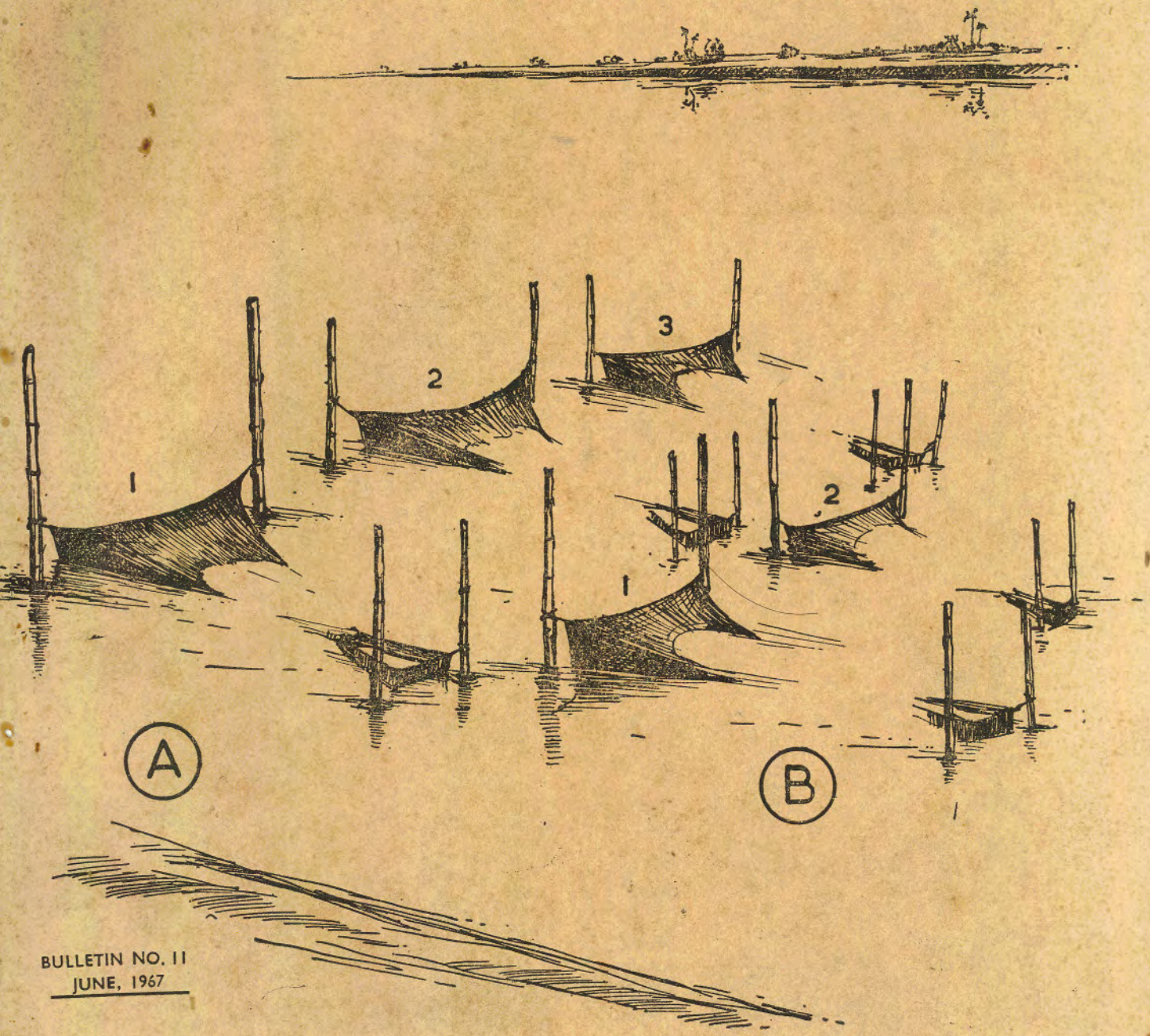
REPORT ON FISH SPAWN PROSPECTING INVESTIGATIONS, 1966

3, BIHAR, UTTAR PRADESH & PUNJAB



BULLETIN NO. 11
JUNE, 1967

GOVERNMENT OF INDIA
CENTRAL INLAND FISHERIES RESEARCH INSTITUTE
BARRACKPORE, WEST BENGAL,
INDIA

REPORT ON FISH SPAWN PROSPECTING INVESTIGATIONS, 1966

Compiled by
H. P. C. SHETTY

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C O N T E N T S

FOREWORD

Spawn prospecting investigations, initiated in the year 1964 by the Central Inland Fisheries Research Institute with a view to locating new centres of availability of quality spawn, were continued during the south-west monsoon months of 1966 by the Institute's Allahabad Sub-station and its attached Units at Hoshangabad and Bhagalpur, in collaboration with the States of Bihar, Uttar Pradesh and the erstwhile Punjab. This report embodies the results obtained therefrom.

The year's investigations were initially planned by Dr. V.G. Jhingran, the then Officer-in-Charge of Allahabad Sub-station, but due to his transfer from Allahabad early in June, 1966, and subsequent appointment as Director, Central Inland Fisheries Research Institute, Barrackpore, the execution and supervision of the programme were carried out by Shri H.P.C. Shetty, the new Officer-in-Charge of Allahabad Sub-Station. Sarvashri J.C. Malhotra and K.K. Ghosh assisted the Officer-in-Charge in the planning of the investigations. The report in its present consolidated final form has been prepared by Shri H.P.C. Shetty, who was in overall charge of the investigations.

The lists of technical personnel, both State and Central, who participated in the investigations at various centres are given in the beginning of the sections dealing with the respective centres. While the State Government personnel participated only in field work, the Central Government personnel, in addition to participating in field work, also analysed the data collected and prepared initial reports thereon, which formed the basis for the final report.

In addition to the above, thirteen members of the subordinate service of the Allahabad Sub-station including three fishermen, and 1, 3 and 37 members respectively of the subordinate services of the Governments of Uttar Pradesh, Bihar and Punjab assisted in these investigations.

As in the previous years, eight spawn collectors from Midnapore District of West Bengal were specially recruited for

the season to assist in these investigations. Their names and addresses are given below :

1	Shri Sudhangshu Burman	:	Vill. Rajnagar, P.O. Putputia, Dt. Midnapore (West Bengal)
2	Shri Himansu Burman	:	-do-
3	Shri Balaram Burman	:	-do-
4	Shri Jagannath Burman	:	-do-
5	Shri Sudhangshu Shekhar Burman	:	-do-
6	Shri Ardhendu Kumar Burman	:	-do-
7	Shri Gokul Mandal	:	Vill.& P.O.Bargada Godar, Dt. Midnapore (West Bengal).
8	Shri Santosh Kumar Mal	:	Vill.Nilkhunta, P.O. Hara Shanker, Dt.Midnapore (West Bengal).

Shri R.K. Saxena, Survey Assistant, was responsible for the final preparation of all the drawings included in this report. He also took a series of photographs in the field, covering all aspects of spawn collection work.

Shri J.K. Verma, Research Assistant, assisted the Officer-in-Charge in the preparation of Weekly Progress Reports during the course of the investigations.

The whole-hearted co-operation received in full measure from the Directors of Fisheries of Uttar Pradesh, Bihar and Punjab deserves a special mention here and is gratefully acknowledged. In addition to readily placing their staff and field equipment at the disposal of the Camps-in-Charge, they also bore the contingent expenditures of the camps.

It is a privilege to place on record the inspiring lead given to this line of work by Shri G.N. Mitra, Joint Commissioner (Fisheries Development), Government of India, who was largely responsible for initiation of these investigations in 1964. He continued to evince very keen interest in the conduct and progress of these investigations in 1966 as well.

V.G. Jhingran

(V.G.JHINGRAN)
DIRECTOR

June 25, 1967.
Central Inland Fisheries
Research Institute,
Barrackpore.

I. INTRODUCTION

The acute shortage of food has made it imperative to give urgent attention to the increasing of fish production in the country to the maximum extent possible. It is a sad tale that as much as 9.59 lakh acres of readily cultivable waters in the country are left unutilised, while those which are presently utilised for fish culture, amounting to about 15.20 lakh acres, are largely understocked. In addition to the above, there are about 15.75 lakh acres of water area that can be reclaimed for fish culture (Report of the Fish Seed Committee, 1966). The present level of fish seed production in the country falls far short of the optimum requirements of even the readily cultivable waters to the extent of as much as 580 crores in terms of spawn (Fish Seed Committee, 1966). In addition to the goal of achieving self-sufficiency in seed requirement in the country as a whole, it is also necessary to plan for the achievement of regional self-sufficiency to the extent possible. This calls for the location of additional high yielding quality seed collection centres. This, combined with the fact that there were hardly any scientific data on record regarding the qualitative and quantitative potentiality of various spawn-yielding river stretches, the lack of standardised methods of collection and measurement of spawn and the lack of knowledge of spawn behaviour in relation to various hydrodynamical factors, prompted the Central Inland Fisheries Research Institute to initiate spawn prospecting investigations in different parts of the country in 1964. The findings of the work carried out in the years 1964 and 1965 have already been published in the Institute's Bulletins No.4 (1965)[1] and No.7 (1966)[2].

Similar work was carried out during 1966 in the States of Bihar, Uttar Pradesh and the erstwhile Punjab, and the results obtained therefrom are detailed in this report. The investigations were undertaken at three centres in Bihar, two centres in Uttar Pradesh and three centres in the erstwhile Punjab (i.e. two centres in the present Punjab and one centre in Haryana). While both the centres in Bihar and the present Punjab and one centre in Uttar Pradesh were sponsored by the respective State Governments, one centre in Uttar Pradesh and the only centre in Haryana were sponsored by the Central Inland Fisheries Research Institute, in continuation of the systematic spawn survey of the

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1. Hence referred to as "CIFRI, 1965".
2. Hence referred to as "CIFRI, 1966".

Yamuna initiated in 1964. As in the previous years, the technical know-how at all the centres was furnished by the Central Government, while the entire contingent expenditure at the State-sponsored centres and a major share of the same at the centrally-sponsored centres were borne by the concerned State Governments. The investigations were also made use of for training local fishermen and State Government personnel in riverine spawn collection techniques.

II. PRE-MONSOON SURVEY AND SELECTION OF SITES

The concerned State Governments were asked well in advance to indicate the rivers and particular regions, where they wished spawn prospecting investigations to be undertaken, taking into consideration the developmental needs of the region. The erstwhile Punjab Government suggested the rivers Beas and Sutlej, while the Bihar Government suggested the rivers Burhi Gandak, Kosi Khanua Dhar and Badua. The Uttar Pradesh Government desired that investigations be taken up on the stretch of river Ghagra within Bahraich district. In addition to taking up all the above proposed rivers, two stretches of river Yamuna, one each in Uttar Pradesh and the erstwhile Punjab, were also included in the prospecting programme, with a view to continue the systematic spawn survey of the Yamuna initiated in 1964.

A pre-monsoon survey of all the above rivers was carried out during May, 1966 for selecting suitable stretches for prospecting and sites for detailed round the clock investigations. The criteria adopted in the selection of stretches and centres have already been described in CIFRI, 1965 and CIFRI, 1966. The main considerations, however, were the extent of operational area that might be available during different floods, accessibility of the sites during monsoon distribution and composition of resident and immigrant fish fauna and the location of tributaries and nullahs flowing into the selected river stretch.

Details of stretches surveyed and the probable sites examined are shown in Table 1. Table 2 depicts the identity and approach details of all the sites selected for detailed investigations. The geographical location of the selected river stretches and sites is shown in Fig. 1.

Table 1.

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

	SURVEY Stretch			SURVEY Site				Stretch selected for prospecting			
River	From	To	Length in km	Name	Bank	Suitability (S/US*)	Justification for acceptance/ rejection.	From	To	Distance in km	Main site for investigations
1	2	3	4	5	6	7	8	9	10	11	12
Yamuna	Agra	Tanda	350	1. Makdoom-Farah	West	US	Precipitous bank.				
				2. Mathura	West	US	On religious and public objection				
				3. Chaensa	West	US	Inaccessible and no proper ground	Dadasia	Tappa	65	Majhawali
				4. Majhawali	West	S	Sloping bank, well connected.	(West bank only)			
				5. Tappa	East	US	Inaccessible during monsoon				
				6. Jewar	East	US	Precipitous bank inaccessible				
				7. Mahaban	East	US	Precipitous				
				8. Mant	East	S	Good collection ground, accessible	Shergarh	Sakraya	41	Mant
				9. Nohijhil	East	US	Inaccessible				
				10. Dankaur	East	US	Inaccessible				
				11. Surajpur	East	US	-do-				
				12. Bagpet	East	S	Good collection ground well connected.				
				13. Tanda	East	S	-do-				
				14. Kuri	East	S	-do-				
Ghagra	Motipur	Barhwal	-	1. Ramwapur	East	S	Precipitous bank	Karsa	Demhua	40	Ghagraghat

contd.....

1	2	3	4	5	6	7	8	9	10	11	12
				2. Dhalauli	East	US	Precipitous bank				
				3. Tikauri	East	US	-do-				
				4. Khasepur	East	US	-do-				
				5. Tapesipah	East	US	-do-				
				6. Ghagraghat	East	S	Suitable collection site				
Burhi Gandak	Majhaul	Khagaria	70	1. Majhaul	North	US	Precipitous bank	Dih	Sansar-pur	50	Khagaria
				2. Siwri	North	US	-do-				
				3. Mohanpur	South	US	-do-				
				4. Bandwar	South	US	-do-				
				5. Chandpura	South	US	-do-				
				6. Menhan	South	US	-do-				
				7. Parihara	North	US	-do-				
				8. Tetri	South	US	-do-				
				9. Hardia	South	US	-do-				
				10. Sadpur	South	US	-do-				
				11. Aho	North	US	-do-				
				12. Kothia	North	S	Suitable collection site				
				13. Khagaria	North	S	-do-				
Kosi Khanua and Khagna	Dhar Simri Bakhti-yarpur	Dhamra-ghat	20	1. Babuaghat	East	S	Good collection site	Rajanpura Thana	Koparia	33	Babuaghat/ Khanuaghat & Koparia
				2. Koparia	East	S	Good collection site; but untimely occurrence of floods				
				3. Dhamraghat	East	US	No suitable site available.				
Badua	Badua	Baghela	22	1. Badharia	East	S	Good collection site	Badharia	Dharara	40	Badharia, Mehdi Jhajha Bhusi and Nawadih
				2. Mehdi Jhajha	East	S	-do-				

Contd.....

1	2	3	4	5	6	7	8	9	10	11	12
Beas	Mirthal	Harike	165	1. Mirthal	West	US	Precipitous bank	Sri Hargovindpur	Harike	145	Wazir Bhullar
				2. Naushara	East	US	-do-				
				3. Sri Hargobindpur	West	US	-do-				
				4. Dhilwan	East	US	-do-				
				5. Budha Thek	West	US	-do-				
				6. Wazir Bhullar	West	S	Good collection site				
				7. Verowal	West	US	Precipitous bank				
				8. Goindwal	West	US	-do-				
				9. Harike	West	US	Inaccessible				
Sutlej	Rupar	Harike	150	1. Rupar	South	US	Precipitous bank	Rupar	Gidder-pindi	144	Loduwal
				2. Machiwara	South	US	-do-				
				3. Mattewara	South	S	Good collection site, accessibility poor				
				4. Phillaur	North	US	No suitable site				
				5. Loduwal	South	S	Good collection site				
				6. Dareiwal	North	US	Precipitous bank				
				7. Gidderpindi	North	S	Good collection site				
				8. Harike	South	US	Inaccessible				

* S - Suitable
US - Unsuitable

Table 2.

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		Ghagra	Burhi Gandak	Khanua Kosi Dhar & Khagna	Badua	Beas	Sutlej
1	2		3	4	5	6	7	8
1. Stretch(from-to)	Dadasia to Tappa	Shergarh to Sakraya	Karsa to Demhua	Dih to Mansi	Rajanpur Thana to Koparia	Badharia to Dharara	Sri Hargobind-pur to Harike	Rupar to Harike
2. Selected site	Majhawali	Mant	Ghagra-ghat	Khagaria	Babuaghat Koparia	Mehdi Jhajha	Wazir Bhullar	Loduwal
3. Bank	West	East	West	North	East	East	West	South
4. Tehsil/Taluk/ Sub-division	Ballabgarh	Mant	Kaiser-ganj	Khagaria	Simri Bakhti-yarpur	Banka	Amritsar	Ludhiana
5. Police Station	Chhaensa	Sureer	Jarwal Road	Khagaria	Simri Bakhti-yarpur	Katoria	Beas	Loduwal
6. District	Gurgaon	Mathura	Bahraich	Monghyr	Saharsa	Bhagalpur	Amritsar	Ludhiana
7. State	Haryana	Uttar Pradesh	Uttar Pradesh	Bihar	Bihar	Bihar	Punjab	Punjab
8. Block	Ballabgarh	Raya	Jarwal	Khagaria	Simri Bakhti-yarpur	Channan	Rayya	Ludhiana
9. Distance from Block H.Q. in km	17.0	14.5	16.0	4.0	12.0	42.0	7.0	11.5
10. Nearest Post Office	Tigaon	Mant	Ghagraghat	Khaga-ria	Simri Bakhti-yarpur	Katsakra (Suiya)	Beas	Loduwal
11. Distance to(10) in km	8.0	1.0	2.0	4.0	12.0	6.0	3.0	1.6
12. Nearest Tele-graph Office	Tigaon	Mant	Jarwal Rd. R.S.	Khagaria	Simri Bakhti-yarpur	Simultala	Beas	Phillaur

contd.....

1	2	3	4	5	6	7	8
13. Distance to(12) in km	8.0	1.0	5.0	4.0	12.0	40.0	3.0	5.0
14. Nearest Telephone	Tigaon	Mant	Jarwal Rd.R.S.	Khagaria	Simri Bakhtiyarpur	Katoria	Beas	Phillaur
15. Distance to(14) in km	8.0	1.0	5.0	4.0	12.0	22.0	3.0	5.0
16, Nearest all weather road	Majhawali	Mant	Ghagraghat	Near site	Simri Bakhtiyarpur	Belhar-Banka (Via Suiya)	Beas	Loduwal
17. Distance to(16) in km	0.1	1.0	0.0	0.0	12.0	6.0	3.0	0.1
18. Nearest Railway Station	Ballabgarh on C.R.	Raya on N.E.R.	Ghagraghat on N.E.R.	Khagaria on N.E.R.	Simri Bakhtiyarpur on N.E.R.	Simultala E.R.	Beas on N.R.	Loduwal on N.R.
19. Distance to(18) in km	18.0	15.0	2.0	4.0	12.0	40.0	3.0	1.7
20. Number of nets that could be operated at different flood levels.	At < 3.5m: 30 nets At > 3.5m: 200 nets	At < 1.4m: 200 nets At 1.4-4.3m: 5 nets At > 4.3: nil	At < 1.0m: 100 nets At 1.0-2.0m: 5 nets At > 2.0m: US*	At < 5m: 3 nets At > 5m: 15 nets	At < 1.0m: 20 nets At 1-2m: 60 nets	At < 1.4m: 100 nets At > 1.4m: 5 to 10 nets	At < 1.0m: 100 nets At 1.0 to 2.0: 5 nets At > 2.0m: US	At < 1.0m: 75 nets At 1.0 to 2.0m: 100 nets.

