly coloured, particularly the loaches of the genera *Botia*, *Noemacheilus* and the cyprinid *Barilius* species and are often exported by aquarium traders.

Two species call for comments.

Barilius evezardi : Day (1878) obtained this species from near Poona, and subsequent to Day, David (1963) recorded it from Vijayawada by a single example. We have now examples from Rabkavi, Jamkhandi taluq, Karnataka which is high up in the middle reaches. It appears to be an uncommon species.

Rita kuturnee : This bagrid catfish is in general more common than *R. gogra* of A₃ category. Its dorsal spine is long, serrated, and the body colour is olive grey in life. The species extends from the upper reaches to Satrashala and no specimens were obtained below Satrashala, or near Vijayawada. Compared to *R. gogra* its capacity to live out of water is much less.

12.2.5. THE MISSING SPECIES

41 species out the total of 195 known from the Krishna system including its tributaries did not come into net during the period of survey. These are as below.

Species not obtained during the present survey

Species	Known maximum size mm	Category
I Family CLUPEIDAE		
1. <i>Hilsa ilisha</i>	600	A ₂
2. <i>Gudusia chapra</i>	304	A ₃
II Family ENGRAULIDAE		
3. <i>Setipinna phasa</i>	304	A ₃
III Family ANGUILLIDAE		

4. <i>Anguilla bengalensis bengalensis</i>	1219	A ₁
IV Family CYPRINIDAE		
5. <i>Chela (Chela) cachius</i>	102	D
6. <i>Chela (Chela) laubuca</i>	89	D
7. <i>Salmostoma phulo phulo</i>	125	D
8. <i>Esomus barbatus</i>	125	D
9. <i>Esomus danricus</i>	127	D
10. <i>Danio (Brachydanio) rerio</i>	50	D
11. <i>Rasbora rasbora</i>	128	D
12. <i>Barilius canarensis</i>	150	C
13. <i>Barilius gatensis</i>	150	C
14. <i>Oreochthys cosuatis</i>	75	D
15. <i>Puntius curmuca</i>	1219	A ₁
16. <i>Puntius lithopidos</i>	179	C
17. <i>Puntius fasciatus</i>	75	D
18. <i>Puntius terio</i>	100	D
19. <i>Osteobrama belangeri</i>	375	A ₃
20. <i>Thynnichthys sandhkol</i>	600	A ₂
21. <i>Labeo dussumieri</i>	325	A ₃
22. <i>Labeo gonius</i>	1500	A ₁
23. <i>Tor mussullah</i>	1219	A ₁
24. <i>Tor neilli</i>	555, 30 kg.	A ₃
25. <i>Crossocheilus latius latius</i>	152	C
V Family COBITIDAE		
26. <i>Lepidocephalus (Lepidocephalichthys) thermalis</i>	100	D
VI Family HOMALOPTERIDAE		
27. <i>Noemacheilus (Acanthocobitis) botia aureus</i>	44	D
28. <i>Noemacheilus (Indoreonectes) evezardi</i>	38	D
VII Family BAGRIDAE		
29. <i>Mystus armatus</i>	146	D
30. <i>Mystus tengara</i>	100	D

VIII Family SCHILBEIDAE			
31.	<i>Eutropilichthys goongware</i>	300	A3
IX Family PANGASIIDAE			
32.	<i>Pangasius pangasius godavarii</i>	1219	A1
X Family SISORIDAE			
33.	<i>Nangra viridescens</i>	85	D
34.	<i>Glyptothorax trewavasae</i>	113	D
35.	<i>Glyptothorax controstrae poonaensis</i>	105	D
XI Family CLARIIDAE			
36.	<i>Clarias dussumieri dussumieri</i>	175	C
XII Family HETEROPNEUSTIDAE			
37.	<i>Heteropneustes fossilis</i>	450	A3
XIII Family GOBIIDAE			
38.	<i>Awaous stamineus</i>	170	C
XIV Family ANABANTIDAE			
39.	<i>Anabas testudineus</i>	225	B
XV Family BELONTIDAE			
40.	<i>Macropodus cupanus</i>	76	D
XVI Family MASTACEMBELIDAE			
41.	<i>Mastacembelus pancalus</i>	177	C

The 41 species are represented by 16 families and Cyprinidae as usual dominates the scene with 21 species (i.e.) more than 50%. All these 41 species were recorded in the Krishna system by earlier workers. These could not be collected as stated earlier either due to their seasonal occurrence or taxonomic change or the species itself has become rare. The reasons are discussed below.

12.2.5.1. SPECIES WHICH ARE UNLIKELY TO OCCUR IN THE KRISHNA SYSTEM AS A WHOLE

Salmostoma phulo phulo : Banarescu (1968) in a revision of the genus *Salmostoma* defined the species limits of this fish in respect of its geographical distribution. Accordingly the nominal species is found in W. Bengal and Assam (Lower Ganges and Brahmaputra). The specimens from Orissa belong to *S.phulo*

orissaensis. Those from south India and Western Ghats are in reality *S. novacula*. Some specimens were sent to Prof. P. Banarescu at the Institute of biology, Bucuresti and he corrected the identifications from *S. phulo* to *S. novacula*. As such David's (1963) record is also only of *S. novacula*; *S. phulo phulo* is absent in the Krishna river system.

Puntius fasciatus (= *P. melanampyx melanampyx*). This species has been included by David (1963) on the basis of a record by Misra (1938) from Sagal Eru stream near Diguvemata, Nallamalai hills, Eastern ghats. The area covered does not fall within Krishna drainage and hence the occurrence of this species in Krishna river system is unlikely. This species also is more confined to the Western Ghats in Kerala.

Puntius terio: Rahimullah (1943) recorded this species in his fish survey of Hyderabad state, from some tanks, reservoirs and not from Krishna. The species is distributed from Punjab, West Bengal, Assam to Orissa only in India. It is unlikely to be a resident of the Krishna system.

Lepidocephalus guntea: This species is found throughout India but is absent in Karnataka, Kerala and south of Krishna, where it is replaced by *L. thermalis*. Tilak and Husain (1981) in their revision of the fishes of this genus state clearly that *L. guntea* is only confined to North India. The inclusion of this species by David (1963) as occurring in Krishna may be a misidentification; its presence is unlikely in Krishna.

Mystus armatus : This species is more confined to the Wynaad range of hills, though a record from "Burma" as such is available by the presence of a specimen in ZSI, Calcutta. Rahimullah (1944) recorded this species in his fish survey of Hyderabad state, from Pocharam reservoir, Medak district; its occurrence in Krishna system is unlikely.

Mystus tengara : known from North India mainly, this species is often confused with *M. vittatus*, its cousin from South India. Rahimullah (1943, 1944) recorded this species from a big tank near Yellareddy town and from Manjra, Haldi and Aleru rivers which are in no way connected to Krishna, on the basis of which David (1963) included it in the the fish fauna of Krishna; it is most unlikely to be present in Krishna system.

Nangra viridescens : Hora and Misra (1938) recorded this species in the Godavari; Rahimullah (1943) and David (1957) from Hyderabad state and Bhadra river at Bhadravati respectively. The species is confined to the Yamuna, Ganga and Brahmaputra systems; its occurrence in Krishna drainage is unlikely.

12.2.5.2. SPECIES WHOSE OCCURRENCE IN KRISHNA IS DOUBTFUL

Gudusia chapra : The normal distribution of this species is "Rivers of India and Bangladesh affluent to the Bay of Bengal (chiefly the Ganges and Brahmaputra systems and the the Mahanadi River of Orissa)" (Whitehead, 1985, p.229). Whitehead (1973) gave the distribution more pin-pointedly as India, Lahore, Orissa, Allahabad, Brahmaputra at Goalpara, Guwahati and Gorakhpur based on specimens. The inclusion of the species in the Krishna fish fauna is on the basis of David (1963) who observed the species in lower reaches. Datta Munshi and Srivastava (1988) however gave the distribution as "Freshwaters of India, Bengal, Bihar, Uttar Pradesh, Bombay, in South upto Krishna river (but absent from Malabar and Madras); Pakistan, Bangladesh, Burma, Nepal and Malaya". It is likely to occur in the Krishna estuary also, but needs confirmation. Our enquiries did not get a positive answer.

Osteobrama belangeri : The natural distribution of this species is Manipur in India, besides Burma and Yunnan. Rahimullah (1943) obtained this species from Osmansagar in the city of Hyderabad. Its record from Krishna by David (1963) is zoogeographically remarkable. We could not get any specimen; occasionally *Rohita vlgorsii* resembles this species.

Clarias dussumieri dussumieri : Hora (1941) in a short note recorded this subspecies from a "Nullah" near Belgaum. The locality cannot be referred to as of Ghataprabha drainage. This subspecies is confined to Kerala only. Its presence in Krishna system is highly unlikely.

12.2.5.3 SPECIES WHICH ARE CONFINED TO TUNGABHADRA ONLY AND ARE UNLIKELY TO BE PRESENT IN KRISHNA RIVER PROPER

Barilius canarensis, *B. gatensis*, *Oreochthys cosuatis* : The first two species have been recorded by Chacko and Kuriyan (1948) and David (1957); the third only by David (1957) from the Tungabhadra drainage. All are inhabitants of lower and middle Western Ghat streams and are more likely to be confined to Tungabhadra; the possibilities of their presence in Krishna are few.

P. lithopidos : David (1957) recorded this species from Tungabhadra. *P. lithopidos* is known from Thekady and Wynaad, Cauvery in Coorg, Nilgiri, besides the record by David in Bhadra river at Bhadravati. The occurrence of this species in Krishna proper is unlikely; even its presence in Tungabhadra needs confirmation.

Labeo dussumieri is more a species of Sri Lanka and southern Western Ghats. It has been recorded from Tungabhadra by Hora (1927) on the basis of a drawing in the Mackinzee collection; by David (1957) from Bhadra river at Bhadravati. It is not known so far north of this range. Its occurrence in Krishna proper is unlikely.

12.2.5.4. SPECIES WHICH ARE LIKELY TO BE PRESENT

Hilsa ilisha is marine, pelagic and schooling in coastal waters, and ascending rivers upstream for spawning. The migration is restricted by barrages. The main breeding season is during the south-west monsoon (June to September) with a shorter season from January to February or March. Two migratory runs are recognized, one during the post monsoon and the other in late winter, the first being the major. The fishery is subject to peaks of abundance once in five years and the catch is not always uniform. In the Krishna estuary, at Nagayalanka, that there was a peak in 1984 and as much as 800-900 kg per day were landed. In July 1989 no specimens were obtained, although the species is an inhabitant of the area and caught occasionally. Some of the specimens dried and sold in Nagayalanka shandy (photo 31) were reported to be *Hilsa* by the fishermen, but this cannot be taken for certainty as they were highly mutilated.

