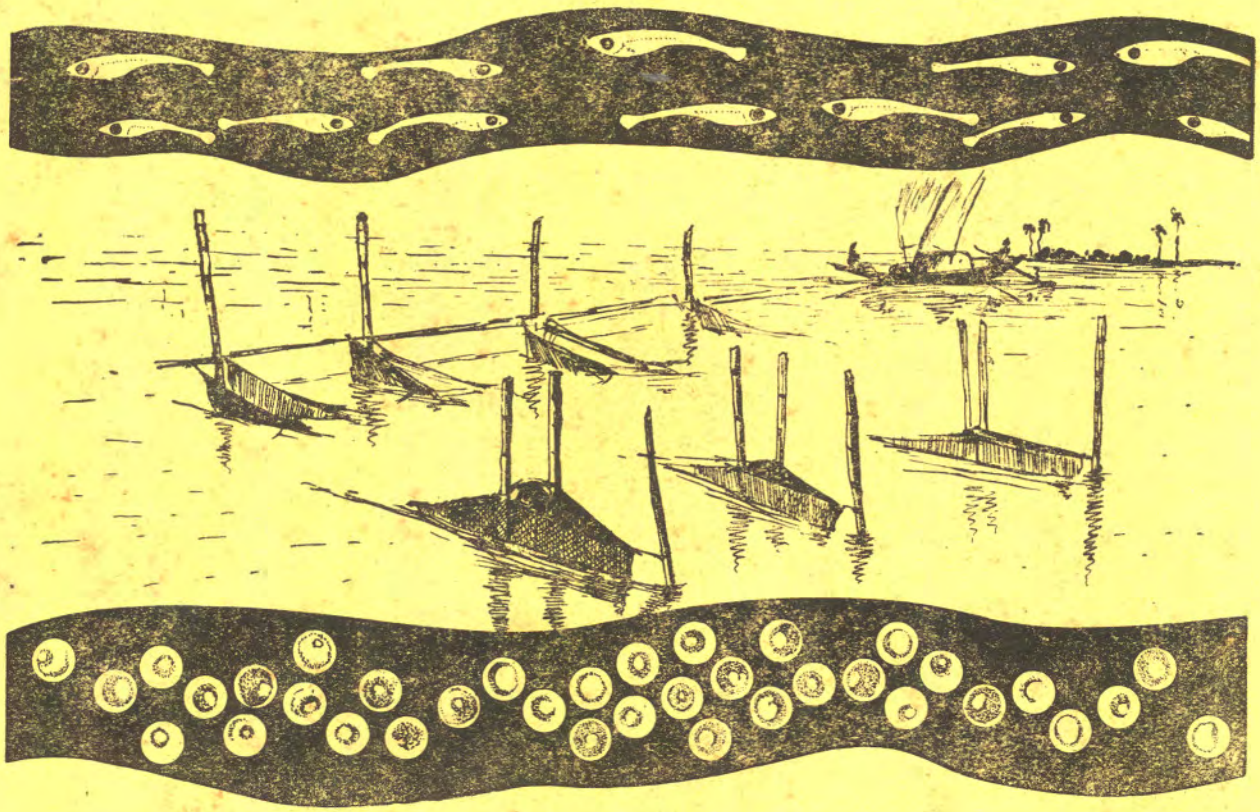
REPORT ON FISH SPAWN PROSPECTING INVESTIGATIONS, 1967

, ANDHRA PRADESH, MADRAS, BIHAR, UTTAR PRADESH AND RAJASTHAN



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December, 1971

CENTRAL INLAND FISHERIES RESEARCH INSTITUTE
(Indian Council of Agricultural Research)
BARRACKPORE, WEST BENGAL
INDIA

REPORT ON FISH SPAWN PROSPECTING INVESTIGATIONS, 1967

ANDHRA PRADESH, MADRAS, BIHAR, UTTAR PRADESH AND RAJASTHAN

by

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CENTRAL INLAND FISHERIES RESEARCH INSTITUTE
(INDIAN COUNCIL OF AGRICULTURAL RESEARCH)
BARRACKPORE, WEST BENGAL
I N D I A

FOREWORD

Results of spawn prospecting investigations, carried out during the south-west monsoon months of 1967 by the Riverine Division of the Institute in the States of Andhra Pradesh, Madras, Bihar, Uttar Pradesh and Rajasthan, are presented in this report. The concerned State Governments actively collaborated in these investigations.

The investigations were carried out by a team of workers under the supervision and guidance of Shri H.P.C. Shetty, the Officer-in-Charge of Allahabad Substation of the Institute. He was ably assisted by Sarvashri J.C. Malhotra and K.K. Ghosh in the initial planning of the investigations. The report has been edited and brought to its present consolidated form by Shri H.P.C. Shetty, who was in overall charge of the investigations, while the initial sectional reports were prepared by the various Central teams which worked in the field and analysed the data. Shri K.K. Ghosh assisted the Officer-in-Charge in editing the report. The State technical personnel participated only in field work, while the analyses of data and the preparation of reports thereon were done entirely by the Central technical personnel.

Shri R.K. Saxena, Survey Assistant, is mainly responsible for the final preparation of all the drawings included in this report and assisted the Officer-in-Charge in the compilation of the data. Shri J. K. Verma, Research Assistant (Statistics), assisted the Officer-in-Charge in the preparation of weekly progress reports during the course of the investigations.

It is a pleasure to record here and acknowledge the whole-hearted co-operation received from all the concerned State Directors of Fisheries, who provided the much needed facilities in regard to staff, field equipment and contingent expenditures.

V. G. Jhingran

(V. G. JHINGRAN)
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1 INTRODUCTION

The pioneering investigations, initiated in 1964 by the Central Inland Fisheries Research Institute, towards locating additional high yielding quality fish spawn collection centres, have yielded rewarding results, which should go a long way in achieving regional self-sufficiency in fish seed requirements of the country. The utter inadequacy of the present level of fish seed production in the country calls for continued efforts in this direction, so that all the cultivable waters could be brought under fish culture, whereby the country's fish production could be appreciably enhanced. With that in view, these investigations were again carried out in 1967 in the States of Andhra Pradesh, Madras, Bihar, Uttar Pradesh and Rajasthan and the results obtained therefrom are embodied in this report. The findings of the earlier years, 1964-66, have already been published as departmental bulletins (Anon, 1965; Malhotra et al., 1966. Shetty, 1967).

The investigations were carried out at six centres spread over five States, as per details given in Table 1.

Table 1 : Details of location of investigated centres

Sl.No.	Name of State	Name of river	Name of investigated centres
1	Uttar Pradesh	Yamuna	Nethla
2	-do-	Gomti	Salempur
3	Rajasthan	Banas	Sopari
4	Bihar	Mahananda	Dingrahaghat
5	Andhra Pradesh	Godavari	Dharmapuri
6	Madras	Cauvery	Kulittalai

Of the above, the last five were sponsored by the respective State Governments, while the first was sponsored by this Institute, in continuation of the systematic spawn survey of the Yamuna initiated in 1964. The pattern of collaboration was as in the previous years. The investigations were also utilised for training local fishermen and State Government personnel in techniques of riverine spawn collection.

2 PRE-MONSOON SURVEY AND SELECTION OF SITES

A pre-monsoon survey of the river stretches suggested by the concerned State Governments, on the basis of their developmental needs, was carried out during April-May, 1967, for selecting suitable stretches for prospecting and sites for detailed investigations. Further, the stretch of Yamuna above Baghpat was also surveyed, as part of the systematic spawn resources survey of the Yamuna. The main criteria in the selection of sites were the same as in the previous years.

Details of stretches surveyed and the probable sites examined are shown in Table 2, while the identity and approach details of all the sites selected for detailed investigations are depicted in Table 3. The geographical locations of selected river stretches and sites are shown in Fig.1.

3 MATERIAL AND METHODS

3.1 Gear used

The 1/8" meshed Midnapore-type net, which has been provisionally adopted as the 'Standard net' (Anon, 1965), was the sole gear employed in the main investigations aimed at ascertaining the spawn yielding potentiality of the selected centres. Other gear employed included the nets provided by some of the States and a few specially fabricated research nets, most of which were tested for their efficiencies vis-a-vis the standard net.

At Salempur on the Gomti, the Uttar Pradesh Government provided State nets of four different sizes, the main dimensions of which are given in Table 4.

Table 4 : Structural details of Uttar Pradesh State nets, operated at Salempur

Dimensions in cm	NET TYPE			
	A	B	C	D
Length of net	201	309	509	296
Width at mouth	281	275	290	259
Height at mouth	62	40	64	46
Ring diameter	25	26	24	24.5

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STRETCHES SURVEYED AND CENTRES INVESTIGATED

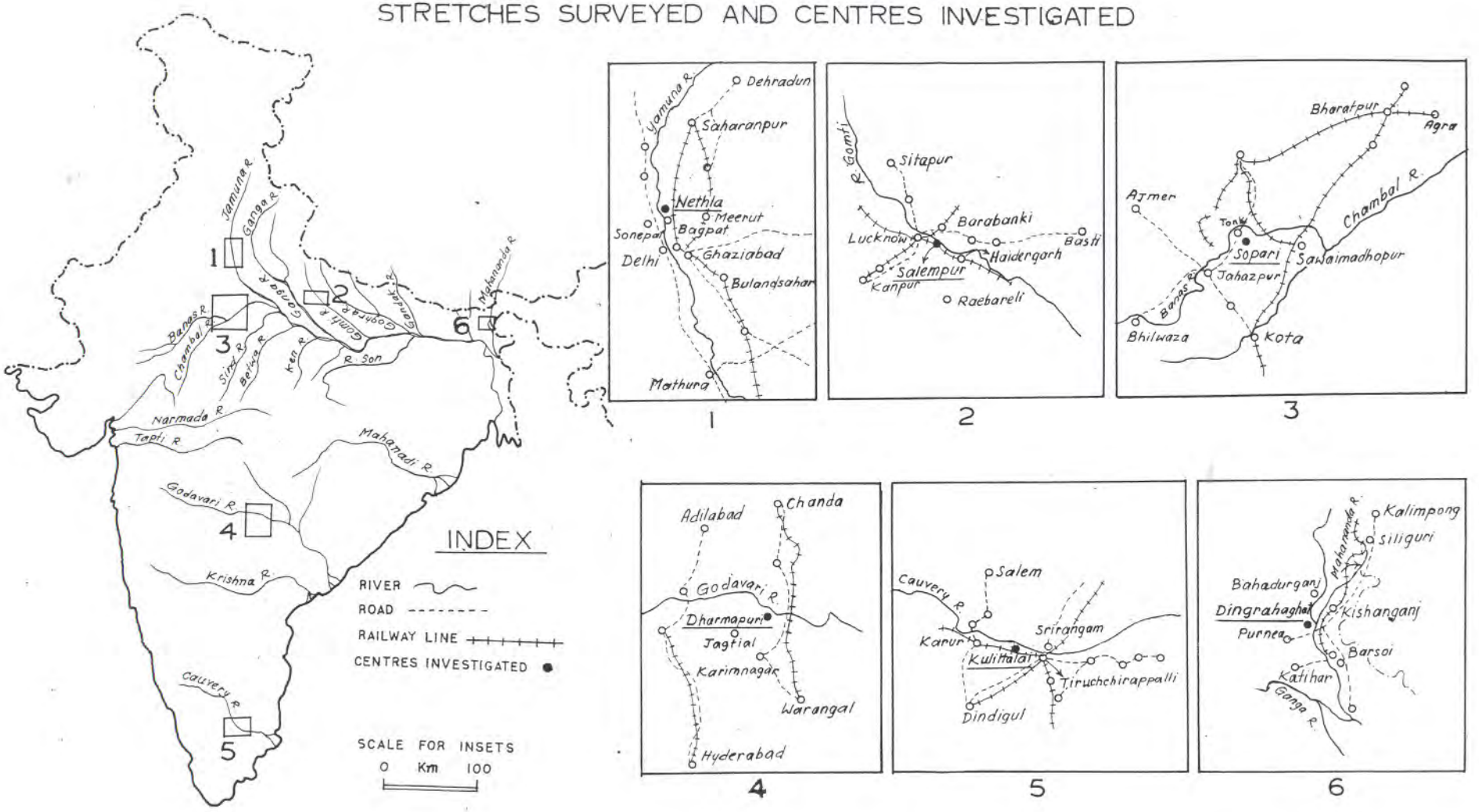

Table 2

Stretches and sites surveyed in the pre-monsoon survey and selected for prospecting investigations

River	SURVEYED STRETCH			SURVEYED SITE				Stretch selected for prospecting			
	From	To	Length in km	Name	Bank	Suitability (S/US)*	Justification for acceptance/rejection	From	To	Distance in km	Main site selected for investigations
1	2	3	4	5	6	7	8	9	10	11	12
Gomti	Lasa	Bhauin	264	1. Lasa	North	US	Good collection site, but poor accessibility.	Bhainsa Kund	Gosain-ka-purwa	75	Salempur
				2. Kathwara	North	S	Good collection site, good accessibility.				
				3. Bhainsa-ghat	South	US	Good collection site of good accessibility, but a paper mill discharges its effluents within 100 m upstream.				
				4. Salempur	South	S	Good collection site, good accessibility. State Govt. proposes to take up spawn prospecting investigations at the site.				
				5. Gosain-ka-purwa	South	S	Good collection site, good approach.				
				6. Naipura-ghat	North	S	Good approach and good collection site, being exploited by the State Govt.				
				7. Kasba	South	US	No suitable site, accessibility good.				
				8. Bhauin	South	S	Good collection site and good approach.				

Table 2 (Contd.)

1	2	3	4	5	6	7	8	9	10	11	12
Yamuna (E.bank)	Shah Alipur	Nethla	120	1. Shah Alipur	East	US	No suitable site, accessibility poor.	Baghpat	Mawi	65	Nethla
				2. Kunda	East	US	Steep bank, accessibility poor.				
				3. Manglaura	East	US	-do-				
				4. Mawi	East	US	No suitable site, accessibility good.				
				5. Tanda	East	US	-do-				
				6. Kutana	East	US	Steep bank, accessibility good.				
				7. Nethla	East	S	Good collection site, accessibility good.				
Yamuna (W.bank)	Modipur	Baghpatghat	128	1. Modipur	West	S	Fair accessibility, good collection grounds.				
				2. Kanjpura	West	US	Poor accessibility, no collection site.				
				3. Nagla	West	US	-do-				
				4. Sanauli	West	US	Poor accessibility, fair collection site.				
				5. Khagipur	West	US	Poor accessibility, no collection site.				
				6. Guaisspur	West	US	-do-				
				7. Basadi	West	US	-do-				
				8. Baghpatghat	West	US	-do-				

Table 2 (Contd.)

1	2	3	4	5	6	7	8	9	10	11	12
Banas	Negria	Sawai Madhopur	240	1. Negria	North	S	Good collection ground, accessibility good.	Negria	Dubbi	185	Tonk (Sopari)
				2. Rajmahal	South	US	Precipitous bank, accessibility to site on opposite bank difficult.				
				3. Bisalpur	North	US	Good collection ground, accessibility during monsoon difficult.				
				4. Tonk (Sopari)	North	S	Good collection ground, good accessibility.				
				5. Dubbi (Sawai Madhopur)	South	US	Precipitous bank, opposite bank suitable.				
				6. Near Bhadoli & Dahlod Villages (Sawai Madhopur)	North	S	Good collection ground, good accessibility.				
				7. Gehlotghat	South	S	Good collection ground, good accessibility.				

Table 2 (Contd.)

1	2	3	4	5	6	7	8	9	10	11	12
Chambal	Sawai Madhopur	Dholpur	230	1. Pali (Sawai Madhopur)	West	S	Good collection ground, good accessibility.	-	-	-	-
				2. Dholpur	West	US	Precipitous bank.				
Cauvery	Mayanur bed regulator	Lower Anicut	185	1. Southern bank of the river from Kulittalai to Trichy (33 km)	South	S	Good collection ground, good accessibility.	Erode Bridge	Grand Anicut	145	Kulittalai
Godavari	Dharmapuri	Mahadevpur	90	1. Dharmapuri	South	S	Good collection ground, good accessibility.	Dharampuri	Mahadevpur	90	Dharampuri
				2. Off Manthani	South	US	Good collection ground, accessibility poor.				
				3. Kaleshwar	South	US	Good collection site, accessibility poor.				
				4. Mahadevpur	South	S	Good collection site, accessibility good.				
Mahananda	Around road bridge on National Highway 31		12	1. Dingrahaghat	West	S	Good collection ground, good accessibility.	Around road bridge on N.H.31		12	Dingrahaghat

* S — Suitable

US — Unsuitable

Table 3

The identity and approach details of the main sites selected for investigations, along with the area available at each site for net operation

Details	Yamuna	Gomti	Banas	Cauvery	Godavari	Mahananda
1	2	3	4	5	6	7
1. Stretch (from to)	Mawi to Mirpur	Bhainsakund to Gosain-ka-purwa	Negria to Dubbi	Erode bridge to Grand Anicut	Dharmapuri to Mahadevpur	Around road bridge on N.H.31
2. Selected site	Nethla	Salempur	Sopari	Kulittalai	Dharmapuri	Dingrahaghat
3. Bank	East	South	North	South	South	West
4. Tahsil/Taluk/ Sub-Division	Baghpat	Mohanlalganj	Tonk	Kulittalai	Jagtial	Baisi
5. Police station	Baghpat	Gosainganj	Tonk	Kulittalai	Dharmapuri	Baisi
6. District	Meerut	Lucknow	Tonk	Trichy	Karimnagar	Purnea
7. State	Uttar Pradesh	Uttar Pradesh	Rajasthan	Madras	Andhra Pradesh	Bihar
8. Block	Baghpat	Gosainganj	Tonk	Kulittalai	Jagtial	Baisi
9. Distance to Block head-quarters in km	8.0	10.0	9.0	2.0	27.0	6.0

Table 3 (Contd).

1	2	3	4	5	6	7
10. Nearest Post Office	Baghpat	Gangaganj	Tonk	Kulittalai	Dharmapuri	Baisi
11. Distance to (10) in km	8.0	1.0	9.0	2.0	1.0	6.0
12. Nearest Telegraph Office	Baghpat	Rahmatnagar	Tonk	Kulittalai	Jagtial	Baisi
13. Distance to (12) in km	8.0	3.0	9.0	2.0	27.0	6.0
14. Nearest Telephone facility	Baghpat	Rahmatnagar	Tonk	Kulittalai	Jagtial	Purnea
15. Distance to (14) in km	8.0	3.0	9.0	2.0	27.0	36.0
16. Nearest all weather road at	Kuti	Salempur	Sopari	Kulittalai	Dharmapuri	Dingrahaghat
17. Distance to (16) in km	3.0	1.0	X	0.3	X	X
18. Nearest Rly. Station	Baghpat Road	Rahmatnagar	Newai	Kulittalai	Mancherial	Purnea
19. Distance to (18) in km	13.0	3.0	32.0	2.0	40.0	36.0

Table 3 (Contd.)