* US = Unsuitable

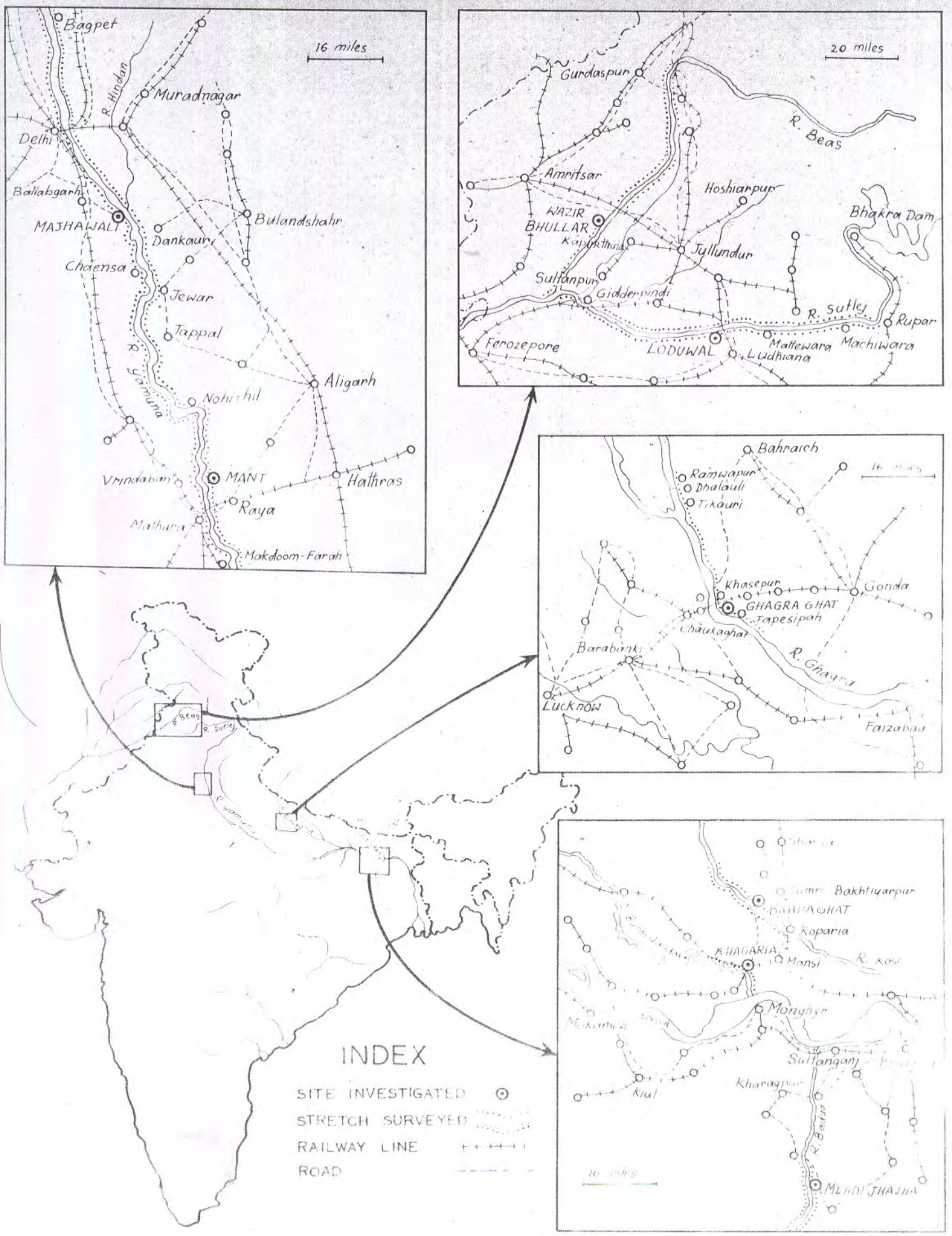

FIG. 1

FISH SPAWN PROSPECTING, 1966
STRETCHES SURVEYED AND CENTRES INVESTIGATED.

III. MATERIAL AND METHODS

1 Gear used

The main investigations were carried out solely by using the standard shooting net (1/8" meshed Midnapore net), selected on the basis of 1964 investigations and since adopted for subsequent investigations (CIFRI, 1965: pp.2 & 175). However, at one centre in Bihar (viz. Khagaria) and at all the three centres in the erstwhile Punjab, nets provided by the respective States were also operated during spawn spurts, to test their efficiency vis-a-vis the standard net.

The State net used at Khagaria in Bihar was of the 'Murshidabad type', described already in CIFRI, 1966 (p.51). This net was also tested at one centre in Punjab, viz. Loduwal.

The Punjab state net had the following structural details: length of the net 372 cm, width at mouth 330 cm, height at mouth 60 cm, ring diameter 25 cm and number of mesh per linear inch 18. The tail-piece, made of muslin cloth, measured: length 142 cm, height 55 cm and width at the rear 22 cm. This tail-piece required only one bamboo pole at its rear end for fixing it to the substratum at the time of operation, as against two poles in the case of the standard net. The ring at the cod end of the net was made of cane, a very non-rigid material. The net did not have a stream-lined shape and there was no provision for increasing its height at the mouth. Becuase of these structural defects, the long tapering funnel of the net was found to collapse in the middle while in operation, resulting in the vomiting of spawn. The tail-piece was not sufficiently long and deep, and this resulted in the death of spawn, specially during scooping. Further, during periods of high turbidity the muslin tail-piece often got clogged, with the consequent adverse effects on rate of filtration and spawn catch.

In addition to the above, a few specially designed research nets were also operated at Majhawali on the Yamuna in Haryana and at Loduwal on the Sutlej in Punjab, to study their relative efficiencies as compared to the standard net, the effects of factors like turbidity and current velocity on net efficiency and the extent of escapement of spawn from the standard net. The nets used for studying relative efficiencies differed from the standard net only in their size. They were got fabricated in four sizes (length), viz. 5m, 7m, 9m and 11m. Trouser-type net, with one leg made of 1/16" meshed netting and

the other of 1/8" meshed netting and the belly made of 1/16" meshed netting, was also operated for eliciting further information on the relative catching efficiencies of the two meshes (1/8" & 1/16") under identical conditions. The extent of spawn escapement in the standard net under different hydrological conditions was investigated through the fabrication and operation of a double-walled 'blanket-type' of net, with its inner wall made of 1/8" meshed netting and the outer wall of 1/16" meshed netting (Fig. 2).

2 Collection and measurement of spawn

The methods of spawn collection and measurement were the same as those adopted during 1965 (CIFRI, 1966). The collection consisted in the main of operating a single trial net round the clock at the investigation centre and commissioning a battery of 3-5 standard nets, the moment the trial net's catch indicated a spawn spurt or bulk spawn availability, i.e. 1 ml of spawn per hour per net. Apart from this a few other adjoining sites were also prospected by periodically operating a trial net, as far as possible during periods of spawn availability. The catches were measured, after seiving, in brass cups of various capacities, ranging from 5 ml to 200 ml.

3 Relative position of nets

The battery of nets operated during periods of bulk spawn availability was arranged in a set pattern as far as possible, as in the previous years, and separate records were maintained regarding the position and performance of individual nets, in order to study the effect of net position on spawn quantity.

4 Qualitative analysis of spawn

The spawn were qualitatively analysed both by microscopic examination at spawn stage and after rearing upto fry stage in nurseries. The methods of analysis were the same as those adopted in the previous years (CIFRI, 1965).

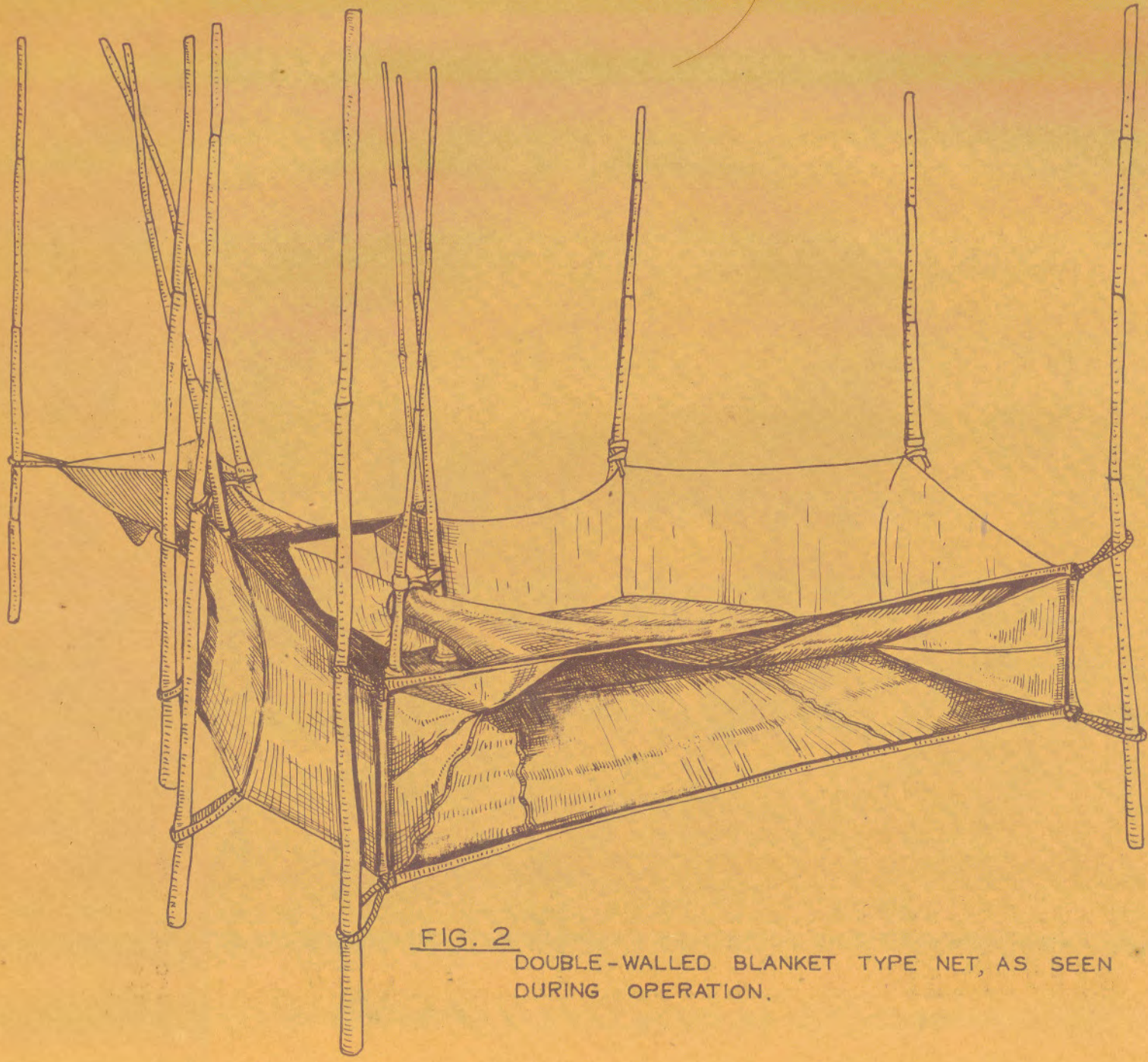

FIG. 2

DOUBLE-WALLED BLANKET TYPE NET, AS SEEN DURING OPERATION.

5 Hydrographical and meteorological factors

Important hydrographical and meteorological factors, viz. flood level, current velocity, turbidity, water and air temperatures and weather condition were determined by the same methods that were adopted during the previous years (CIFRI, 1965).

6 Frequency of observations

Except for associates' quality, water and air temperatures and weather condition, all other observations were made once every four hours during trial netting and once every two hours during periods of bulk spawn availability. However, turbidity and current velocity determinations were restricted to day time only. Air and water temperatures and weather condition were recorded once every four hours throughout the period of investigations, while samples for determining associates' quality were taken only once a day.

IV. DEFINITIONS ADOPTED FOR THE INVESTIGATIONS

The following definitions were decided upon for these investigations.

(i) Day	:	The twentyfour hour period commencing from 4 A.M.(excluding 4 A.M) of a calendar day to 4 A.M. (including 4 A.M.) of the following calender day.
(ii) Date for a day	:	The calendar date at 6 A.M. of the day.
(iii) Surveyed site	:	A site which is surveyed during the premonsoon survey only.
(iv) Prospected site	:	A site where actual observations for spawn availability alone are made during the monsoon season.
(v) Investigated site	:	A site where detailed round the clock observations on spawn, hydrographical and environmental factors are made in the monsoon season.

(vi)	Prospected stretch	:	It is named after the main investigated site.
(vii)	Period of spawn availability	:	The period through which more than 1 ml spawn per net-hour is available.
(viii)	Period of spawn non-availability	:	Periods not covered by (vii).
(ix)	Spawn spurt	:	Period of continuous spawn availability.
(x)	Desirable spawn	:	The catch of spawn having 10% or more of major carps, as revealed by spawn analysis.
(xi)	Undesirable spawn	:	All the spawn catches not covered by (x).
(xii)	Spawn and spawn associates	:	While sieving the total catch of a net through a round-meshed mosquito netting on to a muslin cloth, the quantity that collects on the muslin is termed 'spawn', while the animal aquatic forms that are left over on the sieve itself as 'spawn associates' or 'associates'.
(xiii)	Catch per unit of effort	:	Catch per net-hour.
(xiv)	Seasonal index of spawn quantity	:	The total catch of desirable spawn taken by one standard net in the course of the entire season, generally based on the average of several (upto 5) standard nets.
(xv)	Seasonal index of spawn quality	:	Percentage of major carps in the season's total catch of desirable spawn.

V. OBSERVATIONS

Results of observations made in the various selected stretches, in regard to the quantity and quality of spawn obtained, as also the particular set of conditions under which they occurred, are delineated in the succeeding pages.

1 Ganga river system

(A) River Yamuna

The systematic survey of the river Yamuna, initiated in 1964, was continued during 1966 in two stretches, viz. the Majhawali stretch and the Mant stretch.

(a) Majhawali stretch of Yamuna

Participants

K.K. Ghosh (Leader) K.P. Srivastava R. Tewari	Government of India
Brij Mohan (for 15 days only)	Government of Punjab

The selected Majhawali stretch of the Yamuna extended from Dadasia in the north to Tappa in the south, a distance of about 65 km (Fig.3). Village Majhawali, which was selected for detailed round the clock investigations, is situated on the south-west bank of Yamuna in Ballabgarh tehsil of Gurgaon district, which is presently in Haryana State. The site of seed collection was about 1.5 km off the main village (Fig.4). The river flows in a serpentine course in this region. A small nullah (tributary), which originates from the Yamuna at about 15 km upstream of the site, joins back the river a little upstream of the site at Majhawali, after traversing a distance of about 30 km through low-lying areas. The river bank at the site is at first steep and then slopes gradually. The bank contour at the spot of maximum availability of spawn and fry is diagrammatically represented in Fig.5. This figure also roughly indicates the extent of space available for the operation of shooting nets in different floods, as well as the spots of occurrence of spawn and fry. The flow pattern of the river at this site is largely controlled by the headworks on the river at Okhla, Wazirabad and Tajewala, of which the first one is only about 35 km upstream of the site.

The observations at this site lasted from 1st July to 5th September, 1966. In addition to the detailed investigations at Majhawali, occasional spawn prospecting was carried out at four other centres, viz. Dadasia, Chhaensa, Mohana and Tappa.

(i) Occurrence of spawn and fry spurts and areas of concentration.

Only two spurts of spawn and two of fry were recorded at Majhawali during the entire season. While the two spawn spurts lasted only for 28 hours and 8 hours respectively, the second fry spurt lasted for as long as 152 hours.

With the appearance of each seed spurt, simultaneous trial nettings were done for two hours at all the suitable spots nearby (spots A-K) and the battery of nets operated only at the spot yielding maximum catch of spawn or fry (Fig.4). The results of spurt-wise trial netting are tabulated below.

Table 3.

Spurt-wise availability of spawn or fry at various spots where trial nettings were made.

Spawn or fry spurt	Average spawn/fry catch in ml obtained in two hours											Most suitable spot
	A	B	C	D	E	F	G	H	I	J	K	
S_1	10	30	20	-	-	-	-	-	-	-	-	B
S_2	-	-	-	4	10	3	2	neg.	3	neg	neg	E
F_1	-	-	-	30	55	35	nil	-	-	-	-	E
F_2	-	-	-	4250	4800	3500	100	-	-	-	-	E

Details of occurrence, duration, quantity and quality of spawn and fry spurts recorded at Majhawali are given in Tables 4 and 5.

Table 4.

Flood-phase-wise occurrence, duration and magnitude of spawn and fry spurts recorded at Majhwali on the Yamuna

Flood No.	Phase	From Date	From Hour	Duration in days	Peak flood level Date	Peak flood level Hour	Peak flood level Flood level in metres	Spawn or fry spurt No.	Quality D/UD*	Commencement Date	Commencement Hour	Duration in hrs	Spawn/Fry catch by Standard nets No. of nets	Standard nets Catch in ml	Standard nets Catch in lakhs	State nets No. of nets	State nets Catch in ml	State nets Catch in lakhs
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
I	Rising	1.7.66	6.00	2	3.7.66	6.00	2.78	-										
	Receding	3.7.66	14.00	21				S_1	D	3.7.66	14.00	28	5	3,625	12.69	3	5	0.02
II	Rising	24.7.66	14.00	5	29.7.66	6.00	5.13	S_2	D	28.7.66	4.00	2	2	20	0.07	-	—	-
	Receding	29.7.66	6.00	2				S_2 Contd.	D			6	5	220	0.77	3	100	0.35
III	Rising	31.7.66	22.00	4	3.8.66	14.00	5.30	F_1	UD	2.8.66	2.00	48	3	6,845	8.21	-	-	-
	Receding	3.8.66	18.00	3				-										
	Vacillation phase	7.8.66	10.00	5	9.8.66	20.00	5.33	F_2	D	8.8.66	22.00	86	5	2,07,735	166.37	3	66,080	46.18
IV	Rising	12.8.66	10.00	4	15.8.66	22.00	5.65	F_2 Contd.	UD	12.8.66	10.00	66	1 to 3	3,235	1.62	-	-	-
	Receding	16.8.66	10.00	21	(upto 5-9-66, when the observations were closed)													

* D - Desirable
UD - Undesirable

Table 5.

Catch per unit effort and quality of fish seed collected at Majhawali on Yamuna during different seed spurts in 1966.

Spawn/ Fry spurt	Flood phase	Catch per unit effort (net-hour) in numbers		By analysis (%)			Q U A L I T Y By rearing % (Pooled)						
		Standard net	State net	Major carps	Minor carps	Others	Rohu	Catla	Mrigal	Calbasu	Total major carps	Minor carps	Others
S_1	Receding I	8,562	97	47.6	48.4	4.0	7.8	7.8	2.7	0.3	18.6	80.8	0.6
S_2	Rising II	700	-	54.2	45.8	0	14.2	3.0	1.5	0	18.7	81.3	0
S_2 continued	Receding II	2,640	3,000	61.6	38.4	0							
F_1	Rising III	5,704		3.6	93.3	3.1	Not reared						
F_2	Vacillation	39,423	18,325	12.1	84.2	3.7	10.0	2.5	0.4	0	12.9	84.4	2.7
F_2 continued	Rising IV	8,187		6.0	76.4	17.6	Not reared						
	Pooled seasonal average quality of desirable seed						9.9	2.9	0.6	neg.	13.4	84.1	2.5

The first spawn spurt occurred in the receding phase of the first flood. It commenced 8 hours after the flood level reached its peak and lasted for 28 hours, yielding in all 3625 ml of spawn, in five standard nets. This spurt comprised only desirable spawn and accounted for 97.3% of the season's total spawn yield and 7.1% of the season's total fish seed catches (including fry) made by standard nets. The catch per net-hour in this spurt was found to be 8,562 hatchlings. However, during a brief spell of four hours duration, starting 4 hours after the commencement of the spurt, when the spawn were available in great bulk, the catch per net-hour was found to be as high as 23,540 hatchlings. The catch made during these four hours accounted for 37% of the spurt's total yield.

The second spawn spurt was of extremely short duration only 8 hours. It commenced late in the rising phase of the second flood, just two hours before it touched its peak and continued for another 6 hours in the succeeding receding phase. It contributed to only 2.7% (240 ml) of the total spawn catch of standard nets. This spurt was also entirely of desirable spawn. The catch per net-hour for standard nets was found to be 2,100 hatchlings.

State nets, which could not be operated successfully during the first spawn spurt due to constructional defects, were pressed into service during the second spurt after effecting certain modifications, and as much as 100 ml of spawn could be obtained in three nets.

In the subsequent floods no spawn was encountered. Its place was taken by fry, sometimes in immense numbers. In the rising phase of flood III, a comparatively minor spurt of fry, mostly of uneconomical species, occurred over a duration of 48 hours accounting for only 4.7% of the total fry yield at the site. The major fry spurt of the season commenced in the vacillation period preceding flood IV, when the water level at times touched fairly high levels, as can be made out from Table 4. This spurt yielded a bumper catch of fry, of size range 7-20 mm, but of low major carp content. The major carps present were dominated by Labeo calbasu. This spurt was of 152 hours duration, of which the first 86 hours were in the vacillation phase and yielded 2,07,735 ml of desirable fry in 5 standard nets, while the later 66 hours were in the rising phase of flood IV and yielded only 3,235 ml of undesirable fry in 3 standard nets. On the whole, this spurt accounted for 88.50% of the total fish seed collected at the site by standard nets. While the over-all catch per unit effort during the vacillation phase was 39,423 fry, during brief periods it was much higher, the maximum being 2,33,250 fry over a period of 8 hours.