Setipinna phasa : Whitehead (1985) gave the distribution as "Indian fresh and brackish water (Ganges system, from Diamond Harbour on the Hoogly to as far as up to Allahabad on the Ganges, perhaps further; also rivers and estuaries of Orissa)". The species is recorded from Sittang river, Burma also (Whitehead, 1973). David (1963) observed it in the lower reaches of Krishna. Babu Rao (1962) described *Setipinna godavari* from Godavari estuary which Whitehead (1985) synonymised with *Setipinna tenuifilis* and stated under distribution "perhaps southward from the Godavari river, but no certain records" This problem needs an intense study to determine whether *S. phasa* is present at all, and if not whether it is replaced by *S. tenuifilis*.

Anguilla bengalensis bengalensis : it is one of the three most common commercial eels of our region and is fairly abundant on the east coast of India. In estuarine area live elvers are sold. A specimen of about 900 mm was noticed for sale in Dachepalle market, Guntur district, but it was mutilated. The species is present in Krishna system.

Chela (Chela) cachi and *Chela (Chela) laubuca* : The presence of these species in Krishna is certain as they are widely distributed. Silas (1958) studied specimens of *C. cachi* from Thunga river, Shimoga, Bhadra river at Bhadravati. *C. laubuca* is more prevalent in the Cauvery. David (1963) obtained both the species from Krishna.

Esomus barbatus and *E. danricus* : The second species has been recorded by Raju (1988) from Muniyeru, a tributary of Krishna and the former by David (1963). *E. barbatus* is more confined to Tamil Nadu and Karnataka watershed. It is not known whether David obtained the species from Krishna proper or Tungabhadra. The occurrence of these two species in the Krishna system is possible.

Danio (Brachydanio) rerio : This species has been recorded by Mahmood and Rahimullah (1947) from Hyderabad state and by David (1957) from Bhadra river, at Bhadravati. It is likely to occur in the Krishna also.

Rasbora rasbora : Recorded by David (1963), this is also likely to be present in Krishna.

Labeo gonius : This species was recorded from the lower reaches of Krishna by David (1963). *L. gonius* is widely distributed and is likely to be present in Krishna.

Crossocheilus latius latius : This species was recorded by Fraser (1942) and Hora and Misra (1942) from Deolali and Poona watershed respectively. David (1963) stated this as Krishna headwaters. Mula Mutha river joins Bhima, a tributary of Krishna. This is likely to be in the Krishna system.

Neomacheilus botia aureus : Menon (1987) synonymised this subspecies with *N. moreh* (= *N. sinuatus*) of which we have specimens from Krishna.

Noemacheilus evezardi : This species is found in Western Ghats near Bombay, Pachmarhi hills, Bailadila range, Travancore hills. Its record from Krishna by David (1963) is interesting. The species is likely to be present in the upper reaches of Krishna.

Pangasius pangasius godavari : Described by David (1963) from the Godavari river and sated as occurring in Krishna also. We did not encounter this subspecies. It is likely to be present though it may be mentioned that no subsequent records are known.

Glyptothorax conirostrae poonaensis : Hora and Misra (1942), Fraser (1942) recorded this subspecies from Poona. Recently Ghate *et al.* (1992) recorded this species from Mutha Mula.

Glyptothorax trewavasae : Hora (1938) recorded it from the Yenna Valley, Satara district. Its distribution is Krishna river system, Yenna, Koyana and Tunga rivers. It is an inhabitant of Krishna system.

Heteropneustes fossilis : This is more of a pond or tank fish than of a river system though it cannot be stated that it is not a fluviatile species. I did not take into account any pond or tank fish. This species which is hardy and so common, is an inhabitant of Krishna system.

Awaous stamineus : This goby which David (1963) recorded in the Godavari for the first time is likely to be present in the estuary of Krishna also.

Anabas testudineus : David (1963) recorded this from Krishna and Collair lake. it is common and is likely to be in Krishna also.

Macropodus cupanus : Hora (1937a) recorded this species from Bhadra drainage, Shimoga district. Common in Kerala and Coromandel coasts, this is likely to be in Krishna river too.

Mastacembelus pancalus : David (1963) included it on the basis of specimens obtained from Krishna. This is also unlikely to be absent in Krishna, being a common species.

In summary it can be stated that in the light of the above analysis Krishna river system comprises of only 187 species of fish under 93 genera and 46 families. The 8 species given below are not considered for further discussion in the following pages.

1. *Salmostoma phulo phulo* 2. *Puntius fasciatus* 3. *Puntius terio* 4. *Crossocheilus latius latius* 5. *Lepidocephalichthys guntea* 6. *Mystus armatus* 7. *Mystus tengara* 8. *Nangra viridescens*

12.2.5.5 RARE SPECIES

Most freshwater fishes are not readily observed in their natural habitat and many are difficult to identify except by specialists. Moreover accurate information on the status of reportedly threatened species is often scanty and difficult to obtain. Between the extreme category of extinct and an undisturbed healthy natural population many different degrees of depletions are possible. Lack of information on these species makes their eco-status uncertain. This is further complicated by their distribution which is restricted geographically and appears rare at any one location.

Some of the species in the Krishna river system fall under this category of "Rare" in the sense that they have a small World population, not at present "Endangered" or "Vulnerable" but at risk. Their records have been few and fewer in recent years. Some of them have not been recorded at all.

Family CYPRINIDAE

Tor curmuca (Hamilton) is confined to the streams of Western Ghats, particularly in the states of Kerala and Karnataka. David (1957) recorded it from Bhadra near Bhadravati and no subsequent records from Krishna drainage are known. Jayaram *et al.* (1976) reported under the name *Puntius curmuca* from Andoorpacha, Cardamom hills, Kerala and this is the latest record. It is a commercially valuable species and of good fishery importance.

Tor mussullah (Sykes). The very identity of Sykes "*mussullah*" dodged ichthyologists for a long time mainly because of the zoologically poor description of the fish given by Sykes in his *Fishes of Dekkan* (1941) and also by the erroneous delineation of characters by his assistant in the original drawing. Hora (1942) tried to obtain topotype material from Ghod river, Sirur (Maharashtra) the type locality of the species, but failed.

The last record of this species from the Krishna system is by Silas (1953) who reported specimens from Mahabaleshwar lake, Krishna river at Wai. We could not obtain even a single example despite serious efforts. Fishermen confuse *P. kolus* with *T. mussullah*. This species is the second largest of the four Mahseer species of south India next to *T. khudree*. It is reported to grow to enormous size in the Cauvery and its tributaries attaining a length of 125 cm.

Tor neilli (Day). The generic position was in confusion but has now been resolved thanks to the work of Rainboth (1990). Day (1868) described it under *Barbus* from Tungabhadra river at Kurnool and reported that it attains a weight of 25 to 30 kg. David (1957) reported it from Bhadra river at Bhadravati but subsequent to this, nothing is known of this species. We could not get this fish either at Kurnool or any other locality in Tungabhadra or in Krishna. Fishermen are unaware of this species.

Thynnichthys sandkhol (Sykes). The sandkhol carp is a zoogeographically interesting fish known only from the Krishna and Godavari rivers besides Malaysia and Islands of Western Indonesia. David (1963) reported this species in his paper and also stated that it is available within the Nizamsagar reservoir. Rahimullah (1943) stated that he obtained juveniles of this species. Subsequently no records are known in recent years.

Schismatorhynchus nukta (Sykes) characterized by a deep groove across the snout this *Labeo* like species is uncommon. We obtained specimens from Sangli, Lingalagattu (Sri Sailam), Bagalkot and Mantralayam. Growing to about 304 mm (one foot) it is not much preferred.

Family SCHILBEIDAE

Neotropius khavalchor Kulkarni known as the scale eating fish this catfish is also uncommon. We obtained material from Sangli and Jamkhandi only. Not much is known about this fish and fishermen do not attach much importance to it.

Eutropilichthys goongware. David (1963) recorded this species from Krishna. We could not get any specimens. It is an uncommon species.

12.2.6. DOMINANT SPECIES

Criteria for determining the dominance or otherwise of a freshwater species in a river system is difficult to make, since it varies from area to area and even from section to section besides seasons as flood period when practically no fishing is possible. Moreover the State fishery departments rarely care to maintain catch statistics or landing data of their riverine fisheries. In regard to Krishna, the state of Maharashtra and Andhra Pradesh have some organisation in the form of a few statistical officers to record data, but even the proforma supplied by the Central Institute of Capture Fisheries, Barrackpore is not completed from all landing centres. The main reason is lack of financial resources and to an extent non realization of the ultimate scientific potentialities of these data. In a survey as this one when a centre was visited only once or twice in a year, real sampling or data for species dominant most of the year cannot be gathered, as in conventional manner of recording length weight data for major species month wise. The details given below are as such what I have seen and obtained from the fishery officials and fishermen of the concerned states.

12.2.6.1 DOMINANCE : STATION WISE

Of the various centres sampled, Haripur, Digraj in Satara district, Maharashtra; Babaladi, Rabkavi, Jamkhandi, Rajolibandha, Raichur, Karnataka; Gadwal, Lingalagattu, Ramapuram, Vidyadarapuram, Ibrahimpatnam, in Andhra Pradesh are very productive catchwise. The river at most of these places forms a deep pool like basin, with not much current. At Babaladi for instance, during the premonsoon survey in May 1988 as much as 30 to 40 kg of fish in total was obtained in a single drag net operation (see photos 15 to 18). The composition of the catch was *Catla catla* 3 kg; *A. seenghala* 2 kg, *Wallago attu* 5 kg, the balance made up by *P. carnaticus*, *R. gogra*, *R kuturnee*, *Osteobrama cotio cunma*, *Silonia childreni*, *P. kolus*, etc. At Digraj near Sangli a similar operation (Dec. 1987) yielded about 35 to 40 kg of assorted species. In all these cases the weight of the catch was contributed by a few examples of prime fishes as *Puntius kolus*, *C. mrigala*, *R. gogra*, *A. seenghala*, etc., the next being other smaller sized fish of different species.

In Gadwal the river Krishna cuts through rocky terrain and forms several deep pools, cascades and water-falls. The river is very wide here. Several fish catching centres are present, as many as 17, of which Rekulampally, Juriyala, Gadwal, Bhirampallu, Alampur are important. In the river itself several islands have been formed with some habitations. Abundant fish wealth is present here in these "Gundams" "Donas" Young and old fishermen perch dangerously on precipitous rocks and catch fish with cast nets. *Osteocheilus thomasi*, the Nagendrum fish, *Labeo* species, *R. kuturnee*, *R. corsula* are in plenty here.

Lingalagattu and the river above Sri Sailam reservoir is also rich in yield. *Mystus krishnensis*, *Labeo fimbriatus*, *Labeo calbasu*, *Labeo rohita*, *Cirrhinus mrigala*, were some of the economically important species caught and marketed. Sri Sailam reservoir is not stocked and no fishing is practised. Nagarjunasagar is well stocked and cat fishes is marketed from Macherla. Ibrahimpatnam near Vijayawada is equally a good centre where prawns and major carps are profitably distributed. Nagayalanka is a good centre where from nearby villages, fishermen bring their catch and sell. A good market for dry fish exists here (see photo 31). Most of the sea fishes, as perches, catfishes are dried and sold during weekly shandy days @ rates varying from 5/- to 15/- a kg depending upon size. Fish landings here are estimated to be 30 to 40 metric tones per month of which 60% are salted. Hilsa is sold @ Rs.15/- per kg, whereas others as *Labeo*, fetch a price of 10/- to 12/- a kg. Fresh fish below one kg. are sold @ 8/- or 10/- a kg and those above @ 15/-.