1	2	3	4	5	6	7
20. Number of nets that can be operated at different flood levels	At 2.0 m 100 nets At 3.0 m 100 nets At 6.0 m 50 nets At > 6.0 m Unsuitable	At 1.8 m 100 nets At 3.0 m 50 nets At 6.0 m Unsuitable	At 1.5 m 100 nets At 3.0 m 50 nets	25-30 at all flood level	100 nets at all level	At 1.0 m 25 nets At 2.0 m 25 nets At > 2.0 m 1-3 nets

All the four types were made of cotton netting of 1/8" mesh-size. The tail pieces used were similar in construction and dimensions to those used with the standard net.

The State nets supplied by the Madras Government at Kulittalai, though only of one type, did not show uniformity in their dimensions. The structural details of three randomly chosen nets are shown in Table 5.

Table 5 : Structural details of Madras State nets, operated at Kulittalai.

Structural details	NETS		
	I	II	III
Length of net in cm	335	328	312
Width at mouth in cm	320	327	310
Height at mouth in cm	65	55	56
Ring diameter in cm	20	20	20
Ring material	Cane	Cane	Cane
No. of mesh per linear inch, at 3 random spots	9,10 & 10	9,10 & 10	10,10 & 10
Length of gamcha in cm	91	145	120
Height of gamcha in cm	62	62	55
Width of gamcha at rear end in cm	42	45	50
Material of gamcha	Markin cloth	Markin cloth	Markin cloth

The tail piece, made of markin cloth, was found to adversely affect the catchability of the Madras State net, in that its meshes got clogged very early in operation, thereby reducing the filtration rate of water and often leading to the vomiting of spawn. The catches improved considerably when this gamcha was replaced by that of the standard net. The ring made of cane was another defect. It tended to lose its shape while in operation, thereby altering the stream-lined shape of the net, often leading to its collapse in the middle.

The nets provided by the Andhra Pradesh Government at Dharmapuri could not be tested because of the non-availability of spawn. However, the obvious constructional defects were pointed out and necessary improvements suggested.

The nets supplied were of two different sizes, the dimensions of which are shown in Table 6.

Table 6 : Structural details of Andhra State nets, operated at Dharmapuri

Structural details	NET TYPE	
	I	II
Length of net in cm	400	450
Width at mouth in cm	325	370
Height at mouth in cm	Nil	Nil
Ring diameter in cm	24	21
Ring material	Cane	Cane
Type of gamcha	Triangular or Monk's hood type	Triangular or Monk's hood type

In addition to the above, some specially designed Midnapore-type research nets of different sizes were tested at Salempur (Gomti), Sopari (Banas) and Kulittalai (Cauvery) for determining the effect of net size on its efficiency. These nets were essentially of the same design as the standard net, and differed from it in size only, in that they were made from different lengths of 82 cm Midnapore-type cotton netting. While those operated at Sopari and Kulittalai were among those made from 5, 7, 9 and 11 yds of netting, those employed at Salempur were made from 6, 8, 10, 12, 14, 16 and 18 m of netting. While the first set of nets had been tested earlier during the 1966 season, the second set was fabricated and tested for the first time in 1967. The various dimensions of the above nets are given in Table 7.

In order to test the relative efficiencies of 1/8" and 1/16" mesh sizes, a Midnapore-type net of exactly the same dimensions as that of the standard net, but made from 1/16" meshed netting (Anon, 1965), was operated alongside the standard net at Kulittalai. To test the same under identical conditions, trouser-type nets (Malhotra et al., 1966) were employed at Kulittalai and Sopari.

Table 7

Dimensions of Midnapore-type research nets

Dimensions in cm	QUANTITY OF NETTING USED										
	5 yds	7 yds	9 yds	11 yds	6m	8m	10m	12m	14m	16m	18m
Length of net	210	212	225	275	185	204	319	337	383	310	332
Width at mouth	135	152	167	212	245	245	245	301	320	390	313
Height at mouth	20	27	27	32	43	42	43	48	42	40	52
Ring diameter	24	24	25	25	15	17	17	17	18	17	19

The extent of spawn escapement from the netting used in standard net was tested during this season at Sopari on the Banas, by employing the specially fabricated double-walled blanket-type net (Shetty, 1967).

3.2 Techniques for collection and analysis of spawn, and for determination of hydrographical and meteorological factors

The techniques employed for the collection, measurement and qualitative analyses of spawn and for the determination of selected hydrographical and meteorological factors were the same as those adopted since 1965 (Malhotra et al., 1966; Shetty, 1967). The frequency of observations, was, likewise, the same.

4 DEFINITIONS

The definitions adopted for the investigations were the same as given by Shetty (1967).

5 OBSERVATIONS

5.1 Quantitative and qualitative spawn yielding potentiality of selected stretches, and spawn availability in relation to environmental factors at investigated sites

5.1.1 Ganga River System

5.1.1.1 Nethla stretch of river Yamuna

Participants

D.V. Pahwa (Leader), from 16th July to end K.P. Srivastava (Leader), upto 15th July A.G. Godbole	C.I.F.R.I. /Govt. of India/
J.P. Sharma	Govt. of Uttar Pradesh

The systematic survey of the Yamuna, initiated in 1964, was continued in 1967, when the left over 115 km long productive stretch of the river in its uppermost reaches, from Mawi in the north to Mirpur in the south along the eastern bank of the river in Uttar Pradesh, was surveyed (Fig.2). The investigations were carried out from 27th June to 21st August at Nethla, a village on the eastern bank in Meerut district. It is connected with the Delhi-Saharanpur Road by a tortuous non-metalled 5 km long road. The river in this stretch flows almost in a north-south direction. Just a little upstream of the site, the river has three branches that join to form one stream at the site. While the eastern bank at Nethla is comparatively steep, the western bank is more sloping. Four nullas join the river near about the site, two from western bank joining a little upstream of the site and two on the eastern bank, one upstream and the other a little south of the former. The bank contour, location of site, operational areas in different spawn spurts, etc. are depicted in Fig.3.

Occurrence of spawn spurts

The occurrence of floods in this stretch is largely determined by the Tajewala headworks situated about 150 km upstream of the site. It exercises considerable control over the catchment run off. The flood pattern, therefore, was difficult to discern, being interposed with numerous rising and receding phases. A total of four floods could be discerned, which individually had, perforce, a main and some secondary peaks.

Of these floods, the first three floods yielded spawn in nine spurts, all in the month of July. With the appearance of spurts, trial nets were simultaneously operated at all suitable spots in the vicinity of the site (A, B, C & D in Fig.3), for determining the field of maximum spawn availability, and the battery of five nets were operated at the spot found to yield the maximum spawn. Since some spurts came in quick succession, no fresh attempt at locating maximum concentration spot was made. Spots A, B and C were found to be the best spots during spawn spurts 1, 3 and 8, and 9 respectively.

Details of occurrence, duration, desirability and magnitude of the various spurts of spawn are shown in Table 8. In the entire season, a total of 32,333 ml (c.161.67 lakhs*) of spawn was collected in 178 hours. Of these, 23,591 ml of spawn, collected in 100 hours of receding phases of different floods, were desirable.

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* 1 ml of spawn contained on an average 500 hatchlings.

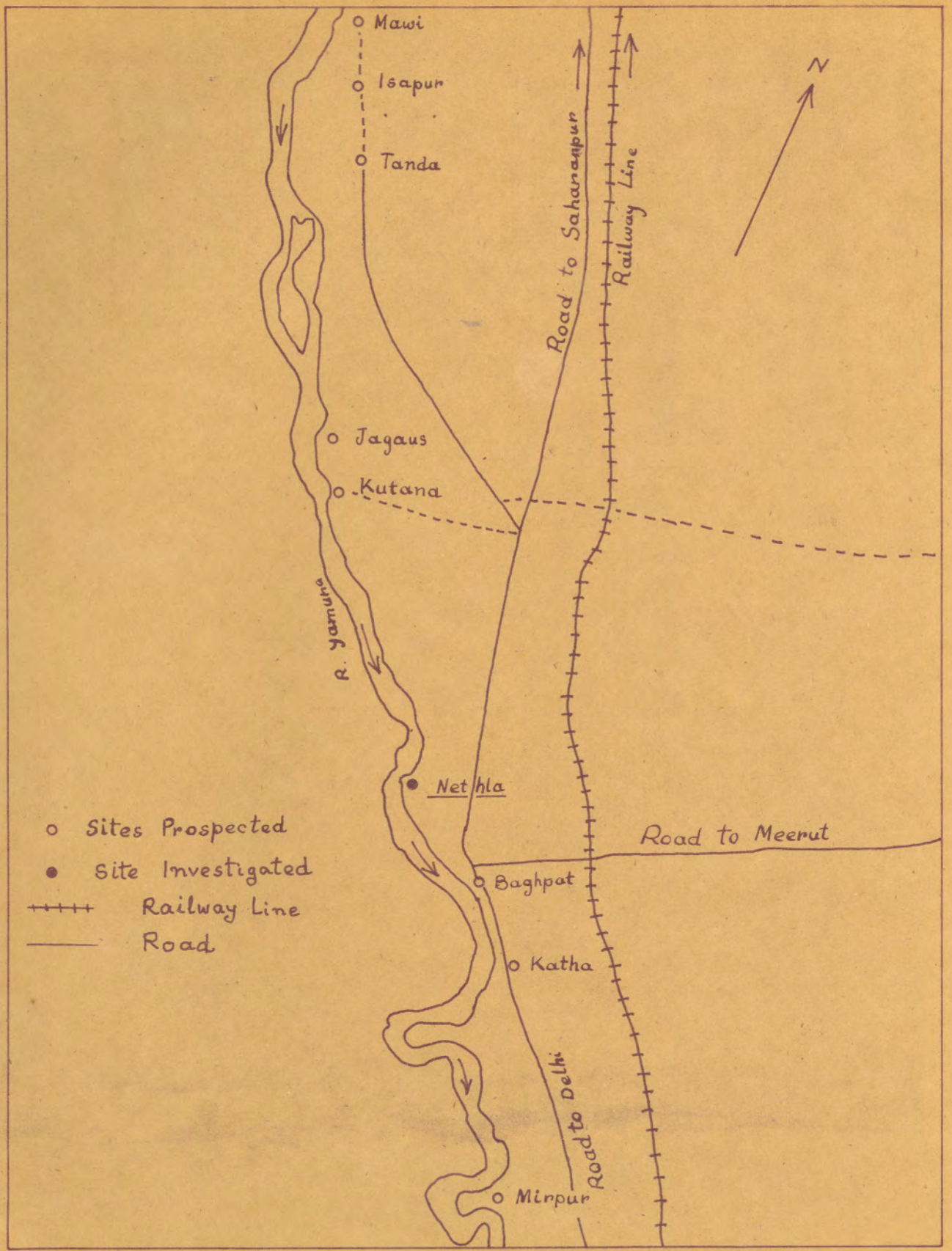

FIG. 2. NETHLA STRETCH OF RIVER JAMUNA, SHOWING SITES PROSPECTED AND CENTRE INVESTIGATED.

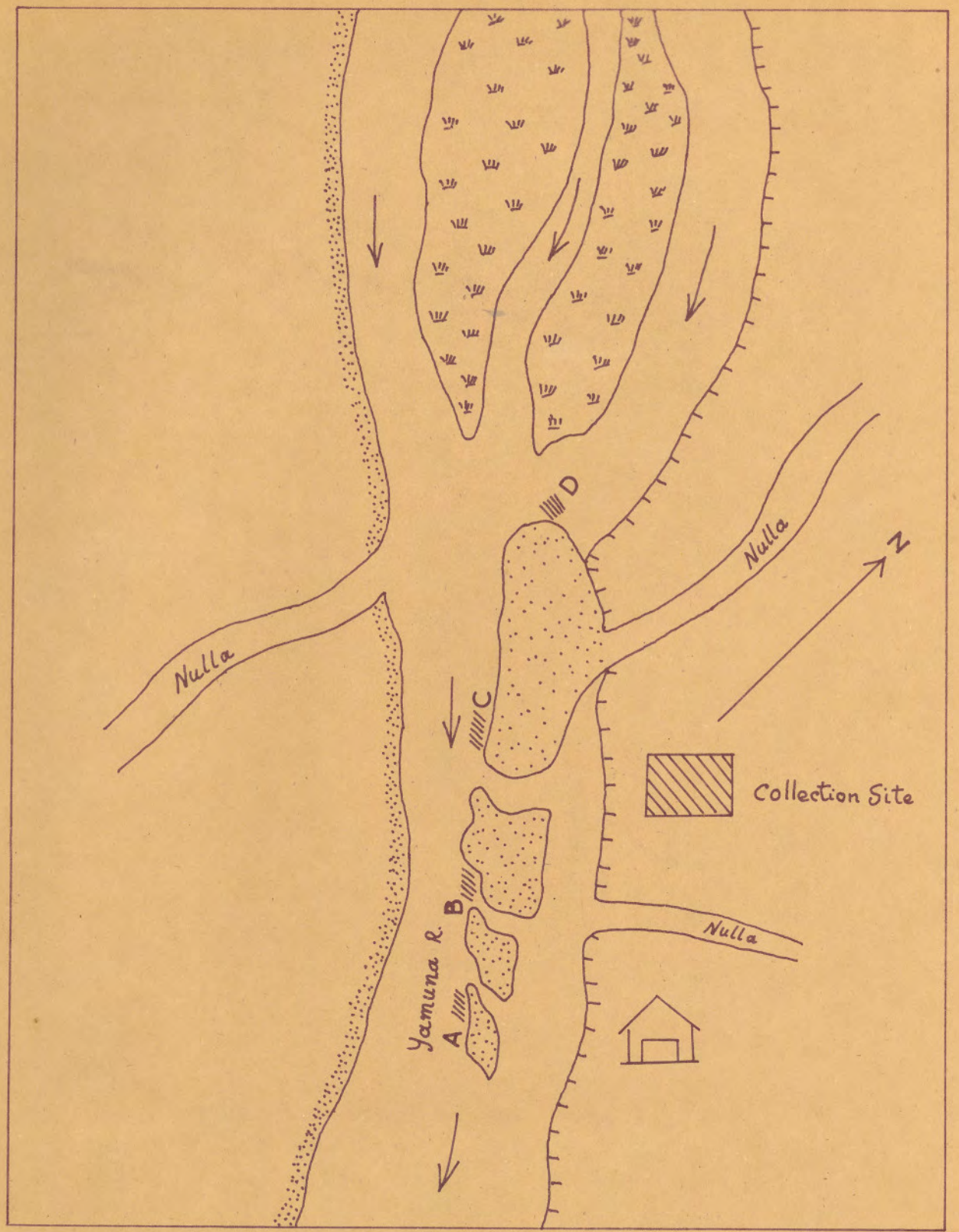

FIG. 3.
THE COURSE, GENERAL TERRAIN AND TOPOGRAPHY OF RIVER JAMUNA AT NETHLA.

Flood I yielded 80.4% of the total spawn collected at the site, the desirable component of which accounted for 92.2% of the total desirable spawn catch and 67.3% of the total seasonal catch made at the site. The II and III floods yielded respectively 14.8% and 4.8% of the total seasonal yield. While the II flood spawn was almost wholly (93.5%) made up of undesirable varieties, the III flood spawn was almost wholly desirable.

Spurt 1 of the season, that came in 52 hours of availability in the receding phase of the first flood was most productive, in that it yielded 62.6% and 85.9% of total spawn yield and the total desirable spawn yield at the site respectively. Spurts 2 to 9 lasted for 6, 34, 10, 10, 4, 34, 10 and 28 hours respectively, of which only the last 8 hours of spurt 3 and spurt 5 were encountered in the rising phases of floods and which comprised only undesirable spawn. All the spurts, except 4, 5, 6 and 8, yielded both desirable and undesirable spawn. While spurts 4, 5 and 8 yielded only undesirable spawn, the short-lived spurt 6 yielded only desirable spawn. No definite pattern in the availability of desirable and undesirable spawn within a spurt was discernible in the case of mixed spurts.

The catch per net-hour was very high in spurt 1, when the desirable spawn came at the average rate of 140.8 ml per net per hour for 44 hours, though the maximum catch per net-hour was found in two hours of desirable spawn availability in the second spurt, when it was 149.0 ml. The undesirable spawn of spurt 1 had also a high rate of yield, being 113.8 ml per net per hour. The only other high rate was in the first 18 hours of availability of spurt 3, when only undesirable spawn were collected at a rate of 59 ml per net-hour. All other spurts yielded spawn at comparatively low rates, ranging between 1.0 and 12.7 ml per net-hour.

Quality of spawn collected

Spurt-wise quality of spawn, as revealed by microscopical analyses of spawn and nursery rearing, is shown in Table 9. The overall component of major carps in the desirable spawn catches of the season was found to be 21.8%. While the major carp content was maximum (36.8%) amongst the desirable components of the 3rd spurt, the next high major carp content of 25.0% was in the Ist spurt. However, it is to be pointed out that the third spurt's desirable component yielded only 138 ml of spawn, as against 20,272 ml in the first spurt.

Table 8

Flood-phase-wise occurrence, duration, desirability and magnitude of spawn spurts at Nethla on R. Yamuna in 1967

Flood details						Spurt details						
Flood No.	Phase	Commence-ment date	Duration in hrs.	Peak: Date Hrs.	Peak: Flood level in metres	No. & desir-ability (D/UD)*	Commence-ment Date Hrs.	Dura-tion in hrs.	Nos. of nets	Spawn catch: In ml	Spawn catch: In lakhs	Spawn catch: Per net-hour in ml
1	2	3	4	5	6	7	8	9	10	11	12	13
I	Rising	28.6.67	120	3.7.67 / 10	1.75							
	Receding	3.7.67	50			1 D	3.7.67 / 10	44	2-5	20,272	101.36	140.8
						1 UD	5.7.67 / 6	8	4-5	4,095	20.48	113.8
	Rising	5.7.67	16	6.7.67 / 6	2.07							
	Receding	6.7.67	8			2 UD	6.7.67 / 8	4	1-5	150	0.75	12.5
						2 D	6.7.67 / 12	2	5	1,490	7.45	149.0
II	Rising	6.7.67	20	7.7.67 / 10	3.10							
	Receding	7.7.67	68			3 UD	8.7.67 / 4	18	1-5	3,704	18.52	55.9
						3 D	9.7.67 / 22	8	5	138	0.69	3.4
	Rising	10.7.67	24	11.7.67 / 6	2.22	3 UD	10.7.67 / 6	8	5	200	1.00	5.0
	Receding	11.7.67	20			4 UD	11.7.67 / 8	10	1-5	220	1.10	5.2

Table 8 (Contd.)

1	2	3	4	5	6	7	8	9	10	11	12	13
	Rising	11.7.67	20	12.7.67 / 22	2.47	5 UD	12.7.67 / 8	10	1-5	35	0.17	1.0
	Receding	12.7.67	164			6 D	13.7.67 / 6	4	1-5	57	0.29	4.8
						7 D	13.7.67 / 4	4	1-5	29	0.14	1.4
						7 UD	14.7.67 / 6	6	5	286	1.43	9.5
						7 D	14.7.67 / 14	14	5	85	0.43	1.2
III	Rising	17.7.67	112	22.7.67 / 18	2.10							
	Receding	22.7.67	28			8 UD	23.7.67 / 14	10	1-3	42	0.21	1.9
	Rising	23.7.67	24	24.7.67 / 2	3.04							
	Receding	25.7.67	38			9 UD	25.7.67 / 16	4	2	10	0.05	1.3
						9 D	25.7.67 / 20	24	5	1,520	7.60	12.7
IV	Vacillation phase, followed by fourth flood that touched a peak level of 3.88 m on 18.8.1967 at 22 hrs.											
						TOTAL :	D / UD	100 / 78		23,591 / 8,742	117.96 / 43.71	

*D — Desirable

UD — Undesirable

Rearings could not be done separately for each spurt for want of nurseries. The only nursery available was stocked with samples from all the spurts. The reared samples from the same showed 7.0% major carps, 86.4% minor carps and 6.6% others. The major carps were rohu (2.7%) and kalbasu (4.3%). The spawn of first spurt's desirable component was reared separately in a village pond, which had not been prepared at all for the purpose. The reared samples on examination showed a major carp content of 7.9%, consisting entirely of kalbasu.