(ii) Quality of fish seed collected

Percentage composition of spawn and fry catches made during the various spurts, based on two hourly sample analyses, is given in Table 5. While both the spawn spurts had a fairly high and almost similar percentage of major carps (47.6 and 48.4% respectively), the major carp content of the fry spurts was considerably low, the highest being only 12.1% in the earlier part of spurt 2 during the vacillation phase.

Samples taken from desirable seed were reared in different ditches near the site and in the nurseries of the Government of Punjab. A detailed account of species composition of different samples is given in Table 6. Here again, the results indicated an almost identical percentage of major carp content in the first and second spawn spurts, viz. 18.6% and 18.7% respectively, which are very much lower than those indicated by the spawn sample analysis method. On the other hand, the reared fry samples taken from fry spurt 2, indicated a major carp content of 12.9%, which is almost similar to the result obtained by the other method.

The conspicuous difference in the results of spawn composition as obtained by spawn analysis and rearing experiments can be explained to some extent by the fact that calbasu, which dominated the major carp part of the spawn, had very poor survival in the nurseries. Further, the nurseries did not have sufficient water to begin with. The low level of water, coupled with high temperatures, might have brought about the large-scale mortality of calbasu. That the rearing method's estimate is not sufficiently higher even in regard to the fry samples can be explained by the fact that the general higher rate of survival of major carps in ponds was offset by the dominating presence, in the samples, of calbasu, whose survival was as bad as that of minor carps and others.

Based on rearing experiments, the overall major carp content of the desirable spawn spurts that occurred at Majhawali during the season was estimated at 18.65%. Rohu was found to be the most dominant major carp of the region. The seasonal spawn index for this centre was found to be 784 ml (c.2.75 lakhs).

Table 6.

Quality of fish seed collected during different spurts in the Yamuna at Majhawali in 1966, as revealed by rearing experiments

Spurt No.	Date of collection of Spawn / Fry	Sample No.	Sample Size	Percentage composition: Major carps: Mrigal	Catla	Rohu	Calbasu	Total	Minor carps	Others
		I	29	6.9	-	17.3	-	24.2	75.8	0
S_1	Spawn 3.7.66	II	142	12.0	1.5	5.7	0.7	19.9	80.1	0
	4.7.66	III	111	-	12.6	5.4	-	18.0	81.1	0.9
		IV	79	-	15.2	-	-	15.2	82.5	1.3
		Pooled average		2.7	7.8	7.8	0.3	18.6	80.8	0.6
S_2	Spawn 29.7.66	I	134	1.5	3.0	14.2	-	18.7	81.3	0
		Average		1.5	3.0	14.2	-	18.7	81.3	0
		I	116	0.8	4.3	7.8	-	12.9	87.1	0
F_2	Fry 9, 10, 11 and 12.8.66	II	124	-	-	12.1	-	12.1	87.9	0
		III	133	-	3.0	10.5	-	13.5	85.7	0.8
		IV	106	1.0	2.8	8.5	-	12.3	75.4	12.3
		Pooled average		0.4	2.5	10.0	-	12.9	84.4	2.7
Pooled average for the season				0.6	2.9	9.9	neg.	13.4	84.1	2.5

(iii) Spawn availability at prospected sites

Spawn prospecting was carried out for two days each at Dadasia, situated upstream of Majhawali, and Chaensa, Mohana and Tappa, all situated downstream of Majhawali. The results obtained through trial net operations at the above sites, along with those at Majhawali are presented in Table 7.

Table 7.

Spawn catch per hour in ml at different sites along the Majhawali stretch of River Yamuna.

Date	Majhawali	Dadasia	Chhaensa	Mohana	Tappa
3.7.66	24	-	-	-	-
4.7.66	19	-	-	-	-
8.7.66	Nil	-	neg.	-	-
9.7.66	Nil	-	neg.	-	-
11.7.66	Nil	Nil	-	-	-
12.7.66	Nil	Nil	-	-	-
23.7.66	Nil	-	-	2	-
24.7.66	Nil	-	-	3	-
28.7.66	1	-	-	-	-
29.7.66	7	-	-	-	-
5.8.66	Nil	-	-	-	2
6.8.66	Nil	-	-	-	neg.
8.8.66	neg.	-	-	-	-
9.8.66	617*	-	-	-	-
10.8.66	300*	-	-	-	-
11.8.66	57*	-	-	-	-
12.8.66	51*	-	-	-	-

*Fry

All the prospected sites were found to be suitable for operating shooting nets. However, Dadasia, where no spawn appeared in the nets appears unlikely to yield any spawn, since it is located very near the Okhla headworks and the river nearabout this region does not received any nullah. Varying quantities of spawn were available at all the three downstream sites, where it is feasible to operate about 60-200 nets at different flood levels. While the Chhaensa and Mohana sites are suitable for exploitation throughout the season, the Tappa site can be exploited only at

higher flood levels. The appearance of spawn at Mohana earlier to its appearance at Majhawali indicates the possibility of carp breeding taking place in the region below Majhawali. This possibility is further strengthened by the fact that a distributary of river Hindan joins the Yamuna between Majhawali and Mohana.

(iv) Spawn availability in relation to hydrographical and biotic factors

Flood level

The flood level in the Yamuna at Majhawali is largely determined by the release of water from the headworks located upstream at Okhla, Wazirabad and Tajewala. The river does not receive any tributary that might flood it between Majhawali and Okhla. The only tributary that joins it at about 15 km above Majhawali, branches off from the Yamuna itself about 30 km further upstream. This tributary serves as a link for the fishes to reach their breeding grounds in the low-lying areas inundated by it. The topography of the areas that get inundated by this nullah is such that mostly all sheets of water get cut off with a slight fall in flood level. Further, since the elevation of the nullah at its southern end is lower than that near its origin above, it first gets inundated through the southern end. It was observed that when the flood level crossed 5.15 m above the summer level, water from the Yamuna started flowing into the upper end of the nullah, developing therewith a fairly strong current. This level was first touched on 3.8.'66, while rain and suitable climate for spawning occurred more than 8-10 days earlier. This largely explains the non-availability of spawn in any sizable quantity and the bulk availability of fry a week later at Majhawali.

From the fact that four floods, each higher than the previous one, were experienced at Majhawali and only the first two yielded spawn, the first in early July and the second in late July, and about 2 week old fry were available from 8th August onwards, it may be surmised that in the upper stretches of the Yamuna the peak breeding of major carps takes place in July, in the early flood of the season.

Turbidity

Turbidity values mostly ranged from 100-600 ppm, except during the peak periods of FloodsII andIIIwhen it ranged from 600-1100 ppm. During the periods of spawn availability, it ranged between 300 and 600 ppm. However, no direct correlation could be made out between turbidity and spawn availability.

Current velocity

In the season as a whole, current velocity ranged from 0.9-4.3 km per hour, but fish seed were available only at intermediate values, i.e. at moderate current velocity. While the current velocity ranged from 1.6-3.4 km/hr, parallel to the bank, during periods of spawn availability, it ranged from 1.2-2.2 km/hr during the fry availability periods.

Associates

Associates occurred in only very few numbers throughout the season and were encountered more frequently early in the season. As such, no correlation could be traced regarding the relative abundance of spawn and associates at the site. The more common species of associates at the site were Puntius ticto, P. stigma, P. sophore, Rohtee cotio, Aspidoparia morar, Ambassis nama, A. ranga, Glossogobius giuris and shrimps. Advanced fry of Wallago attu were encountered in plenty during fry spurt 2.

(v) Efficiency of State nets

The efficiency of nets supplied by the Government of Punjab was tested against the standard net. When operated during the first spawn spurt, it was found that the State net had serious constructional defects that closed its mouth even when stretched. They were operated again during the second spawn spurt after effecting certain improvements. But after being in water for about four hours, the rings, which were made of thin cane, collapsed. However, during these four hours their efficiency was found to be almost 100%. After strengthening the rings and net mouth, they were again operated during the fry spurt, when they showed an efficiency of 40%. These State nets were bigger in size than the standard net and the rings being too large and made of thin cane could not maintain their rigidity for long in the water.

(vi) Efficiency of nets of different sizes

Nets of various sizes, made of 5 m, 7 m, 9 m and 11 m of Midnapore-type netting, were operated against the standard net for comparison of their catching efficiencies. These nets differed from the standard net only in their size, the shape and material being identical. The catches per net-hour in the various nets on the different days of observation are given in Table 8, from where it is seen that there is a parabolic rate of increase of efficiency with the increase in size of nets. It is to be mentioned, however, that the comparisions were, perforce, limited to a few observations only since the spawn spurts were of extremely short duration.

Table 8.

Comparative efficiency of different sized nets

Date	Catch per unit of effort and efficiency	5m	7m	9m	11m	Standard (14 m)
3.7.66	CPUE*	800	1,625	2,000	7,250	14,300
	Efficiency	5.6%	11.4%	14.0%	50.0%	100%
4.7.66	CPUE*	125	350	900	2,025	3,825
	Efficiency	3.3%	9.1%	23.5%	53.0%	100%
29.7.66	CPUE *	720	1,500	2,100	2,880	4,380
	Efficiency	16.7%	34.2%	48.0%	65.7%	100%
Average	Efficiency	8.5%	18.2%	28.5%	56.5%	

* Catch per net-hour.

(vii) Escapement from net made of 1/8" meshed Midnapore-type netting

In order to find out the extent of spawn escapement, if any, from 1/8" meshed netting and to determine its dependence on current velocity, turbidity and size of hatchlings, a specially designed double-walled blanket-type of net (see **III** - 1) and Fig.2) was operated at this centre. Here again the latter part of the study was handicapped by the short duration of spawn spurt. However, the study did indicate the escapement of spawn, which was, on an average, about 40%. The turbidity during the operation of this net was comparatively low (about 650 ppm) and the current velocity was around 1.8 km/hr.

(viii) Comparison of catching efficiencies of 1/8" and 1/16" meshed Midnapore-type nettings.

The trouser-type net, which was specially designed for determining the comparative efficiencies of 1/8" and 1/16" meshed Midnapore-type nettings, could be operated only for a very brief period, and no significant results could, therefore, be obtained therefrom.

(b) Mant stretch of Yamuna

Participants

S.J. Karamchandani (Leader) G.K. Bhatnagar B. Ghosh	Government of India
D.P. Singh (3.7.66 to 29.7.66) R.K. Sharma(3.8.66 to 3.9.66)	Government of Uttar Pradesh

The Mant stretch of Yamuna taken up for investigation extended from Sakraya in the south to Shergarh in the north, a distance of about 41 km by river course (Fig.6). Mant, the centre selected for detailed investigations, is situated on the eastern bank of the Yamuna in Mathura district of Uttar Pradesh. The river follows a serpentine course in this stretch, specially in the immediate neighbourhood of Mant (Fig.7). The river in this region is flanked by extensive low-lying areas, which get

inundated with high rise in flood level, when the river loses much of its serpentine course. The river bank at Mant is gradually sloping for about 90 metres, after which there is a sudden steep fall. This is succeeded by another stretch of gradually sloping low-lying area extending for about 45 metres before it meets the river at its summer level (Fig.6). The entire area is of sandy terrain.

Apart from the detailed investigations at Mant, periodic spawn prospecting was conducted at Sakraya, downstream of Mant, and at Bijoli, Sureer, Sultanpur and Shergarh, all upstream of Mant (Fig.6). The investigations lasted from 1.7.'66 to 31.8.'66.

(i) Occurrence of spawn spurts

During the entire period of investigations, only two floods were experienced at Mant. The first flood was already on at the start of the investigations on 1.7.'66 and lasted till 20.7.'66, while the second flood which commenced on 25.7.66 was still in its receding phase when the investigations were closed on 31.8.'66. There was a brief vacillation period in between the two floods. Details of occurrence of the floods, the peak flood levels reached, etc. are shown in Table 9. Appearance of spawn in bulk quantities commenced at the fag end of the receding phase of the first flood and continued through the vacillation period to the early part of the rising phase of the second flood. However even though spawn was appearing in the nets every day during this period, viz. from 17.7.'66 to 27.7.'66, its availability, as per the definition adopted for this report, was not continuous. There were now and then periods of very low concentration of spawn or even its total absence. As such, strictly in accordance with the definition adopted, as many as nine spurts of spawn could be recognised during this period, with intervals in between of low availability or non-availability ranging from 6-16 hours. This could have been due to different spurts of spawning of individuals of the same species or of several species.

Table 9.

Flood pattern at Mant on the Yamuna during 1966

Flood No.	Duration of rising phase	Flood peak		Duration of receding phase
		Date Time	Height in m (MSL)	
I Flood	1.7.66 to 4.7.66	4.7.66 22 hrs.	164.08	4.7.66 to 20.7.66
Vacillation phase	21. 7. 66	to		24. 7. 66
II Flood	25.7.66 to 20.8.66	20.8.66 14 hrs.	166.79	20.8.66 to 31.8.66

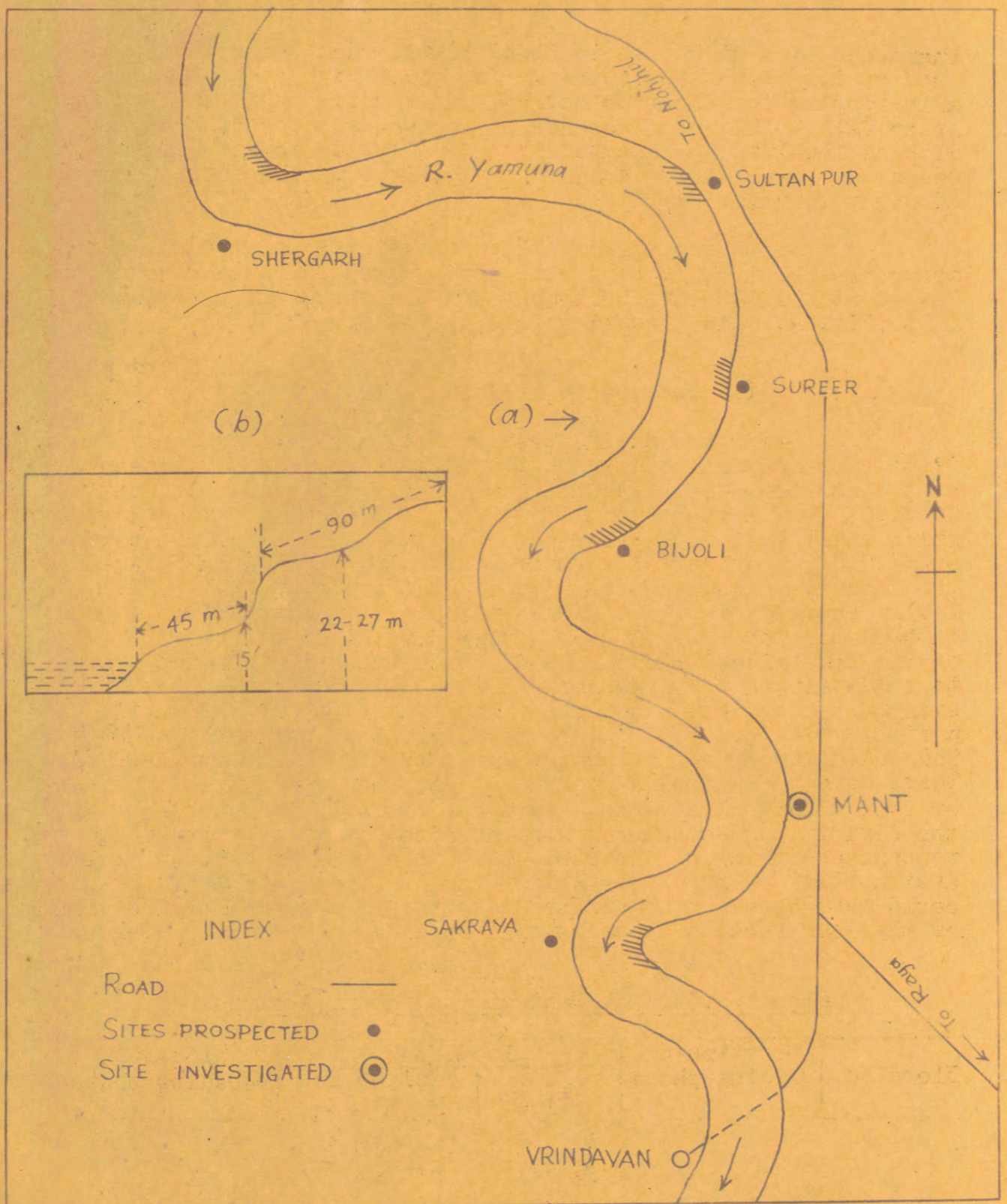

FIG. 6 (a) MANT STRETCH OF YAMUNA SHOWING SITES PROSPECTED AND CENTRE INVESTIGATED.
(b) CROSS SECTION OF THE YAMUNA AT MANT.

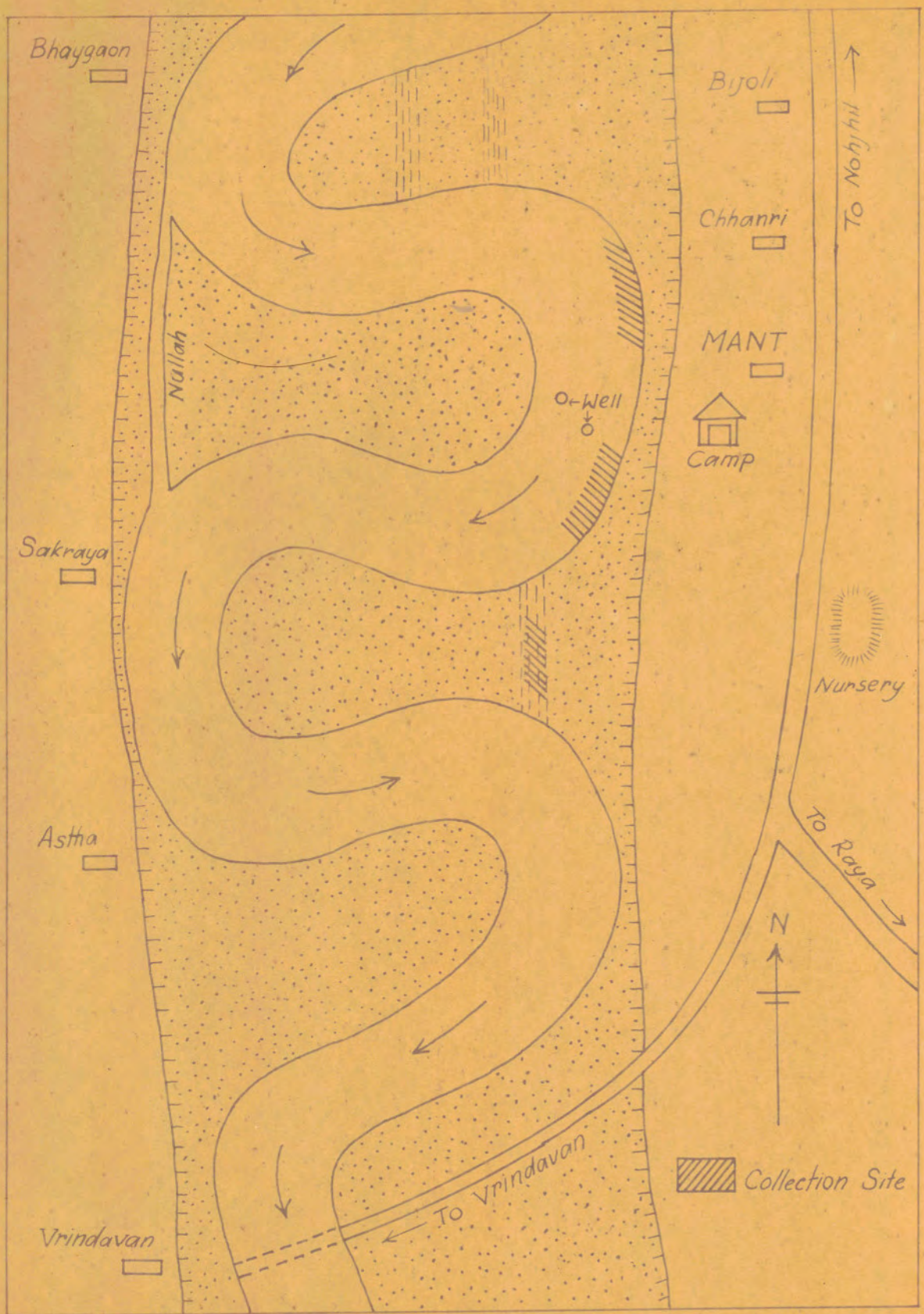

FIG. 7.

THE COURSE, GENERAL TERRAIN AND TOPOGRAPHY OF RIVER YAMUNA AT MANT.