Some data obtained on landings are as bellow:

In the year 1988-89 quantity of fish landed from river Krishna in Sangli district is as below:

Landing centre	Kg
Tambave	1200
Kosegaon	800
Batre	880

Bhilwadi	1600
Mahsal	1520
Miraj	400
Sangli	800

From the River Varna the quantity landed is as below

<i>Landing Centre</i>	<i>Kg</i>
Chikurde	1160
Mangala	960
Shegaon	1280
Samdali	1600

The species composition was of *Catla*, *Puntius kolus*, *P. carnaticus*, *P. jerdoni*, *Channa marulius*, *Rita kuturnee*, *Salmostoma* species and *Aorichthys seenghala*.

12.2.6.2 DOMINANCE : FAIMILY WISE

In terms of species abundance, an analysis of the 46 families show the dominance rate as below.

		Species	Percentage
MOST DOMINANT	1.	Cyprinidae	77 41.18
DOMINANT	2.	Bagridae	10 5.35
	3.	Homalopteridae	7 3.74
	4.	Schilbeidae	6 3.20
	5.	Sisoridae	6 3.20
	6.	Clupeidae	4 2.14
	7.	Mugilidae	5 2.67
	8.	Engraulidae	4 2.14
	9.	Channidae	4 2.14
	10.	Chandidae	4 2.14
	11.	Carangidae	4 2.14
	12.	Cobitidae	3 1.60
	13.	Siluridae	3 1.60
	14.	Leiognathidae	3 1.60
	15.	Cynoglossidae	3 1.60
	16.	Gobiidae	3 1.60
	17.	Mastacembelidae	3 1.60

REPRESENTED	18.	Anguillidae	2	1.08
	19.	Clariidae	2	1.08
	20.	Ariidae	2	1.08
	21.	Poeciliidae	2	1.08
	22.	Platycephalidae	2	1.08
	23.	Lutjanidae	2	1.08
	24.	Gerreidae	2	1.08
	25.	Nandidae	2	1.08
	26.	Cichlidae	2	1.08
	27	Other families	1 each	10.64
	to			
	46.			
		Total	187 species	100.0

Specieswise Cyprinidae is the most dominant, followed by Perches and Catfishes. This is on expected lines since the Cypriniform fishes have in general become the dominant freshwater group in any land mass to which they have had access. Wherever they occur naturally in any considerable number they have differentiated into many more species than other groups. In most places, the species of the small sized Cyprinoids are the principal forage fishes, on which the larger predatory species feed. They swarm in great abundance in the lowland rivers (*Danio*, *Rasbora*, *Salmostoma*) and in the highland brooks (*Neomachellius*, *Lepidocephalus*, *Barilius*). Wherever the other larger predators are few or are absent and occasionally even when they are fairly numerous, Cyprinoids themselves have evolved into large important predatory forms. Though the Siluriform fishes have accompanied the Cyprinoids in their geographical radiation, the ability of some genera to transgress short stretches of sea may have materially facilitated their colonisation (Jayaram, 1974).

12.2.6.3. DOMINANCE : SPECIES WISE

In terms of species abundance it is seen that prized fishes as *Puntius kolus*, *Puntius jerdoni*, *Labeo calbasu*, *Labeo pangusia*, *fimbriatus*, *Tor khudree*, *Rita gogra*, *A. seenghala*, *W. attu* are dominant in the catches from the Maharashtra area of the river. Andhra Pradesh shares equally a rich species harvest such as *Mystus krsishnensis*, *Rita kuturnee*, *Notopterus notopterus*, *Puntius carnaticus*, *Cirrhinus mrigala*, *Clarias batrachus*, *Aorichthys seenghala*, *Silonia childrenti*, *Channa marulius* etc. The estuarine area of the river contributes some percentage of the total yield. Fishes as *Hilsa ilisha* though seasonal are valuable. Karnataka stretch of the river is rather poor in comparison, being hedged in between by the Koyana dam in Maharashtra on the upper reaches and Sri Sailam and Nagarjunasagar dam in Andhra Pradesh on the middle reaches. Moreover, the river stretches is over hard gneiss rocks and plains of the Raichur series as explained in the introductory chapter and may be the reason for poor representation of quality fishes. Mostly species of

Salmostoma, *Osteobrama*, *Rohtee*, *Garra* predominate as naturally occurring. *Puntius kolus*, *Wallago attu*, *Labeo fimbriatus*, *Cirrhinus mirigala* occur sporadically. Introduced fishes as Catla, Rohu, Mrigal are caught during the seasons. Sandy stretches are populated by species of *Danio*, *Rasbora* etc.

As is to be expected Loaches of the genus *Noemacheilus*, *Botla* are present in the hilly regions of the Krishna basin particularly where the river flows through a rocky boulderous bed forming pools as at Ondishi, Wai.

If the occurrence of the 78 species of A and B categories alone is plotted as per their distribution in the three states through which the river flows, it is seen that Andhra Pradesh has 69 species (88.46%), Maharashtra 31 species (39.74%) and Karnataka 25 species (32.05%) in their respective stretches. The 27 estuarine species contribute a good percentage to Andhra Pradesh fish fauna of Krishna. It must be conceded that this analysis is based only on one/two time sampling. Species as *C. mrigala* *A. aor.* etc. are not necessarily confined to states indicated.

12.2.6.4. ANALYSIS FOR DOMINANCE OF A & B CATEGORY FISHES

		Maharashtra	Karnataka	Andhra Pradesh
A ₁	1. <i>Chanos chanos</i>		-	x
	2. <i>Labeo calbasu</i>	x	x	x
	3. <i>Labeo rohita</i>	x	x	x
	4. <i>Tor khudree</i>	x	x	x
	5. <i>Cirrhinus mrigala</i>		-	x
	6. <i>Catla catla</i>		x	x
	7. <i>Aorichthys aor</i>	-	-	x
	8. <i>Mystus krishnensis</i>		-	x
	9. <i>Wallago attu</i>	x	-	x
	10. <i>Bagarius bagarius</i>	-	-	x
	11. <i>Channa marulius</i>	-	-	x
	12. <i>Channa striatus</i>	x	-	-
	13. <i>Lates calarifer</i>	-		x
	14. <i>Daysciaena albida</i>		-	x
	15. <i>Mugil cephalus</i>	-	-	x
A ₂	16. <i>Elops machnata</i>		-	x
	17. <i>Megalops cyprinoides</i>	-	-	x
	18. <i>Notopterus notopterus</i>	x	x	x
	19. <i>Puntius carnaticus</i>	x	x	x
	20. <i>Labeo pangusia</i>	x	-	x
	21. <i>Silonia childreni</i>	-		x

	22.	<i>Liza macrolepis</i>	-	-	X
	23.	<i>Mastacembellus armatus</i>	X	X	X
A3	24.	<i>Anguilla bicolor</i>	-	-	X
	25.	<i>Puntius jerdoni</i>	X	X	-
	26.	<i>Puntius kolus</i>	X	X	X
	27.	<i>Puntius sarana</i>	X	X	X
	28.	<i>Schismatorhynchus nukta</i>	X	X	X
	29.	<i>Labeo boga</i>	X	-	-
	30.	<i>Labeo fimbriatus</i>	-	X	X
	31.	<i>Labeo nigrescens</i>	-	X	-
	32.	<i>Cirrhinus cirrhosa</i>	-	-	X
	33.	<i>Cirrhinus fulungee</i>	X	X	-
	34.	<i>Cirrhinus reba</i>	X	X	X
	35.	<i>Osteochilus thomassi</i>	-	-	X
	36.	<i>Garra mullya</i>	X	X	X
	37.	<i>Rita gogra</i>	X	X	X
	38.	<i>Mystus cavasius</i>	X	X	X
	39.	<i>Mystus gulio</i>	-	-	X
	40.	<i>Aorichthys seenghala</i>	X	X	X
	41.	<i>Ompok bimaculatus</i>	X	X	X
	42.	<i>Proeutropiichthys taakree</i>	-	-	X
	43.	<i>Eutropiichthys vacha</i>	X	-	-
	44.	<i>Clarias batrachus</i>	-	-	X
	45.	<i>Arius jella</i>	-	-	X
	46.	<i>Arius arius</i>	-	-	X
	47.	<i>Hyporhamphus limbatus</i>	-	-	X
	48.	<i>Xenentodon cancila</i>	X	-	X
	49.	<i>Platycephalus crocodiles</i>	-	-	X
	50.	<i>Platycephalus indicus</i>	-	-	X
	51.	<i>Channa punctatus</i>	X	-	X
	52.	<i>Terapon jarbua</i>	-	-	X
	53.	<i>Sillago sihama</i>	-	-	X
	54.	<i>Scomberoides lysan</i>	-	-	X
	55.	<i>Lutjanus lutjanus</i>	-	-	X
	56.	<i>Scatophagus argus</i>	-	-	X
	57.	<i>Etroplus suratensis</i>	-	-	X
	58.	<i>Liza parsia</i>	-	-	X
	59.	<i>Liza tade</i>	-	-	X

	60.	<i>Rhinomugil corsula</i>	-	x
	61.	<i>Psettodes erumei</i>	-	x
	62.	<i>Glossogobius giuris</i>	x	x
	63.	<i>Macrognaathus aculeatus</i>	-	x
B	64.	<i>Nematolosa nasus</i>	-	x
	65.	<i>Salmostoma longicauda</i>	x	-
	66.	<i>Rasbora daniconius</i>	x	x
	67.	<i>Barilius bendelisis</i>	x	-
	68.	<i>Osteobrama vigorzi</i>	x	x
	69.	<i>Labeo potail</i>	x	-
	70.	<i>Labeo sindensis</i>		x
	71.	<i>Mystus vittatus</i>	-	x
	72.	<i>Ompok pabo</i>		x
	73.	<i>Channa gachua</i>	x	x
	74.	<i>Alepes para</i>		x
	75.	<i>Lelognathus equulus</i>	-	x
	76.	<i>Gerres filamentosus</i>		x
	77.	<i>Pseudapocryptes lanceolatus</i>		x
	78.	<i>Trypauchen vagina</i>	-	x

In summary it can be stated from the above that carps dominate the scene as is the general trend in Indian river systems. This is confirmed by species Richness Index of Margalef (1968) also when calculated for number of species order wise.

Order	Total number of species	Total number of examples	Species Richness Index
Clupeiformes	8	10	3.337
Elopiformes	2	3	0.910
Anguilliformes	2	5	0.621
Osteoglossiiformes	1	14	
Gonorhynchiformes	1	1	
Cypriniformes	88	2111	11.366
Siluriformes	31	267	5.369
Atheriniformes	7	288	1.059
Channiformes	4	4	0.793
Perciformes	39	441	6.240
Matacembeliformes	3	19	0.679
Tetraodontiformes	1	2	
	<u>187</u>	<u>3205</u>	

Familywise also it is seen that Cyprinidae shows a high Index 8.186; the Cyprinid genera *Puntius* 2.060, *Labeo* 2.134. These trends confirm the domination of Cyprinids.