The seasonal indices of spawn quantity and quality for this centre were estimated to be 6,006 ml and 7.0% respectively.

Spawn availability at prospected sites

In addition to the investigations at Nethla, prospecting for spawn by operation of a trial net over six hours' duration was also done at Jagaus, Kutana, Baghpat, Katha and Mirpur. Of these, Jagaus, Kutana and Baghpat were found to be suitable for net operation throughout the season, while the others appeared to be suitable only at certain flood levels. In regard to quantitative potentiality, Baghpat seemed to be about as good as Nethla. Next in order came Kutana and Katha. Three other sites at Mawi, Isapur and Tanda were found to be unsuitable.

Spawn availability in relation to hydrographical and biotic factors.

Flood level

At Nethla, which was found to be a good site for spawn collection, flood levels play a very important role in that the fields of operation are either located in the main bed (See Fig.3) or across sand bars, which become unsuitable at higher flood levels. It was observed that the site became unsuitable for net operation as soon as the flood level rose beyond 2.10 m above summer level. Even when it was possible to operate one or two nets, they never yielded spawn.

The rate of change of flood level was also seen to have a direct bearing on the magnitude of spawn occurrence. Stationary flood levels were certainly not conducive to good availability, while changes at the rate of about 1 cm per hour were found to be most conducive.

Table 9

Spurt-wise quality of spawn collected at Nethla on R. Yamuna, in 1967

Spurt No.	D/UD	Percentage composition									
		By spawn analysis			By rearing						
		Major carps	Minor carps	Other's	Major carps					Minor carps	Others
					Catla	Rohu	Mrigal	Kalbasu	TOTAL		
1	D	25.0	74.4	0.6	*0.0	0.0	0.0	7.9	7.9	88.2	3.9
	UD	5.2	94.3	0.5							
2	UD	0.0	100.0	0.0							
	D	17.0	83.0	0.0							
3	UD	0.0	100.0	0.0							
	D	36.8	63.2	0.0							
	UD	0.00	93.0	7.0							
4	UD	0.2	98.0	1.8							
5	UD	0.0	100.0	0.0	+0.0	2.7	0.0	4.3	7.0	86.4	6.6
6	D	10.0	87.0	3.0							
7	D	11.5	88.5	0.0							
	UD	6.3	93.7	0.0							
	D	22.3	77.7	0.0							
8	UD	0.0	100.0	0.0							
9	UD	4.0	95.0	1.0							
	D	14.3	84.3	1.4							

D — Desirable
UD — Undesirable

* Based on rearing of spawn of spurt 1.
\+ Based on combined rearing of spawn of spurts 1-9.

Turbidity

Turbidity ranged between 100 ppm and 750 ppm throughout the season, while during spawn spurts it ranged between 300 ppm and 750 ppm. No correlation could be determined between turbidity values and spawn catch or availability at this site.

Current velocity

No correlation between availability of spawn or its quantity and current velocity could be found, but for the fact that spawn availability was always associated with velocities higher than or about 1 km/hr. Its values ranged between 0.74 and 2.20 km/hr in the entire season, while spawn availability periods had velocities in the range 0.90-1.70 km/hr.

Associates

No indicator species for predicting spawn availability in quality or quantity could be found. They were more abundant in the early part of the season only. L. bata was the most dominant species.

Weather conditions

Extreme weather conditions were not observed at the site, and no direct or indirect bearing of the same on spawn availability was noticed, except that stormy conditions adversely affected the operation of nets.

5.1.1.2 Salempur stretch of River Gomti.

Participants

Shri	H.A. Khan (Leader)	C.I.F.R.I. Govt. of India
"	M.Y. Kamal	
"	N.K. Tandon	Govt. of Uttar Pradesh
"	D.N. Modi	

The Salempur stretch of river Gomti extended from Bhainsakund in the west to Gosain-ka-purwa in the east, a distance of about 75 km (Fig.4). The village Salempur, which was selected for detailed

round-the clock investigations, is situated on the southern bank of the Gomti in Mohanlalganj tehsil of Lucknow district in Uttar Pradesh. The collection site is located about 1.5 km off the main village on the northern bank of the Gomti, opposite to Salempur Fort (Fig.5). The regular observations were conducted from July 4th to August 31st, 1967. The centres selected for occasional prospecting were Bhainsakund, Sondhiamaoghat and Gosain-ka-purwa.

The river in this region shows serpentine meandering and takes an easterly course at Salempur. A seasonal nulla, called Loni Kadi, joins the river at its southern bank near the village Salempur. The southern bank of the Gomti is very steep and precipitous, while the opposite bank is gently sloping. The river course, general terrain, topography, etc. at the collection site are depicted in Fig.5.

Occurrence of spawn spurts

Although the river Gomti experienced four floods at the site, only floods II and III yielded spawn in two spurts. With the appearance of each spawn spurt, trial nets were simultaneously operated at 4 suitable spots (Fig.5) and the spot of maximum spawn availability was chosen for the operation of full battery of nets. Spot A was found to be the most suitable spot during both the spurts.

Details of occurrence, duration, desirability and magnitude of the two spawn spurts are shown in Table 10. A total of 7,083 ml (c.49.58 lakhs*) of spawn was collected in the whole season by 5 standard nets. During the first spurt, 290 ml of spawn were collected in 12 hours' time in the rising phase of flood II, and another 4,395 ml in 88 hours of its receding phase. Of these 100 hours, 98 hours yielded desirable spawn, amounting to 4,535 ml, while the remaining 2 hours yielded 150 ml of undesirable spawn. The spurt contributed to 66.1% of the total spawn catch made at the site, while its desirable component accounted for 96.8% of its total catch and 66.2% of the total desirable spawn catch made during the entire season. The receding phase of flood III yielded the 2nd spawn spurt lasting for 74 hours, of which 70 hours yielded 2,313 ml of desirable spawn and the remaining four hours yielded 85 ml of undesirable spawn, giving in all 2,398 ml of spawn in this spurt. This accounted for 33.9% of the season's total spawn yield. The desirable spawn collected during this spurt made up 33.8% of the total desirable spawn collected in the entire season. Spurt 1 was the more productive of the two, in that its catch per net-hour amounted to 9.37 ml, as against 6.6 ml of spurt 2. Besides the catches made by standard nets as analysed above, 2,616 ml and 2,378 ml of spawn respectively were also collected by State and specially fabricated research nets in the course of the investigations.

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*1 ml = 700 nos.

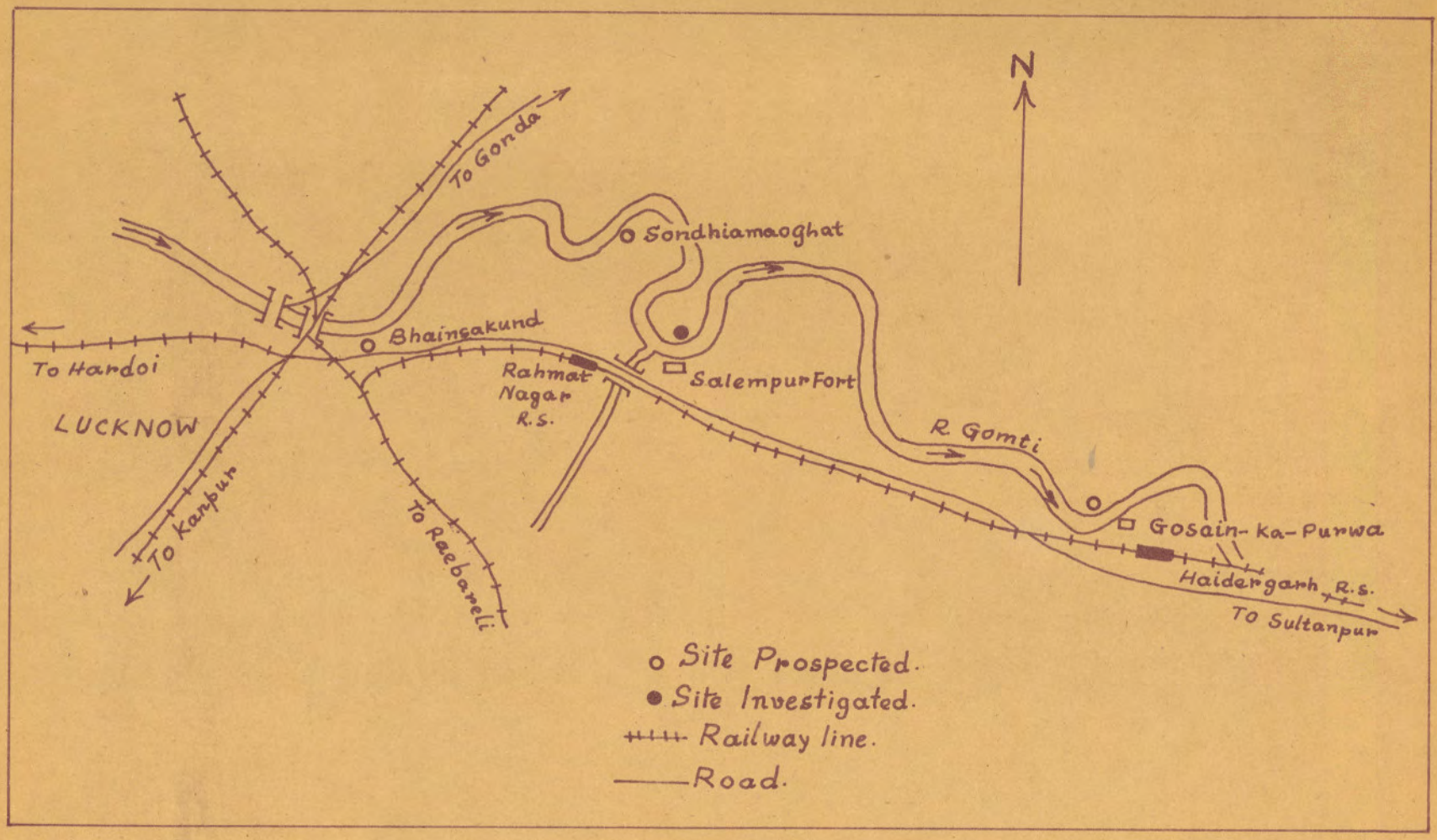

FIG. 4.

SALEMPUR STRETCH OF RIVER GOMTI, SHOWING SITE PROSPECTED AND CENTRE INVESTIGATED.

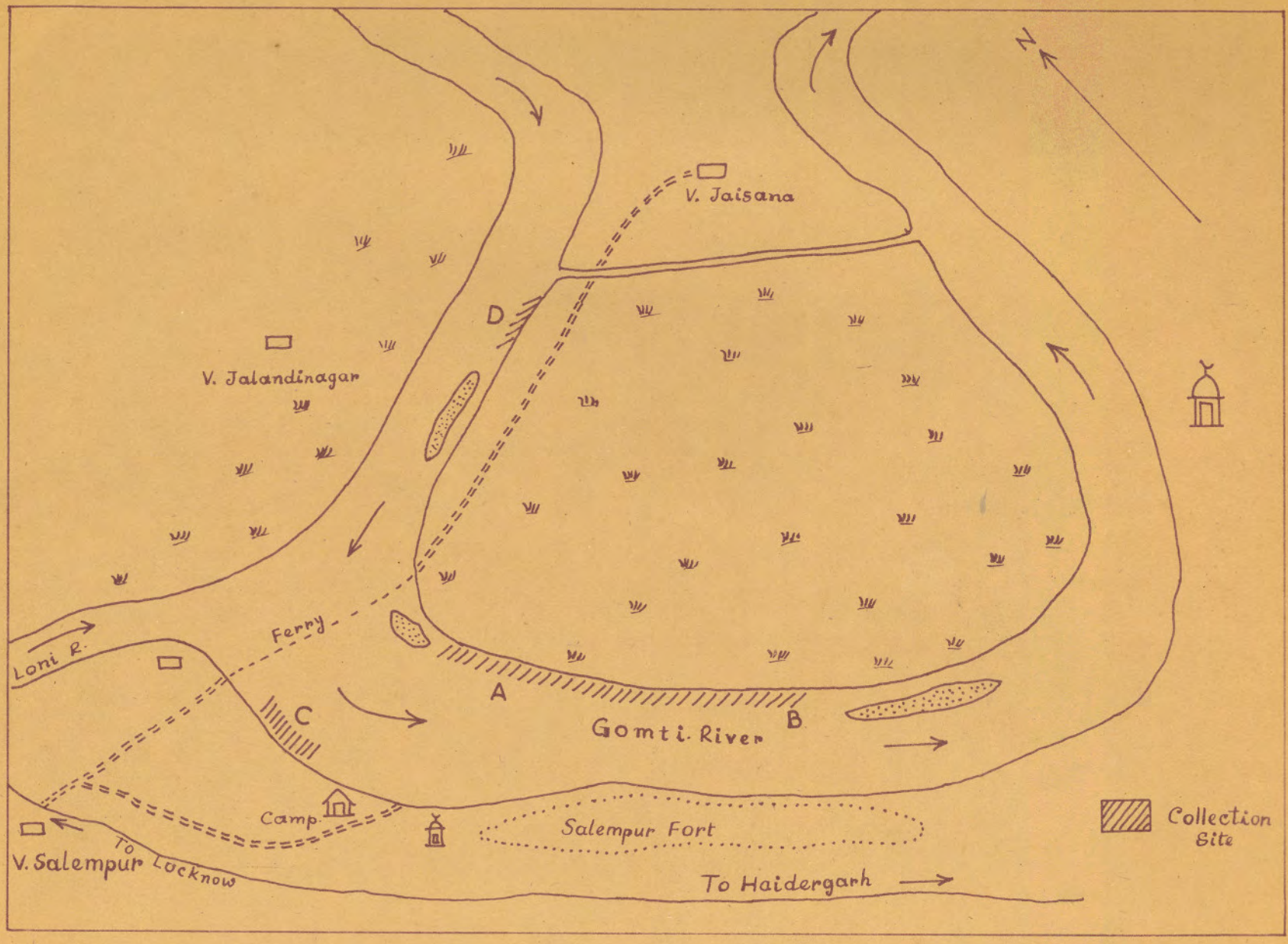

FIG. 5. THE COURSE, GENERAL TERRAIN AND TOPOGRAPHY OF RIVER GOMTI AT SALEMPUR.

Table 10

Flood-phase-wise occurrence, duration, desirability and magnitude of spawn spurts at Salempur on R. Gomti in 1967.

Flood No.	Flood details: Phase	Commencement: Date	Commencement: Hour	Duration in days	Peak: Date	Peak: Hour	Peak: Flood level in metres	Spawn spurt details: Spurt No.	Commencement: Date	Commencement: Hour	Duration in hrs.	Spawn desirability (D/UD)*	Total catch in ml
1	2	3	4	5	6	7	8	9	10	11	12	13	14
I	Rising	4.7.67	06.00	4	8.7.67	06.00	1.23						
	Receding	8.7.67	18.00	6½									
Vacillation	Phase	15.7.67	10.00	3									
II	Rising	18.7.67	10.00	3½	21.7.67	18.00	1.94	1	21,7,67	08.00	12	D	290
	Receding	21.7.67	20.00	13½				1 (Contd)			86	D	4,245
Vacillation	Phase	4.8.67	06.00	2½							2	UD	150
III	Rising	6.8.67	22.00	2½	8.8.67	22.00-02.00	3.32						
	Receding	9.8.67	06.00	8½				2	10.8.67	18.00	70	D	2,313
Vacillation	Phase	17.8.67	22.00	7½							4	UD	85
IV	Rising	25.8.67	18.00	3	28.8.67	18.00	2.47						
	Receding	28.8.67	02.00	3	The IV flood was still in its receding phase when the investigations were concluded at this centre on 31.8.67.								
TOTAL :				57½							174	D/UD	6,848/235

*D — Desirable
UD — Undesirable

Quality of spawn

Details of spurt-wise quality of spawn, as revealed by spawn analyses and nursery rearings, are given in Table 11.

As revealed by spawn analyses, while the undesirable spawn in spurts 1 and 2 had only 5.0% and 6.0% respectively of major carps, the desirable part of the two spurts contained as much as 17.6% and 22.5% respectively of major carps. However, rearing of composite samples taken from the first and second spurts, revealed major carp contents of 41.5% and 25.3% respectively. In one of the rearings from spurt 1, the major carps were found to be as high as 60%. These differences may be attributed mainly to differential mortality of different species and the rearing of both spurts in the same nurseries. The first spurt was dominated by mrigal followed by rohu, while catla was conspicuous by its total absence. On the other hand, the 2nd spurt was distinctly dominated by catla.

The seasonal indices of spawn quantity and quality for the centre were found to be 1,373.6 ml and 26.4% respectively.

Spawn availability at prospected sites

Of the various sites prospected for spawn availability, Bhainsakund site was found unsuitable, because of effluent discharge into the river by a paper mill about 200 m upstream of the site on the opposite bank. The site at Sondhiamaoghat on the southern bank of the river has a gently sloping bank contour, but becomes inaccessible during monsoon. On the other hand, the site at Gosainka-purwa on the northern bank was found suitable for commercial exploitation.

Spawn availability in relation to hydrographical and biotic factors

Flood level

The flood levels indicated in Table 10 are with reference to the lowest level observed during the investigations.

Table 11

Spurt-wise quality of spawn collected at Salempur on R. Gomti in 1967

Spurt No.	Desirability (D/UD)*	Spawn quality in percentage										
		By spawn analysis			By rearing							
		Major carps	Minor carps	Others	Rohu	Catla	Mrigal	Calbasu	Major carps total	Minor carps	Others
I	D	17.6	82.3	0.1	10.4	Nil	25.8	5.3	41.5	58.5	Nil
	UD	5.0	95.0	Nil							
II	D	22.5	77.5	Nil	4.1	9.8	5.0	6.4	25.3	74.7	Nil
	UD	6.0	94.0	Nil							

* D — Desirable
UD — Undesirable

Flood 1, which attained its peak level of 1.23 m on July 8, was of low magnitude and did not yield any spawn. The second flood, which touched a peak of 1.94 m on 21st July, yielded 4,685 ml of spawn in spurt 1. Even though the spawn was available for about 12 hours during the rising phase, bulk of it was collected in the receding phase.

The availability of spawn for short duration during the rising phase may be due to the fact that the breeding ground is probably situated in the upper reaches of the river at an altitude not much higher than the peak attained by the flood at Salempur, so much so that when the water level was receding at the breeding ground, it was simultaneously rising at the collection site. The availability of spawn in the receding phase of the third flood (peak = 3.32 m) in early August was an indication that the breeding ground was situated at a height between 2 to 3 m above summer level. The fourth flood, which touched the highest level of 2.47 m, did not yield any spawn, indicating thereby that breeding of major carps probably ends by the middle of August in this region.