This period was succeeded by a total absence of spawn for full 48 hours, after which the spawn did occur sporadically during the period 29th July to 1st August, but touched the index of availability only very briefly, once on 29th July and again on 31st July. These could hardly be described as spurts. All the same, it was only during this period that desirable spawn could be obtained in this stretch of the river. No further occurrence of spawn was recorded in the main river, while negligible quantities of undesirable spawn were collected in the side channel on 11th and 22nd August.

Details of occurrence, duration, magnitude and quality of the nine spawn spurts are delineated in Table 10. The spawn quantities indicated in the Table mostly constitute the catch of five standard nets. Of the nine spurts, the first four occurred in the receding phase of the I flood, the fifth to seventh during the vacillation period between floods I and II, and the remaining two during the rising phase of the II flood. All these nine spurts yielded only undesirable spawn in varying quantities, ranging from only 41 ml in the first spurt to 1996 ml in the 8th spurt. The nine spurts together lasted over 138 hours, with the duration of individual spurts ranging from only 10-32 hours, and yielded a total of 4636.5 ml of spawn in 1-5 (mostly five) standard nets. This accounted for 96.7% of the season's total spawn catch. Of the 94 hours of intervening time between spurts, the spawn occurred during only 54 hours, amounting to 79.5 ml. When the spawn catch obtained during the spurts only is taken into consideration, the percentage contributions of I flood, vacillation period and II flood were respectively 19.01, 33.73 and 47.26.

Spurt-wise catch per net-hour ranged from 812 hatchlings in the 1st spurt to 5260 hatchlings in the 7th spurt. In the individual 2-hourly observations, however, the catch during these spurts ranged from the minimum of 350 hatchlings to as much as 14,700 hatchlings per net-hour during the 8th spurt on 25th July. But the higher values were observed only during brief spells.

In the above period the spawn catch was generally a little heavier during night hours. But during the period 30th July to 1st August, when small quantities of mostly desirable spawn were encountered in the rising phase of the II flood, the catches were obtained mostly during day time hours. It is noteworthy that the occurrence of desirable spawn coincided with a slight fall in flood level during the above period. The maximum catch per net-hour during this period was only 840 hatchlings, on 31st July, and this lasted over only two hours.

Table 10

Occurrence, duration, magnitude and quality of spawn spurts recorded at Mant on the Yamuna in 1966

Spurt No.	Duration			Spawn catch			Flood No.	Flood phase	Quality
	From date/ hr.	To date/ hr.	Period in hours	In ml	In lakhs	Average catch per net-hour (in ml)			
1	17.7.66 22	18.7.66 8	10	41.0	0.14	2.32	I	Rec.	UD
2	18.7.66 22	19.7.66 12	14	183.5	0.64	3.45	I	Rec.	UD
3	19.7.66 18	20.7.66 6	12	466.5	1.63	14.10	I	Rec.	UD
4	20.7.66 18	21.7.66 6	12	190.5	0.67	3.99	I	Rec.	UD
5	21.7.66 14	22.7.66 14	24	523.00	1.83	4.85	Vacillation phase bet when Floods I & II.		UD
6	22.7.66 22	23.7.66 8	10	342.0	1.20	9.75	-do-		UD
7	23.7.66 18	24.7.66 6	12	699.0	2.45	15.03	-do-		UD
8	24.7.66 22	26.7.66 6	32	1996.0	6.99	13.40	II	Ri.	UD
9	26.7.66 22	27.7.66 10	12	195.0	0.68	4.50	II	Ri.	UD
	Total :		138	4636.5					

Rec. = Receding Ri. = Rising
UD = Undesirable

(ii) Quality of spawn collected

Two-hourly spawn analyses, carried out to determine the percentage composition of the catches, revealed a total absence of major carps in all the nine spurts. Minor carps (mostly Chela spp. and Barilius spp.) constituted 61-100% of the catches, the remaining miscellaneous species being dominated by Mugil spp. Since these were in advanced stage of development, they could be easily identified and, as such, the samples were not reared in nurseries.

Of the 40 ml of spawn caught during the period 30th July to 1st August, as much as 38 ml constituted desirable spawn, with their major carp content in the 4-hourly catches ranging from 56-78%. The spawn collected from 29th-31st July were also reared in a nursery to find out the exact species composition. This indicated a major carp content of 26.3%. The details of species composition are given below :

Table 11.

Quality of spawn collected during July 29-31, as revealed by rearing

Sample	Percentage Composition							
No.	Size	Major carps					Minor carps	Others
		Rohu	Mrigal	Catla	Calbasu	Total		
I	95	10.5	10.5	3.2	2.1	26.3	72.6	1.1

The above Table shows a predominance of rohu and mrigal among the major carps in this stretch of the river.

(iii) Spawn availability at prospected sites

Of all the five prospected sites, spawn was encountered only at Sureer, but that too in negligible quantities. Accessibility is highly unsatisfactory in the case of all the sites, and in many of them only a few nets can be operated in a row.

At Sakraya, situated downstream of Mant, the river has steep banks. But a shallow site is available on the opposite bank. This site is, however, likely to get marooned during high floods

and is, therefore, unsuitable for commercial exploitation. At Bijoli, where also the river has steep banks, nets can be operated properly only during low floods. Similar is the condition at Sureer, where, however, when during high floods the water overflows the steep banks, it would be possible to operate a number of nets in the vicinity of the temple nearby. This also is unlikely to yield spawn, since the current in the area happens to be too feeble. Similar conditions are encountered at the prospected site opposite Shergarh. The Sultanpur site is thoroughly unsuitable because of steep banks and presence of 'Jhau' (wild tall bushes) in the adjoining low-lying area.

(iv) Spawn availability in relation to hydrographical and biotic factors

Flood level

As depicted in Table 9, the Yamuna at Mant experienced only two floods, with an intervening vacillation phase of four days' duration. The I flood was of lower magnitude and was less protracted than the second. The maximum water levels reached during the two floods were 164.08 m and 166.79 m (MSL) respectively. It was found that the operation of shooting nets was not possible when the water level exceeded 165.5 m. After eight days of commencement of the II flood, i.e. from 2nd August, the water level remained consistently above 165.5 m till almost the end of the period of investigations. This made the operation of shooting nets impossible in the main river during that period. That lower flood level is more suitable for spawn collection at Mant is evident from the fact that about 99% of the season's total catch was obtained when the flood level was at its lowest, ranging from about 161.5 m to 162.5 m. Further, the pattern of the second flood was rather abnormal in that its rising phase was of extremely long duration. There is every possibility of quality spawn having been washed away during this prolonged rising phase. This inference is supported by the occurrence of high quality spawn from 30th July to Ist August, when there was a temporary fall in the water level. It could, therefore, be presumed that had this flood followed the usual pattern, common of the Yamuna, quality spawn in quantities could have been possibly harvested. From the current observations it can also be surmised that desirable spawn are most likely to occur at Mant in late July and early August.

Current velocity and turbidity

In the season as a whole, both current velocity and turbidity fluctuated widely, from 0.81 - 3.75 km/hr and 107-1750 ppm respectively. However, spawn availability was found to coincide with their lower values. The present observations tend to indicate that a current velocity of 0.81 - 1.12 km/hr, in conjunction with low turbidity values of 107 to 244 ppm, is most conducive to high spawn yields in the Yamuna at Mant.

Temperature and weather condition

No definite correlation was discernible between spawn availability on the one hand, and air and water temperatures and weather condition on the other, except that stormy weather rendered shooting net operation difficult.

Associates

Like the spawn, the filtered-off associates were more numerous during the earlier part of the season (I flood + vacillation phase). But while the spawn occurred in comparable quantities in both the rising and receding phases of this flood, the associates occurred in distinctly larger numbers during the receding phase. However, again both the spawn and associates appeared in larger numbers in the rising phase than in the receding phase during the II flood. As such, there does not appear to be any definite correlation in regard to the relative abundance of spawn and associates.

Of the associates collected during the entire season, the forage fishes, carps and predatory fishes made up 57%, 12.1% and 30.9% respectively; whereas during the period of spawn availability they respectively made up 68.8%, 10.3% and 20.9%. Puntius ticto (23.9%) among forage fishes, Labeo bata (5.2%) and Cirrhinus reba (4.9%) among carps and Glossogobius giuris (15.1%) among predatory fishes dominated the season's associate catches.

(v) Spawn catch in relation to net position

The observations made on the magnitude of spawn catches in relation to net position, indicated that spawn catches were heavier in the first row facing the current, and among these the one nearest the bank yielded the maximum catch.

(B) River Ghagra

Participants

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M.R. Sinha }

O.P. Sharma } Government of Uttar Pradesh

A 40-km stretch of river Ghagra, extending from Karsa in the north to Demhua downstream, was prospected for spawn during the period 1.7.'66 to 2.9.'66. Ghagraghat, situated on the eastern bank of the river in Jarwal block of Bahraich district, was selected for detailed round the clock investigations. Ten centres were chosen for occasional prospecting, of which eight were situated in Barabanki district, viz. Karsa, Purainpur, Sardaha, Bairagmapur, Lorhemau, Sihorwa, Chirra and Demhua, the first two upstream of Ghagraghat and the remaining downstream of Ghagraghat. The two other centres were Kaithi and Sangam, both situated in Gonda district (Fig.8).

The Ghagra flows in an almost north-south direction above Ghagraghat, while below this place it takes an easterly course. The river bank at Ghagraghat site is gently sloping, while the opposite bank is highly precipitous. A little above the site there is an embankment of the railway bridge, extending for nearly 2 km. The river bed is sandy and much of it adjoining the eastern bank is covered with deeply-rooted bushes, locally termed 'Jhaoo'. Further, sections of the eastern bank are cultivated with crops of paddy maize, sugarcane, etc. right down to the water's edge, which makes it difficult to reach the water in those areas for operating nets. The width of the river is only about 2 km at the site, while it is much broader both upstream and downstream, with bigh channels and islands in between. The boats and pontoons of the fair weather pontoon bridge are all placed in shallow waters at the site, and this leaves only limited space for the operation of nets. The river course, general terrain, topography, etc. at the site are depicted in Fig.9.

(i) Occurrence of spawn and areas of concentration

Even though the river experienced five floods at the site, only one spurt of spawn was encountered during the entire season. To determine the spot of maximum spawn availability,

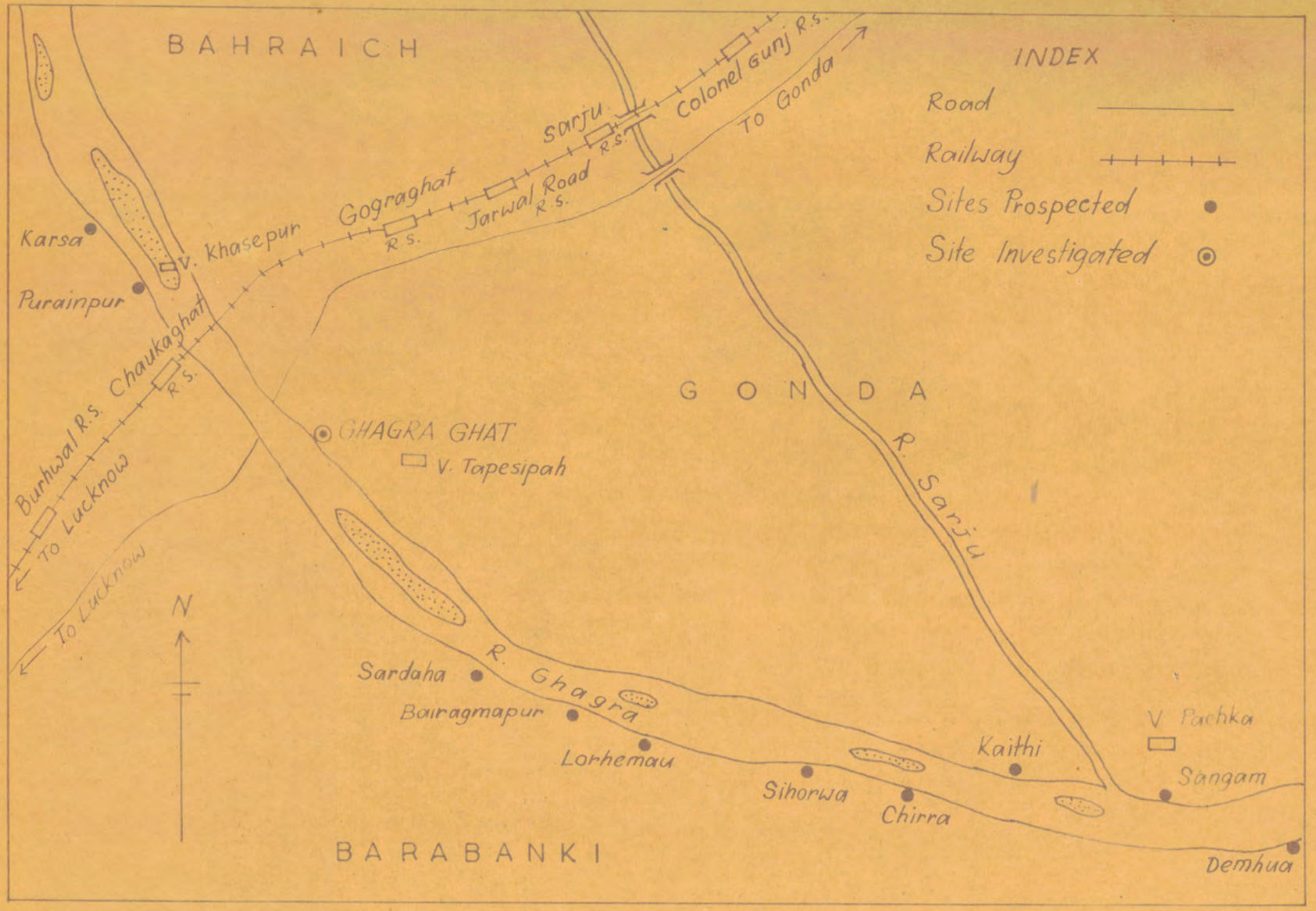

FIG. 8.

GHAGRAGHAT STRETCH OF RIVER GHAGRA, SHOWING SITES PROSPECTED AND CENTRE INVESTIGATED.

trial nettings were done for a period of two hours at four suitable spots A, B, C & D (Fig.9) during the single spawn spurt, which occurred in the receding phase of the first flood. Of the four, spot A was found to yield the maximum catch, while spot D yielded no spawn at all. Spots B and C yielded only traces of spawn. Such trial netting was repeated during the subsequent floods as well in order to find out whether any of the spots would yield spawn. However, since there were no further spawn spurts, this did not yield any useful information. However, spot A appeared to be the most suitable, since the net operated there recorded the occurrence of spawn even when it occurred only in traces during the 2nd and 4th floods, while the nets at other spots did not yield any except traces only at B during the 2nd flood.

Details of occurrence, duration and magnitude of the only spawn spurt encountered at Ghagraghat are shown in Table 12. This spurt occurred entirely in the receding phase of the first flood. It commenced about 12 hours after the flood level reached its peak and lasted for 28 hours, yielding in all 1112 ml of spawn, estimated at about 3.89 lakhs of hatchlings, in 5 standard nets. This spurt yielded only desirable spawn right through the period of its duration and accounted for practically the season's entire catch, the only remaining measurable catch of spawn being 2 ml, obtained during the receding phase of the same flood about 16 hours after the spawn spurt fell below the index of availability. The catch/net/hour for the spurt as a whole was found to be 2828 hatchlings, the maximum being 5775 hatchlings at about 10 hours after the commencement of the spurt.

Practically no spawn could be obtained in the subsequent floods. While the 3rd and 5th floods were entirely devoid of spawn, traces only were encountered in both the rising and receding phases of the 2nd flood and the rising phase of the 4th flood. All these floods attained higher levels than the first, and the water level never came down to even the peak level of the first flood throughout the remainder of the investigation period.

(ii) Quality of spawn collected

The percentage composition of the spawn catches in regard to major groups, as obtained through two-hourly spawn samples analyses and through rearing experiments in nurseries

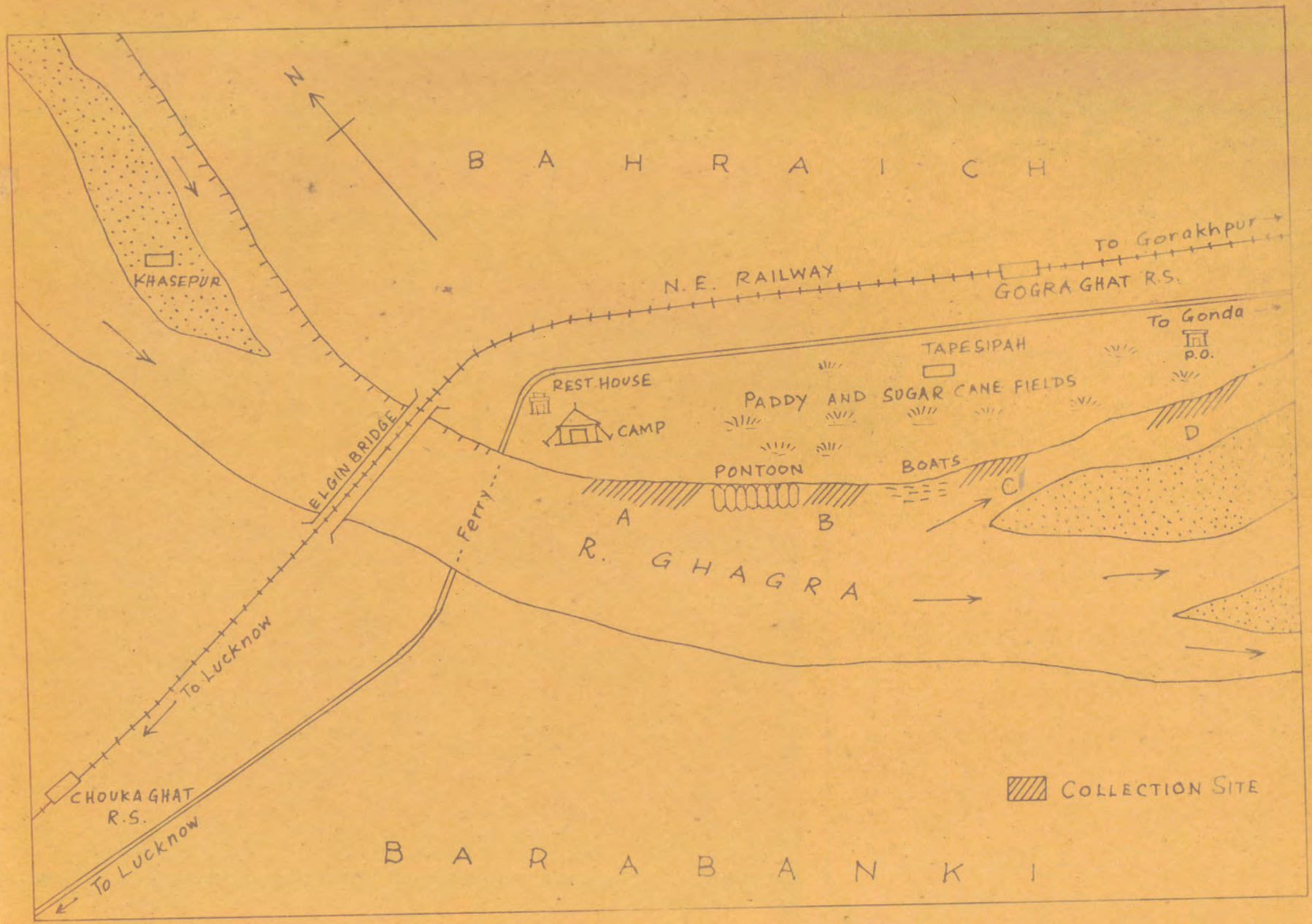

FIG. 9
THE COURSE, GENERAL TERRAIN AND TOPOGRAPHY OF RIVER GHAGRA AT GHAGRAGHAT.

Table 12.