13. SPATIAL DISTRIBUTION

Dams on Indian rivers have been in existence from time immemorial and many such as the Grand Anicut on the Cauvery built by Karikala Chola (Ca 100 A.D.) stand mute testimony. A good number had fallen into disrepair even before British occupation. It was not until the nineteenth century that the more important of them were renovated.

The possible damage to fisheries and especially to migrant fish populations were also known along with the construction of the dams. Thus Sir Arthur Cotton who was instrumental in putting up the Sunkesela Anicut on the Tungabhadra, was also the first to call attention of the then British Government in 1867 to the possible damage to Indian fisheries. Francis Day who was working at that time on Fishes of India condemned (1873) dams as barriers to the passage of fishes. In recent years this problem has been highlighted by Hora (1940, 1942, 1947, 1947a, 1948, 1949, 1949a, 1955). Others who have in a similar manner voiced the deleterious effect of dams are Thomas (1887), Khan (1940), Raj (1941), Devanesan (1942), Rai (1948), Chacko (1952, 1954), Prashad and Job (1949), Miles and Job (1955).

Besides obstructing the passage of migratory species, dams also disturb the natural distribution of many species. Although the fact remains that few species choose to remain in their preferred ecological niches, and all species are not found at all places, the sudden altered habitat from a lotic to a lentic system does affect many species. Some of them disappear altogether from below the obstruction and some manage to colonise their old habitats at the time of discharge of excess water or overflow.

Jhingran (1983) in his classical treatise on the Fish and Fisheries of India, categorized the effects of dams of fish populations as obstructional and ecological; obstructional in the sense that they act as physical barriers to migrations preventing fish access to their usual breeding, rearing and feeding grounds. The ecological changes adversely affect both the migratory and non-migratory species of fishes. The new habitat formed above and below the dam, tend to make some species to shift to new spawning and migration ranges, anadromous fish tend to settle down, and infra specific differentiation of fish occur besides the change in the substrata for egg laying.

The migratory fishes can be classified depending upon their habits as (i) resident species preferring to remain confined within local territories (ex. *Notopterus* sp., *Channa* sp., *Mastacembelus* sp., *Garra* sp., *Osteobrama* sp.) (ii) local migrants which tend to perform seasonal migrations within short distances for breeding etc (ex. Mahseers, major carps, monsoon breeding catfishes) and (iii) long distant migrants (ex. *Hilsa*, *Anguilla*, *Pangasius*).

A study of species found above and below a dam makes interesting reading and throws light on their spatial distribution. Jayaram and Majumdar (1976) listed species found above and below Hirakud Dam on the Mahanadi. Earlier Job, David and Das (1955) surveyed the same river for a stretch of 104 km, but prior to the construction of the Hirakud Dam. Jayaram *et al.* (1982) made such an analysis of the Cauvery fish and Jayaram (1982) discussed the pattern of the distribution and made recommendations.

In respect of Krishna no such attempt has so far been made. The collections made are analysed to find out whether the dams on the Krishna have affected the distribution of the fish species and if so to what extent it has been altered and the patterns they have devised.

Of the 187 species of Krishna system under discussion, 44 are marine, 37 are widely distributed and are of easy dispersal. These 81 species are as such left out of consideration. The remaining 106 species are analysed as to their distribution in the Krishna river proper. These are grouped as under.

Zone	I.	Above Dhom Dam
Zone	II.	Between Dhom Dam and Almatti Dam
Zone	III.	Between Almatti Dam and Sri Sailam Dam
Zone	IV.	Between Sri Sailam Dam and Nagarjunasagar Dam
Zone	V.	Below Nagarjunasagar Dam

Their distribution is plotted as per their occurrence in the above zones of the river (Table 13.1).

The stretch of the river above Dhom Dam (Zone I Stations Ondishi, Dhom) has the u/m species exclusive to it.

1. *Salmostoma longicauda*
2. *Danio aequipinnatus*
3. *Puntius parrah*
4. *Parapsilorhynchus tentaculatus*
5. *Psilorhynchus balitora*
6. *Noemacheilus denisonii*
7. *Noemacheilus evezardi*
8. *Glyptothorax trewavasae*
9. *Glyptothorax conirostrae poonaensis*

Amongst these, the occurrence of *Danio aequipinnatus* in Zone I only and its replacement in other zones by *D. malabaricus* is discussed elsewhere (Jayaram 1991). The other species are all inhabitants of clear swift waters and they cannot be expected

to cross the Dhom Dam (exception *P. parrah*) in view of their preference for rich oxygenated water with a boulderous bed where they will be able to seek shelter.

TABLE 13.1. DISTRIBUTION CHART OF KRISHNA FISHES

	I Ondishi to Dhom	II Wai to Bagal- kot	III Jamkhandi to Lingala- gattu	IV Kurnool to Mach- erla	V Dachepalle to Confluence
1. <i>Hilsa ilisha</i>					x
2. <i>Anguilla bengalensis</i>					x
3. <i>Anguilla bicolor</i>					x
4. <i>Salmostoma acinaces</i>		x	x	x	x
5. <i>Salmostoma boopsis</i>	x	x	x		x
6. <i>Salmostoma clupeoides</i>	x	x	x		x
7. <i>Salmostoma novacula</i>	x	x	x	x	
8. <i>Salmostoma horai</i>			x		x
9. <i>Salmostoma longicauda</i>	x				
10. <i>Esomus barbatus</i>					x
11. <i>Esomus danricus</i>					x
12. <i>Danio aequipinnatus</i>	x				
13. <i>Danio malabaricus</i>			x		x
14. <i>Danio devario</i>		x	x		
15. <i>Brachydanio rerio</i>					x
16. <i>Rasbora rasbora</i>					x
17. <i>Aspidoparia morar</i>		x	x		
18. <i>Amblypharyngodon melettina</i>			x		
19. <i>Barilius barila</i>		x	x		
20. <i>Barilius barna</i>		x			
21. <i>Barilius canarensis</i>		Tungabhadra			
22. <i>Barilius evezardi</i>			x		
23. <i>Barilius gatensis</i>		Tungabhadra			
24. <i>Oreochthys cosuatis</i>		Tungabhadra			
25. <i>Puntius amphius</i>		x			
26. <i>Puntius carnaticus</i>		x	x		x
27. <i>Puntius curmuca</i>					x
28. <i>Puntius dorsalis</i>					x

	I	II	III	IV	V
29. <i>Puntius filamentosus</i>		x	x		
30. <i>Puntius kolus</i>	x	x	x		x
31. <i>Puntius jerdoni</i>	x	x	x		x
32. <i>Puntius lithopidos</i>	Tungabhadra				
33. <i>Puntius melanostigma</i>		x	x		
34. <i>Puntius narayani</i>	x	x			
35. <i>Puntius parrah</i>	x				
36. <i>Puntius sahayadriensis</i>	x	x			
37. <i>Puntius sophore</i>		x	x		
38. <i>Rohtee ogilbil</i>		x	x		
39. <i>Osteobrama belangeri</i>	Doubtful				
40. <i>Osteobrama cotio cunma</i>		x	x	x	x
41. <i>Osteobrama neilli</i>			x		
42. <i>Osteobrama vigorsii</i>		x	x		
43. <i>Thynnichthys sandkhol</i>				x	x
44. <i>Schismatorhynchus nukta</i>		x	x		x
45. <i>Labeo ariza</i>			x		
46. <i>Labeo boga</i>			x		
47. <i>Labeo boggut</i>		x	x		
48. <i>Labeo fimbriatus</i>		x	x		
49. <i>Labeo nigrescens</i>		x	x		
50. <i>Labeo pangusia</i>		x	x		x
51. <i>Labeo potail</i>			x		
52. <i>Labeo porcellus</i>		x			
53. <i>Labeo dussumieri</i>	Tungabhadra				
54. <i>Labeo kawrus</i>		x	x		
55. <i>Labeo gonius</i>				x	x
56. <i>Labeo sindensis</i>			x		
57. <i>Tor khudree</i>	x	x	x		
58. <i>Tor mussullah</i>	x	x			
59. <i>Tor neilli</i>			x		
60. <i>Cirrhinus cirrhosa</i>					x
61. <i>Cirrhinus fulunge</i>		x			
62. <i>Osteochilus nashii</i>		x	x		
63. <i>Osteochilus thomassi</i>		x	x		
64. <i>Parapsilorhynchus tentaculatus</i>	x				

	I	II	III	IV	V
65. <i>Garra bicornuta</i>		x			
66. <i>Garra gotyla stenorhynchus</i>		x	x		
67. <i>Psilorhynchus balitora</i>	x				
68. <i>Botia lohachata</i>		x			
69. <i>Botia striata</i>		x			
70. <i>Lepidocephalus thermalis</i>		x			
71. <i>Noemacheilus anguilla</i>		x			
72. <i>Noemacheilus botia aureus</i>		x			
73. <i>Noemacheilus denisonii</i>	x				
74. <i>Noemacheilus evezardi</i>	x				
75. <i>Noemacheilus moreh</i>		x			
76. <i>Noemacheilus rueppelli</i>		x			
77. <i>Noemacheilus striatus</i>		x			
78. <i>Rita gogra</i>		x	x	x	
79. <i>Rita kuturnee</i>		x	x		x
80. <i>Mystus krishnensis</i>			x		
81. <i>Mystus malabaricus</i>		x			
82. <i>Ompok pabo</i>			x		
83. <i>Proeutropiichthys taakree</i>					x
84. <i>Neotropius khavalchor</i>		x	x		
85. <i>Eutropiichthys goongware.</i>				x	x
86. <i>Eutropiichthys vacha</i>				x	
87. <i>Silonia childreni</i>			x		x
88. <i>Pangasius pangasius godavari</i>					x
89. <i>Nangra itchkeea</i>		x	x		
90. <i>Glyptothorax lonah</i>				x	
91. <i>Glyptothorax madraspatanum</i>		x			
92. <i>Glyptothorax trewavasae</i>	x				
93. <i>G. controstrae poonaensis</i>	x				
94. <i>Clarias dussumieri</i>			x		
95. <i>Hyporhamphus limbatus</i>				x	x
96. <i>Xenentodon cancila</i>		x	x		
97. <i>Oryzias melanostigma</i>				x	x
98. <i>Gambusia affinis</i>		x			
99. <i>Lebistes reticulatus</i>		x			
100. <i>Chanda thomassi</i>		x			
101. <i>Pristolepis malabarica</i>		x			

	I	II	III	IV	V
102. <i>Etroplus maculatus</i>			x		x
103. <i>Etroplus suratensis</i>			x		x
104. <i>Rhinomugil corsula</i>			x	x	x
105. <i>Mastacembelus pancalus</i>					x
106. <i>Macropodus cupanus</i>					x

Zone II between Dhom dam and Almatti dam, covering the stations between Wai and Bagalkot has the u/m species endemic to it.