Current velocity and direction

The current velocity fluctuated from 1.3 to 3.0 km per hour during the entire season, while the high spawn yield was obtained at a current velocity of 1.3-2.0 km per hour. At Salempur, the main current hits the steep southern bank causing its erosion, while the gently sloping collection site on the opposite northern bank is situated in what is to be normally regarded as a shadow zone. However, the momentum of the faster waters of Loni Nadi, entering the river on the opposite southern bank, diverts the current of the main river at an angle of about 20°, thereby neutralising the shadow zone creating effect of the main current on the northern bank and setting up instead a moderate current velocity suitable for spawn collection.

Turbidity

Turbidity values ranged from 165-950 ppm. Peak turbidity values coincided with flood peaks, and bulk of spawn was available during the receding phase when turbidity ranged between 330 and 500 ppm. However, no direct correlation could be noticed between turbidity and spawn availability at this centre.

Associates

No indicator species could be made out from among the associates encountered in the collections. They occurred in large numbers during both spawn availability and non-availability periods. Prawns were the most dominant, followed by Oxygaster spp., Puntius ticto, Mastacembelus pancalus and Cirrhinus reba.

5.1.1.3 Sopari (Tonk) stretch of river Banas

Participants

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Shri S.D. Gupta	
" M.K. Sharma	Govt. of Rajasthan
" D.R. Kishore	
" V.K. Kakkar	

With the growing demand for quality fish seed emerging out of the expansion of fisheries activities in Rajasthan, it was felt imperative by the State Government to exploit fully its extensive natural resources, where, till 1967, collection of carp spawn from their natural habitat was not in vogue. At the instance of the Government of Rajasthan, a detailed pre-monsoon survey of selected stretches of rivers Banas and Chambal was carried out, and the stretch of river Banas adjoining Tonk (Sopari stretch) was selected for detailed monsoon investigations.

The Sopari stretch of the Banas extended from Negria in the west to Dubbi in the east, a distance of about 185 km. The site selected for detailed round the clock investigations is located opposite village Sopari, about 10 km from Tonk on the north bank of the Banas. Sopari, situated on the south bank, is connected with the site by an all-weather metalled road and a pucca road-bridge. About 6 km upstream, river Mashi falls into the Banas near Gehlot Ghat, while river Dai drains into the Banas at Bisalpur about 40 km upstream. Further upstream at Negria, it is joined by river Khari (Fig.6). Besides, about 3 km upstream of the site a seasonal nulla, the Sohela, joins the Banas on its north bank. Another nulla joins the river on its south bank, opposite the main collection site, a little below the road bridge (Fig.6). The course, general terrain and topography of river Banas adjoining the Sopari site are depicted in Fig.7.

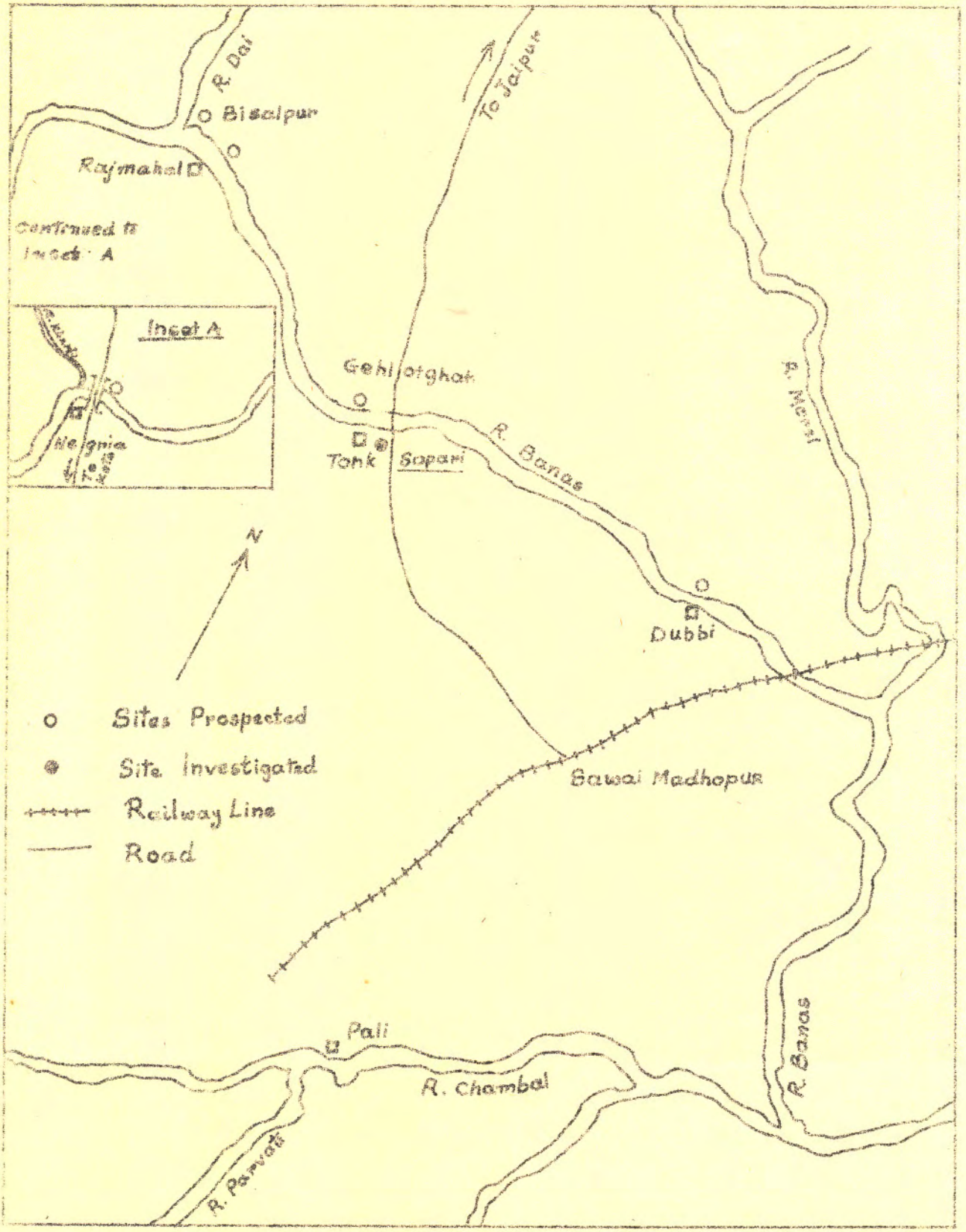

FIG. 6. SOPARI STRETCH OF RIVER BANAS, SHOWING SITES PROSPECTED AND CENTRE INVESTIGATED.

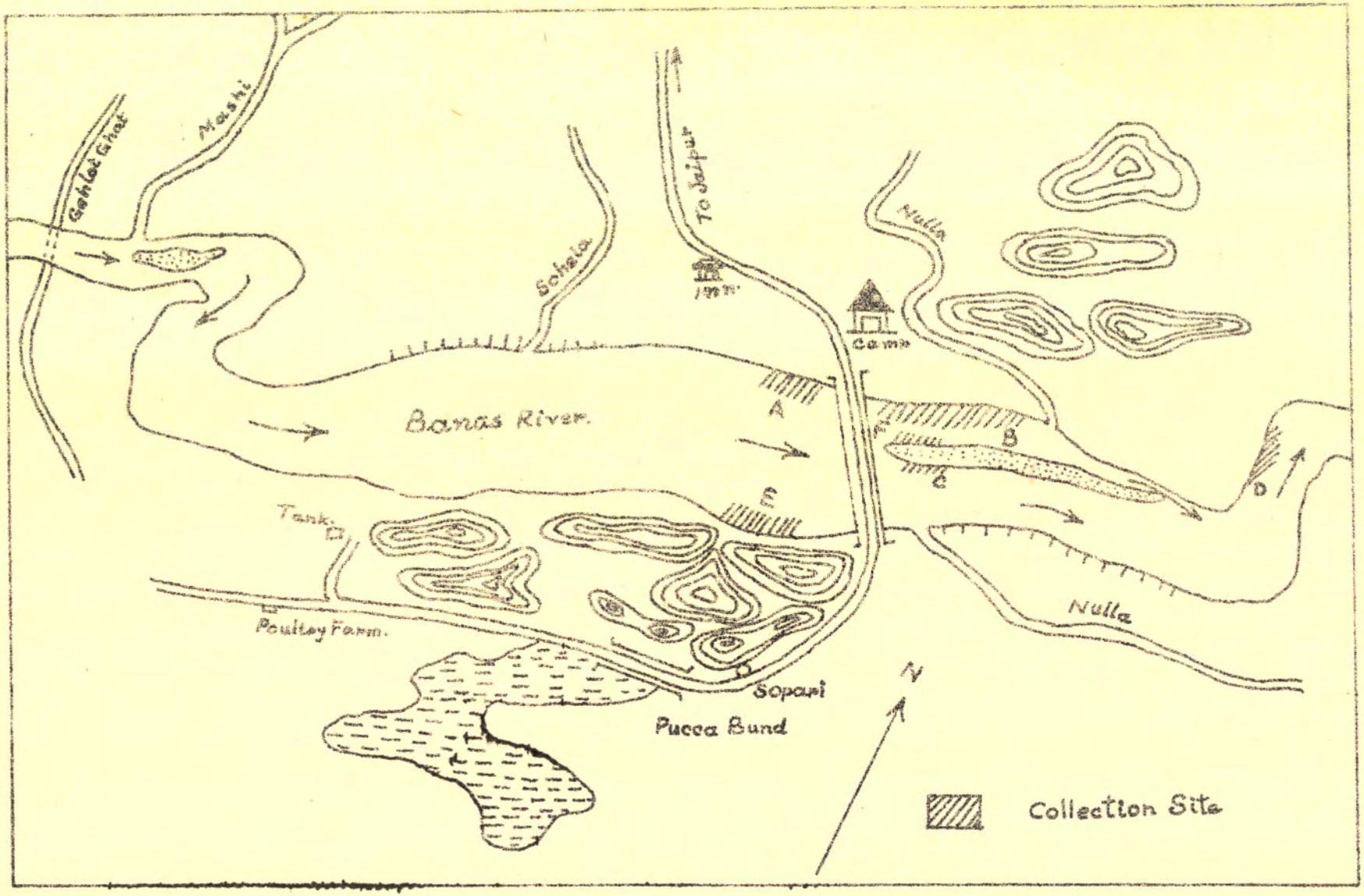

FIG. 7.

THE COURSE, GENERAL TERRAIN AND TOPOGRAPHY OF RIVER BANAS AT SOPARI

Extreme summerconditions were prevailing at the time of initiation of the investigations, with the river showing extensive sandy islands and a low rate of flow parallal to the course of the channel. The maximum depth of the river, barring a couple of deep pools, did not exceed three feet in the vicinity of the site. This almost placid condition of the river underwent a distinctive change with the advent of the first major flood. Sudden and voluminous rise in water-level, following periods of heavy rains in the catchment area, brought about a turbulent flow in the river, submerging the islands completely and resulting in rapid erosion through abrasion of stream sides by mineral sediments carried in suspension by currents of high velocity. However, after each flood the river soon returned to its normal flow within a short period. The observations at this site lasted from 1st July to 7th September, 1967.

Occurrence of spawn spurts

A total of 8,765 ml of spawn and 980 ml of fish eggs were collected in the course of six major floods that occurred in river Banas in 1967 in three to five standard nets. The floods were invariably caused by rains in the adjacent catchment area. In Table 12 are shown the days of major floods, the dates of attainment of peak flood levels, quantities of spawn collected in each flood and the duration of each spawn spurt.

With the appearance of each spawn spurt, trial nettings were done simultaneously at six suitable spots (A to F) available in the vicinity of the site, and the spot yielding maximum catch in two-hours was chosen for operating the full battery of nets. Spot C was found to be the most suitable during the first two spawn spurt, while spots B and A were found to be the best during spawn spurts 3 and 4 respectively.

The first spawn-spurt occurred in the receding phase of the first major flood on 6.7.1967. The spurt commenced as soon as the water level, after attaining a peak, started falling down. This spawn-spurt lasted only for a short duration of four hours, yielding 17 ml of spawn, all desirable, in three standard nets. This spurt accounted for only 0.19% of the total spawn catch of the season. The catch per net per hour was estimated to be 990 hatchlings.

The second spawn spurt too was of a very short duration, commencing in the receding phase of flood II. The spurt appeared with the fall in water level, soon after attaining its peak. This spurt lasted for six hours only, yielding in all 39 ml of spawn, which formed 0.47% of the total catch of the season. The catch per net-hour was estimated to be 1,364 hatchlings.

The major spawn spurt of the season commenced at 10 hrs. on 6.8.1967 in the receding phase of the third flood. The water level, after attaining its peak of 2.79 m on 5.8.1967 at 14 hrs. started declining from 18 hrs that day. The flood level again showed a little upward trend from 6 hrs on 6.8.1967 and vacillated for the next 28 hours, and spawn suddenly appeared in this period at 10 hrs. on 6.8.1967 and the trial net collected 35 ml of spawn in two hrs. In the eight-hour duration of the rising trend of this vacilating flood, when a rise of 0.31 m in the water level was recorded, 1,270 ml of spawn could be collected in five standard nets. This accounted for 14.7% of the total spawn catch of the season. The catch per net-hour was estimated to be 11,112 hatchlings. However, the water-level again started receding from 20 hrs. on 6.8.1967, but the spawn continued to appear in bulk. The maximum collections were made between 20 and 24 hrs. on 6.8.1967, when the pooled two-hourly collections of 5 standard nets were observed to vary between 585 and 1,220 ml, with the catch per net-hour ranging between 58.50 ml and 124 ml. On 7.8.1967, the total two-hourly spawn catch of five standard nets ranged from 150 to 270 ml. On 8.8.67, the intensity of spawn availability declined considerably. Though the pooled collection of 5 standard nets at 6 hrs. amounted to 310 ml, from 8 hrs. onwards there was a gradual decline in spawn availability and it completely disappeared by 18 hrs. This receding phase of the III flood yielded 75.4% of the total spawn catch of the season. The catch per net-hour amounted to 9,637 hatchlings.

The last spawn-spurt occurred during the season's IV major flood. The water level started receding from 2 hrs. of 15.8.67 and the spawn appeared on 17.8.67 at 10 hrs. This spurt lasted only for 14 hrs. and the pooled two-hourly spawn catches in five standard nets ranged between 15 ml and 165 ml. The maximum collections were made at 16 hrs. that day, when five standard nets collected 165 ml in two hours. This spurt yielded 9.4% of the season's total spawn catch, the catch per net-hour being 4,155 hatchlings.

No spawn was collected in subsequent floods. Out of the four spawn spurts encountered during the 1967 season, spurt 3 was the most remunerative, (28.14 ml per net-hour) followed by spurt IV. Spurts 1 and 2 yielded only meagre quantities of spawn. The season's average amounted to 22.33 ml per net-hour.

Table 12

Flood-phase-wise occurrence, duration, desirability and magnitude of spawn spurts at Sopari on R. Banas in 1967

Flood details						Spawn spurt details								
Flood No.	Phase	Duration		Peak		Spurt No.	Commencement		Duration in hrs	Desirability (D/UD)*	No. of nets	Total catch in ml	Catch in lakhs	Catch per net-hour in numbers
		From	No. of hrs.	Date/ hour	Flood level in metres		Date	Hour						
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Rising	1.7.67	152	6.7.67 / 18	1.24									
I														
	Receding	6.7.67	254			1	6.7.67	18	4	D	3	17	0.085	1,414
	Rising	18.7.67	186	25.7.67 / 6	0.88	Nil								
II														
	Receding	29.7.67	284			2	25.7.67	6	6	D	5	39	0.195	1,948
Vacillation	Phase	29.7.67	72											
	Rising	2.8.67	64	5.8.67 / 14	2.79									
III	Vacillating	5.8.67	28			3	6.8.67	8	10	D	5	1,270	39.39	15,874
	Receding	6.8.67	112			3	6.8.67	20	48	D	5	6,608		12,338
Vacillation	Phase	10.8.67	96											
	Rising	13.8.67	42	15.8.67 / 22	2.17									
IV														
	Receding	17.8.67	78			4	17.8.67	10	14	D	5	831	4.155	5,935
Vacillation	Phase	18.8.67	312											
	Rising	31.8.67	30	3.9.67 / 18	2.53									
V														
	Receding	4.9.67	84											

* D — Desirable UD — Undesirable

Occurrence, quality and quantity of fish-eggs

During the course of these observations, a total of 980 ml of carp eggs were collected. Table 13 depicts the quantity and quality of the fish eggs collected. 40 ml of eggs were collected in two waves of the rising phase of Flood II on 20.7.67. Fish eggs started appearing in the nets at 6 hrs. and in a spell of four hours 40 ml of eggs were collected in one standard net. From 21.7.67 to 24.7.67, the flood level vacillated between 0.21 and 1.17 m, and on 24.7.67 again at 6 hrs. the eggs appeared in the net. Between 6 and 14 hrs., a total of 145 ml of eggs were collected in one standard net. These two eggs spurts carried a major carp content of 37.7% and 48.2% respectively.

Table 13

Quantity and quality of fish eggs collected at Sopari on river Banas

Date	Flood No. & phase	Total quantity of eggs		Percentage composition		
		ml	No.	Major carps	Minor carps	Others
20.7.67	III Rising	40	480	37.7	60.3	2.0
24.7.67	II Receding	145	1,740	48.2	29.0	22.8
1.8.67	Vacillation phase between floods II & III	795	9,180	55.6	32.4	18.0

Another egg-spurt was encountered during the vacillation phase between Floods II and III on 1.8.67, when a total of 795 ml of eggs was collected between 6 and 14 hrs. in three standard nets. This egg-spurt had a major carp content of 55.6%, with a predominance of L. rohita (41.4%), followed by C. mrigala (8.3%).

The availability of fertilized eggs indicated the location of breeding ground in the vicinity of the site. It was deduced that spawning probably occurred somewhere near river Mashi, which drains into the Banas on its north bank about 6 km upstream. The survey of

a considerable stretch of river Mashi and a number of seasonal nullas draining into it revealed the presence of a number of suitable places which could have served as breeding grounds of major carps. Major carp congregation for spawning in river Mashi was reported to have been seen by local people during previous years. However, actual spawning could not be observed, though sizeable stretches of river Mashi and Sohela nulla were combed during the flood period and trial nettings made at several spots.

Quality of spawn collected

Percentage composition of spawn catches made during different spurts was determined by microscopical analyses of two-hourly spawn samples and also from samples of fry drawn from earthen gamlas, ditches or nurseries where the spawn were reared. The results obtained are shown in Table 14.

All the four spurts, which in all yielded a total of 8,765 ml of spawn, appeared to be desirable. The first and second spurts contained only a moderate percentage of major carps. L. rohita, followed by C. mrigala, C. catla and L. calbasu were the dominant major carps during the first spurt, in the order mentioned, while among minor carps, C. reba, followed by Barilius shacra and Puntius sophore formed the bulk. L. rohita was again the dominant major carp during the second spurt also, followed by C. mrigala, while C. reba and L. bata constituted the most dominant minor carps.