Occurrence, duration and magnitude of floods and spawn spurt at Ghagraghat on River Ghagra

Flood No.	Phase	From		Duration in days	Peak flood level*			Spawn spurt				Spawn catch			
		Date	Hour		Date	Hour	Flood level in m	Quantity	Commencement Date	Commencement Hour	Duration in hours	No. of Std. nets	Catch in ml	Catch in lakhs	Catch per net/hour in numbers
I	Rising	1.7.66	18.00	2	3.7.66	2.00	1.27	-	-	-	-	-	-	-	-
	Receding	4.7.66	6.00	9	-	-	-	D	4.7.66	14.00	28	5	1,112	3.89	2,828
Vacillation phase		13.7.66	18.00	6	-	-	-	-	-	-	-	-	-	-	-
II	Rising	19.7.66	14.00	10	28.7.66	18.00	2.10	-	-	-	-	-	-	-	-
	Receding	29.7.66	6.00	3	-	-	-	-	-	-	-	-	-	-	-
III	Rising	31.7.66	2.00	3	3.8.66	2.00	2.17	-	-	-	-	-	-	-	-
	Receding	4.8.66	6.00	3	-	-	-	-	-	-	-	-	-	-	-
IV	Rising	7.8.66	10.00	6	11.8.66	2.00	2.14	-	-	-	-	-	-	-	-
	Receding	13.8.66	6.00	7	-	-	-	-	-	-	-	-	-	-	-
Vacillation phase		19.8.66	22.00	2	-	-	-	-	-	-	-	-	-	-	-
V	Rising	21.8.66	10.00	6	26.8.66	2.00	2.03	-	-	-	-	-	-	-	-
	Receding	27.8.66	10.00	5	-	-	-	-	-	-	-	-	-	-	-

* Height above the lowest observed water level during the investigations.
Add 104.73 m to the above for getting height above sea level.

and chetty pots, is delineated in Table 13. The spawn analyses revealed that the only spawn spurt yielded desirable spawn, with a major carp content of as much as 32.45%. Except during a brief 2-hour period when the major carp content fell to 8%, the catches obtained consisted entirely of desirable spawn throughout the spurt, with the major carp content in the 2-hourly samples ranging from 14 to 62%. The minor carps generally dominated the catches, the 'cthers' being few or altogether absent.

Table 13

Quality of spawn obtained during the spawn spurt recorded at Ghagraghat on River Ghagra

Fish Group		Percentage composition		
		By spawn analysis	By rearing in	
			Nursery	Chetty pot
Major carps	Rohu	-	6.6	22.2
	Catla	-	0.8	-
	Total	32.45	7.4	22.2
Minor carps		65.00	92.6	77.8
Others		2.55	-	-

The rearing experiments, on the other hand, revealed a much lower percentage of major carps, it being only 22.2% and 7.4% respectively in the chetty pots and nurseries. This is evidently due to differential mortality. The higher percentage in the case of chetty pots was probably due to the fact that the sample for analysis was taken from the chetty pot a month ahead of that from the nursery. Only rohu and catla were encountered in the reared samples, with a distinct dominance of the former. Rohu had better survival in chetty pot than in the nursery, while the reverse was true of catla.

The seasonal spawn index for this centre was found to be 228.40 ml (c.0.80 lakh).

(iii) Spawn availability at prospected sites

Of all the ten sites prospected, spawn was available in traces only at Lorhemau on the southern bank in Barabanki district and at Kaithi and Sangam on the northern bank in Gonda district. Kaithi and Sangam are situated on either side of the confluence of river Sarju with river Ghagra. Apart from the negligible or nil spawn catch at all the prospected sites, their accessibility was very unsatisfactory. As such, Ghagraghat appears to be the most suitable site in the entire 40-km stretch prospected.

(iv) Spawn availability in relation to hydrodynamical and biotic factors

Flood level and current velocity

Duration of and the level attained by the various floods are shown in Table 12. The river was already in a rising condition at the commencement of the observations on 1st July, and as such the exact summer level could not be ascertained. The flood levels indicated are with reference to the lowest level observed during the investigations. The river experienced five floods at Ghagraghat, and of these the later four attained higher levels than the first. Only the 1st flood yielded spawn in bulk quantities in its receding phase. The peak level attained by this flood was only 1.27 m. From the second flood onwards, the water level mostly remained above 1.70 m, the respective peak levels attained by the 2nd to 5th floods being 2.10 m (28th July), 2.17 m (3rd August), 2.14 m (11th & 12th August) and 2.03 m (26th & 27th August). Apart from raising the water level of the river, these floods completely changed the direction and velocity of the current at the collection site. At the comparatively low level of the first flood, the current was flowing almost parallel to the bank, with a velocity ranging from 1.5-2.8 km/hr during the spawn availability period. At the higher levels of the subsequent floods, the main current, after hitting the eastern bank just upstream of the site, was getting diverted towards midstream at a fairly sharp angle to the bank at the collection site. The subsidiary current flowing through the collection site was mostly far too feeble. It is probable that major bulk of the spawn was carried away along the main current in midstream, and this was possibly the main reason for the non-appearance of the spawn in the nets during these floods and not to their non-availability in the river. This

presumption is further substantiated by the fact that fairly heavy collections of almost pure major carp fry could be made in the adjoining puddles and backwaters after they got isolated by the receding flood. Under such conditions, the only way to collect spawn at this site is to employ nets, which can be operated in deeper waters in faster currents. However, at lower flood levels, the site is suitable for commercial exploitation, even though the space for fixing up nets is very much restricted by the large number of pontoons and boats anchored there and by the cultivated and wild growing vegetation. The exploitation should preferably commence in June itself, so as to make full use of the earlier low floods.

Turbidity

Turbidity values ranged from 172-900 ppm. Peak turbidity values coincided with flood peaks, except during the 4th flood. The turbidity was maximum, about 900 ppm, during the period of spawn availability. However, no correlation could be noticed between turbidity and spawn availability at this centre.

Associates

The associates were mostly either altogether absent or were present only in negligible numbers. However, during the period of spawn availability they occurred in fairly moderate numbers, ranging from 5-50 in 2-hourly collections. They occurred in appreciable numbers only during the second fortnight of August. The more common species of associates encountered at the site were Notopterus notopterus, Oxygaster phulo, Aspidoparia morar, Cirrhinus reba, Puntius ticto, Barilius barila and Noemacheilus sp. No correlation could be made out in regard to relative abundances of spawn and associates at the site.

(v) Spawn catch in relation to net position

Observations made on the relative spawn catches of nets placed in different positions did not yield conclusive data in view of the extremely short duration of spawn availability at the site. The scanty data indicated that the nets placed nearer the bank and in comparatively shallower waters generally yielded heavier catches.

(C) River Burhi Gandak

Participants

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A.G. Godbole
} Government of India

A 50-km stretch of the river Burhi Gandak, from Dih in the west to Sansarpur in the east, was selected for spawn prospecting (Fig. 10). The stretch of the river near Khagaria town (Monghyr District), adjoining road bridge No.72 on National Highway No.31, was chosen for round the clock detailed investigations from 10.6.66 to 31.8.66. While the regular observations and collections were made on the northern bank, trial operations were conducted on the southern bank as well (Fig. 11).

A little beyond Sansarpur, about 5 km downstream of the Khagaria site, Burhi Gandak joins the Ganga. The river is channalised between two embankments almost all along its course and is joined by only two rivulets, R. Karee at Samastipur and R. Balan at Dih. Because of the steep nature of the banks, no suitable site is available for the operation of shooting nets along the greater part of its course. The river follows a serpentine course, and at places the bends are almost at right angles, giving rise to rotatory currents. Since the slope of the river bed is not very steep, with any appreciable rise in the water level of the Ganga, there occurs a back-flow into Burhi Gandak as far as 12-15 km upstream, neutralising its currents and creating almost lagoon conditions for varying periods of time.

(i) Occurrence of spawn

The river experienced only two floods, with a vacillation phase in between, during the period of investigations under report. The river, which was at its summer level at the start of the investigations, started rising on 18.6.66, reaching the first flood peak of 6.36 m on 7.7.66. The spawn started appearing about 16 hours before the flood level reached its peak on the 7th and continued to occur in varying quantities in its receding phase during the succeeding two days till the level fell below 6.0 m. Although the spawn occurred continuously during the above period, it touched the index of availability only for a brief spell of 4 hours, from 22 to 2 hrs on the 7th, when the

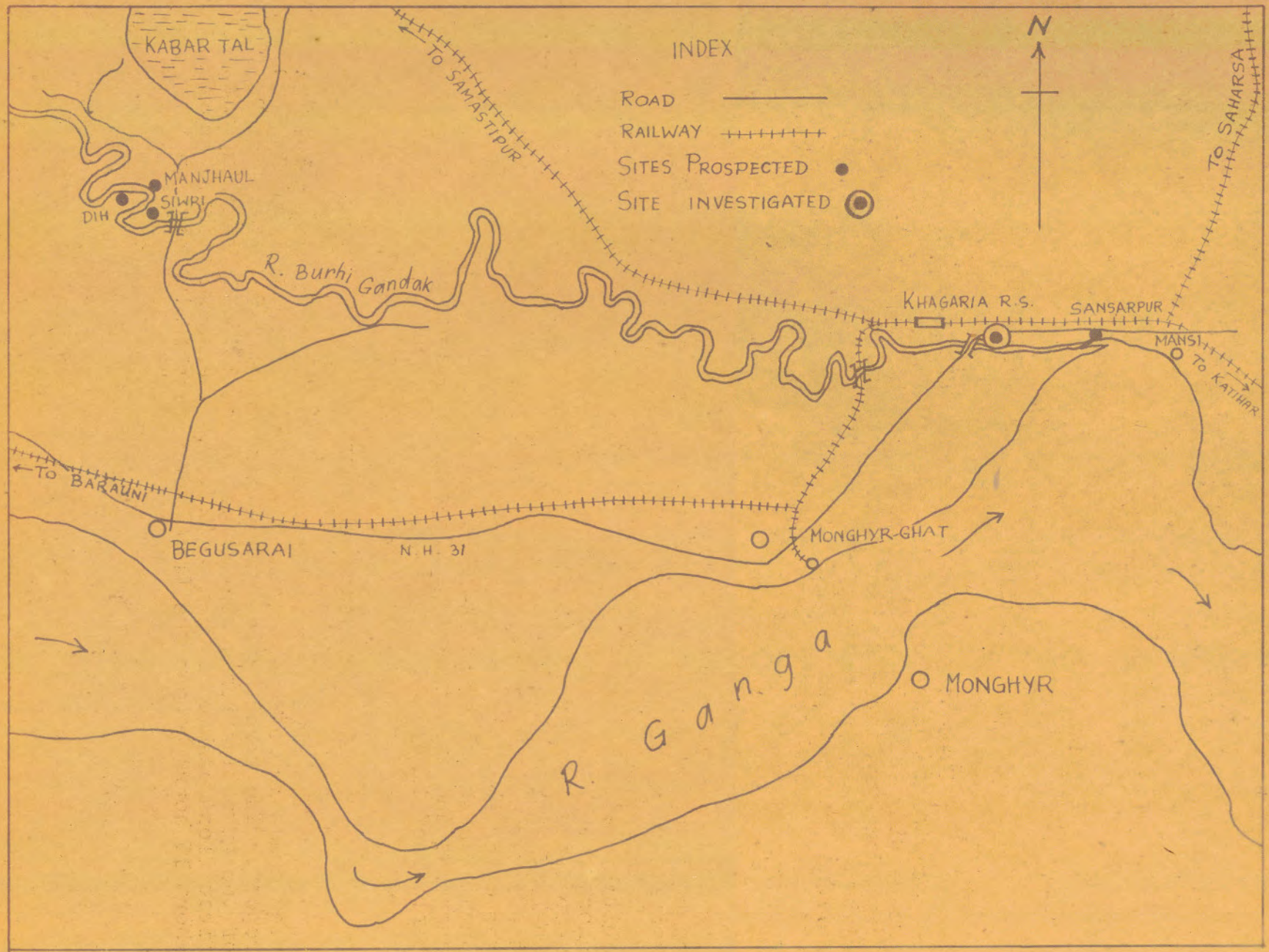
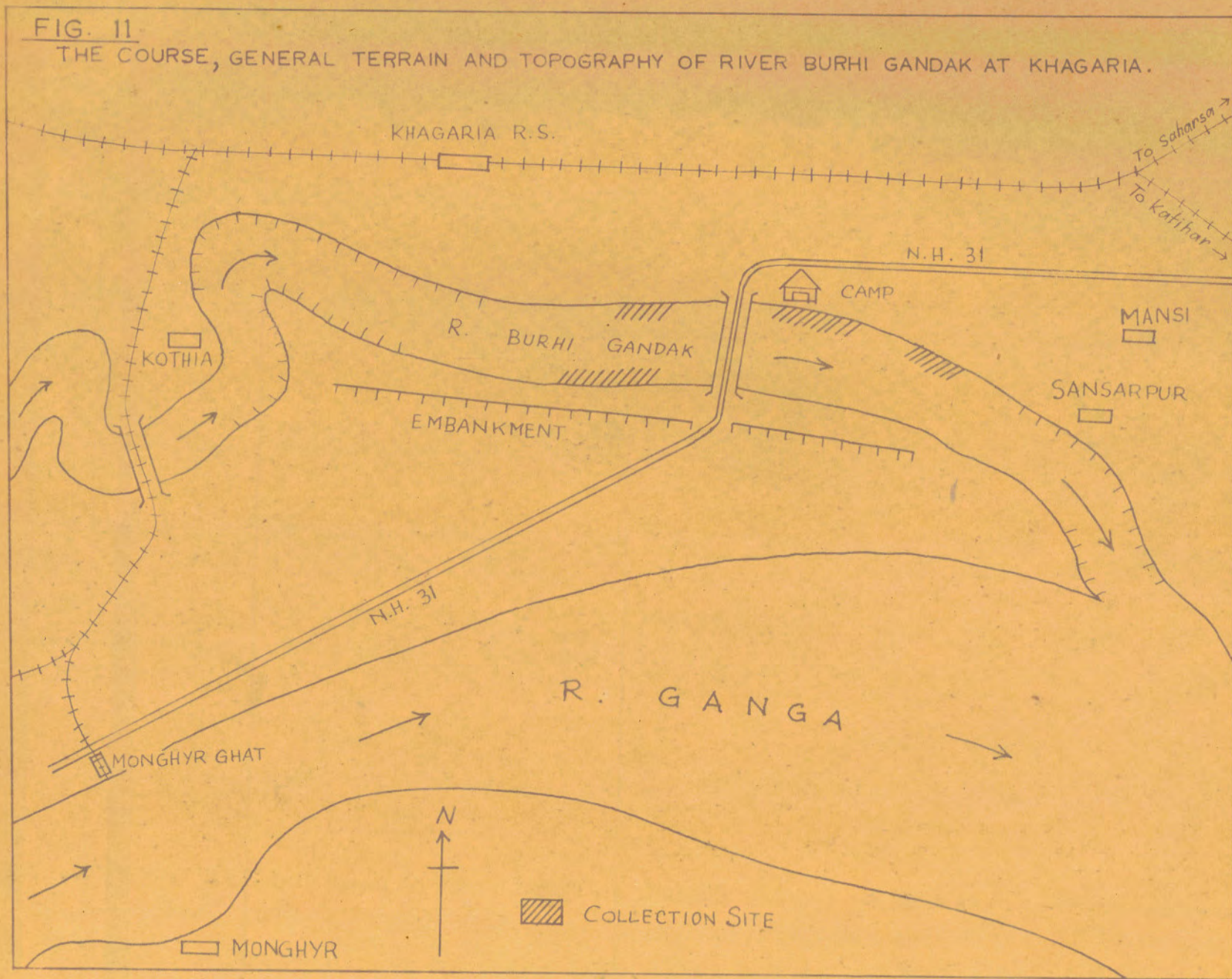


FIG. 10.

KHAGARIA STRETCH OF BURHI GANDAK SHOWING SITES PROSPECTED AND CENTRE INVESTIGATED.

FIG. 11

THE COURSE, GENERAL TERRAIN AND TOPOGRAPHY OF RIVER BURHI GANDAK AT KHAGARIA.



catch per net-hour amounted to only 420 hatchlings. As per the definition adopted in this report, this can hardly be called a spurt. This spell contributed 169 ml of spawn, in five standard nets, and this constituted about 95% of the season's total catch of only 178 ml. The remaining 9 ml of spawn were collected on 20th and 21st July in a single standard net during the vacillation period between the first and second floods.

Details of occurrence of spawn at Khagaria in relation to different phases of the floods are shown in Table 14.

(ii) Quality of spawn collected

All the spawn catches were invariably found to be of the undesirable type. Spawn analyses of the 4-hourly collections revealed that the major carps were totally absent and that the minor carps constituted as much as 99% of the catch. On the other hand, rearing experiments conducted in earthen gamlas indicated the percentage composition as 65.28% minor carps and 34.92% others.

(iii) Spawn potentiality of the prospected stretch

Of the several sites examined during the pre-monsoon survey, apart from Khagaria, only Kothia was found suitable for prospecting. This was because of the presence of high embankments on either side in most of the places. During the monsoon season, however, prospecting was done at four more centres at Dih, Manjhaul and Siwri, located west of Khagaria, and at Sansarpur in the east. No spawn could be obtained at any of the sites, nor are they even otherwise very suitable. In short, the entire selected stretch of Burhi Gandak appears unsuitable for commercial exploitation for spawn.

The absence of major carp spawn in the river may probably be attributed to the following factors : (1) formation of rotatory currents in the river due to its serpentine course; (2) channelisation of the river between two embankments, without any adjacent nallahs or confluent fields where major carps could ascent to breed; (3) neutralisation of the river's currents and establishment of near lagoon conditions because of back-flow from the Ganga; (4) existence of only two incoming streams, one of which has sluice gates at the point of its confluence with the river, and (5) low water level during greater parts of the year, which leads to the draining off of all the available major carps, by the fishermen, leaving practically no breeders for the monsoon season.

Table 14.

Occurrence, duration and magnitude of spawn and floods at Khagaria on River Burhi Gandak, 1966.

Flood No.	Phase	From		Duration in days	Peak flood level			Commencement of spawn occurrence		Duration in hrs.	Spawn catch				Quality
		Date	Hour		Date	Hour	Ht. in m	Date	Hour		No. of nets	Catch in ml	Catch in numbers	Catch per net-hour in numbers	
I	Rising	18.6.66	14.00	19	7.7.66	18.00 to 22.00	6.36	6.7.66	2.00	20	1-5	50	17,500	217	UD
	Receding	7.7.66	2.00	6	-	-	-	Continuation of the above		42	5	119	41,650	199	UD
Vacillation phase I		14.7.66	6.00	12	16.7.66	10.00	5.24	20.7.66	6.00	24	1	9	3,150	131	UD
II	Rising	26.7.66	6.00	13	8.8.66	22.00	8.42	-	-	-	-	-	-	-	-
	Receding	9.8.66	14.00	4	-	-	-								
Vacillation phase II		13.8.66	10.00	9	-	-	-								
III	Rising	22.8.66	18.00	4½	27.8.66	6.00	8.54								
	Receding	27.8.66	10.00	5	-	-	-								

UD = Undesirable

(iv) Spawn availability in relation to hydrographical and biotic factors

Hardly any valid correlation can be drawn here between spawn availability and the various hydrodynamical factors, in view of the very poor spawn catch obtained at this centre. It is, however, noticed that about 95% of the season's spawn catch was obtained when the flood level fluctuated between 6.00 and 6.36 m. It is, therefore, likely that 6.0 m is the minimum flood level required to flood and flush out the breeding grounds. During the II flood when this height was again touched, spawn did not appear, evidently because the water kept on rising further up to over 8 metres. The only other noteworthy feature was the occurrence of filtered off associates in larger numbers during the spawn availability period.

(D) River Kosi Khanua Dhar and R. Khagna

Participants

H.A. Khan (Leader), M.Y. Kamal — Government of India

Ram Shobit Singh — Government of Bihar

Two adjacent tributaries of R. Kosi, viz. Kosi Khanua Dhar and Khagna, were chosen for spawn prospecting during 1966. Of these, the former had been prospected during 1965; but since no conclusive results could be obtained then, it was decided to repeat the investigations at that site. River Khagna was taken up at the specific request of the Bihar Government. It was possible to prospect both the stretches by our party, since the selected site on River Khagna got flooded only late in the season after the spawn occurrence was definitely over in Kosi Khanua Dhar.

The area selected for prospecting covered a 33-km stretch of the Kosi System from Rajanpur Thana in the west to Koparia in the east. This included the stretch of Kosi Khanua Dhar (from Rajanpur Thana to Babuaghat), a 4-km stretch of river Khagna upto Koparia, and the intervening and adjacent stretches of river Kosi (Fig.12). Detailed round the clock investigations were carried out from June 1 to July 12, 1966 at Babuaghat

on the Kosi Khanua Dhar, located in Simri Bakhtiyarpur tehsil of Saharsa district. Thereafter, similar work was undertaken at Koparia on the Khagna till July 31, 1966. For a brief period from June 18 to June 25, when the Babuaghat site turned unsuitable due to heavy silting and changed current pattern, the investigations were carried out at Khanuaghat, about 3 km upstream of Babuaghat. All these three sites are situated on the eastern bank of the rivers. The sites prospected included Rajanpur Thana and Ghogsam on Kosi Khanua Dhar, and Belwara and Kachot on the Kosi. This entire stretch is heavily exploited by parties of commercial fishermen.