10. *Barilius barna*
11. *Puntius amphibius*
12. *Labeo porcellus*
13. *Cirrhinus fulungee*
14. *Garra bicornuta*
15. *Botia lohachata*
16. *Botia striata*
17. *Lepidocephalus thermalis*
18. *Noemacheilus anguilla*
19. *Noemacheilus botia aureus*
20. *Noemacheilus moreh*
21. *Noemacheilus ruppelli*
22. *Noemacheilus striatus*
23. *Mystus malabaricus*
24. *Glyptothorax madraspatanum*
25. *Gambusia affinis*
26. *Lebistes reticulatus*
27. *Chanda thomassi*
28. *Pristolepis malabarica*

Of these 19 species *Puntitus amphibius*, *Labeo porcellus*, *Gambusia affinis* and *Lebistes reticulatus* are likely to occur in other zones below Almatti dam also as these are easily transplanted through human agencies at the time of stocking or propogation for larvicidal work. The Cyprinodonts and Poecilids are known for their fast breeding rates. All the other species are typical inhabitants of this zone characterized by pebbly to sandy bottom, narrow channels and of higher elevations than the other zones. These species are incapable of transgressing the Almatti Dam to colonize lower areas in a natural way.

Zone III between Almatti dam and Sri Sailam dam covering stations Jamkhandi to Lingalagattu has the following species endemic to it.

29. *Amblypharyngodon meletina*
30. *Barilius evezardi*
31. *Osteobrama neilli*
32. *Labeo ariza*
33. *Labeo boga*
34. *Labeo potail*
35. *Labeo sindensis*
36. *Tor neilli*
37. *Mystus krishnensis*
38. *Ompok pabo*
39. *Clarias dussumieri*

Of the above 11 species *Labeo* spp., *Ompok pabo* are likely to occur below Sri Sailam dam also, as they are generally more adaptable than others and can easily get transposed either through human agencies, or other means such as through connecting channels, etc. These do not have any specific habitat preferences. The position of *Clarias dussumieri* is doubtful (see p.12). The other species are restricted to this area where the water storage and flow is high over a sandy cum pebbly bottom.

Zone IV between Sri Sailam dam and Nagarjunasagar dam covering stations Nagarjunasagar and Buggavagu has only two species in it.

40. *Eutropiichthys vacha*
41. *Glyptothorax lonah*

Both these can be expected definitely to occur below Nagarjunasagar also and as such cannot be called endemic. It is not surprising that this zone is having only two species in it and that too not likely to be restricted to it. The backwash of Nagarjunasagar during floods reaches upto Sri Sailam dam making the area contiguous and hence fish can easily disperse themselves below Sri Sailam dam.

Sri Sailam dam is a barrier and hence we find not many of the species found above Sri Sailam occurring below it.

Zone V below Nagarjunasagar dam covering stations Macherla to Nagayalanka has the u/ m species in it.

42. *Anguilla bicolor*
43. *Anguilla bengalensis*
44. *Hilsa ilisha*
45. *Esomus barbatus*
46. *Esomus danricus*

47. *Brachydanio rerio*
48. *Rasbora rasbora*
49. *Puntius curmuca*
50. *Puntius dorsalis*
51. *Cirrhinus cirrhosa*
52. *Proeutropilichthys taakree*
53. *Pangasius pangasius godavarii*
54. *Macropodus cupanus*
55. *Mastacembelus pancalus*

Of these 14 species, *Hilsa ilisha* and *Anguilla* species are long distant migrants but cannot negotiate the Nagarjunasagar dam even if they are able to transgress so far. *Puntius curmuca* is rare and its occurrence in upper reaches require further investigation. It is unlikely to occur above the Nagarjunasagar dam in a natural manner. The other species are likely to occur above the dam also as they are capable of easy dispersal through human agencies at time of stocking (*Cirrhinus cirrhosa*, *Puntius dorsalis*) when along with other selected natural spawn or fry of carps these get mixed up. Species of *Esomus*, *Rasbora*, *Macropodus*, *Brachydanio*, *Mastacembelus*, *P. taakree* establish themselves through intervening canals etc.

Thus it is seen that out of the above 55 species only 9 species in Zone I, 19 in Zone II, 11 in Zone III, 2 in Zone IV and 14 in Zone V are endemic to respective zones. The low endemism is in keeping with the ecological conditions available in the river from its origin to confluence.

Division of a river into distinct biological zones each with characteristic fish fauna has been adopted by many workers. Huet (1959) divided the European streams into four zones based on distribution. Besides, the aquatic fauna which live in the river stretch, the physiographical features, nature of bottom, gradient, current velocity, food, shelter, breeding grounds are all utilised in the classification. The endemic species reflect the above facts, such as the loaches remaining in fast flowing boulderous streams, and other cyprinids preferring meandering stretches with sandy and clayey bottom. It also shows that barrages at Rabkavi, Vijayawada have no effect on the distribution of these species. For purpose of the survey I divided the river into four sectors (see p.) which is justified by the above distributional patterns also.

Now analysing the remaining 51 species found overlapping in one or more zones we find that no species is found in all the five zones contiguously. * (56) *Salmostoma novacula* is the only species from zone I to IV. This indicates that Nagarjunasagar dam is an effective barrier not allowing the dispersal of any of these 51 species. However we find that (57) *Puntius jerdoni* and (58) *Tor khudree* are found contiguously from Ondishi to Lingalagattu above Sri Sailam (Zones I to III). These have been able to transgress the Dhom and Almatti dams during floods or they may

* Serial number continued with species classification

have been in existence even before the construction of these dams which are only of recent origin.

Only three species are seen contiguous in Zones I and II (Ondishi to Bagalkot). These are:

59. *Puntius narayani*
60. *Puntius sahayadriensis*
61. *Tor mussullah*

In reality these species are inhabitants of the upper reaches and are rarely found below. *Tor mussullah* is a rare species (see p.124).

From below Dhom dam to confluence (Zones II to V) transgressing Almatti, Sri Sailam and Nagarjunasagar dams the following two species alone are found.

62. *Salmostoma acinaces*
63. *Osteobrama cotio cumma*

Both are prolific breeders and are capable of establishing their populations easily through canals and other linkages.

In Zones II, III and IV (from below Dhom to Nagarjunasagar dam) is found (64) *Rita gogra* the Bagrid catfish, hardy and capable of cutaneous respiration. This also can easily transgress barriers through linkage canals.

The following species are found in Zones II and III (below Dhom dam to Sri Sailam dam).

65. *Danio devario*
66. *Aspidoparia morar*
67. *Barilius barila*
68. *Puntius filamentosus*
69. *Puntius sophore*
70. *Rohtee ogilbii*
71. *Osteobrama vigorsii*
72. *Labeo boggut*
73. *Labeo fimbriatus*
74. *Labeo kawrus*
75. *Labeo nigrescens*
76. *Osteochilus nashii*
77. *Osteochilus thomassi*
78. *Garra gotyla stenorhynchus*
79. *Neotropius khavalchor*
80. *Nangra itchkeea*
81. *Xenentodon cancila*

The distribution of the above species is as to be expected since the condition of the river in these zones are ideal for their life. The Almatti dam evidently has not much effect and also some of the species may have established much earlier. Species of *Labeo* may have been dispersed through human agencies.

82. *Rhinomugil corsula* is the only species that is found in Zones III to V (below Almatti dam to confluence). This occurrence above Nagarjunasagar and Sri Sailam Dam is noteworthy.

No species is found contiguous in Zones III and IV (between Almatti and Sri Sailam dam).

83. *Thynnichthys sandkhol*, 84. *Labeo gonius*, 85. *Eutropiichthys goongware*, 86. *Oryzias melanostigma*, 87. *Hyporampus limbatus* are the only species found in Zones IV and V contiguously.

88. *Salmostoma horai*, 89. *Danio malabaricus*, 90. *Silonia childreni*, 91. *Etroplus maculatus*, 92. *Etroplus suratensis* are found in Zones III and V although their occurrence in IV is also likely.

93. *Puntius carnaticus*, 94. *Puntius melanostigma*, 95. *Schismatorhynchus nukta*, 96. *Rita kuturnee*, 97. *Labeo pangusia* are found in zones II, III and V and these are likely to be present in Zone IV.

The following species are found in all zones except IV (between Sri Sailam and Nagarjunasagar).

- 98. *Salmostoma boopsis*
- 99. *Salmostoma clupeioides*
- 100. *Puntius kolus*

Their occurrence in IV is not unlikely.

The distribution of the following species is not discussed as they do not occur in the Krishna river proper as their presence is doubtful.

- | | |
|----------------------------------|------------------|
| 101. <i>Barilius canarensis</i> | Tungabhadra only |
| 102. <i>Barillus gatensis</i> | Tungabhadra only |
| 103. <i>Oreichthys cosuatis</i> | Tungabhadra only |
| 104. <i>Puntius lithopidos</i> | Tungabhadra only |
| 105. <i>Labeo dussumieri</i> | Tungabhadra only |
| 106. <i>Osteobrama belangeri</i> | Doubtful |

14. EXOTIC SPECIES

Jhingran (1963) gave a list of important Exotic fishes introduced in Indian waters. Of the 15 species, five are game fishes, 8 food fishes and 2 larvicidal. The game fishes are.

<i>Salmo trutta fario</i>	Brown Trout
<i>Salmo gairdneri</i>	Rainbow Trout
<i>Salmo fontinalis</i>	Lake Trout
<i>Oncorhynchus nerka</i>	Pink Salmon
<i>Salmo salar</i>	Atlantic Salmon.

The last of these game fishes was transplanted in Laribal hatchery in Kashmir in 1969. The Pink Salmon was imported from Japan and introduced in the Nilgiri waters, Kodai hills, high ranges of Travancore, Kashmir and Himachal Pradesh.

None of these is found in the Krishna system nor any attempt has been made for their introduction in the headwaters.

The Exotic food fishes introduced are.

<i>Carassius carassius</i>	Golden carp
<i>Ctenopharygodon idella</i>	Grass carp
<i>Cyprinus carpio</i>	Common carp
<i>Hypophthalmichthys molitrix</i>	Silver carp
<i>Osphronemus goramy</i>	Gourami
<i>Puntius javanicus</i>	Tawes
<i>Tilapia mossambica</i>	Tilapia
<i>Tinca tinca</i>	Tench

Of these eight species, culture of grass carp, common carp, silver carp is widely practised. Gourami is cultured individually or in combination with other fishes. *Tilapia* is a prolific breeder and is a pest in places where it occurs. It is unsuitable for fish culture along with Indian major carps.

None of these was encountered in the Krishna system though in some tanks culture of common carp is in vogue.

The two exotic larvicidal fishes *Gambusia affinis* introduced from Italy in 1938 and *Lehistes reticulatus* from South America have been collected from Krishna river at Wai. These were not obtained elsewhere. As they do not grow to any large sizes, their presence is not commercially valuable.