Spurt 3, which yielded bulk of the season's spawn catch, showed a considerably higher percentage of major carps both, in the samples analysed microscopically (76.5%) as well as in those reared in State nurseries (82.9%). This spurt lasted for 56 hours from 6.8.67 to 8.8.67. The collection of 6.8.67 was stocked separately, while an admixture of those made on 7.8.67 and 8.8.67 was reared together in another nursery. The sample from the collection of 6.8.67 revealed a high percentage of L. rohita (61.1%), followed by C. catla (6.8%) and meagre percentages only of C. mrigala and L. calbasu. On the other hand, the pooled sample of 7.8.67 and 8.8.67 comprised a high percentage of rohu (41.7%), followed by mrigal (32.3%), C. catla and L. calbasu. This indicates that there had been definite spawning bursts of different species on different dates and that the collection on 6.8.67 comprised a preponderance of L. rohita, as compared to the collection made on 7.8.67 and 8.8.67 when C. mrigala dominated the catch.

The percentage of major carps was again high in the fourth spurt (71.9 by rearing), with C. mrigala dominating the catches, followed by L. rohita, C. catla and L. calbasu, while L. bata, B. sheera, C. reba, P. sophore and L. pangusia dominated the minor carps.

The seasonal indices of spawn quantity and quality for this centre were found to be 1,601 ml and 81.5% respectively.

Spawn availability at proposed sites

Besides the observations at Sopari, occasional spawn prospecting was carried out at Negria, Bisalpur, Rajmahal, Gehlot Ghat and Dubbi. Of the various sites prospected, spawn was encountered in sizeable quantities only at Dubbi near Sawai Madhopur. All the sites prospected were found to be thoroughly suitable for the operation of a battery of shooting nets. Varying quantities of spawn were available at all the four sites situated upstream of Sopari, Viz. Negria, Bisalpur, Rajmahal and Gehlot Ghat. These sites were found to be suitable for exploitation throughout the season.

Spawn availability in relation to hydrographical, meteorological and biotic factors

Flood level

A total of six major floods occurred in river Banas, out of which the first four, as discussed above, yielded varying quantities of spawn. Floods V and VI did not yield any quantity of spawn. It was observed, through fishing done in the vicinity of Negria and Rajmahal, that by the time floods V and VI occurred in the river, majority of major carps had already bred, in that almost all the specimens encountered were seen to be in spent condition. Further, the floods V and VI, especially the latter, were so severe in nature that they completely engulfed the site and made it unsuitable for net operation.

It was observed that spawn was available in the river only when the water level rose to more than 0.6 m above the summer level. This probably serves to establish a link between the Banas - reduced to a mere trickle during summer months - and its tributaries and nullas, so as to enable the major carp population to ascend these water courses to find a suitable breeding ground. However, a rise in water level exceeding 2.5 m unfavourably transformed the topography of the site, rendering the operation of nets difficult.

Table 14

Spurt-wise quality of spawn collected at Sopari on R. Banas in 1967

Spurt No.	Desirability (D/UD)*	SPAWN QUALITY IN PERCENTAGE									
		By spawn analysis			BY REARING						
					Major carps					Minor carps	Others
		Major carps	Minor carps	Others	Rohu	Catla	Mrigal	Calbasu	TOTAL		
1	D	21.0	78.0	1.0	6.8	3.0	4.6	1.6	16.0	83.2	0.8
2	D	23.7	76.0	0.3	10.6	1.2	7.7	0.3	19.8	79.5	0.7
3	D	76.5	23.2	0.3	41.7	8.3	32.3	0.7	82.9	16.4	0.7
4	D	74.1	25.0	0.9	5.6	4.4	61.3	0.6	71.9	26.5	1.6

* D — Desirable

UD — Undesirable

Turbidity

Turbidity alone did not appear to have any direct bearing on spawn availability. During peak spawn collection days, turbidity at this site ranged between 400 and 1,200 ppm.

Current velocity

On 6th and 7th August, 1967, the days of peak spawn availability, current velocity ranged from 1.3-3.7 km/hour.

Air and water temperature

During peak period of spawn availability, air and water temperatures were found to range from 26°-32°C and 27°-32°C respectively, while in the season as a whole their respective ranges were 24°-39°C and 24°-38°C.

Associates

The associates' quantity, ranging in number from 100-150 per hour in the initial phases of the investigation, gradually declined to range from 1-25 per hour in the second spurt and nil to 6 in the third spurt. Only stray specimens of associates were encountered in the fourth spurt. Amongst the associates, Cirrhinus reba; Labeo bata; Puntius sophore and P. ticto; Barilius shacra and B. barila; Oxygaster bacaila; Notopterus notopterus; Mystus cavasius; Nemachilus zonatus; Rhinomugil cascasia, Glossogobius giuris; P. conchonius and Aspidoparia morar were prominent.

5.1.1.4 Dingrahaghat stretch of river Mahananda

Participants

Shri A.N. Ghosh (Leader)	C.I.F.R.I. Govt. of India
" K.V. Rao	
" T.D. Nangpal	
" Parasmani Sinha	Govt. of Bihar
" Pratap Narayan Thakur (for 11 days only)	

Even though Bihar leads the rest of the country in regard to the collection of riverine spawn of major carps, certain areas of North Bihar, particularly the district of Purnea, have to depend for their fish seed requirements on sources elsewhere in the State. Therefore, with a view to achieve regional self-sufficiency, the Government of Bihar suggested the location of a commercially exploitable spawn collection centre on the Mahananda in the district of Purnea.

The Mahananda, originating in the eastern sector of the Himalayas, flows in a north to south direction in Purnea district (Fig.8). In its upper course, till it reaches Kishangunj, the river has a sharp downward gradient and is torrential during monsoon. Below Kishangunj, where the gradient changes, the river is almost perennial. Lower down, the river flows into the Padma in Bangladesh, after giving off a branch near the border of Purnea and Malda districts, *viz.* River Kalindi, which joins the Ganga near Rajmahal.

Dingrahaghat, situated about 35 km east of Purnea Town on the western bank of Mahananda near the road bridge of National Highway No.31, was selected for detailed round-the clock investigations (Fig.9). A 100 km stretch of the river, extending from Dinghrahaghat to a little above Thakurgunj upstream (Fig.8), was selected for prospecting.

Occurrence of seed spurts

During the period of investigations, altogether five floods of varying magnitudes were recorded at Dinghraghat. Of these, the second and fifth floods, which attained their peaks on 28.6.67 and 23.7.67, did not yield any fish seed. The I flood yielded two spawn spurts, while the III flood yielded a spurt of fertilised eggs. The IV flood yielded three spurts of fry. Details of occurrence, duration, magnitude and desirability of the various seed spurts are given in Table 15.

The first spawn spurt was of a brief duration of only 4 hours, and occurred in the rising phase of the I flood just before it reached its peak level. This spurt yielded only 4 ml of undesirable spawn, the magnitude of catch being only 1 ml per net-hour. In the strict sense, this can hardly be termed a 'spurt'.

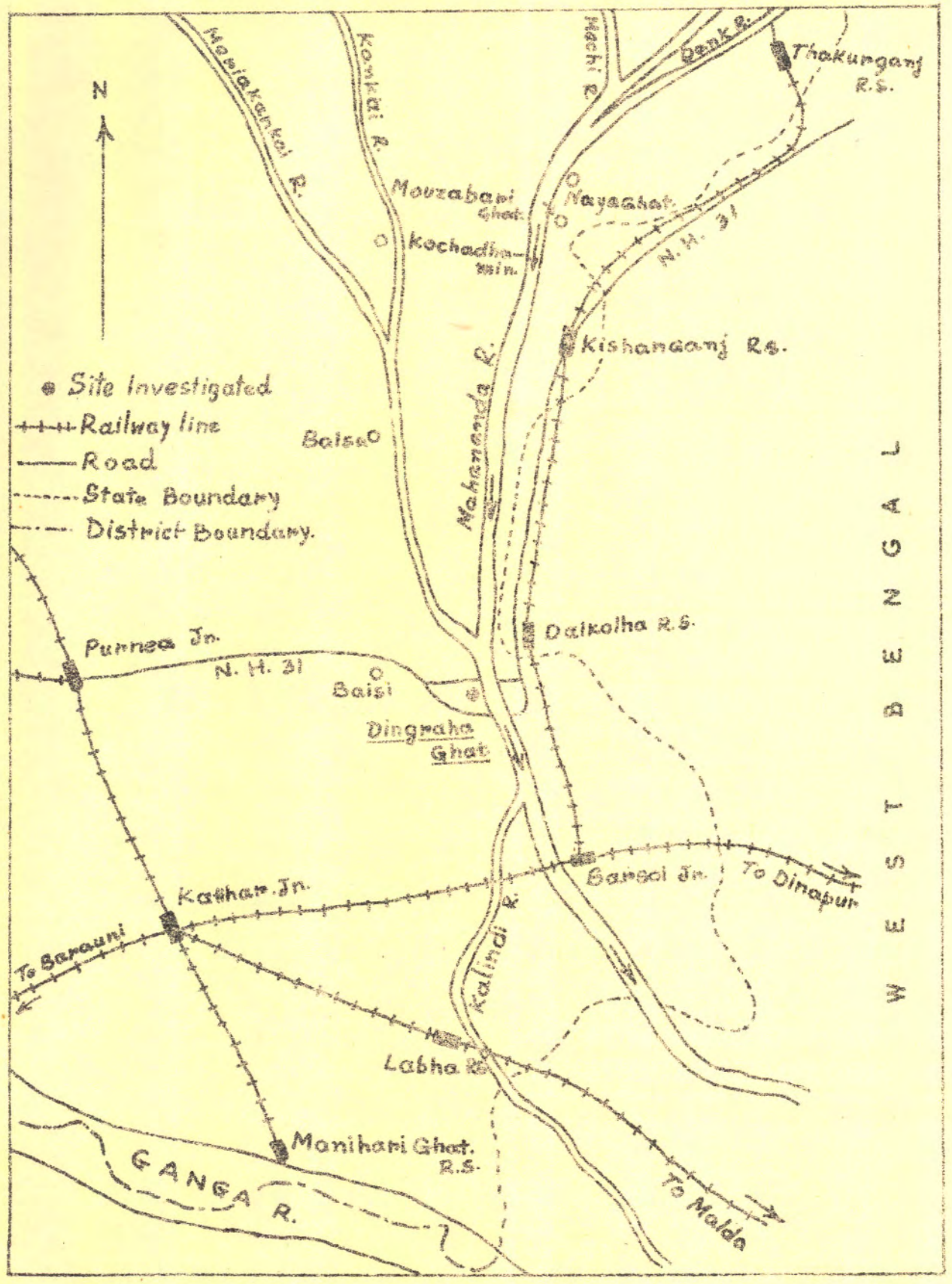

FIG. 8. DINGRAHAGHAT STRETCH OF RIVER MAHANANDA, SHOWING SITE INVESTIGATED.

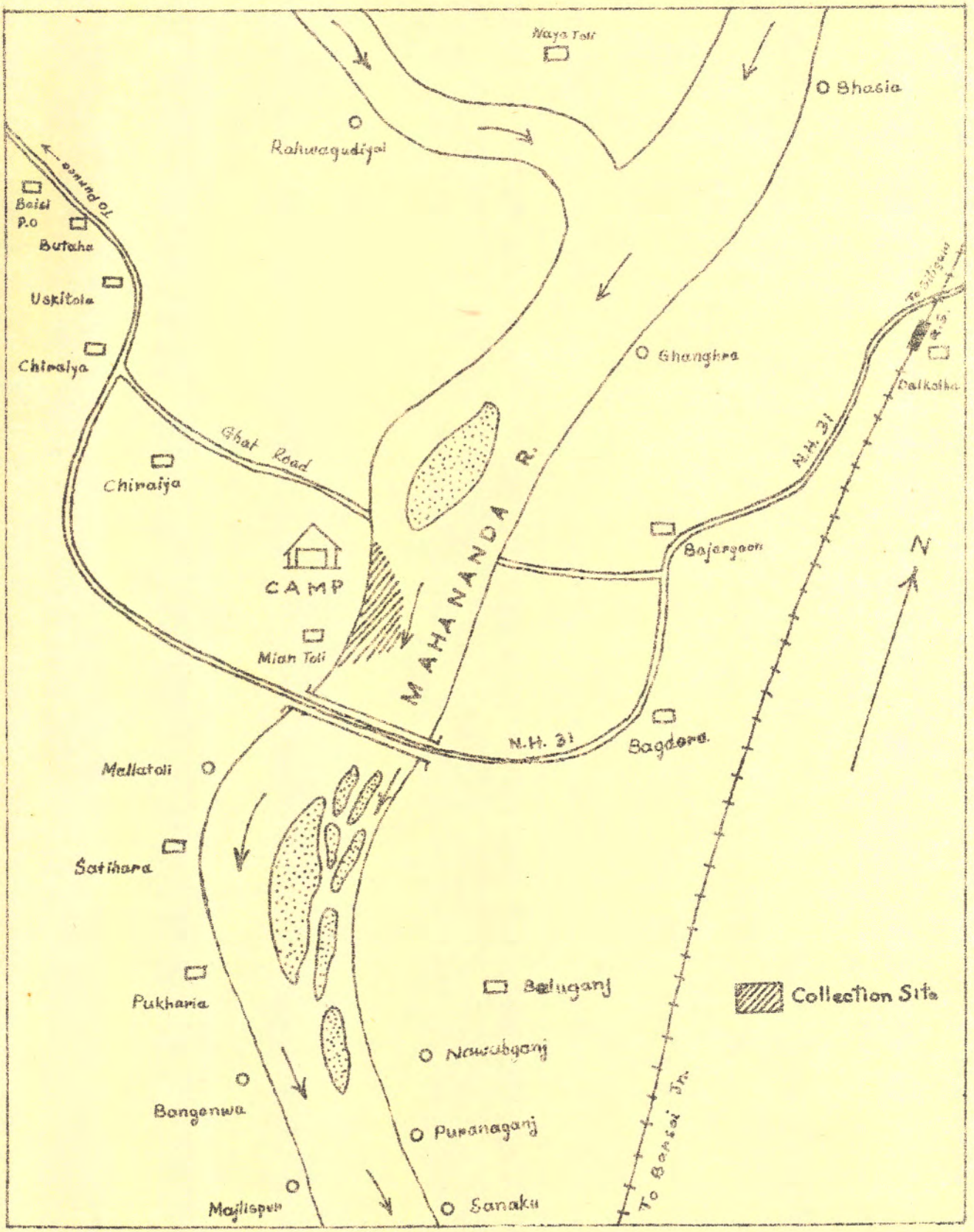

FIG.9

THE COURSE, GENERAL TERRAIN AND TOPOGRAPHY OF RIVER MAHANANDA AT DINGRAHAGHAT.

Table 15

Flood-phase-wise occurrence, duration, magnitude and desirability of seed spurts at Dingrahaghat on R. Mahananda in 1967

Flood details				Spurt details				Total catch+		Catch per net-hour in ml	Desirability (D/UD)@
Flood No.	Phase	Peak		Type & number	Commencement		Period in hrs.	in ml	in lakhs		
		Date	Flood* level in m		Date	Hour					
I	Rising	20.6.67	1.98	$Spawn_1$	20.6.67	6	4	4	0.02	1.00	UD
	Receding	-	-	$Spawn_2$	21.6.67	15	25	502	2.51	10.04	D
III	Temporary recession during rising phase	11.7.67	4.29	$Eggs_1$	9.7.67	18	14	2,010	1.01	35.89	D
	Rising	19.7.67	4.61	Fry_1	18.7.67	8	6	430	0.11	14.33	D
IV	"	-	-	Fry_2	19.7.67	19	5	175	0.55	11.67	D
	Receding	-	-	Fry_3	21.7.67	10	36	2,205	0.55	24.78	UD

* Above the initial water level observed at the commencement of the investigations.

\+ 1 ml = 500 spawn.

@ D = Desirable
UD = Undesirable

The second spawn spurt occurred in the receding phase of the I flood and lasted for 15 hours, yielding in all 502 ml of desirable spawn. This accounted for the season's total catch of desirable spawn at this centre. The catch per net-hour during this spurt amounted to 10.04 ml.

The rising phase of the III flood was interposed with short durations of falling flood levels. The only spurt of fertilised eggs occurred during one such temporary recession of flood level. This spurt lasted for 14 hours and yielded 2,010 ml of desirable fertilised eggs. The availability of eggs ceased with the turn in the phase of this flood. This availability of major carp eggs during a temporary recession in the rising phase of the flood indicates that breeding was probably taking place in shallow areas in the vicinity of the collection site. The cessation of freshets was responsible for the fall in water level in such areas, resulting in the flowing down of fertilised eggs with the receding waters.

All the three fry spurts occurred during the IV flood. The first two fry spurts occurred during periods of stationary or very slowly increasing water levels in the rising phase of the flood. These spurts yielded 430 ml and 175 ml respectively of desirable fry. The break in fry availability between the two spurts was associated with abrupt rise in water level. The 3rd fry spurt occurred during the receding phase of the same flood. It lasted over 36 hours and yielded 2,205 ml of undesirable fry, consisting mainly of catfishes and carp minnows.

Quality of fish seed collected

Percentage compositions in regard to the quality of eggs, spawn and fry catches made during the various spurts, based on microscopical analyses of two-hourly samples and on nursery rearings, are depicted in Table 16.

The major carp content of the desirable spawn spurt was found to be 87.9% by spawn analysis and 94.0% by rearing. The egg and fry spurts also showed very high percentages of major carps. In every case the major carp content consisted entirely of rohu.

The seasonal indices of spawn quantity and quality were found to be 251 ml and 94% respectively.