(i) Occurrence, areas of concentration and quantity of spawn at Babuaghat/Khanuaghat

A total of four spawn spurts were encountered during the season, 3 at Babuaghat and 1 at Khanuaghat, ranging in duration from 18 to 48 hours. With the appearance of each spawn spurt, trial nets were simultaneously operated at 2-4 suitable spots (A-E, Fig.13) in the Babuaghat/Khanuaghat stretch of the river, in order to locate the spot of maximum spawn availability, which was then chosen for the operation of full battery of nets. The results obtained in these trial nettings are given in Table 15.

Table 15.

Spurt-wise spawn availability at various spots in two-hour trial nettings at Babuaghat/Khanuaghat

Spurt No.	Spawn catch in ml					Most suitable spot
	Khanuaghat		Babuaghat			
	A	B	C	D	E	
1	-	-	negl.	2	negl.	D
2	2	3	negl.	negl.	-	B
3	-	-	-	5	3	D
4	-	-	negl.	5	10	E

negl. = negligible.

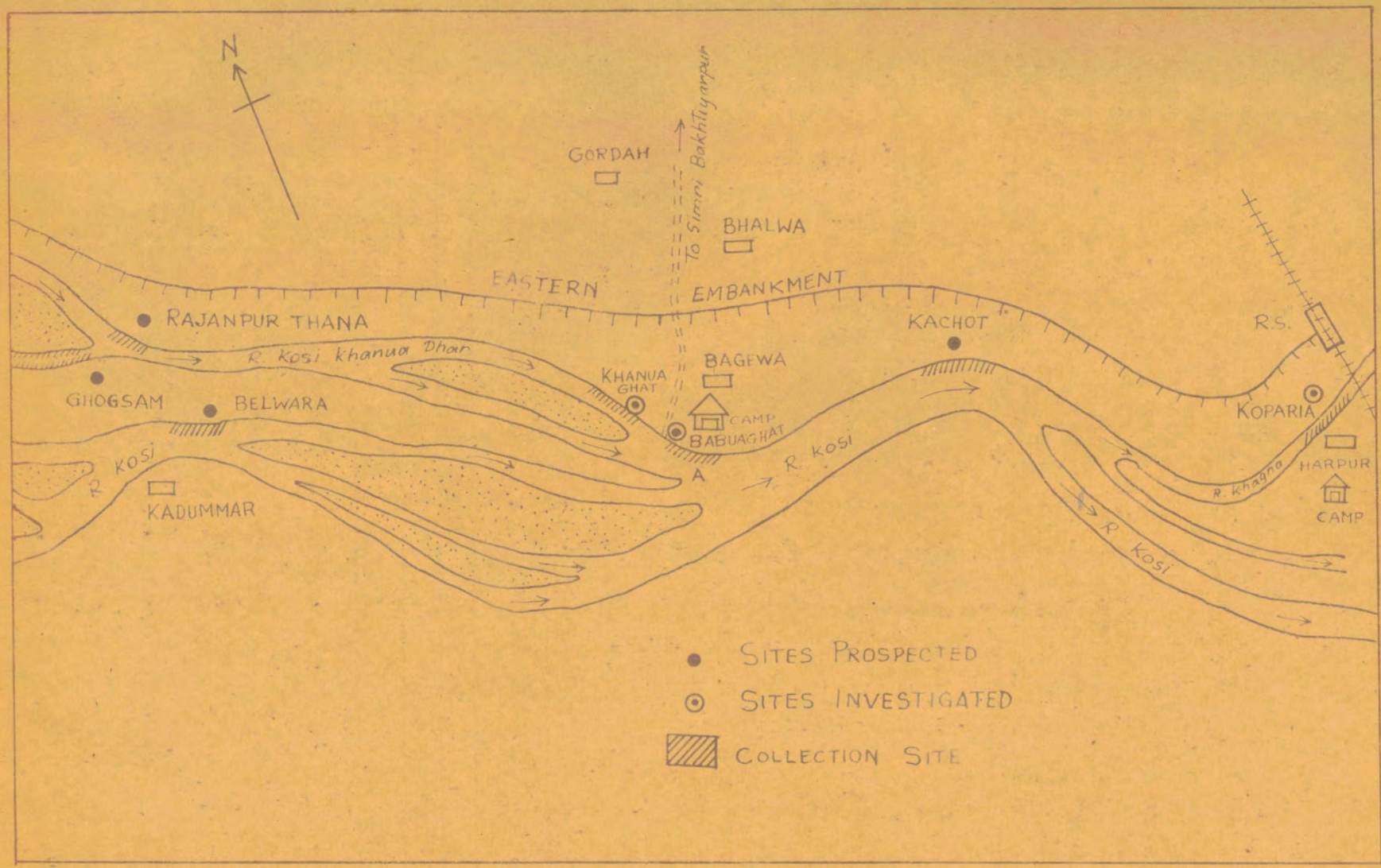


FIG. 12.

BABUAGHAT STRETCH OF KOSI KHANUA DHAR AND KOPARIA STRETCH OF KHAGNA, SHOWING SITES PROSPECTED AND CENTRES INVESTIGATED.

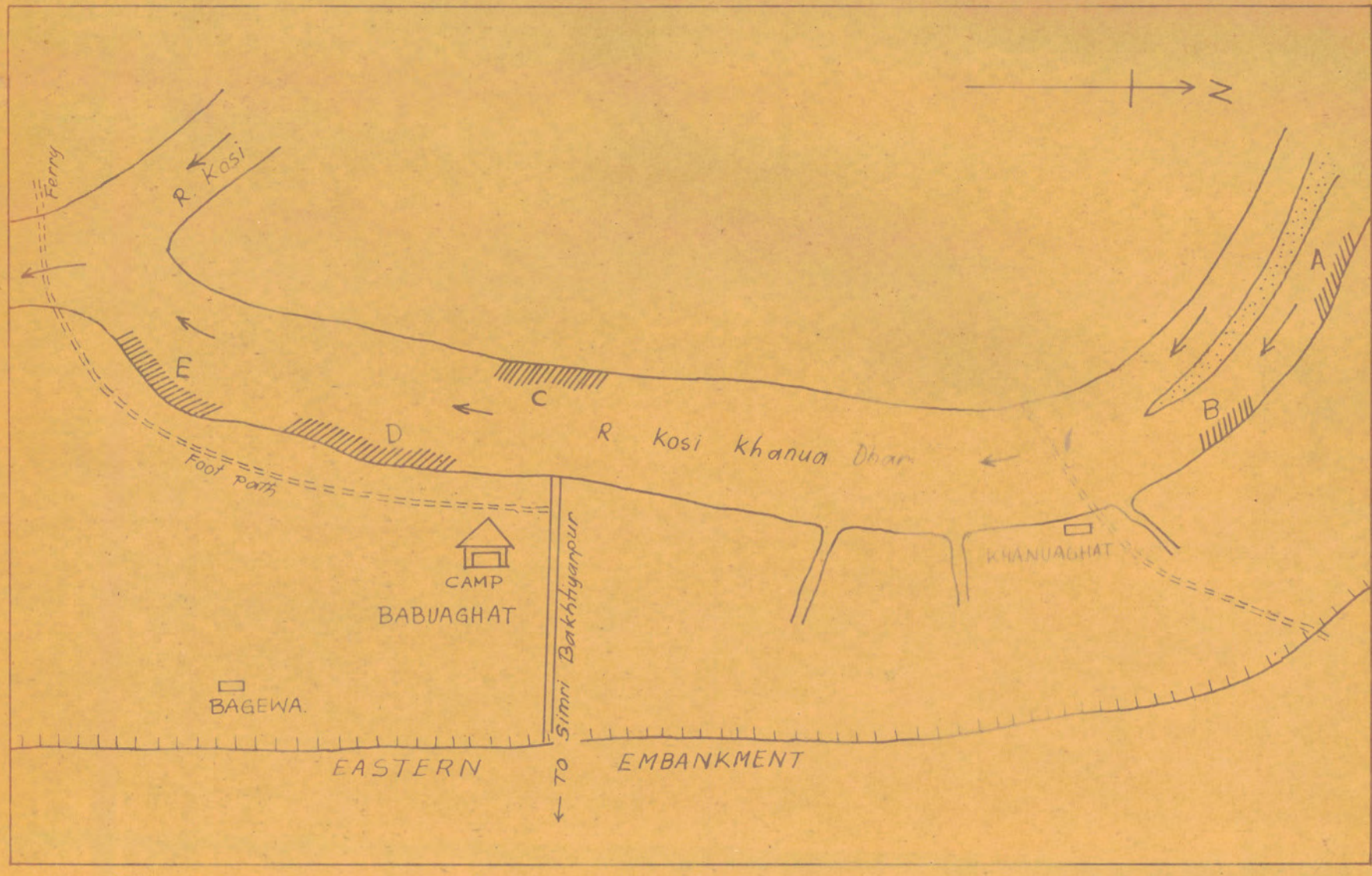


FIG. 13

THE COURSE, GENERAL TERRAIN AND TOPOGRAPHY OF KOSI KHANUA DHAR AT BABUAGHAT.

The difference in spawn concentration at the two spots in Khanuaghat during spurt 2 was not very marked. At Babuaghat on the other hand, spot D, which yielded the maximum quantity during spurts 1 and 3, was completely eclipsed by spot E during spurt 4.

Details of occurrence, duration, desirability and magnitude of the various spawn spurts are shown in Table 16. In the season as a whole, a total of 7483 ml (c.37.4 lakhs*) of spawn was collected at the Babuaghat and Khanuaghat sites. Of these, 7436 ml of spawn were obtained during the four spurts, while the remaining 47 ml were collected at other times when the catch concentration had fallen below the index of availability. All the four spurts were associated with the rising phase of the flood, and no spawn could be obtained during the receding phase and the vacillation period between floods. Although the spawn availability at this centre lasted a total of 128 hours in the entire season, desirable spawn could be collected only during 30 hours. The total catch of desirable spawn in five standard nets amounted to 3,320 ml (c. 16 lakhs), which formed 44.7% of the season's total catch during the four spurts.

Spawn spurt 1, which occurred in the rising phase of flood I at Babuaghat and lasted for 18 hours, was completely devoid of desirable spawn. The 2nd spawn spurt, which was recorded at Khanuaghat in the rising phase of flood II, lasted for 48 hours and yielded 2.4% of the season's total desirable catch. This spurt also yielded a greater quantity of undesirable spawn. The 3rd spawn, which also occurred in the rising phase of flood II and lasted for 22 hours, was again devoid of desirable spawn. The 40-hour long 4th spurt, which also occurred in the rising phase of flood II, contributed 97.6% of the season's total desirable spawn in only 16 hours. It also yielded an equally heavy quantity of undesirable spawn. Spurts 2 and 4 accounted fully for the season's entire desirable spawn yield, collected in only 30 hours. The desirable and undesirable spawn formed 44.6% and 55.4% respectively in the season's total catch. Of all the four spurts, the 4th spurt was most productive, as can be made out from Table 17.

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* 1 ml of spawn contained on an average 500 individuals at this centre, since the hatchlings were mostly 5-5.5 mm in length.

Table 16

Occurrence, duration, desirability and magnitude of spawn spurts at Babuaghat/Khanuaghat on Kosi Khanua Dhar, 1966.

Flood details						Spawn spurt					Spawn catch			
Flood No.	Phase	Duration From	Duration No. of days	Peak Date	Peak Flood level in m*	Spurt No.	Duration From Date	Duration From Hour	Duration Period in hrs.	Spawn desirability	Total catch in ~~mds~~	Duration From Date	Duration From Hour	Duration Period in hrs.
I	Rising	3.3.66	12½	15.6.66	0.91	1	9.6.66	6	18	UD	120	9.6.66	6	18
	Receding	15.6.66	1½	-	-	-	-	-	-	-	Nil			
Vacillation phase		17.6.66	5½	-	-	-	-	-	-	-	Nil			
II	Rising	22.6.66	9½	2.7.66	2.18	2	23.6.66	6	48	UD	220	23.6.66	10	34
										D	80	23.6.66	6	14
						3	26.6.66	8	22	UD	360	26.6.66	8	22
						4	27.6.66	14	40	UD	3416	27.6.66	14	24
										D	3240	28.6.66	6	16
	Receding	2.7.66	1½	-	-	-	-	-	-	-	Nil			
Vacillation phase		4.7.66	6½	-	-	-	-	-	-	-	Nil			
III	Rising	10.7.66				The III flood was still in its rising phase when the investigations were concluded at this centre on 12.7.66.								
Total :			59						128	UD	4116			98
										D	3320			30
											7436			

* Height above the lowest observed water level during the investigations. UD = Undesirable. D = Desirable.

Table 17.

Spurt-wise and entire season's spawn catch per net-hour

Catch per net-hour (in ml)	SPURTS				Entire season
	1	2	3	4	
	1.5	1.3	3.3	33.3	11.8

(ii) Quality of spawn collected

Spurt-wise quality of spawn, as revealed by spawn analyses and nursery rearings is shown in Table 18.

Table 18.

Spurt-wise quality of spawn

Spurt No.	D/UD	Percentage composition								
		By spawn analyses			By rearing					
		Major carps	Minor carps	'Others	Major carps				Minor carps	'Others'
					Catla	Rohu	Mrigal	Calbasu		
1	UD	3.3	96.7	nil	-	-	-	-	50.9	49.1
2	UD / D	4.1 / 19.2	95.9 / 80.8	nil	-	20.0	-	-	78.0	2.0
3	UD	1.2	98.8	nil	not reared			-	-	-
4	UD / D	2.8 / 19.4	97.2 / 80.6	nil	-	40.0	-	-	36.2	23.8

As revealed by spawn analyses, while the undesirable 1st and 3rd spurts contained only 3.3% and 1.2% respectively of major carps, the desirable part of 2nd and 4th spurts contained as much as 19.2% and 19.4% respectively of major carps. However, rearing of composite samples taken from the 2nd and 4th spurts

revealed a conspicuously high percentages of 20 and 40 respectively. In one of the rearings from spurt 4, the major carp component was found to be as high as 55%. These differences may be attributed mainly to differential mortality of different species and the rearing of spawn of different spurts in the same nurseries.

Fuller details of the rearing experiments are given below in Table 19.

Table 19.

Spurt-wise and flood-wise spawn quality as determined from rearings in nursery pits

Flood No.	Spurt No.	Rearing No.	Sample size	Percentage of Catla	Rohu	Mrigal	Calbasu	Minor carps	'others'
I		1	170	-	-	-	-	90.4	9.6
	1	2	36	-	-	-	-	55.4	44.5
		3	15	-	-	-	-	6.7	93.3
	Weighted average			-	-	-	-	50.9	49.1
II	2	4	182	-	20.0	-	-	78.0	2.0
	4	5	166	-	26.0	-	-	71.0	3.0
		6	43	-	39.5	-	-	37.2	23.3
		7	40	-	55.0	-	-	-	45.0
	Weighted average				35.1			46.5	18.3

The index of spawn quantity, as well as of desirable spawn quality, based on nursery rearings, is given below in Table 20.

Table 20.

Indices of spawn quantity and quality at Babuaghat/Khanuaghat

Quantity (ml)	Quality (%)		
	Major carps	Minor carps	'others'
664.0 (c.3.3 lakhs)	35.1	46.5	18.3

(iii) Spawn investigations at Koparia on R. Khagna

The investigation site was shifted from Babuaghat to Koparia on the Khagna after July 12th, since because of the rising water level the area adjoining Babuaghat was getting increasingly inundated, leaving no suitable spots for net operation. River Khagna gets inundated late in the season and attempts to prospect there for spawn earlier in the season could not be gone through since there was hardly any water in the river. When finally the investigations could be taken up there in the third week of July, the period of spawn availability was already over and only advanced fry and fingerlings could be collected. Therefore, this site is unsuitable for commercial exploitation for spawn.

(iv) Spawn availability at prospected sites

Of the various sites prospected for spawn availability, those at Kachot and Belwara on the main Kosi had steep banks, which were also subject to heavy erosion. There was very little space for operation of nets at these sites, nor did the trial operations yield any spawn. Both these sites are, therefore, considered unsuitable. On the other hand, the sites at Rajanpur Thana and Ghogsam on the Kosi Khanua Dhar were found suitable for commercial exploitation.

(v) Spawn availability in relation to hydrographical and biotic factors

Flood level

Flood in the Kosi and its dhars is caused by heavy rains on the southern slopes of the Central Himalayan range, and its magnitude on the plains depends on the amount of water released by the Kosi Barrage. Some important tributaries like Kamla, Bagmati, etc. join the Kosi before the origin of Kosi Khanua Dhar. Further, in its course Khanua Dhar is joined by other smaller dhars. As mentioned earlier, all the spurts occurred during the rising phase of the two floods. This makes it probable that the spawn that occurred in Kosi Khanua Dhar most likely came down from the main Kosi, which in its turn might have received it from some other tributary having flood of a higher magnitude than that of Kosi Khanua Dhar. The reported heavy occurrence of major carp spawn in River Kamla lends support to the above inference.

Because of the construction of the Kosi embankment, the Babuaghat/Khanuaghat stretch of the river overflows its banks when the flood level exceeds 2.0 m above the summer level and inundates the adjoining low lying areas, when operation of shooting nets becomes no more feasible. The embankment has also in all likelihood cut off connections to the probable breeding grounds of major carps.

Current velocity

The Kosi and its dhars carry a heavy load of silt during the floods. This combined with the prevailing fast current results in the frequent choking of nets and tail pieces, which leads to the vomiting of spawn from the net. A slow current velocity of 1.3 - 2.0 km/hr. was found to be most conducive to spawn collection at Kosi Khanua Dhar.

The fast flowing waters of the river often bring about conspicuous erosion of the banks, as happened at Babuaghat during the year under report. The erosion of the bank a little upstream of the collection site changed the course of the current and converted the collection site into a shadow zone temporarily.

Weather conditions

Overcast sky and/or little drizzle, coupled with gentle wind, were found to be ideal for spawn collection. Heavy rains and stormy winds resulted in almost complete disappearance of spawn from the nets.

Associates

The associates did not show any definite correlation with spawn availability, and no indicator species could be made out. However, they adversely affected net efficiency by choking tail pieces and caused heavy mortality among spawn during segregation. They also depleted spawn population, in that during periods of spawn availability the guts of associates were found fully gorged with spawn.

(vi) Effect of position of net on catching efficiency

The observed data at the centre indicated that nets in the foremost row yielded better catches than those behind it, while in the same row the one nearest to the bank in shallower waters yielded the best results.

(E) River Badua

Participants

A.N. Ghosh (Leader) B.N. Saigal K.V. Rao R.K. Bhattacharya T.D. Nangpal	Government of India
B.P. Singh G.C. Nishad	Government of Bihar

Of late there has been an appreciable decline in the quantum of fish spawn collected at some of the important collection centres in the lower stretches of the Ganga River System. This is most likely due to the fact that many of the tributaries that used to bring the first freshets of south-west monsoon directly to the Ganga, thereby bringing about a suitable environment for carp breeding, have now been harnessed through the construction of dams, weirs and barrages, and the rain water is stored in the newly formed reservoirs below the headwaters of the tributaries. This change in the water table of the tributaries has reduced the extent of suitable environment hitherto available for carp breeding, thereby affecting the spawning success of major carps in the main river. It is, therefore, necessary to explore the possibility of locating additional spawn collection centres in such regions, specially in the foot-hill regions near the reservoirs, which have either a rich indigenous fauna or have been artificially stocked over the years. River Badua, which is a southern tributary of the Ganga originating in the hilly terrains of Santhal Parganas, is one such river. It was harnessed in 1963 with the construction of the Hanumana Dam above the village Biji Kharua, resulting in the formation of Badua reservoir. The reservoir had been stocked with major carps during the years 1963-'65. Further, local reports indicated the congregation during early monsoon of a large number of big-sized major carps in the south-west corner of the reservoir where it meets the river. This prompted the undertaking of spawn prospecting investigations in river Badua, which, if successful, should not only provide a lucrative source of spawn locally for the region, but also obviate the necessity of artificially stocking the reservoir.

River Badua is seasonal in nature containing water only during the monsoon months. All along its course till it meets the reservoir, the river flows through hilly terrain with sharply changing slope gradients along its long axis, interrupted by huge boulders across the river bed giving rise to water falls ranging in height from 3 to 40 feet. The average slope gradient of the river in this course is recorded by the Irrigation Department as 2.5 feet per mile. The river bed is sandy for about 3 km from the point of its confluence with the reservoir upstream to village Mehdi Jhajha, while in the rest of the river it is rocky with intermittent sand patches.