Thus Krishna can be stated to be free from major exotic species as seen in other river systems.

15. DISCUSSION

Cauvery, Krishna and Godavari are the three main rivers which support the vital agro economic base for the lakhs of population living around them. They are the carriers of the rain waters of the south eastern border of the Peninsular Plateau and contribute to a large extent the supporting base for the Wetland ecosystem of the Eastern Ghats area. Their waters are being harnessed for several purposes as irrigation, human uses, industry, fisheries, poultry, animal husbandry, veterinary and for hydro-electric power generation. The economic prosperity of the southern states of Tamil Nadu, Kerala, Karnataka, Andhra Pradesh, Maharashtra and Madhya Pradesh is closely interwoven with the water supply and potentialities of these rivers. A number of multipurpose projects have been completed on these rivers and several are on the anvil. The recent on-going project of diverting a part of Krishna waters from the Sri Sailam reservoir to Madras for drinking water purposes is an example.

Despite all such importance the biomonitoring of these rivers has not been extensively done.

Recently a coordinated project on the Cauvery for monitoring its quality was undertaken under the auspices of the Madras Science Foundation involving several universities, colleges, institutions on the banks of the river. No similar exercise has been attempted on Krishna or Godavari mainly for lack of a consolidated data base on the bioresources. The writer's account of the survey of Cauvery (Jayaram *et al.* 1982) formed a background for further work being done by the Madras Science Foundation. The present investigation on Krishna may serve similar purpose. No comprehensive study on the Godavari is available as at present.

However each one of the above rivers has its own characteristics and fauna. Krishna and Godavari, in a sense, form a break point for some fishes from colonising the Cauvery. Jayaram (1979) showed that whilst Krishna and Godavari shared many fish species, Cauvery did not and has its own exquisite species, as *Labeo kontius*, *Puntius dubius*, etc. which are absent in Krishna and/or Godavari. Recently Yazdani (1992) analysed the distribution of 110 fish genera found in Ganga, Brahmaputra, Godavari and Mahanadi, Narmada and Tapi, Krishna and Cauvery. He concluded that among the rivers of Peninsular India, the Cauvery exhibits highest diversity in its ichthyofauna and that species of *Puntius* show extraordinary diversity in the same river. Likewise *Bagarius*, *Rita*, *Eutropiichthys*, *Schismatorhynchus* are confined to Krishna and/or Godavari and have not been able to penetrate below. Even in other biotic and abiotic factors these rivers differ. Venkateswarlu and Seshadri (1990) showed that Rivers Krishna and Godavari differed in some of their characteristics. They studied samples from Gadwal on Krishna, Majira (a tributary of Godavari) between Singur and Sangareddy and Tungabhadra at Kurnool. It was seen that carbonates were more in Tungabhadra but bicarbonates were quite high in Majira whereas in Krishna or Tungabhadra the latter were few. Blue green algae populations were considerable in Tungabhadra unlike in Krishna.

It is seen in this study also that Diatoms dominate the algae population and the potamoplankton is more than the limnoplankton. From Nagarjunasagar reservoir we could get only *Navicula* sp. unlike other areas of the flowing Krishna segments. Also Tungabhadra at Kurnool had fewer zooplankton populations than other locations on Krishna because of stagnation.

Phytoplankton density was maximum in premonsoon and minimum in postmonsoon. With the increase in temperature gradual increase in phytoplankton number was noticed. The clear fresh water diatoms present in the river have a potential to create algal blooms at stagnant points as at Haripur ghat, Sangli, Nawab's Bungalow, Kurnool. These algal blooms release oxygen by their photosynthetic activity and make up for the deficiency of dissolved oxygen. But excessive growth of algae act as a screen preventing the penetration of sunlight to lower depths and the photosynthesis is disrupted; consequently the food web equilibrium is disturbed. Some of these algae as *Anabaena*, *Cosmarium*, *Oscillatoria* are pollution sensitive whilst some as *Navicula*, *Euglena*, are pollution tolerant.

High turbidity affect water environment by rapidly absorbing radiant energy in the upper layers of water impairing photosynthesis (Bartsch, 1960). Turbid water, as at Hidkal Dam, Pandarpur, Kurnool, Wai, Haripur ghat, Sangli decreases light penetration, limits productivity of phytoplankton and the oxygen concentration becomes low. Thus because of such waters the oxygen concentration was 3.0 mg/l at Wai during premonsoon period, 3.04 mg/l at Pandarpur, 2.5 mg/l at Haripur ghat, Sangli. Conversely the clean waters at Babaladi, Karad showed 8.0 mg/l and 10.4 mg/l respectively. But Tungabhadra at Kurnool showed a higher concentration of oxygen 7.8 mg/l in premonsoon period, may be due to the time of collection (5 p.m.) when the layers would have got warmed up. But the fact remains that turbid waters are not productive as others, as seen from quality and quantity of fish sampled.

Bicarbonate alkalinity was generally more during the postmonsoon unlike the premonsoon period. Carbondioxide alkalinity and pH are inter dependent on each other in an aquatic environment. The buildup of bicarbonate alkalinity at the postmonsoon is due to increased discharge in the river and also due to leaching from the soil besides addition of inorganic wastes by flood water. Free CO₂ was absent throughout during the premonsoon but traces at Karad and 5.3 mg/l at Haripur ghat, Sangli during postmonsoon was detected. This was because of the river being polluted at the latter station at all times. As Sreenivasan (1978) stated that in waters where the photosynthesis is poor, all the carbondioxide is not utilised and therefore when its presence is detected correspondingly the carbonate alkalinity is absent. This is confirmed by our findings also. At the above station carbonate alkalinity was zero.

Dissolved Oxygen in most of the stations at both pre and postmonsoon periods were at optimal levels. However, the low concentration at Wai, Pandarpur, Haripur ghat, Sangli, Mantralayam was due to pollution. At these stations the high concentration of wastes almost eliminates the dissolved oxygen content. Bacteria

thriving in these septic zones utilize the dissolved oxygen thereby reducing it or even almost bringing to low levels as 0.28 mg/l as at Haripur ghat, Sangli (postmonsoon). The high level of 10.4 mg/l at Karad (premonsoon period) and 9.6 mg/l at Wai during postmonsoon needs clarification. The latter may be due to the blooming of algae caused by inflow of sewage wastes. At Karad, the Koyana and Krishna join and the flow was very slow. The river was also shallow.

Velocity of water was greater in postmonsoon generally in all stations as compared to premonsoon period. Low flow of water in summer causes temporary deterioration in water quality by altering the physical, chemical and biological parameters. Depression of the biological communities takes place and in polluted areas as Kurnool, Haripur ghat, Sangli the biotic communities are reduced in quality and quantity as evidenced from data obtained. High rate of flow dilutes the pollutants giving an opportunity to the physical, chemical and biological factors to improve.

Macrophytes including grasses, shrubs and trees have been identified and enumerated. These contribute their own role in maintaining an ecological balance by symbiotic relationships with aquatic insects which form part of the food chain of fish and also strengthen the river banks, protecting them from erosion by the flood waters. The listing of species above high flood level and affected by floods would serve to indicate the seasonal changes that may occur during pre floods and post floods of the river.

Wherever possible the medicinal and aromatic plants have also been marked. Some of them could be profitably cultivated further in the denoted areas and exploited judiciously.

The Krishna and Godavari deltas are in contact with one another and contain mangals about 100 sq km in extent according to Blasco (1975). Ecologically speaking there is development of an off shore sandbar which diminishes daily the marine influence on the mangroves. During the heavy flood season large areas are inundated with freshwater and consequently the seasonal changes in salinity are high between the hot dry season, and the rainy season. Mangroves adapted to such variations of water salinity as *Avicennia* are present in Krishna estuary. There are two types of halophytic vegetation in this region (a) those growing on the river banks, and those growing on alluvial soil in the interior of the delta. On the river banks the vegetation consists of tall dense close thickets of *Cyperus* species, the rhizomes of which are constantly under water. In the vicinity of these thickets undershrubs as *Acanthus ilicifolius* grow where the area have been cleared. On the old alluvial soil, discontinuous thickets of 0.5 m to 2 m in height are found. Species as *Avicennia officianalis*, *A. marina*, *Sueda maritima*, *Heliotropium curassavicum*, *Aeluropus lagoides* are found.

For the first time the inventorisation of the algae is made with the data available for the entire river stretch. An algal atlas on for that matter, a plankton atlas of any

river system as a whole is sadly lacking in our country. This report could serve as a starting point.

One-time examination of water samples from Wai, Haripur ghat, Sangli, Pandarpur showed fluctuations in MPN of Coliforms and also presence of pathogenic organisms in these locations. The disparity in figures obtained and also published data indicates the non-reliability of this parameter in judging the status of pollution.

The MPN coliform data for samples (Table 6.1) from Bagalkot, Kurnool, Mantralayam when compared to that of Wai, Haripur ghat, Sangli and Pandarpur show remarkable variations. As per tolerance limits prescribed by the Indian Standards Institution for sewage effluents discharged into inland surface waters, the monthly average of coliform organisms MPN per 100 ml should not be more than 5000 with less than 5% of the samples with values more than 5,000. As per this classification the river even at Kurnool should be considered as fit for public water supply which, in fact is being done now after treatment. Counting coliform MPN is generally advocated to assess the level of faecal contamination of water. Coliforms as such cannot be used as indicators of the virological quality of water. The enteric viruses are capable of surviving for longer periods than enteric bacteria (Rao *et al.* 1984). Enumeration of Coliphages as indicators of sewage pollution and enteric viruses is now being recommended. However, the algal indices of Palmer and the quality of fish samples clearly demonstrate without doubt the undesirable status of the river stretch at these locations.

Considering the various segments of the river in the three states, it is seen that the incidence of pollution is greatest in Maharashtra, Andhra Pradesh and Karnataka in that order. Even in these states only in selected localities the pollution load is high as at Wai, Haripur ghat, Sangli, Nawab's Bungalow, Kurnool and Harihar. The Tungabhadra basin has some major industries unlike Krishna basin and consequently pollution is greater in that river and has received considerable attention also. Between the two categories of non point and point sources of pollution, the former is much more than the latter (Tables 5.1 and 5.2). Industries as Ugar Kagwad Sugar Factory at Sangli, the Krishna Co-operative Sugar Factory, Shivnagar near Karad discharge their effluents through canals and pipes after some treatment and the sillage is used for land filling. In the case of K.C.P Sugar Mills at Vuyyuru near Vijayawada a well organised system of canals and pipes take away the discharges.

The pollution loads from the urban sources at Wai, Haripur ghat, Sangli, Nawab's Bungalow, Kurnool and from the industrial sources as at Karad, Kurnool, Jamkhandi, Harihar, Nagarjunasagar, Vijayawada should be minimised through waste water treatment in respect of urban pollutants and continuous surveillance, by monitoring of the physicochemical and biotic parameters in respect of the industrial pollutants.