Table 16

Quality of fish seed collected during various spurts at Dingrahaghat on R. Mahananda in 1967

Spurt	QUALITY (%)																		
	By analysis			By rearing in nursery pits at the camp								By rearing in State nurseries						
				Major carps								Major carps						
	Major carps	Minor carps	Others	Rohu	Catla	Mrigal	Cal-basu	TOTAL	Minor carps	Others		Rohu	Catla	Mrigal	Cal-basu	TOTAL	Minor carps	Others
$Spawn_1$	-	86.80	13.20	NOT REARED														
$Spawn_2$	87.90	8.64	3.46	NOT REARED								94.00	-	-	-	94.00	4.00	2.00
$Eggs_1$	71.37	-	28.63	85.78	-	-	-	85.78	12.79	1.43		79.14	-	-	-	79.14	20.86	-
Fry_1	66.15	24.44	9.41	69.14	-	-	-	69.14	21.60	9.26								
Fry_2	62.67	22.53	14.79															
Fry_3	-	23.51	76.49	NOT REARED														

Spawn yielding potentiality of Dingrahaghat stretch

In river Mahananda, commercial spawn collection is resorted to regularly in its Kalindi branch upto a point about 10 km upstream of the railway bridge near the Labha railway station. Samples of spawn collected at Labha, situated 60 km downstream of Dingrahaghat, showed 71% rohu and 5% catla. Further, spawn availability had commenced at Labha three days prior to that at Dingrahaghat. This indicates that the spawn available at the two centres are from different sources, and that rohu is the only major carp breeding in the Mahananda above Dingrahaghat, while catla also breeds, to a lesser extent, below Dingrahaghat. The availability of spawn during the first two spurts, and not fertilised eggs, tends to indicate their descent from the upper reaches of the river. However, the low water level of the river above Mouzabarighat even during the monsoon months precludes the possibility of any resident population of major carps in that stretch. Therefore, a rapid survey was carried out in the stretch between Dingrahaghat and Galgalia, covering all the tributaries joining the Mahananda in this stretch to locate resident major carp populations. The centres covered were Mouzabarighat and Thakurgunj on R. Mahananda, Pothia on R. Donk, Galgalia on R. Mechi and Baisi on R. Kankai (Fig.8). The survey showed that no major carp fishery exists in the rivers Donk, Mechi and Kankai, and also in the Mahananda above Nayaghat, a mile upstream of Mouzabarighat. Flourishing adult major carp fishery, consisting of breeders and spent fish, is existent only near Mouzabarighat during monsoon and post-monsoon months. Heavy catches of rohu were reported from this region in mid-June, 1967. It was also learnt that there was no fishery for juvenile major carps in this region. It may, therefore, be surmised that the spawn collected at Dingrahaghat must be the result of rohu breeding in Mouzabarighat region, while the availability of eggs with further rise in water level indicates the possibility of rohu breeding in the vicinity of Dingrahaghat. The fact that the water had not spread out into the tributaries or other adjoining enclosed water areas when the eggs were available, suggests breeding taking place in the low lying areas of the main river from a resident population. This presumption was further substantiated by the collection of a few gravid female rohu about 1/2 km upstream of the collection site. Therefore, exploitation of the stretch of R. Mahananda from Mouzabarighat to Labha can be expected to yield very high quality spawn in sizable quantities.

Availability of fish seed in relation to hydrographical conditions

Flood level and rainfall

The floods at the centre were mostly influenced by the rainfall in the river's upper catchment area, viz. in the regions of Thakurgunj, Pothia and Kishangunj, while the local rainfall at Baisi had only a negligible effect. It may, therefore, be stated that the success of spawn collection at this centre is dependent on the timely rainfall in the above regions.

It was observed at Dingrahaghat that desirable egg and spawn spurts occurred only during falls in water level, while the desirable spawn spurts occurred only in the rising flood phase. While the spawn appeared during the period/the flood level receded from 1.64 m to 1.62 m, the eggs appeared when the flood level decreased from 2.93 m to 2.79 m.

/when

Turbidity

The bulk of desirable fish seed collection at Dingrahaghat was made in the turbidity range of 500-650 ppm, while undesirable seed were available even at lower turbidity values.

Current velocity

While the current velocity at the site ranged from 0.8-2.4 km/hr during the entire season, bulk catches of fish seed were usually associated with a range of 1.4-2.25 km/hr.

5.1.2 Dharmapuri stretch of river Godavari

Participants

Shri K.K. Ghosh (Leader)	C.I.F.R.I. Govt. of India
" P.L. Narayana Rao	
" M.J. Reaz Ahmed	Govt. of Andhra Pradesh
" R.D. Shendrikar	
" A. Ammanna Setty	
" T.K. Roop Singh	

In addition to the above, Sarvashri Y. Venkata Rao, V.Sambayya and Rahmat Ali of the State Government also occasionally participated in the programme.

The selected Dharmapuri stretch of the Godavari extended from Bornpalli in the north-west to Mancherial in the south-east, a distance of about 80 km (Fig.10). Village Dharmapuri, which was selected for detailed round the clock observations, is situated on the south-western bank of the river in Jagtial tehsil of Karimnagar district, Andhra Pradesh. The river flows in an almost north to south direction in this region, and has a bed strewn with rocks all over. The river bank topography of this site is, like most of the sites in the upper stretches, gradually sloping. The bank contour, river bed topography and extent of area available for net operation are diagramatically represented in Figure 11.

The observations at this site commenced on the 22nd June and lasted till 27th August. In addition to the observations at Dharmapuri, periodic prospecting was done at Bornpalli, Rajaram, Thaimapur, Rayapatnam causeway, Luxxatipet and Mancherial in the selected stretch and also at Manthani downstream. A rapid survey of other sites in the upper stretches was done upto Basar, where the river enters Andhra Pradesh.

Occurrence of spawn

Even though the river experienced two major floods during the season, no spawn spurt was encounterd, the level of availability having been touched for a brief period of two hours only. The first freshets of the season were received by the river in this region on the 22nd of June, and the water level rose by 3.25 m to touch the peak of first flood on 25th of June. The receding phase yielded only a few hatchlings and early fry and a large number of eggs of Gobius striatus. The water after receding in a fluctuating manner, again rose and touched a peak on 4th of July at 22 hrs, when the flood level was 2.52 m only. In the following receding phase, some spawn were available for four hours only on 5th July. The criterion for availability was, however, not satisfied. The rate of collection was only about 200 hatchlings per net per hour.

The second flood started rising on the 12th of July, at a low rate for the first 7 days, after which the rate increased appreciably to the extent of 25 cm per hour during the last 20 hrs. The peak

level of 9.83 m was touched on 25th July at 14 hrs, and soon after the flood receded below the 7.00 m level, spawn of very low intensity were available for a very short period, from 8 hrs to 12 hrs of 27th July. But the flood phase turned at 12 noon and the river again started rising and went beyond the 7 m level by the evening of the same day. During this short-lived appearance of spawn, the availability criterion was not fulfilled in the strict sense, since the spawn intensity was found to be about 0.6 m (c.300) only per net per hour. The next 7 days saw the level of water fluctuating at a high level around 7 m mark. The decreasing trend in the receding phase commenced on 3rd August and went on till the closure of observations on 27th August, when the flood level was only 1.7 m above the summer level. This trend was interspersed with frequent rises of low magnitude and duration, giving rise to secondary peaks of floods. One such rise and recession was associated with the appearance of spawn for 6 hours from 6 hrs. to 12 hrs. of 16th August. The criterion of availability was, however, fulfilled for only 2 hours, when the catch per net hour was 1 ml. On the whole, this period yielded only about 300 hatchlings per net per hour.

The details of occurrence of floods and spawn at Dharmapuri are shown in Table 17.

Quality of spawn

Since no sizable quantity of spawn was collected, rearing experiments could not be undertaken. Spawn analysis of the samples of the three appearances showed the major carp content as 5% for the spawn of 5th July, 18% for that of 27th July and 19% for that of 16th August. The rest of the spawn were mostly of minor carps. However, a sample drawn from the nursery stocked with the collection made by the State Department along side the nets operated under the investigations, showed the Labeo fimbriatus content as 40%, with catla forming about 1% only. The low percentage of major carps as revealed by spawn analysis may be attributed to the difficulty in classifying 5-6 mm sized spawn of L. fimbriatus on the basis of present day knowledge on the subject. The data gathered were too meagre to work out indices of spawn quantity and quality for this centre.

Spawn potentiality of the prospected sites

The stretch prospected in 1967 is strewn with many sites which are easily accessible by road and where grounds suitable for

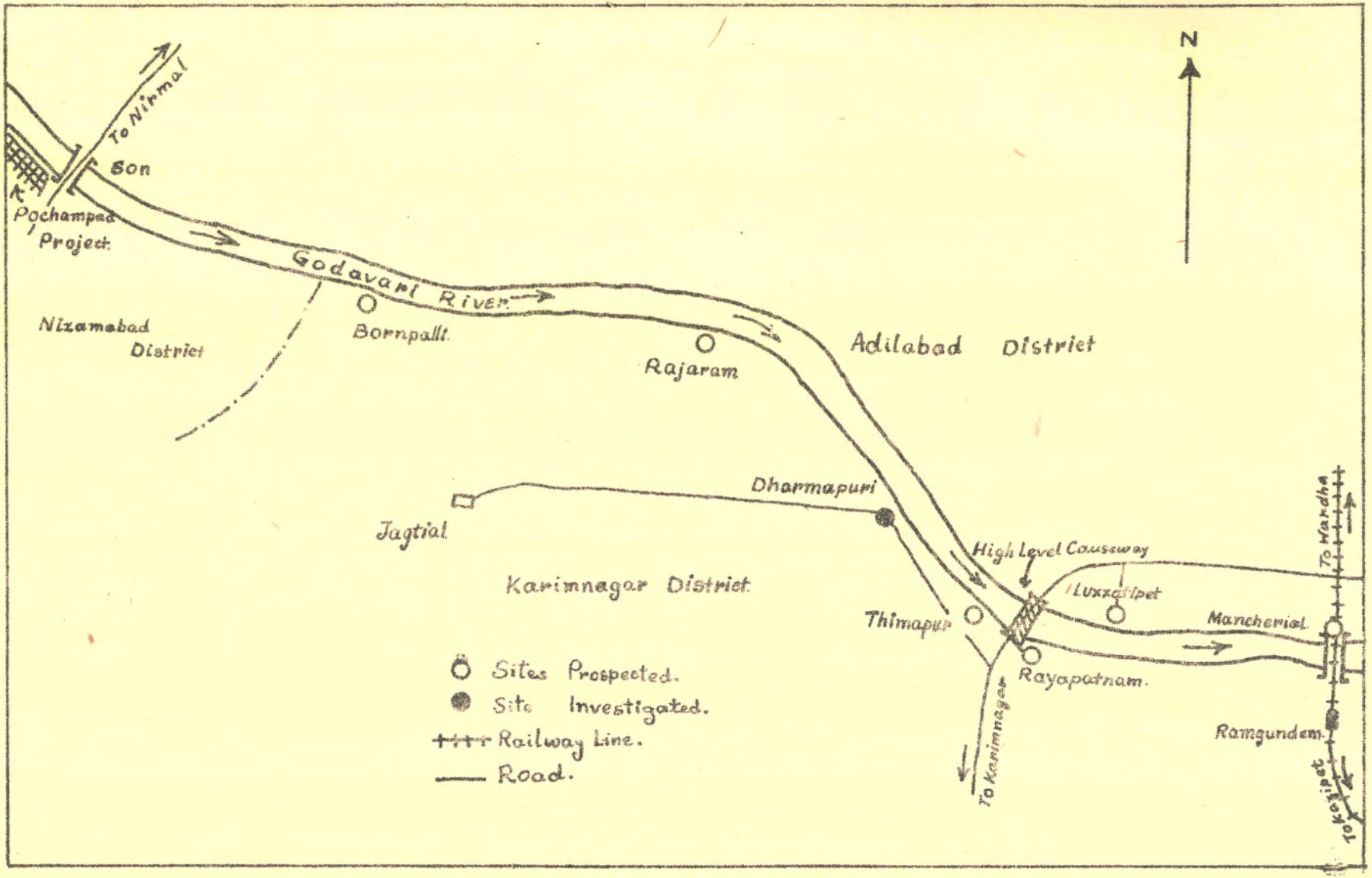

FIG. 10. DHARMAPURI STRETCH OF RIVER GODAVARI, SHOWING SITES PROSPECTED AND CENTRE INVESTIGATED.

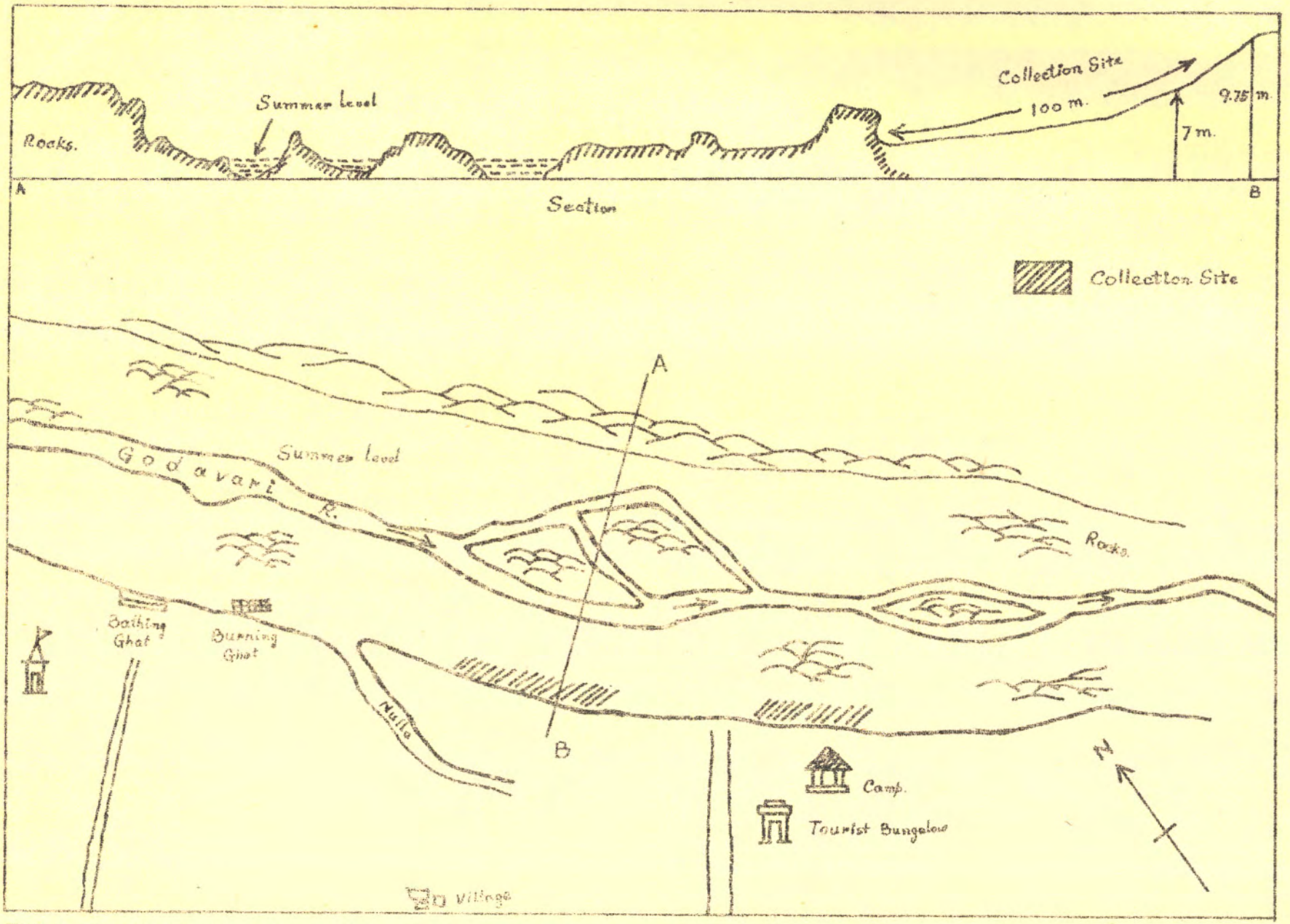

FIG.11. THE COURSE, GENERAL TERRAIN AND TOPOGRAPHY OF RIVER GODAVARI AT DHARAMAPURI.

operation of a few shooting nets are available. Most of these sites were prospected in 1967 and were found suitable for spawn collection. However, their relative merits could not be assessed because of wide-spread failure of spawn during the year. The year 1967 was seen to be associated with non-availability of spawn in any appreciable quantity at all the sites examined under this investigation or operated by the State Fisheries Department in the Nizamabad, Adilabad and Karimnagar districts, which cover the entire upper stretch of the Godavari within Andhra Pradesh.

The extremely low availability over such widespread regions may probably be attributed to one or more of the following factors :

(i) The exceptionally high rate of the second flood, upto 25 cm per hour during the last 20 hours, might have adversely affected the breeding opportunities.

(ii) The vacillation of water level around a very high level of 7 m during the receding phase of flood II for an inordinately long duration of 7 days might have dispersed the available spawn.

(iii) Large scale commercial fishing in deep pools in recent years might have substantially impaired the breeding stock and consequently the recruitment.

Spawn availability in relation to hydrographical and biotic factors

Hardly any correlation could be detected between spawn availability and various hydrodynamical factors, in view of the extremely scanty spawn availability. The only single factor that appeared conspicuous in 1967 was the exceptionally high rate of flooding (upto 27 cm per hour) in the second flood of the season, which in other years was known to yield appreciable quantities of spawn. It is reported that such a high rate was not observed in earlier years. Again, the vacillation of the flood at a high level of about 7 m above the summer level for an inordinately long duration of about 7 days might have adversely affected the flow of spawn in concentrated channels as happens in systematic current patterns of receding phases.

Amongst the associates, which were also very rarely encountered, the more dominating species were Gobius striatus, Cirrhinus reba and Oxygaster bacaila, in that order.

Table 17

Occurrence, duration and magnitude of floods and spawn appearances at Dharmapuri on R. Godavari

Flood No.	Phase	Flood details: Commencement Date	Commencement Hour	Duration	Flood peak Date	Flood peak Hour	Flood peak level in m	Details of spawn appearance*: Commencement Date	Commencement Hour	Duration in hrs.	Desirability (D/UD)+	Catch per net-hour in numbers
I	Rising	22.6.67	22	3 days	25.6.67	14	3.25					
	Receding	25.6.67	14	9 days								
	Rising	4.7.67	18	4 hrs.	4.7.67	22	2.52					
	Receding	4.7.67	22	8 days				5.7.67	6	4	UD	200
II	Rising	12.7.67	18	11 days	25.7.67	14	9.83					
	Receding	25.7.67	14	2 days	Flood level ranged			27.7.67	8	4	D	300
	Vacillation phase	27.7.68	14	7 days	Between 6.25 ml & 8.41 ml							
	Receding phase with minor vacillation	3.8.67	18	24 days				16.8.67	6	6	D	300

* These were not spurts in the strict sense as per definition. The criterion of availability was fulfilled only once on 16.8.67 for two hours from 10.00 a.m., when the catch per net-hour was 1 ml.

\+ D — Desirable
UD — Undesirable

5.1.3 Kulittalai stretch of river Cauvery

Participants

Shri	J.C. Malhotra (Leader)	C.I.F.R.I. Govt. of India
"	N.G.S. Rao	
"	V. Natarajan	Govt. of Madras
"	S. Arockiasamy	

River Cauvery, which is the largest perennial river south of the Krishna in Peninsular India, has been harnessed by the construction of dams or bed regulators at several places, viz. Krishnarajasagar, Mettur, Jedarpalayam, Mayanur, Upper Anicut, Grand Anicut and Lower Anicut (Fig.12). In years of normal rain, the flooding of the Cauvery is mainly controlled by the discharge of water from the Krishnarajasagar and Mettur (Stanely) reservoirs.

The stretch of the Cauvery selected for spawn prospecting during 1967 extended from Erode railway bridge in the north-west to Grand Anicut in the east, a distance of about 145 km by the river route. Detailed round-the-clock observations were recorded at Kulittalai from June 19, 1967 to September 2, 1967. In addition to this, sites at Kangyampalayam, Unjalur, Solasiromani, Ellampally, Velur, Nerur, Ranganathapuram, Krishnarayapuram (Sittalvai), Mahadanapuram, Lalapet, Karuppathur, Thimmachipuram, all upstream of Kulittalai and at Marudur, Pattavaithalai, Sirugamani, Perugamani, Tirupparaithurai, Elamanur, Jeeyapuram, Mekkudi, Kambarasametai, Tiruchchirappalli (3 sites) and Sarakarapalayam, downstream of Kulittalai (Fig.13), were examined both in the pre-flood and during the flood period for their suitability to operate shooting nets. In the pre-flood period, water depth all through the Kulittalai stretch seldom exceeds 60 cm mark, except at the three reservoirs of Jedarpalayam and Mayanur bed regulators and Grand Anicut. These three reservoirs are the only areas which serve as deep pools, wherein broad and other adult fishes take shelter during the pre- and post-release periods. Fluctuations in the water level of this stretch are dependent on the quantum of water released from the Stanley reservoir. At Kulittalai, the effect of water release from the Stanley Reservoir is felt after about 24 hours.