Detailed round the clock spawn investigations were carried out at the lowermost stretch of the river adjoining the reservoir near the village Mehdi Jhajha, while a 40-km stretch of the river extending from Badharia in the north to Dharara in the south was taken up for prospecting survey (Fig.14). Because of wide fluctuations in water level and current velocity, the actual site of detailed investigations had to be shifted now and then between the villages Badharia and Nawadih, over a distance of about 5 km, depending on the operational suitability at the various sites. The operations were started at Badharia and successively shifted to Mehdi Jhajha, Nawadih, Bhusi and finally again to Mehdi Jhajha (Fig.15).

(i) Occurrence and magnitude of floods

Due to torrential currents during floods, it was at times not possible to fix the flood measuring pole at the collection sites, and at such times the fluctuations in the reservoir level were taken to indicate the trend of changes in the river as well. However, fall in water level of the river was not necessarily reflected in the reservoir level, since the latter depended on the release of water from the reservoir to the irrigation canals. The floods in the river were almost invariably caused mainly by rains in the adjacent catchment area. There occurred two major floods, one during the last week of June and early first week of July (27th June - 2nd July) and the other early in August with its peak on 10.8.'66. Minor floods, lasting from a few hours to one or two days, were recorded in the 2nd and 3rd weeks of July, 2nd, 3rd and 4th weeks of August and the 1st week of September.

During the first flood, the water level first rose by 1.1 m in about 3 days' time from 27th - 29th June and then rose abruptly by another 4.27 m in the next 24 hours. With the

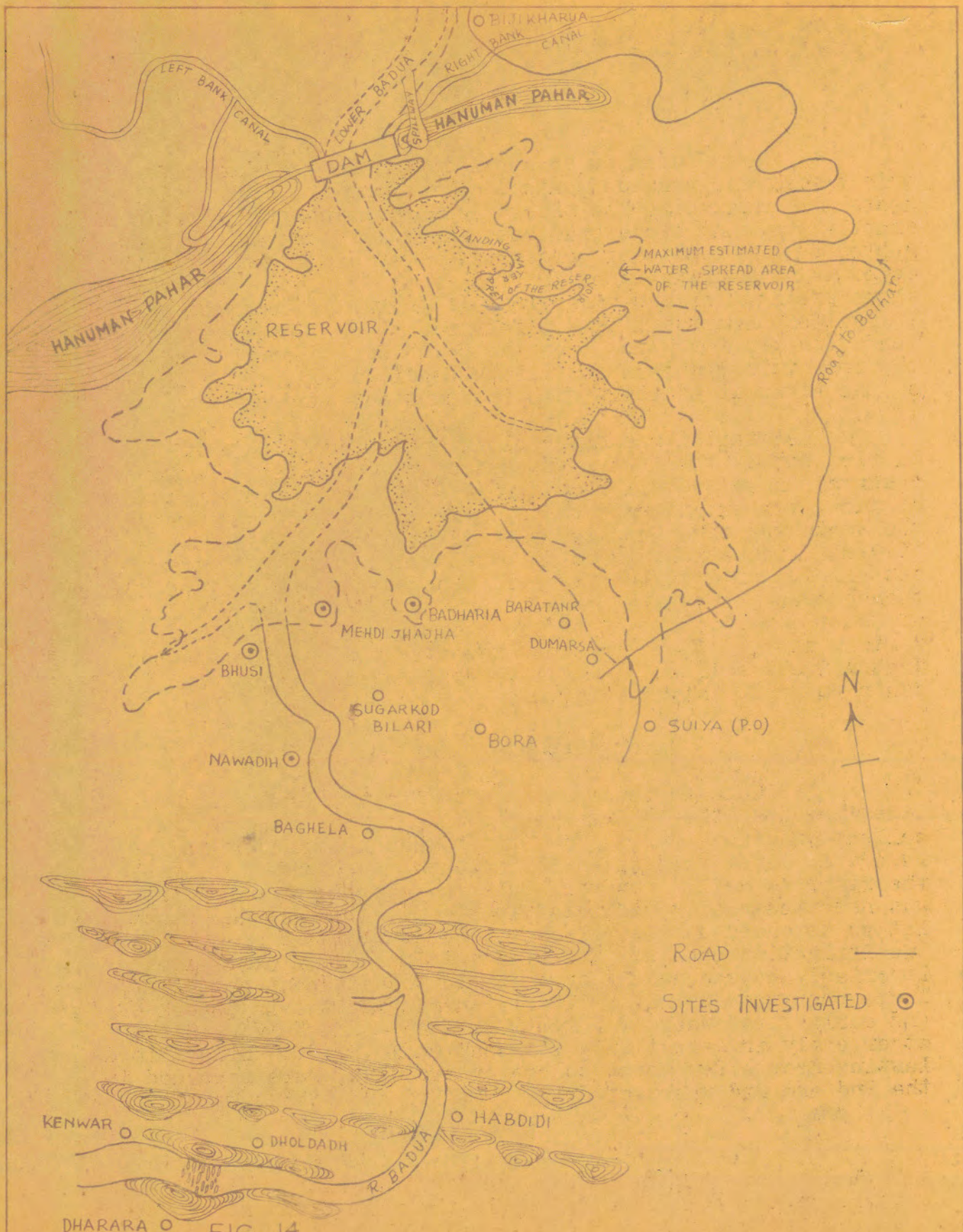

FIG. 14

MEHDI JHAJHA STRETCH OF RIVER BADUA AND BADUA RESERVOIR SHOWING CENTRES INVESTIGATED

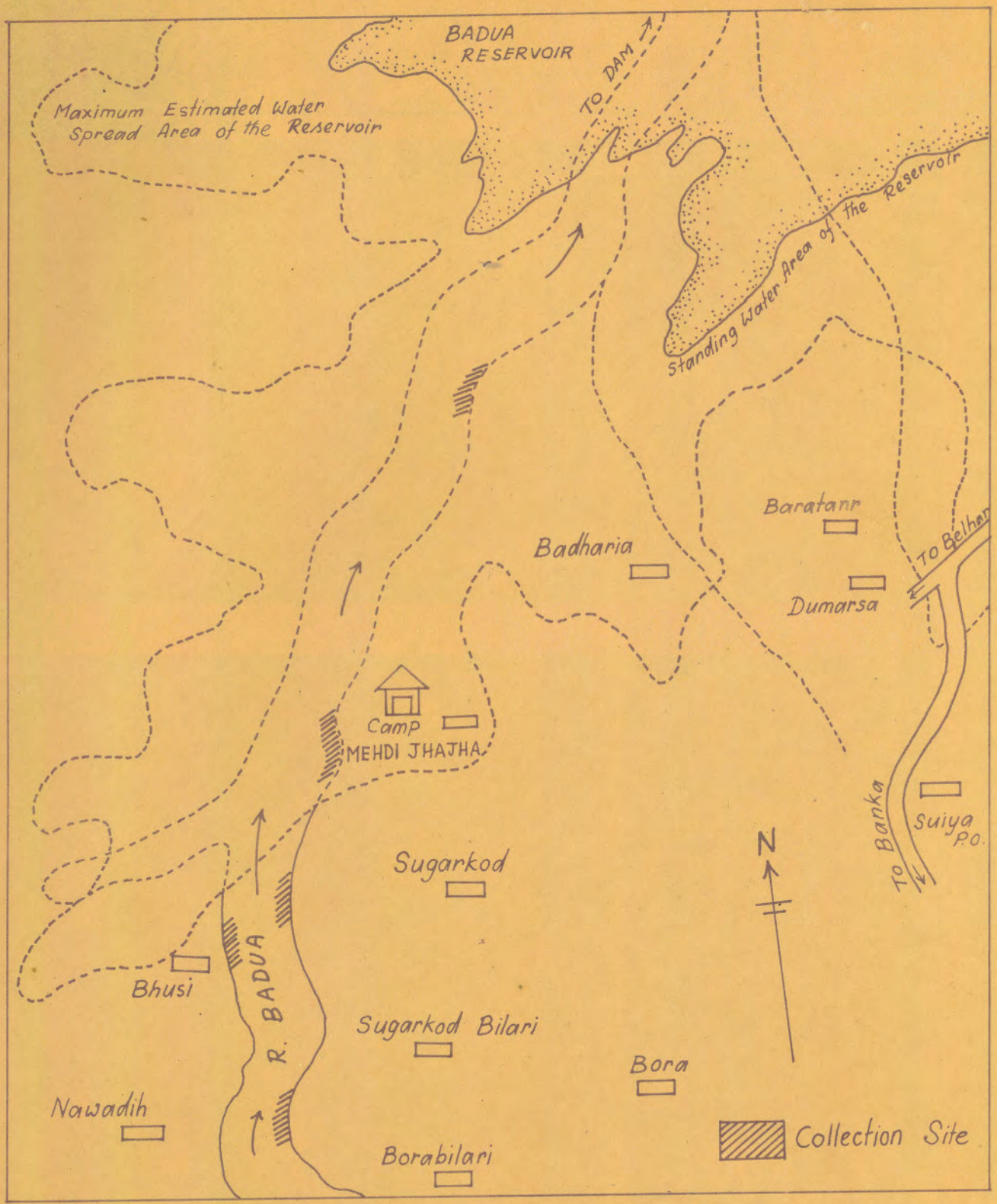

FIG. 15.

THE COURSE, GENERAL TERRAIN AND TOPOGRAPHY OF RIVER BADUA AT MEHDI JHAJHA.

cessation of rains on 3.7.66, the river became almost dry, but the reservoir continued to expand and engulfed the collection site at Badharia, which necessitated its shifting to Mehdi Jhajha about 2 km upstream. The second flood on 9.7.66 caused the site to be shifted another 3 km upstream to Nawadih. However, immediately after this flood receded on 10.7.66, this site became almost dry and had to be shifted 2½ km downstream to Bhusi, where the operations could be continued till the river became dry on 28.7.66. Further rains in the 1st week of August led to the second major flood referred to above.

Details of rainfall at Badua during the season are given in Table 21. It is evident from Table 21 that most of the floods were caused by local rainfall.

Table 21.

Rainfall at Badua during the monsoon season of 1966 (in cm)

June 1966		July 1966		August 1966		September 1966	
Date	Rainfall	Date	Rainfall	Date	Rainfall	Date	Rainfall
1	2	3	4	5	6	7	8
13	-	1	0.13	1	-	1	-
14	-	2	1.14	2	0.13	2	-
15	-	3	-	3	0.30	3	2.79
16	-	4	-	4	0.25	4	0.38
17	-	5	-	5	0.13	5	0.08
18	-	6	0.81	6	2.16	6	-
19	-	7	0.25	7	0.76	7	-
20	-	8	-	8	2.29	8	-
21	0.18	9	-	9	-		
22	-	10	2.54	10	6.35		
23	-	11	-	11	-		
24	0.13	12	-	12	3.30		
25	0.71	13	1.91	13	-		
26	0.89	14	-	14	-		

contd.....

1	2	3	4	5	6	7	8
27	0.25	15	-	15	0.08		
28	3.81	16	-	16	-		
29	1.52	17	-	17	-		
30	4.19	18	-	18	0.46		
		19	1.27	19	0.51		
		20	0.97	20	-		
		21	1.65	21	-		
		22	-	22	0.64		
		23	-	23	1.02		
		24	-	24	0.99		
		25	-	25	-		
		26	-	26	-		
		27	-	27	-		
		28	-	28	-		
		29	-	29	-		
		30	0.43	30	-		
		31	-	31	-		

Note: The dates underlined indicate days on which floods occurred in river Badua.

(ii) Occurrence, quantity and quality of fish eggs

Fish eggs started appearing in the nets during the rising phase of the first flood in the early hours of 28.8.66 and continued to be available at varying magnitude during the rising phase of the subsequent floods. However, major carp eggs were absent from the catches obtained after the 3rd week of July. The date-wise quantity of fertilised eggs collected during different floods, along with its percental composition is given in Table 22.

Table 22.

Quantity and quality of fish eggs collected from River Badua in 1966

Date	Flood No.	Total quantity of eggs in ml	Percental composition	
			Major carps	Minor carps and others
28.6.66	I	5,000	32.5	67.5
29.6.66	I	11,665	25.0	75.0
9.7.66	II	935	3.0	97.0
13.7.66	III	225	nil	100.0
17.7.66	IV	420	9.0	91.0
20.7.66	V	850	20.6	79.4

The availability of fertilised eggs instead of hatchlings indicated local spawning. This was confirmed by actual observation of spawning of both major and minor carps on 28.6.66 and 29.6.66 during the rising phase of the first major flood. While the minor carps, minnows and gobieds started spawning with the initial rising phase of the flood, major carps congregated and started spawning a little later when the flood level reached 0.76 m. This could be made out by the difference in the diameter of fertilised eggs collected in the nets. The concentration of major carp eggs in the collections increased progressively with further rise/in the water level upto 1.52 m, there was a decline in the major carp egg content, which became negligible when the water level crossed this limit and was ultimately absent with the abrupt rise in water level in the later phase of the flood on 30.6.66. In the subsequent floods of lower magnitude, when the water level was not raised by more than 0.30 m, major carp egg content was either negligible or nil.

No fertilised eggs could be collected in the receding phase of any of the floods, which fact indicated that fish from the reservoir migrated to the breeding ground only during the rising phase of the floods.

/ in flood level till it reached 1.40 m with further rise

(iii) Availability of fish eggs at prospected sites

Trial nettings made in the upper stretches upto Dharara to ascertain whether there was any other breeding ground in the river, which could have possibly contributed to the egg catches made in the lower stretches, revealed that during the year under report no breeding took place in that stretch of the river for want of sufficient water, which alone could have permitted the fish from the reservoir to migrate up. At Dharara, 32 km upstream of the reservoir, the river bed shows an extremely steep fall (Fig.16) and it would be impossible for the fish to negotiate the same in the absence of sufficient water level in the river. Local enquiries revealed that during years of normal rainfall, huge concentrations of major carps had been taking place all along the stretch of the river from Badharia to Dharara. It is, therefore, probable that in such years breeding of major carps must be taking place on a much higher scale than that observed in 1966.

(iv) Availability of fish eggs in relation to hydrographical and meteorological factors

Flood level and rainfall

The foregoing account has shown that major carp eggs occurred in the Badua invariably with some rise in water level of the river, and always in the rising phase of the flood. They occurred in good numbers during that part of the first flood when the water level rose from 0.76 m to 1.40 m, beyond which their occurrence dwindled, to disappear altogether with a sudden further rise in the level. In the subsequent minor floods when the water level was not raised by more than 0.30 m, the occurrence of major carp eggs was negligible or nil. When the water level did rise by more than 0.30 m on 20.7.66, major carp eggs appeared in the collection, but in lesser magnitude than during the first flood. This was probably due to the lesser magnitude and erratic pattern of rising of this flood. Further, a sudden flood of appreciable magnitude immediately raising the water level by over 1.06 m, as observed on 9th and 10th August, failed to yield any major carp eggs. As such, it appears that in this particular environment, major carp breeding is prompted by a gradual rise in water level ranging between 0.61 to 1.40 m, while further rise, erratic fluctuations and abrupt rise in water level appear to be unfavourable.

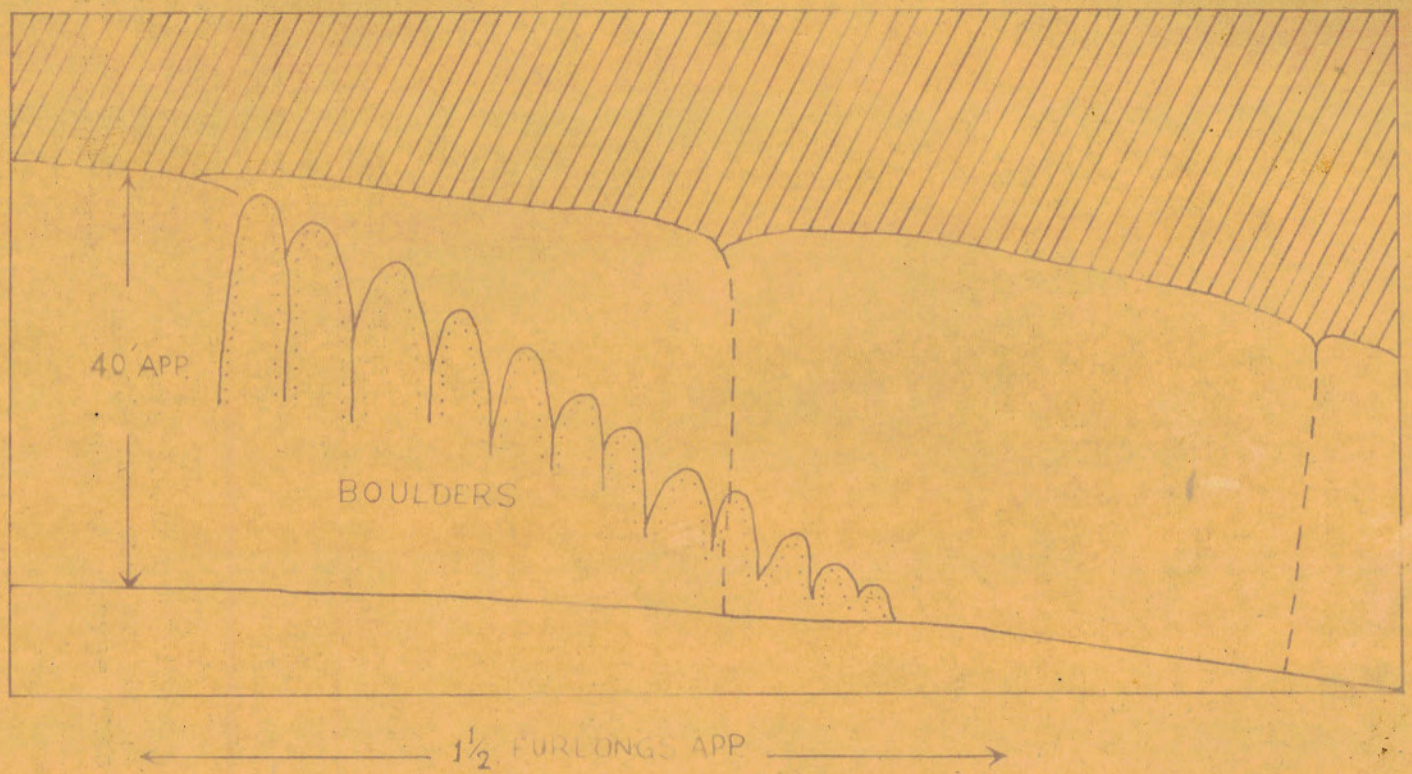

FIG. 16
LONGITUDINAL SECTION OF RIVER BADUA AT DHARARA.

It has been shown above that the floods in river Badua were caused mostly by rainfall in the adjacent catchment area. As such, the failure or success of major carp spawning in this river depends largely on local rainfall, specially in its upper stretches. The total rainfall in the region during 1966 was only 45.39 cm, against an average of 152 cm during the preceding five years. This considerable decline in rainfall, combined with prolonged drought between two successive rainfalls, necessitated an early discharge from the reservoir for irrigation purposes. During years of normal rainfall, large number of major carps are reported to be migrating up the steep gradient upto Dharara in the appreciably high flood level. Because of the failure of monsoon in 1966, the major carps could not migrate up beyond Bhusi, thereby being unable to utilise the likely spawning area between Bhusi and Dharara.

pH, turbidity and weather conditions

Almost all the bulk collections of eggs were made when the pH value of the water ranged between 6.8 and 7.4. A slightly alkaline medium seemed to favour the breeding of major carps. Maximum availability of major carp eggs coincided with higher turbidity values, ranging from 1200-2500 ppm. It is possible that higher turbidity increased the spawning activity in this environment. Gentle wind and heavily overcast sky with occasional showers were found to be most favourable for egg availability in appreciable quantities.

Current velocity

Because of river Badua's torrential nature, even a column of water as high as only 10-30 cm had a current velocity of 2.0-3.5 km per hour even in the absence of flood. The current velocity was found to be generally uniform all along the width of the river, unlike as in the rivers of plains where it is very low at the margins. High velocities of upto 6 km/hr obtaining during the floods, coupled with shifting sands, often made net operation impracticable in the river. It was, therefore, necessary to make the collections at the nearest point of the confluence of the river with the reservoir, where the current velocity was substantially reduced. This necessitated the shifting of the collection site with floods of different magnitudes.