Though Krishna waters are put to very intensive and multifarious uses the fact has to be accepted that it has some resilience on account of its self purification

capacity. The MPCB has classified the river stretch in Maharashtra as belonging to class C and D fit for drinking water sources with conventional treatment followed by disinfection and for propagation of Wildlife and Fisheries respectively. On the other hand the APCB has classified the river stretch in Andhra Pradesh as belonging to class D only i.e. only for Wildlife and Fisheries.

The investigations confirm more or less the above classification. However, as shown by Rekha and Krishnamoorthy (1977) the animal and plant communities provide a static record of the conditions prevailing for a period of time. The advantage of biological monitoring over chemical and bacteriological methods is that it presents a better picture of the contents and quality of the media and their relationship with other abiotic factors.

Biological assessment of water quality based on faunal components has been done in three rivers of United Kingdom (Balloch *et al.*, 1976). The invertebrates as annelids and molluscs have been used as indicators. The advantage of these animals is their easy availability and collection in good numbers. In Krishna we have records of *Brachionus calyciflorus*, *Keratella tropica* at Sangli, *Filinia longiseta* at Pandarpur besides two species of *Brachionus* and the presence of molluscs as *Bellamya bengalensis*, *Thiara tuberculata* at Haripur ghat, Sangli and *Thiara torutosa* and *T. lineata* at Kurnool. These can be used as faunal bioindicators. The presence of snails as listed in Table 10.1.1 which are possible carriers of cercarial infection would also indicate the utility of such bio-indicators.

As regards fish species in respect of Krishna it is seen that the system has more number (188) than Cauvery (142) Jayaram *et al.* (1982) or Godavari (118) David, (1963).

It should however be stated that David's account is not of the entire river and as such the figure may be more. Quality wise it is seen that Krishna has 63 species of A Category and 15 of B Category whereas Cauvery has 36 of A and only 4 of B. Percentage wise.

	Krishna	Cauvery
A Quality	33.5%	25.35%
B Quality	7.98%	2.82%

Qualitatively the number of fish species found in Krishna is more. This is a corollary to the river characteristics and ecological conditions. Landing wise the yeild is more in terms of weight and species composition. Species as *Mystus krishnensis* growing to over 30 kgs, *Tor khudree*, *Aorichthys aor*, *Labeo* species as *panqusis*, *boga*, *nigrescens*, *Puntius* species as *kolus*, *sarana*, *jerdoni*, the nagendrum fish

*As per list of Jayaram *et. al* (1982)

Osteocheilus thomassi, *Rita gogra* and *kuturnee* are fishes very much contributing to the rich fishery wealth of the river. *Puntius sarana* is extensively found unlike in Cauvery where *Cirrhinus reba* dominates which is of a poorer quality. Though discarded, *Osteobrama* species abound in Krishna. Genera as *Rita*, *Bagarius*, *Ompok*, *Schismatorhynchus*, *Neotropius*, *Eutropiichthys*, which are freshwater forms are exclusive to Krishna and/or Godavari. The vast expanse of the estuary of Krishna contributes its own share to the piscine wealth of the river. The Clupeoids, Engraulids, Perches, are all rich resources exploitable profitably. Some of the rare species as *Tor mussullah*, *Tor neilli* require intense search and would prove to be added value. The new records and extensions of geographic ranges are also of additional importance.

The spatial distribution of the fish fauna demonstrates that the Nagarjunasagar dam is a barrier and Almatti dam is of no significance. Jayaram *et al.* (1982) divided the Cauvery into three zones based on the distribution patterns of its fish fauna as mountainous course, plateau course and plains course. Each zone was shown to have its own peculiar fauna, the plains course having over 104 species and the mountainous course with the minimum number of species of uneconomical varieties.

In respect of Krishna such a zonation is not discernible as can be seen from the Shannon Weiner Index given below.

Species diversity using Shannon Weiner Index was calculated for species confined to zones I, II, III, IV and V. The values are:

Zone	I	2.080
	II	2.643
	III	2.490
	IV	1.270
	V	2.045

The diversity is more or less uniform except in zone IV, Sri Sailam dam to Nagarjunasagar, which has only three species and which are likely to occur below Nagarjunasagar also. This would indicate that this habitat is more or less homogenous. It also would seem that many species could become differentiated within the same geographic region. A single species rarely forms a continuous belt as seen in this study.

Seasonwise certain species alone occur both during premonsoon and postmonsoon periods, this being regulated by the availability of water in the river and water flow. Some species as *Salmostoma boopsis*, *P. narayani*, *Labeo potail*, *L. sindensis*, *L. porcellus*, *Cirrhinus fulungee* etc. do not occur in premonsoon period at all and some as *Labeo ariza*, *L. kawrus* during postmonsoon period. In respect of species found all through the percentage of number of examples to the total collected and the total of each species for certain important species are as below.

A Category of Fishes	Percent of total of all species		Percent of total of all species	
	Pre monsoon	Post monsoon	Pre monsoon	Postmonsoon
<i>Notopterus notopterus</i>	70.0	30.00	8.14	5.17
<i>Labeo calbasu</i>	64.71	35.29	25.58	20.69
<i>Labeo rohita</i>	42.31	57.69	12.79	25.86
<i>Labeo pangusia</i>	61.54	38.46	9.30	8.62
<i>Tor khudree</i>	77.42	22.58	27.91	12.07
<i>Silonia childrent</i>	72.73	27.27	2.33	3.45
<i>Lates calcarifer</i>	20.00	80.00	1.16	6.90
<i>Mugil cephalus</i>	72.73	27.27	9.30	5.17
<i>Mastacembelus armatus</i>	30.00	70.00	3.49	12.07
Other species				
<i>Salmostoma clupeoides</i>	17.72	82.28	2.89	9.76
<i>Salmostoma longicauda</i>	4.11	95.89	0.62	10.51
<i>Danio aequipinnatus</i>	95.95	4.05	14.64	0.45
<i>Danio malabaricus</i>	14.94	85.06	2.68	11.11
<i>Rasbora daniconius</i>	37.04	62.96	4.12	5.11
<i>Puntius kolus</i>	46.74	53.26	8.87	7.36
<i>Puntius sarana</i>	25.27	74.73	4.74	10.21
<i>Puntius sophore</i>	61.31	38.69	17.32	7.96
<i>Puntius ticto</i>	36.36	63.64	10.72	13.66
<i>Osteobrama cotio cunma</i>	54.17	45.83	10.72	6.61
<i>Cirrhinus reba</i>	62.14	37.86	17.94	7.90
<i>Chanda ranga</i>	23.06	72.94	4.74	9.3

The absence of species as *Tor mussullah*, *Tor neilli*, the sporadic occurrence of *Puntius curmuca*, *Thynnichthys sandkhol*, *Schismatorhynchus nukta*, *Neotropius khavalchor*, *Eutropilichthys goongware* need particular attention. Most of these are prime food fishes. Species as *T. neilli* grow to 30-35 kg could become valuable additional resources if located, conserved and judiciously exploited. An ecostatus study of some of these species is badly needed and strongly recommended.

The increasing practice of brackishwater aquaculture in the esuarine area of Krishna is a healthy sign. The vast coastal areas of our country with an estimated

extent of about 9.0 lakh hectare of brackishwater offer immense promise for profitable aquaculture of prawns and selected fin fish. It is seen that *Penaeus monodon* and *P. indicus* are extensively cultivated, though culture of fin fish as *Chanos*, Mulletts are not very prevalent. The seed is obtained from the river itself and with additional inputs from the State Fisheries the scope could be vastly expanded. The landing data in Krishna estuary for 1986, 1987 (table 10.2.1) is indicative of the potentialities. Amongst fin fish several candidate species are present which should be tried. Species as *Lates calcarifer*, *Arius jella*, *Nandus nandus*, *Etroplus* sp. are some of the potential species.

To conclude it can be stated that Krishna is rich in quality and quantity of fish life so far, without the influence of any commercial exotic species in the fluvial sections and the polluting agencies not widely spread to affect the river greatly. Some of the fishing practices need watchful regulatory measures. The urban and industrial pollutions at selected places need regular surveillance and continuous monitoring. The fishery wealth can be exploited judiciously with well planned management. Some of the areas need protected measures.

It is earnestly hoped that this study would form a data base for further work on KRISHNA.

16. SUMMARY AND CONCLUSIONS

1. The origin of the river Krishna is near Ondishi village, near Wai, Satara district, Maharashtra and not Wai proper, as has been erroneously believed so long.
2. Krishna river provides an interesting example of fluvial geomorphology in the fact that in the course of its passage from the origin to confluence it exhibits all stages of life as youth, maturity and old age.
3. Krishna is polluted at Wai, Haripur ghat, Sangli; R. Tungabhadra its tributary, is polluted at Kurnool, Mantralayam and R. Bhima at Pandarpur.
4. Industrial wastes pollute Krishna at Karad, Sangli, Jamkhandi, Vyyurru. Tungabhadra is polluted similarly at Kurnool and Haripur.
5. The self purification capacity of the river is good.
6. Comparatively Karnataka region of Krishna is less polluted than Maharashtra or Andhra Pradesh.
7. In the Krishna system the pollution load is greatest in Tungabhadra.
8. MPN Coliform at Wai, Haripur ghat, Sangli, Pandarpur in Maharashtra showed variations. Same count at Kurnool, Bagalkot and Mantralayam showed a vastly different picture. The reliability of MPN Coliform is doubted.
9. Zoo and phytoplankton populations were greater in premonsoon periods than postmonsoon.

10. Copepods followed by Rotifers amongst Zooplankton dominate. Upper reaches of Krishna have richer communities than the middle or lower ones.
11. Bacillariophyceae was abundant in most stations where the air temperature was above 29⁰C in the postmonsoon period. Chlorophyceae thrive well at 30 to 32⁰C during summer. Diatoms dominate the algal population and the potamoplankton is more than the limnoplankton.
12. As per Palmer's Index presence of more than five algal genera out of top eight indicate the polluted nature of the river at particular locations.
13. As per Nyggard's Index Wai alone seems to be highly polluted, and as per Palmer's Index, stations listed as polluted are confirmed.
14. Bioindicator species of algae and mollusca confirm the polluted nature of the river stretches.
15. Most of the original vegetation on either side of the river have either been lost or replaced for exotics and cultivares due to human agencies. Evergreen forests are present only near origin and head waters besides Sri Sallam Reserve Forest area. A good formation of mangroves exists in the estuarine region.
16. For the first time a list of algae of the Krishna river is compiled which should prove useful to make a beginning in the preparation of Plankton atlas of Indian river systems.
17. 145 species of plants have been recorded and as many as 39 are of medicinal value. 30 species of molluscans have been recorded a few of them being faunal bioindicators and a few of economic value.
18. *Parryesia favidens* var *deltae* and *P. pachysoma* are first time records of Gastropod molluscs in the Krishna basin. The geographical range of *Parreysia cylindrica* is extended to Andhra Pradesh also.
19. Occurrence of the Tiger prawn *Penaeus monodon*, *P. indicus* and their cultivation in the estuarine areas is recorded.
20. Fishing practices, gear and tackle used are of conventional type. Destructive fishing practices are prevalent, as dynamiting, lack of mesh regulations and an uniform policy for the riverine fisheries.
21. A total of 195 species of fish is so far known from the Krishna river system of which only 187 can be considered validly occurring. Reasons for discarding the eight have been given.
22. Out of the 187 species, 154 have been collected falling under 46 families and 93 genera. Of the remaining 33 species three are doubtful, five occur only in Tungabhadra and not in Krishna proper, and 25 (four of which are rare) could not be obtained for reasons explained.
23. A classified list of the 195 species of fish is given. They are be classified as

per their quality into four categories, A,B,C, and D as per size. The economic, fishery and taxonomic values of some are discussed.