Kulittalai, is situated on the south bank of the Cauvery at about 33 km from Tiruchchirappalli and is easily accessible by both road and rail. The site where round-the-clock observations were recorded is known as 'Thirukadambathurghat', commonly known as 'Kadambarkoilghat'. It is about 0.3 km from the trunk road and 3.5 km from Kulittalai railway station (Fig.14).

Occurrence of spawn spurts

To select the spot of maximum spawn concentration during different spawn spurts at Kulittalai, trial nets were simultaneously operated at different suitable spots (Fig.14) for a period of two hours. The spot where the yield of spawn per net per hour was the maximum was considered as the spot of maximum spawn concentration for the spurt. In all the first three spurts, spots A and B were found to be more or less equally suitable and decidedly better than the other spots. Hence, further trials to determine the spot of maximum concentration were not undertaken during the subsequent spurts.

Only 3 floods were recorded in the Cauvery at Kulittalai during the course of the investigations. The first flood commenced on 4.7.67, and its rising phase was spread over 820 hours, till 7.8.67. The rising phase of the II flood, which commenced on 9.8.67, lasted for only 48 hours. The third flood was still rising at the time of closure of observations.

In all, 6 spawn spurts were recorded during the season, varying in duration from 4 hours to 30 hours, and yielding a total of 1,258 ml of spawn in 1-5 standard nets. A further 107 ml of spawn were also collected by the standard nets outside the spurts, raising the season's total spawn catch by the standard nets to 1,365 ml. In addition to this, 2-3 state nets and 5 research nets collected 662 ml and 1,153 ml of spawn respectively. All the spurts occurred in the rising phases of the floods, the first four during the I flood and the last two during the II flood. The III flood did not yield any spawn, evidently due to the lack of breeders at that time.

Details of occurrence, duration, magnitude and desirability of the various spawn spurts are shown in Table 18. Of the six spurts, spurts 2, 5 and 6 yielded only desirable spawn, while spurt 3 yielded only undesirable spawn. Percentages of desirable spawn in spurts 1 and 4 were 30 and 68.8 respectively. Spawn occurrence at

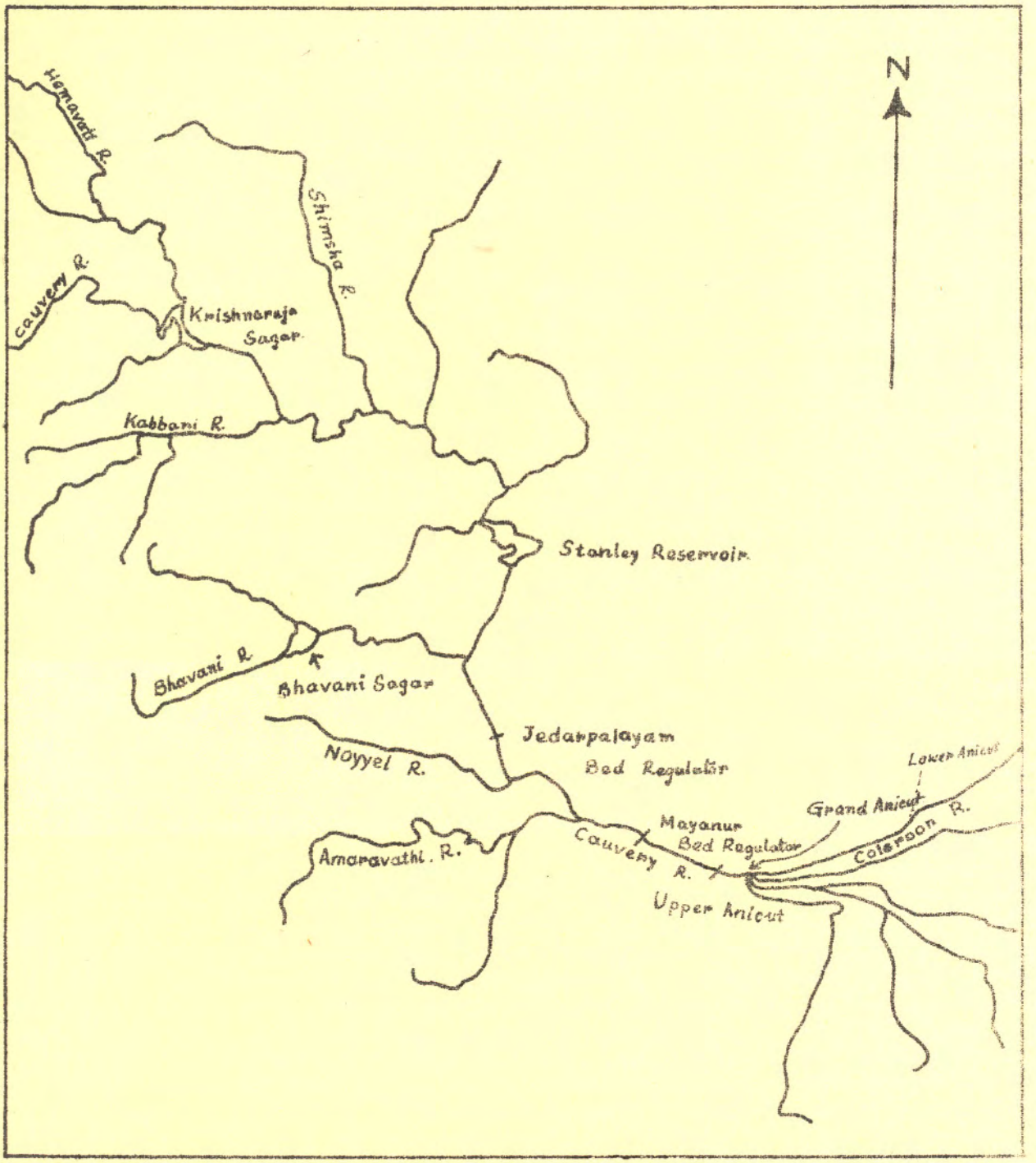

FIG. 12. CAUVERY RIVER SYSTEM, SHOWING LOCATION OF MULTI-PURPOSE RIVER-VALLEY PROJECTS.

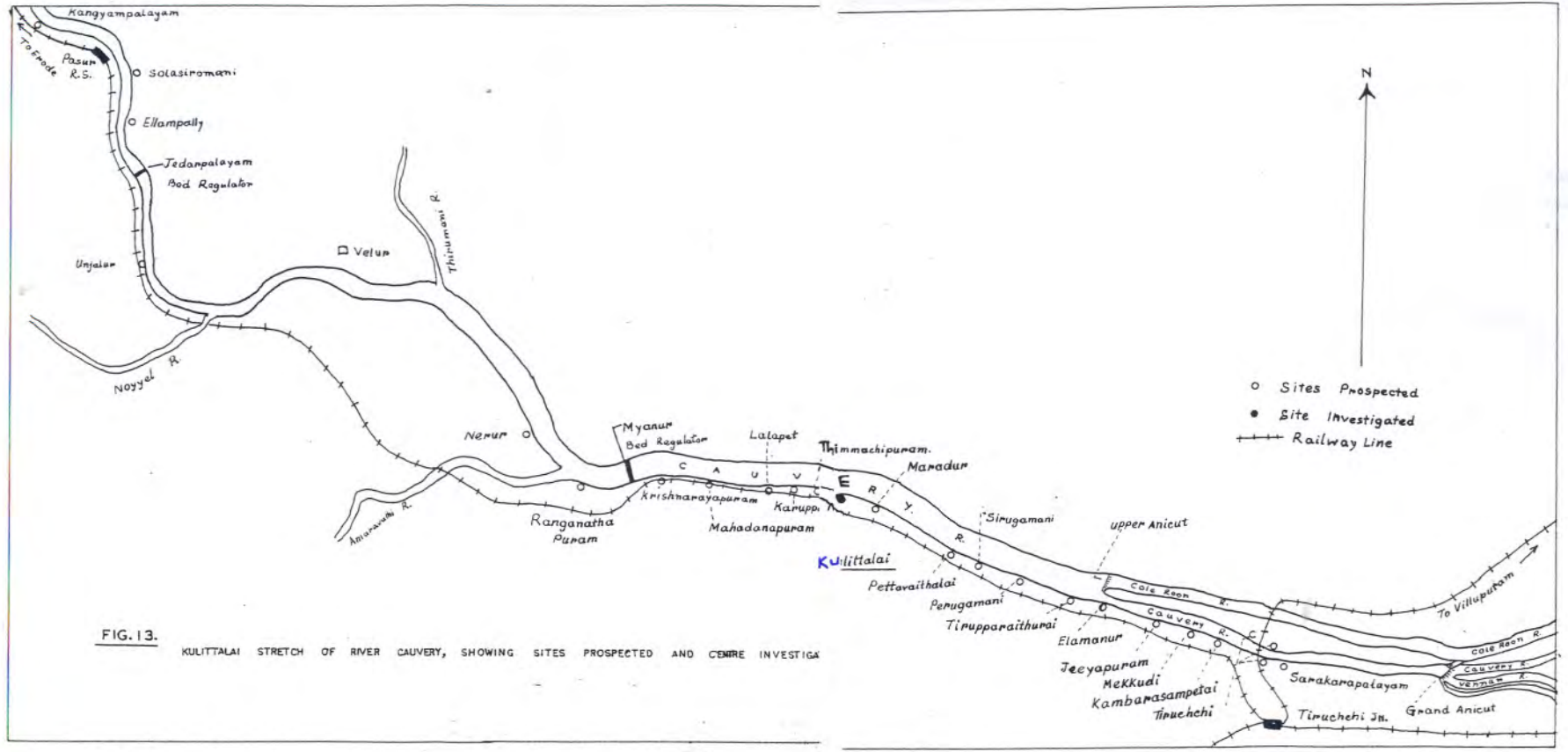

FIG. 13.

KULITTALAI STRETCH OF RIVER CAUVERY, SHOWING SITES PROSPECTED AND CENTRE INVESTIGA

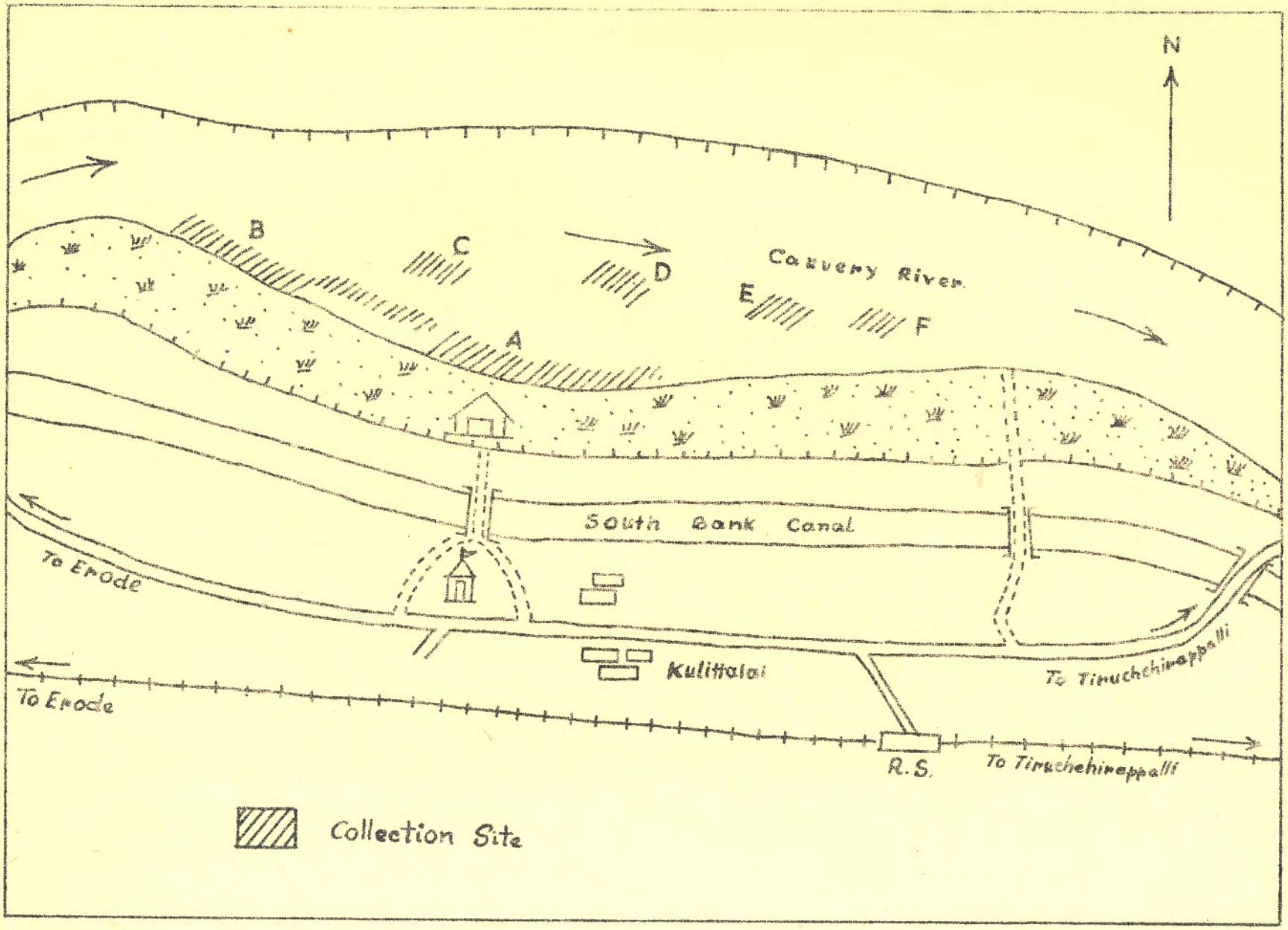

FIG.14. THE COURSE, GENERAL TERRAIN AND TOPOGRAPHY OF RIVER CAUVERY AT KULITTALAI

Kulittalai commenced after about 14 hours of the waters, released from the Stanley reservoir, reaching the Kulittalai area. The first spurt commenced at 8 hours on 5th July and lasted for 30 hours, yielding in all 864 ml of spawn, accounting for 63.3% of the season's total catch by the standard nets. In regard to quantity, this was by far the most important spurt, which yielded as much as 260 ml of desirable spawn. However, from the point of view of quality this was poorer than the desirable spurts 2 and 6. The 2nd spurt, which commenced at 18 hours on 29th July, lasted for only 10 hours, but yielded 126 ml of high quality desirable spawn. The 3rd and 4th spurts, both of which occurred in the first week of August, yielded a total of only 179 ml of spawn, out of which only 22 ml collected in the 4th spurt were desirable. The 5th and 6th spurts, both of which commenced on 10th August, yielded 23 ml and 66 ml respectively of desirable spawn. It is noteworthy that most of the spawn collected at this centre occurred mainly between dusk and dawn, except for spurt 1.

Quality of spawn collected

Quality of spawn collected in the various spurts, in regard to group and/or species composition, was determined both by microscopical analysis of two-hourly spawn samples, as well as by nursery rearing. The results obtained are given in Table 19. The overall major carp content of the desirable segment of spurt 1 was found to be 13.8% by spawn analysis. When a sample of the overall catch of the same spurt, including the undesirable segment, was raised in a nursery, the major carp content was found to be 13.6%, as against 6.8% when spawn analyses results are taken into consideration. This difference must evidently be due to differential mortality in the nurseries. Major carps constituted as much as 75% of the spawn of spurt 2, as determined by spawn analyses, while the same for spurt 3, the desirable segment of spurt 4 and spurts 5 and 6 were found to be 4.3%, 27%, 51.2% and 69.9% respectively. Compsoite samples of spurts 3 and 4 when reared in a nursery yielded a major carp content of 51.9%, while the same in the reared composite samples of spurt 5 and 6 was found to be 26.2%. The seasonal indices of spawn quantity and quality are found to be 125 ml and 50.0% respectively. The percentages of minor carps and 'others' in the season's catch were 28.3 and 21.1 respectively.

Table 18

Flood-phase-wise occurrence, duration, desirability and magnitude of spawn spurts at Kulittalai on the R. Cauvery in 1967

Flood details						Spawn spurt details				
Flood No.	Phase	Commencement Date / Hours	Duration in hrs.	Peak Date / Hour	Peak Level in m	Spurt No.	Commencement Date / Hour	Duration in hrs.	Desirability (D/UD)*	Catch in ml
1	2	3	4	5	6	7	8	9	10	11
I	Rising	4.7.67 / 18	820	7.8.67 / 22	1.30	1	5.7.67 / 08	30	D	87
									UD	264
									D	173
									UD	340
						2	29.7.67 / 18	10	D	126
						3	4.8.67 / 20	10	UD	147
						4	5.8.67 / 18	4	UD	10
									D	22
	Receding	7.8.67 / 22	28			-	-	-	-	-
II	Rising	9.8.67 / 02	48	11.8.67 / 02	1.09	5	10.8.67 / 02	4	D	23
						6	10.8.67 / 22	6	D	66
	Receding	11.8.67 / 02	144	-	-	-	-	-	-	-
Vacillation phase		17.8.67 / 02	384	-	-	-	-	-	-	-
III	Rising	1.9.67 / 22	26	Was still rising at close of observations	-	-	-	-	-	-

* D -- Desirable UD -- Undesirable

TOTAL : 1,258

Table 19

Spurt-wise quality of spawn collected at Kulittalai on R. Cauvery in 1967

Spurt No.	Desirability (D/UD)*	Spawn quality in percentage									
		By spawn analysis			By rearing						
		Major carps	Minor carps	Others	Major carps				Minor carps	Others
					Catla catla	Cirrhinus cirrhosa	Labeo kontius	TOTAL		
1	D	14.0	86.0	0.0	13.6	2.0	4.2	19.8	42.0	38.2
	UD	1.7	98.3	0.0						
	D	13.7	86.0	0.3						
	UD	5.5	94.0	0.5						
2	D	75.0	19.4	5.6	No results obtained, due to mass mortality in nursery					
3	UD	4.3	95.1	0.1						
4	UD	8.0	91.0	1.0	51.9	0.0	1.3	53.2	22.2	24.6
	D	27.0	72.0	1.0						
5	D	51.2	48.8	0.0	26.2	0.0	35.7	61.9	13.5	24.6
6	D	69.9	28.3	1.8						

* D — Desirable
UD — Undesirable

Suitability of prospected sites for spawn collection

Of the various sites surveyed in the selected stretch, only at Thimmachipuram grounds suitable for the operation of shooting nets were available. This site has also good accessibility. Limited areas for the operation of shooting nets are also available at Pettavaithalai and Tirupparaithurai, but accessibility to both these sites is poor. Moreover, at both the sites, operation of shooting net is possible only upto a certain water level, and with any further increase in the level of the river, the sites become unsuitable for net operation, because of increased water depth and changed current pattern. All the other sites were found unsuitable for the operation of shooting nets, either because of steep banks, or for want of proper accessibility, or both. At most of these unsuitable sites, the speed of the current, because of comparatively steep upstream to downstream gradient of the river bed, was too fast to facilitate the operation of shooting nets. Further, at most of these sites, protective boulder dams, constructed for the protection of the embankment, project into the river, thereby disturbing the normal current pattern of the river and making the area unsuitable for shooting net operations.

Spawn availability in relation to hydrographical and biotic factors

Flood level

The fluctuations in water level in the Kulittalai stretch of the Cauvery are directly related to the fluctiations in the release of water from the Stanley reservoir. It may be mentioned here that the various river valley projects on this river not only prevent the formation of deep pools in the river bed, but have most probably eliminated the ones that were there before the construction of these projects. As such, the reservoirs of the Jedarpalayam and Mayanur bed regulators and that of Grand Anicut are the only places where adult carps take shelter during the period when the discharge from the Stanley reservoir is at its lowest ebb.

As pointed out earlier, all the six spurts occurred during the rising phase of the floods. Spawn spurt 1, the major spurt of the season, commenced 14 hours after the water released from the Stanley reservoir reached Kulittalai. Periods of varying duration were interposed between the various spurts, as can be made out from Table 18. From this, it could be surmised that the very first discharge from the reservoir probably provided the necessary stimulation to the early breeders to attain maturity and increased the water level of the river to a height that flooded most of the breeding grounds of these fishes. The low percentage of cultivable carps in spurt 1, as revealed by spawn analysis as well as by rearing, indicates a low percentage of these species amongst the early breeders. The non-availability of spawn for varying periods in-between the spurts may be either because the quantum of freshets was not sufficient enough to impart the required stimulation to the maturing late breeders to attain maturity, or the water level could not reach such heights as to flood their breeding grounds, or because of both. Once the rate of discharge and the water level reached the optimum, spawn became available.

Current velocity

Current velocities encountered during the periods of spawn availability at the investigation site varied from 1.1-2.6 km per hour, and it was observed that velocities ranging from 1.0-2.0 km/hr were more conducive to the collection of spawn. Observations on current velocity at net mouths, commissioned in parallel-cum-series pattern, mad with a flow-meter, indicated that the lowest limit of current velocity conducive to the collection of spawn in the nets was 0.9 km per hour, and any decrease below this limit adversely affected the collection.

Turbidity

Turbidity did not appear to noticeably affect the availability of desirable spawn at Kulittalai. Any apparent correlation of turbidity with the spawn catch is due to the fact that flood and current pattern play a vital role in spawn concentration and turbidity is highly correlated with floods and even current. High turbidity can affect the catching efficiency of shooting nets, by clogging the meshes. However, at Kulittalai, the catching efficiency of the nets did not appear to have been affected even by the observed higher range of turbidity.

Temperature

There appeared to be no definite correlation between the concentration of desirable spawn at the site and air and water temperatures. But spawn availability is indirectly related to temperature, in that the temperature, coupled with the inflow of freshets, probably stimulates gonadial maturation and provides the necessary breeding stimulus. Secondly it is also well known that higher temperatures enhance the development of the embryo and reduces the time taken for hatching. During the present investigations, at the time of spawn availability the water temperature from dawn to dusk ranged between 27.0°C and 31.0°C and from dusk to dawn between 24.0°C and 26.0°C. From the size and stage of development of the hatchlings, it could be made out that breeding probably took place about 25-30 hours earlier. This indicates that breeding must have taken place sometime between dusk and dawn, since the spawn were available at the collection site mostly during night hours. As such, it would appear that major carps in this region prefer the lower temperature range of 24.0°C-26.0°C for their breeding.

Associates

No indicator species could be made out among the associates. The bigger associates, like fishes and insects, often constituted highly undesirable elements, in that they were injuring or feeding upon the hatchlings in the gamcha. It is, therefore, highly imperative to segregate the hatchlings from the associates immediately after scooping from the gamcha, and prior to their temporary storage. For this it would be necessary to repeat the sieving process, which, however, tends to cause injury to the spawn. Therefore, high associate content in spawn catches will lead to greater mortality of spawn during segregation. During the present investigations, appreciable quantities of filamentous algae occurred in spurt 1 as associate contaminanes, which greatly hampered the segregation process. The usual double-walled sieve of round-meshed netting cloth and muslin proved of little use. Hence, atri-walled sieve, made by keeping 1/8" meshed Midnapore-type netting over the double-walled sieve, was used. This helped in the complete removal of the algae and resulted in least injury to the spawn.

5.2 Catching efficiency of nets in relation to type, size and mesh size

5.2.1 Relative efficiency of State nets

The State Governments of Uttar Pradesh, Madras (now Tamil Nadu) and Andhra Pradesh provided their spawn collection nets for testing their relative efficiency vis-a-vis the standard net.

All the four types of U.P State nets, which had similar mesh size and tail piece as those of the standard net, were found to be relatively less efficient than the standard net, their respective average efficiencies being 41.8%, 74.2%, 54.2% and 69.5%. Inferior quality of the netting and lack of suitable streamlined shape were the main defects of these State nets.

The Madras State nets showed an efficiency of only 71% during the first spawn spurt. It was then noticed that its main defect lay with its markin cloth tail piece. In subsequent spurts, this tail piece was replaced by the one used for the standard net. This substantially improved the efficiency of the State net, making it apparently more efficient than the standard net, with its relative efficiency ranging from 114-253%. The season's pooled efficiency worked out to 107%. However, the catches made during these experiments were too poor to give conclusive indication of the State net's efficiency. The State net had another serious defect in its cane ring, which tended to lose its shape while in operation. It would be advantageous to replace it by split bamboo ring.

The Andhra Pradesh State nets could not be tested due to non-availability of spawn.

5.2.2 Effect of net size on its catching efficiency

This aspect was tested at Salempur on the Gomti, Sopari on the Banas and Kulittalai on the Cauvery. The results obtained were not consistent, possibly due to the limited period of experimentation and poor catches. The nets operated at Sopari and Kulittalai were of sizes, viz. 5 yds, 7 yds, 9 yds and 11 yds nets. The last net was operated only at Kulittalai. At Sopari, where this testing was done over 12 hours, it was found that all these experimental nets generally recorded lesser efficiency than the

standard net, while the 7 yds and 9 yds nets mostly yielded better catches than the smaller 5 yds net. However, no regular pattern of relative efficiency could be made out, possibly due to the different positional identity and operational depths of the various nets, since they could not be suitably staggered during the short span of only 14 hours of spawn availability. On the other hand, the results obtained at Kulittalai indicated that all the experimental nets, except possibly the 7 yds net, were more efficient than the standard net. However, the actual catches were far too meagre to afford definite indications of relative efficiencies. Further experimentation over prolonged duration is called for to decide whether smaller nets can be adopted.

The nets employed at Salempur were of different sizes, viz. 6 m, 8 m, 10 m, 12 m, 14 m, 16 m and 18 m nets. The limited observations at this centre indicated the 10 m, 14 m, 16 m and 18 m nets as superior to the standard net, with the 16 m net yielding the best results, while the 8 m and 12 m nets were nearly as efficient as the standard net. Only the smallest 6 m net proved distinctly inferior.

The above inconsistent results indicate the necessity for further experimentation over prolonged periods of spawn availability, with proper staggering of nets as per a suitable design experiments, to decide the effect of net size on its efficiency.

5.2.3 Relative efficiency of 1/8" and 1/16" meshed standard-type nets

A 1/16" meshed net, similar in all other respects to the standard net, was operated alongside the standard net at Kulittalai, in order to test their relative efficiencies in the prevailing conditions of turbidity and current velocity. It was observed that the average catch of the 1/8" meshed net was always higher than that of the 1/16" meshed net, evidently due to the prevailing moderate current at Kulittalai not bringable to wash away the silt depositing on the close meshes of the 1/16" meshed net, thereby reducing its effective mesh size and consequently the filtration rate. This was tested further by operating a trouser-type net (vide supra), where also the 1/8" meshed lag yielded higher catches than the 1/16" meshed lag. These results indicate that 1/8" mesh is more suitable for the Kulittalai region.

A trouser-type net was also operated at Sopari on the Banas, where the 1/16" meshed lag yielded better catches. Even though definite conclusions cannot be drawn as to the better suitability of

the 1/16" meshed net for this area, because of the brief duration of the experiment, its better performance could be partly explained as due to the higher current velocity prevailing in the area than at Kulittalai. During periods of peak spawn availability, the respective ranges of current velocity at Kulittalai and Sopari were 1.0-2.0 km/hr and 1.3-3.7 km/hr.

5.2.4 Spawn escapement from 1/8" meshed Midnapore-type netting

With a view to finding out the extent of spawn escapement, if any, from 1/8" meshed Midnapore-type netting that is used in the fabrication of standard nets, a specially designed double-walled net fabricated in 1966 (Shetty, 1967) was operated over two days at Sopari on the Banas. This net had an inner wall of 1/8" meshed netting and an outer wall of 1/16" meshed netting. The escapement of spawn ranged on an average between 28% and 37.5%. While the average current velocity was 1.5 km/hr on both the days, the average turbidity value was 700 ppm on the first day (7.8.67) and 375 ppm on the other day (17.8.67). It was observed that the rate of escapement was higher on the latter day at lower turbidity values.

6 DISCUSSION

Details of spawn spurts, encountered at the various centres, in regard to their quantity and quality and inter-relations between spawn availability and hydrographical, meteorological and biotic factors have been elucidated in the foregoing pages under Section 5. Of the various centres investigated, only Sopari on R. Banas yielded very high quality (81.5% major carps) spawn in sizable quantities, while Salempur on the Gomti also yielded appreciable quantities of desirable spawn with a moderately good percentage (26.4%) of major carps. Both these centres can be commercially exploited to good advantage. The findings in regard to the Sopari centre are highly significant in that spawn collection was till then unknown in Rajasthan, where there is an acute shortage of fish seed and a large extent of water areas is lying unutilized for fish culture.

Even though in terms of quantity the spawn yield at Dingrahaghat on the Mahananda was not very significant, it is noteworthy that the major carp content in the catches was as high as 94% and consisisted wholly of rohu. Further, as pointed out earlier, Purnea district

forms one of the deficit areas in North Bihar, and the present finding should go a long way towards achieving regional self-sufficiency. The spawn production in the area could be enhanced by prohibiting the fishing of adult fishes in the stretch of the river between Mouzabarighat and Labha. At present only rohu seems to breed in the stretch between Dingrahaghat and Mouzabarighat. It is suggested that this could be enriched by the stocking of fingerlings of other major carps in this region.

In terms of quantity alone, Nethla on the Yamuna yielded an appreciably greater quantity of spawn than all the other centres, but the seasonal index of quality, as revealed by rearing experiments, was only 7.0%. However, spawn analyses had revealed a higher percentage of major carps (10.0-36.8%) in the various spurts, with an overall average of 21.8%. The lower percentage obtained in rearing experiments could be partly due to the fact that samples from all the spurts were reared together in the same nursery, and partly due to the possibility of having classified the spawn of some of the little known minor carps as that of major carps in spawn analyses. In the season's overall catch, the minor carps constituted as much as 86.4% and since some of these species, such as L. bata and C. reba, are cultured in Uttar Pradesh, this centre appears to be worth exploiting. Apart from this, the quantity of major carps obtainable at this centre is also not insignificant, in view of the very heavy spawn catches at the centre.

Spawn collection at Dharmapuri on the Godavari was a total failure during the year. This could be attributed to : (i) the exceptionally high rate of rise in the second flood (27 cm per hour for the last 24 hours), which must have adversely affected the breeding opportunities, (ii) the vacillation of the water level around a very high level of 7 m during the receding phase of flood II for an inordinately long period, which might have served to disturb and disperse the spawn flow, and (iii) the large scale commercial fishing in recent years, which might have considerably reduced the breeder stock and impaired recruitment.

While the quantity of spawn collected at Kulittalai on the Cauvery was not very appreciable, its quality was fairly high in having an overall major carp content of 50.6%, as revealed by rearing. The comparatively low magnitude of the catch may be attributed to the low density breeder population. In the entire prospected stretch, deep pools exist only in the reservoirs adjoining the Jedarpalayam and Mayanur bed regulators and the Grand Anicut. In order to ensure better spawn yield, it is highly imperative to enforce necessary restrictions on fishing in these reservoirs and to stock them heavily for a few years with yearlings of major carps. The increasing population of tilapia in the river may also be having an adverse effect on the major carp populations.

The seasonal indices of desirable spawn quantity and quality for the various investigated centres are given in Table 20.

Table 20

Seasonal indices of spawn quantity and quality at various sites investigated in 1967

Name of river	Name of centre	Index of spawn quantity (in ml)	Index of spawn quality, based on nursery rearing. (% of major carps)
Yamuna	Nethla	6,006.1	7.0
Gomti	Salempur	1,373.6	26.4
Banas	Sopari	1,801.0	81.5
Mahananda	Dingrahaghat	251.0	94.0
Godavari	Dharmapur	Nil	Nil
Cauvery	Kulittalai	125	50.6

7 TRAINING OF STATE GOVERNMENT PERSONNEL AND LOCAL FISHERMEN

Details of various categories of personnel, other than the State participants, who underwent training in the techniques of spawn prospecting investigations in the various States are given below in Table 21.

Table 21

State-wise details of personnel trained in spawn collection techniques

State	State Government personnel		Private personnel
	Technical personnel	Fishermen and other fidld staff	
Uttar Pradesh	1	5	6
Rajasthan	2	12	2
Andhra Pradesh	4	4	-
Madras	10	4	3

8 SUMMARY

i) During 1967, spawn prospecting investigations were carried out along six riverine stretches in the country, one each of the Yamuna (U.P.), Gomti (U.P.), Banas (Rajasthan), Mahananda (Bihar), Godavari (Andhra Pradesh) and Cauvery (Madras).

ii) Based on an extensive pre-monsoon survey of the above stretches, six sites were selected for detailed investigations, viz. Nethla on R. Yamuna, Salempur on R. Gomti, Sopari (Tonk) on R. Banas, Dingrahaghat on R. Mahananda, Dharmapuri on R. Godavari and Kulittalai on R. Cauvery. At all the sites, round-the-clock observations were made every two hours or four hours, depending on the magnitude of spawn occurrence, on the quantity and quality of spawn and spawn associates collected in each net, the positional identity of each net, flood level, air and water temperatures and weather conditions. Current velocity and turbidity were also similarly recorded, but only between 6 and 18 hours.

iii) At the beginning of each spawn spurt, the spot of maximum spawn concentration was determined through trial netting at all suitable spots, and the full battery of nets operated at the selected spot.

iv) At Nethla on the Yamuna, 9 spawn spurts were recorded, yielding in all 23,591 ml and 8,742 ml of desirable and undesirable spawn respectively. Flood I yielded 80.4% of the season's total spawn catch and accounted for 93.2% of the season's desirable spawn catch. Spurt 1, which was the most productive, contributed to 62.6% of the total spawn catch. The seasonal indices of spawn quantity and quality for the site were estimated to be 6,006.1 ml and 7.0% respectively.

v) A total of 7,083 ml of spawn, 6,848 ml of which were desirable, was collected at Salempur on the Gomti in two spurts during the II and III flood respectively. The two spurts contributed more or less equally to the desirable spawn catch at the centre. The seasonal indices of spawn quantity and quality were found to be 1,373.6 ml and 26.4% respectively. State nets of 4 sizes operated at this centre were found to be inferior to the standard net, while some of large-sized research nets were found to be more efficient than the standard net.

vi) 8,765 ml of spawn, all desirable, were collected in four spurts at Sopari on R. Banas. Further, 980 ml of desirable eggs were also collected. The third spurt yielded 7,878 ml of spawn, forming 90.1% of the season's total catch at the site. The indices of spawn quantity and quality were estimated to be 1,801.0 ml and 81.5% respectively. Research nets made from 5 yds, 7 yds and 9 yds of 1/8" meshed netting were found to be less efficient than the standard net, while the rate of escapement from 1/8" meshed netting was found to range from 28-37.5% over a turbidity range of 375-700 ppm and current velocities around 1.5 km/hr.

vii) 502 ml of desirable spawn in one spurt, 2,010 ml of desirable eggs in the one spurt and 605 ml of desirable fry in 2 spurts, were collected at Dingrahaghat on the Mahananda. The undesirable seed collected amounted to only 4 ml of spawn and 2,205 ml of fry. All the desirable seed catches had very high major carp content. The seasonal indices of spawn quantity and quality for the centre were estimated to be 251.0 ml and 94.0% respectively. The major carp contents in the egg and fry spurts, as revealed by rearing, were 85.8% and 69% respectively. Rohu was the only major carp in all the catches.

viii) Practically no spawn was available at Dharmapuri on R. Godavari, due probably to the abnormal flood conditions and large scale commercial fishing.

ix) A total of 1,258 ml of spawn was collected at Kulittalai on the Cauvery in 6 spurts and another 107 ml outside the spurts in 1-5 standard nets. Moreover, 2-3 State nets and 5 research nets collected 662 ml and 1,153 ml of spawn respectively. All the spurts occurred in the rising phases of the I and II floods, with the I flood yielding the first 4 spurts. Spurt 1 yielded 63.3% of the season's total catch by the standard nets. The total catch of desirable spawn by the standard nets amounted to 497 ml. The seasonal indices of spawn quantity and quality were estimated to be 125 ml and 50.6% respectively. Most of the spawn occurred mainly between dusk and dawn. Breeding of major carps in the area appears to be taking place at night, when temperature is comparatively low. After replacing their tail piece with that of the standard net, the Madras State nets proved at least as efficient as the standard net. 1/8" meshed net was found to be more efficient than the 1/16" meshed net at this centre.

x) Of the various sites investigated, Sopari on R. Banas was found to be most productive, followed by Salempur on the Gomti, while the spawn, eggs and fry obtained at Dingrahaghat on R. Mahananda, though in limited quantities, showed a very high percentage of major carps. The spawn production in R. Mahananda and in the Kulittalai stretch of R. Cauvery can be enhanced by enforcing suitable conservation measures and stocking of yearlings of major carps. The Nethla stretch of R. Yamuna may also be exploited to advantage, in view of the very heavy spawn catches obtaining there, containing a large proportion of cultivable minor carps and not too insignificant quantity of major carps as well.

xi) 17 technical personnel and 25 field staff of the concerned State Governments and 11 private personnel were trained in the techniques of spawn collection and transport.

9 REFERENCES

1	Anon	1965	Report on fish spawn prospecting investigations, 1964.1, Uttar Pradesh and Gujarat. Bull. cent. Inl. Fish. Res. Inst., Barrackpore, 4 : 211+xiii pp.
2	Malhotra, J.C., K.K. Ghosh and Others	1966	Report on fish spawn prospecting investigations, 1965. 2. Uttar Pradesh, Bihar and Maharashtra. Bull. cent. Fish. Res. Inst., Barrackpore, 7 : 69 pp.
3	Shetty, H.P.C.	1967	Report on fish spawn prospecting investigations, 1966. 3. Bihar, Uttar Pradesh and Punjab. Bull. cent. Inl. Fish. Res. Inst., Barrackpore, 11 : 80 pp.

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