24. The relative abundance or dominance of species stationwise, familywise, specieswise, seasonwise is discussed. Cyprinidae or carps dominate the scene as is common in most Asian river systems.
25. Andhra Pradesh sector of Krishna has the greatest percentage of fish species 88.46% followed by Maharashtra (39.74%) and Karnataka (32.05%).
26. The river is divided into five zones as per barriers present. The percentage of endemism of fish species found in the five zones of the river is in keeping with the ecological conditions available in the river.
27. The division of the river into four sectors for survey purposes is justified by the patterns of fish distribution also.
28. Zones I to IV have only one species.
29. No species is found contiguous in all the five zones.
30. Occurrence of *Rhinomugil corsula* from below Almatti dam to below Praksam barrage is noteworthy.
31. Nagarjunasagar dam and Sri Sailam dam are effective barriers for fish migrations.
32. Almatti dam has not much effect on the fish dispersal.
33. Zones II and III (below Dhom dam to Nagarjunasagar dam) is a rich area for fish life with good potentialities.

17. RECOMMENDATIONS

1. The pollution loads from the urban sources as at Wai, Haripur ghat, Sangli, Nawab's Bungalow, Kurnool and from the industrial sources at Karad, Kurnool, Jamkhandi, Harihar, Nagarjunsagar, Vijayawada should be minimised through waste water treatment in respect of the former and continuous surveillance and monitoring in respect of the latter.
2. Presence of faunal bioindicator species of algae and molluscs should be utilized for biomonitoring.
3. Though the Krishna waters can be classified as fit for bathing and drinking purposes after treatment, non-point sources of pollution prevalent at Wai, Sangli, Pandarpur, Jamkhandi, Bagalkot, Kurnool should be effectively controlled.
4. The presence of economically valuable fishes of as many as 63 species (32.14%) of A Category and 15 of B (7.65%) Category should be profitably used and judiciously exploited.

5. Fish species as *Osteobrama cotio cunma* at present being discarded should be used for conversion as bone meal.
6. The doubtful occurrence of species of *Hilsa*, *Setipinna*, *Gudusia* should be cleared and settled once for all by intense location surveys.
7. *Tor khudree*, *Mystus krishnensis* should be transplanted into other suitable zones and steps to establish their populations undertaken.
8. Intense location survey and ecostatus studies of *Tor neilli*, *Tor mussullah*, *Thynnichthys sandkhol*, *Eutroplichthys goongware* are urgently needed.
9. Areas as Rekulampally, Gadwal should be declared as sanctuaries where fish congregate and breed but indiscriminate fishing is being done.
10. Sri Sailam reservoir should be stocked and profitably exploited.
11. Exotic species as such have not penetrated the river system. This should be zealously gaurded and monitored to see that harmful species as *Tilapia* do not enter.
12. The single species exploitation in Dhom reservoir and the population dynamics of the fishes of the reservoir need an intense study.
13. Harmful single species fishing as at Dhom should be restricted.
14. Dynamiting isolated river stretches in Nagarjunasagar, Sri Sailam, Dindi reservoir, Babalddi, Rabkavi, Mehsal require vigil and strict enforcement of fishing act provisions.
15. Aquaculture in brackishwater areas of the estuary with candidate species found in Krishna is recommended.
16. The distribution status of species as *Gudusia chapra*, *Osteobrama belangeri* in Krishna and of *Barilius canarensis*, *B. gatensis*, *Oreichthys cosuatis*, *Puntius curmuca*, *P. lithopidos*, *Labeo dussumieri* in Tungabhadra and/or Krishna needs a special study.
17. The systematic status of *Setipinna godavari*, *S. tenuifilis* vs *S. phasa* in the Krishna river requires a separate field study.

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19. LITERATURE

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1. Long view of R. Krishna at Ondishi Village with channel of the River (see arrow). 9.3.1990.



2. The channel of the R. Krishna near Ondishi Village. 9.3.1990.



3. View of Dhom reservoir with Panoramic view of Sahayadri range, Western ghats, West of Wai, Satara district, Maharashtra State. 3.11.1988.



4. Dhom reservoir. 3.1.1988.



5. Original course of R. Krishna barred by stone embankment (see arrow) and the stretch below it at Dhom. 2.1.1988.



6. The original course of R. Krishna dammed and diverted at Dhom, 2.1.1988.



7. Upstream view of R. Krishna at Wai. 2.1.1988.



8. Polluted downstream view of R. Krishna at Wai town. 2.1.1988.



9. Upstream view of R. Tungabhadra, Nawab's Bungalow near Kurnool Town. 14.12.1987



10. View of R. Krishna at Haripur ghat, Sangli, Downstream. 28.12.1987.



11. View of R. Krishna at Haripur ghat, Sangli, Upstream. 28.12.1987.



12. View of *Crocodilus palustris* caught from R. Krishna at Babaladi. 19.5.1988.



13. Dragnet operation at Haripur ghat, Sangli. 28.12.1987.



14. Dragnet operation at Haripur ghat, Sangli. 28.12.1987.



15. View of dragnet operation in R. Krishna at Babaladi. 19.5.1988.



16. View of dragnet operation at Babaladi. 19.5.1988.



17. View of dragnet operation at Babaladi. 19.5.1988.



18. View of dragnet operation at Babaladi. 19.5.1988.



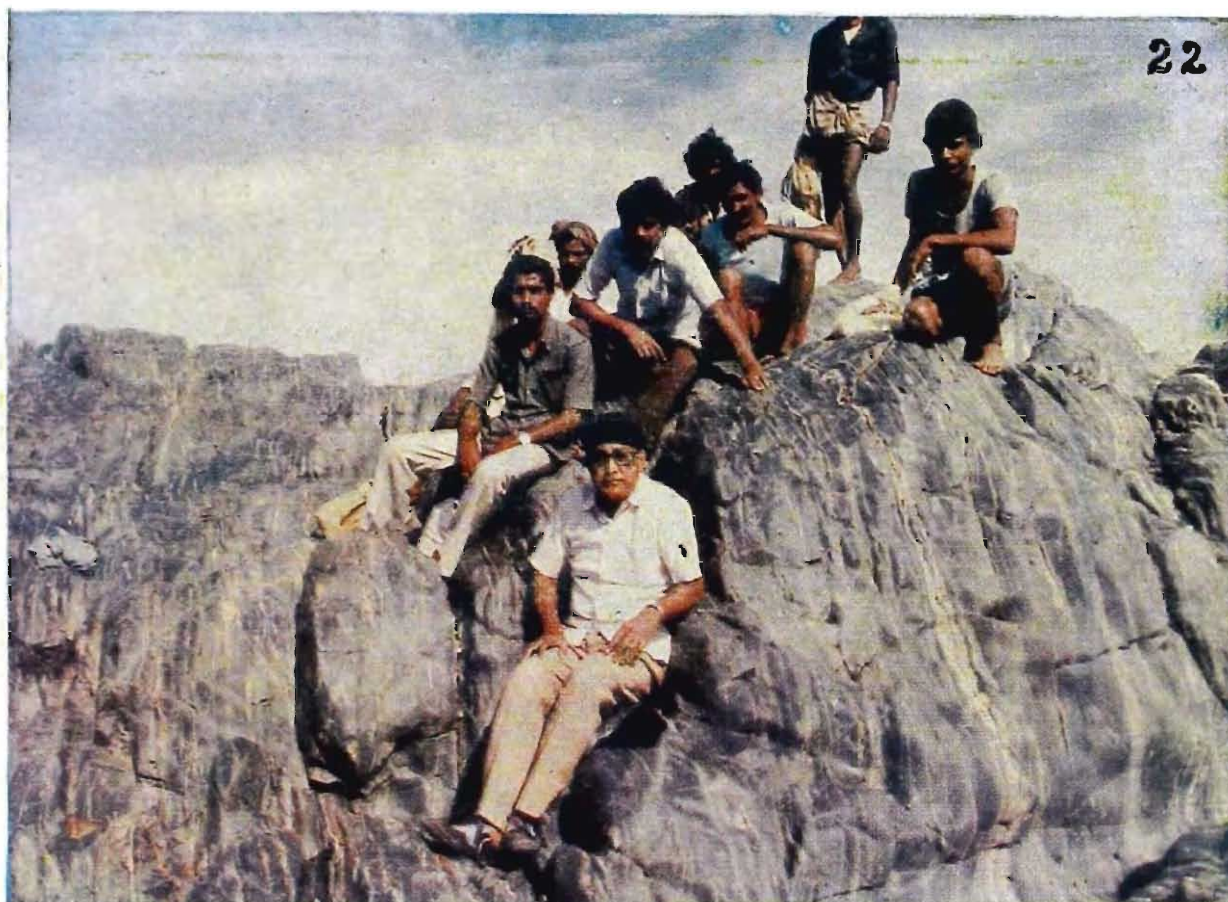
19. View of "Amli" *Salmostoma novacula* being dried on the river bed at Dhom reservoir, West of War, Satara district, Maharashtra State, 3.1.1988.



20. View of cast net, weed being dried up at Pondugala 13 kms from Dachepalle, Guntur District, A.P. 21.12.1988.



21. View of Rekulampally gorge in H.F. Level near Gadwal. 28.5.1988.



22. Dr. K. C. Jayaram with fishermen at Rekulampally in Gadwal. See granite rock structure. 28.5.1988. (Photo BHR).



23. Upstream view of R. Krishna forming a Gundam at Rekulampally near Gadwal. 28.5.1988.



24. Downstream view of R. Krishna at Dongadugundam, Rekulampally, Gadwal. 9 kms from Gadwal, Mahabubnagar District, A.P. 17.12.1987.



25. View of fishermen at Rekulampally waterfalls of R. Krishna, Gadwal. 17.12.1987.



26. A fisherman throwing his net for catching the fish in R. Krishna at Rekulampally in Gadwal. 17.12.1987.



27. A fisherman looking for fish at Lingalagattu. 11.12.1987.



28. Fishermen throwing their nets at Lingalagattu. 11.12.1987.



29. Bamboo trap "Mavulu" used to catch catfish in Buggavagu reservoir at Shymarajapuram lock. 20.12.1988.



31. Heap of dry fish for sale at shandy at Nagayalanka on 21.1.1990.



30. *Mystus krishnensis*, weight about 25 kg caught from Naklakavi, Chinna Agraharam, Gadwal. 28.5.1988.