General

The establishment of the fact that major carps can also breed in hilly terrains, as revealed by this investigation, has opened up a new avenue for augmenting the collections presently made only in the rivers of the plains. This investigation has also revealed that the spawning activities in this river are solely due to the migration of breeding population from the reservoir, and that there is no other source to bring in spawn, as the river is only seasonal and does not inundate any other standing water harbouring fish fauna. It is, therefore, necessary to examine in detail the fish population of the reservoir, and also to organise the collection of eggs and spawn in the river at the breeding ground and raise them in farms for purposes of supply elsewhere and also for re-stocking the reservoir, before they are lost in the reservoir or in its exit canals. The results obtained here also call for such investigations to be undertaken in the headwater regions of other similarly placed recent reservoirs in the southern drainage of the Ganga.

2. INDUS RIVER SYSTEM

(A) River Beas

Participants

D.V. Pahwa (Leader) S.D. Gupta	Government of India
Surendra Swaroop Tejendra Bahadur Singh	Government of Punjab

The stretch of river Beas adjoining the village Wazir Bhullar situated on its western bank, near the Beas railway station in Amritsar district, was selected for detailed round the clock spawn investigations from 1.7.'66 to 31.8.'66. The stretch selected for prospecting extended from Sri Hargobindpur in the north-east to Harike in the south-west, a distance of about 145 km (Fig.17). Almost all along its stretch from Wazir Bhullar to Harike, the river is flanked by a 5-7 km wide stretch of marshy land, dotted with thorny shrubs. In the vicinity of Wazir Bhullar, the river is joined by three incoming nallahs,

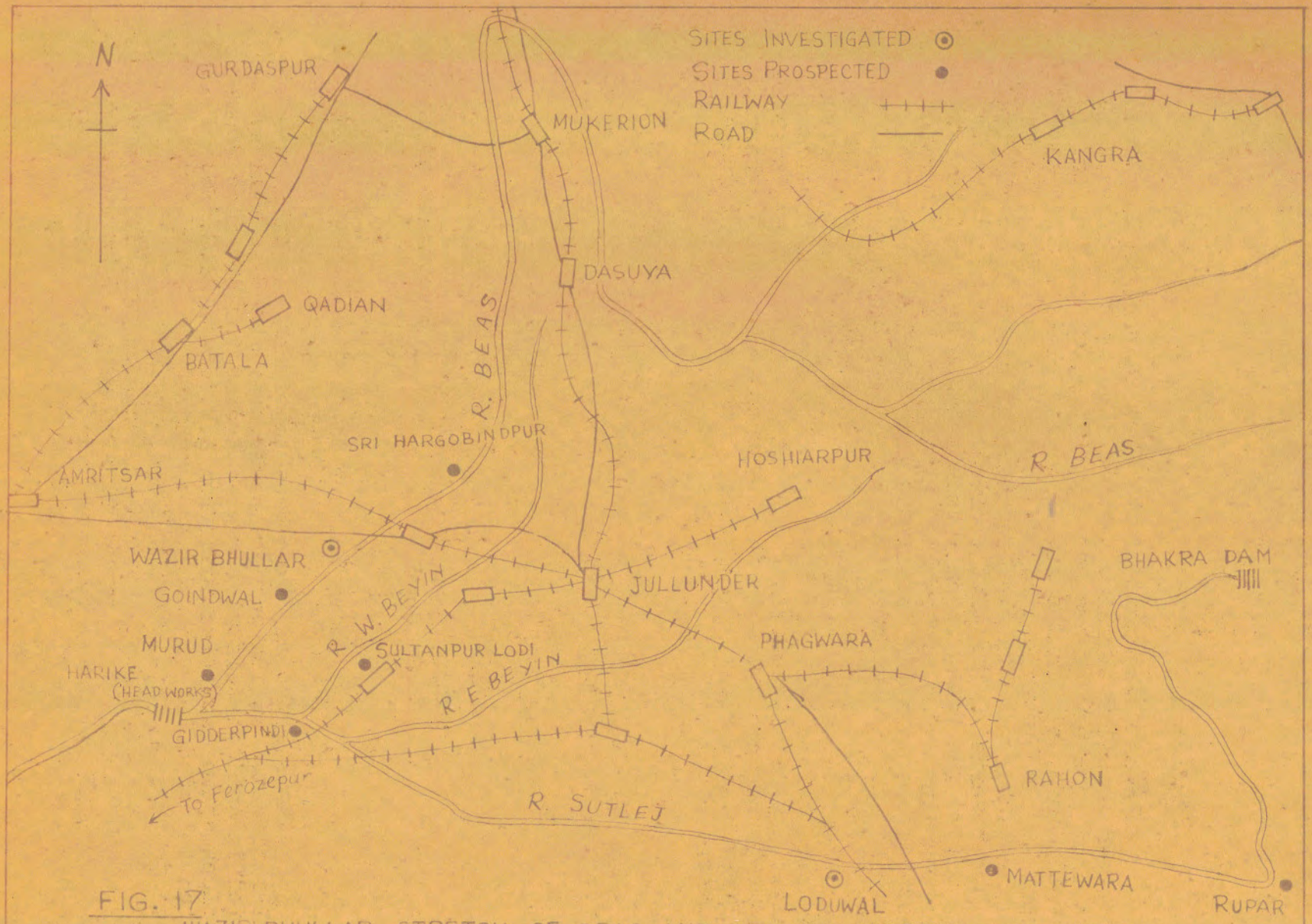

FIG. 17

WAZIR BHULLAR STRETCH OF BEAS AND LODUWAL STRETCH OF SUTLEJ, SHOWING SITES PROSPECTED AND CENTRES INVESTIGATED.

all on the western bank (Fig.18). The regular shooting net operations at Wazir Bhullar were carried out at four different spots (A, B, C & D), all situated within a stretch of about 2 km, depending on their suitability at the time of operation. The river bank at these sites is fairly steep and at lower flood levels it is possible to operate the nets in only a single row adjacent to the bank.

(i) Occurrence of spawn and areas of concentration

At the start of the investigations, the river was already in a flooded condition and the water level was found to be steadily going down. During the course of the investigations, three more floods were experienced, of which the first one was distinctly higher than the rest. The rising phase of the first flood lasted from 20th to 27th July, when the flood attained its peak (Table 23). However, there was a slight vacillation during this rising phase, when from 8 hours on the 22nd to 18 hours on the 23rd, the flood level receded from 1.95 m to 1.68 m. It was during this temporary recession of flood level that the river yielded the season's entire catch of only 60 ml of spawn in 4 standard nets in the course of only 4 hours on 22.7.66, the catch per net-hour being only 3.75 ml or 1312 hatchlings. The second and third floods, which occurred during the period 31st July to 8th August, with their peaks on 1st August and 8th August respectively, did not yield any spawn. The fluctuations in water level after 8.8.66 were mostly negligible till 22.8.66, after which the water went down to its pre-monsoon level.

At the time of spawn availability, trial netting was done at the spots A, B & C (Fig.18) to determine the spot of maximum abundance. While the catch per net-hour was 3.75 ml at A, it was less than 1 ml at B and C. As such, spot A was found to be the most suitable spot. Since this is situated upstream of all the three nullahs, it is presumed that none of these nullahs brought down the spawn and that it must have flowed down from the upper reaches of the river.

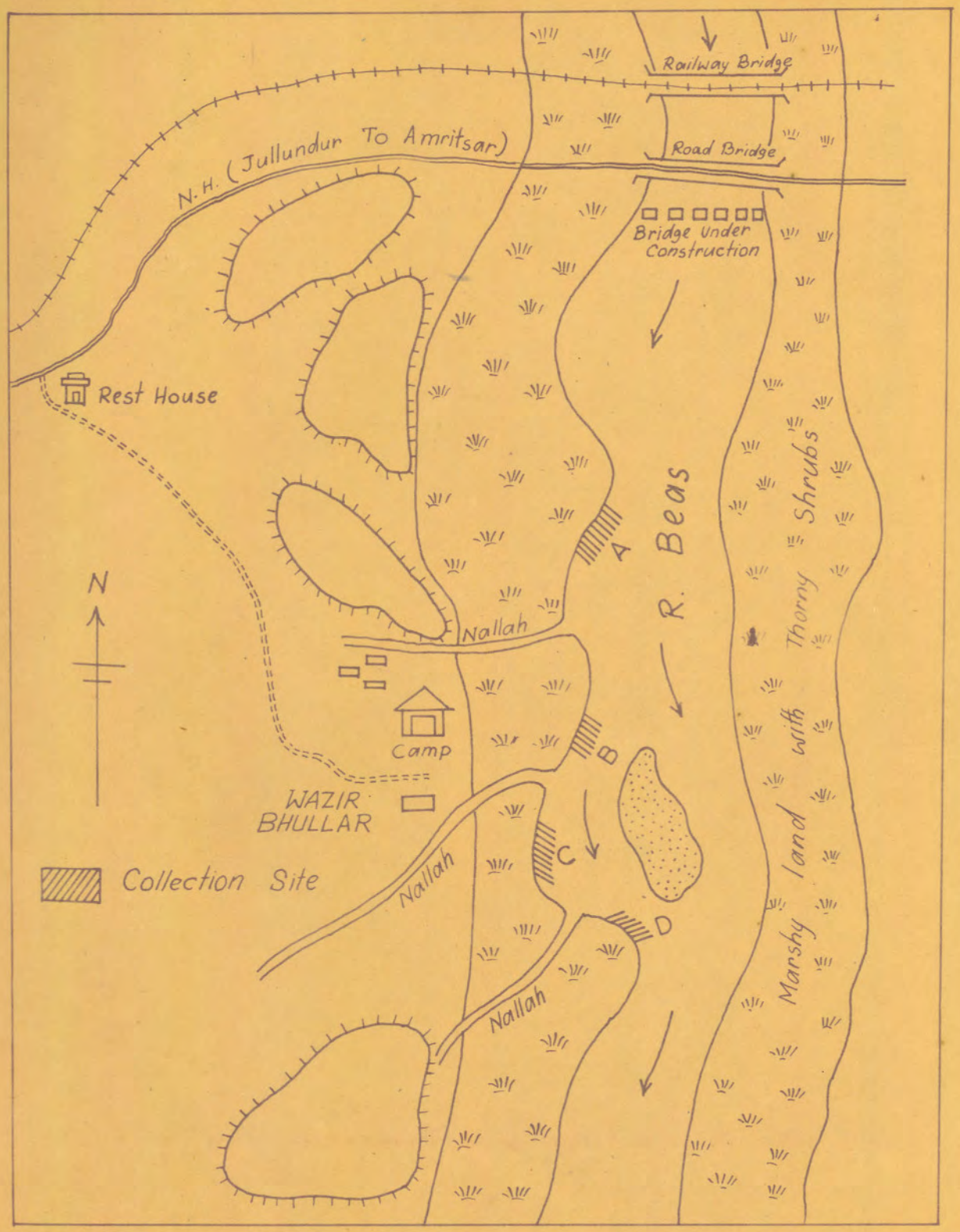

FIG. 18.

THE COURSE, GENERAL TERRAIN AND TOPOGRAPHY OF RIVER BEAS AT WAZIR BHULLAR.

Table 23.

Occurrence, duration and magnitude of floods and spawn spurt at Wazir Bhullar on R. Beas

Flood No.	Phase	From		Duration in days	Peak flood level			Spawn spurt			Duration in hrs.	Spawn catch			
		Date	Hour		Date	Hour	Height* in mm	Quality	Commencement Date	Commencement Hour		No. of Std. nets	Catch in ml	Catch in numbers	Catch per net-hour in numbers
I	Rising	20.7.66	2.00	7	27.7.66	10.00	3.40	UD	22.7.66	10.00	4	4	60	21,000	1,312
	Receding	27.7.66	12.00	3	-	-	-	-	-	-	-	-	-	-	
II	Rising	31.7.66	6.00	1	1.8.66	10.00	1.91	-	-	-	-	-	-	-	-
	Receding	1.8.66	14.00	4	-	-	-	-	-	-	-	-	-	-	-
III	Rising	5.8.66	14.00	1½	6.8.66	2.00	1.98	-	-	-	-	-	-	-	-
	Receding	7.8.66	6.00	5	-	-	-	-	-	-	-	-	-	-	-

* Height above the lowest observed water level during the investigation period.

UD = Undesirable.

(ii) Quality of spawn collected

The spawn catch was analysed for determining its quality both through spawn analysis and through rearing in a nursery. The results obtained are shown in Table 24.

Table 24.

Quantity of spawn collected at Wazir Bhullar on the Beas, 1966.

Method of analysis	Percentage composition		
	Major carps	Minor carps	Others
By spawn analysis	Nil	93.0	7.0
By rearing	Nil	98.4	1.6

As can be seen from the above table, the catch consisted entirely of undesirable spawn, the major carps being totally absent. Labeo bata and Garra gotyla were the dominant minor carps, the others being Cirrhinus reba, Labeo dyocheilus, Barilius barila & Oxygaster bacaila. The miscellaneous fishes included the catfishes, gobeids and clupeids.

(iii) Potentiality of selected stretch for spawn collection

A number of centres, viz. Verawal, Ghatka, Goindwal, Murud and Harike were visited in order to find out their suitability and potentiality for spawn collection. Because of the adjoining marshy land, which got inundated during the floods, it was impossible to operate shooting nets at any of the above centres. As such, the entire selected stretch appears unsuitable for a commercial collection of major carp spawn. While the upper region of the stretch seems to be devoid of any sizable major carp population, as revealed by local enquiries, the lower region, even though it may be harbouring appreciable numbers of major carps, becomes thoroughly inaccessible during the monsoon months.

(iv) Spawn availability in relation to hydrographical factors

In view of the very brief spell of spawn occurrence at this centre, it is not possible to draw any correlation with any of the hydrographical factors.

(v) Efficiency of state net

One Punjab State net was operated alongside the standard nets at the time of spawn availability to find out its comparative efficiency. It was found that the standard net was about four times as efficient as the State net, their respective catch per net-hour being 3.75 ml and 1 ml. This serves to confirm the results obtained at Majhawali on the Yamuna.

(B) River Sutlej

Participants

J.C. Malhotra (Leader) N.K. Srivastava	Government of India
Paramjit Singh Y.R. Thapar	Government of Punjab

The stretch of river Sutlej selected for spawn prospecting extended from Rupar Headworks in the east to Gidderpindi in the west, a distance of about 144 km by the river route (Fig. 17). Village Loduwal, situated on the south bank of the river in Ludhiana district, was selected for round the clock investigations from July 1 to September 7, 1966. The place is well connected both through railway and road. The exact spot where the investigations were conducted is about 1.6 km north of the village off the G.T. Road. Since the Sutlej has been harnessed upstream by the construction of Bhakra Dam and Rupar Headworks, the flooding of the river at Loduwal depends on the release of water from the Bhakra Reservoir and not due to inflow of freshets from the catchment area. As such, even during the monsoon months the river holds only little water in between the floods, and at such times shooting net operations have to be carried out almost in the middle of the river. With the sudden rise in water during floods, the nets had to be shifted towards the marginal region. The river at the site is sandy in nature and slopes gradually towards the middle. At less than 1.0 m flood level about 75 nets can be operated, while at levels between 1.0 and 2.0 m about 100 nets can be operated.

(i) Occurrence and magnitude of spawn spurts and areas of concentration

With the appearance of spawn in each spurt at Loduwal trial nets were simultaneously operated at four suitable spots (A, B, C, D & E in Fig.19), in order to determine the spot of maximum spawn concentration. The results of these trials are given in Table 25.

Table 25.

Two-hourly spurt-wise spawn yield during trial net operations in the Sutlej at Loduwal

Spurt number	Spawn catch in ml at spots					Most suitable spot
	A	B	C	D	E	
1	100	15	Nil	Nil	-	A
2	10	Nil	-	Nil	45	E
3	15	5	-	Nil	50	E

It can be seen from the above table that the pocket of maximum spawn concentration shifted from spot A during the first spurt to spot E during the second and third spurts. While spot B was not unproductive, spot D did not yield any spawn. Spot C could be examined only during the first flood, after which it became too deep to allow net operation. The unproductive nature of spots C and D must be due to the bend in the river course and the presence of sand bars in this region, forcing the current to take a mid-stream course and turning spots C and D into shadow zones.

During the entire period of investigations, three spurts of spawn of 10-42 hours' duration were recorded at Loduwal during the floods I, II and IV respectively. All the spurts occurred in the receding phases of these floods, which attained their peak levels on 3rd July, 26th July and 7th August respectively. Altogether the river experienced six floods during the period, but the floods III, V and VI, as also the five vacillation periods, failed to yield any spawn (Table 26).

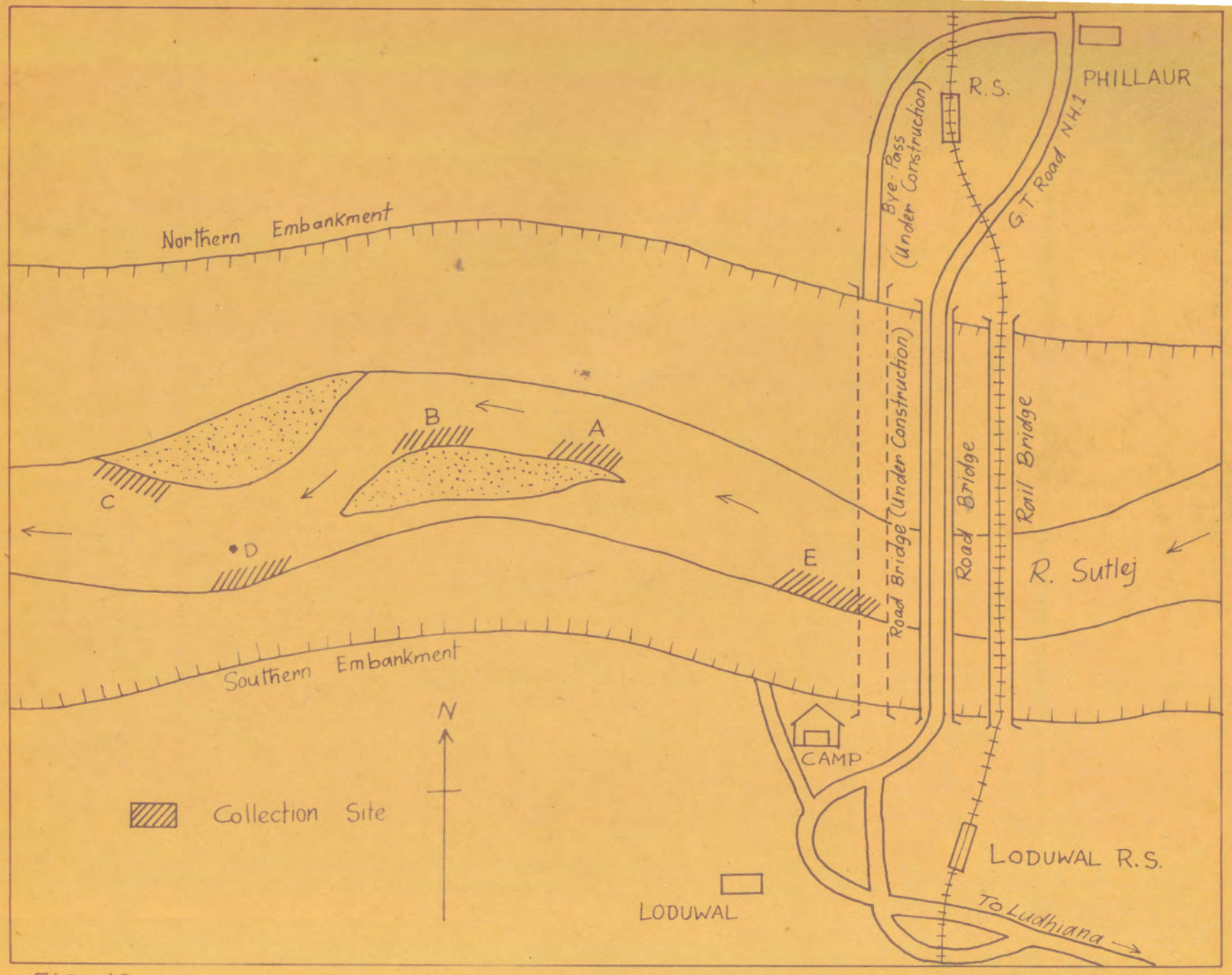

FIG. 19.

THE COURSE, GENERAL TERRAIN AND TOPOGRAPHY OF RIVER SUTLEJ AT LODUWAL.

Table 26.

Flood-phase-wise occurrence, duration and magnitude of spawn spurts at Loduwal on the Sutlej in 1966.

Flood Details						Spawn spurt			Spawn catch						
		Duration		Peak					By standard nets			By state nets			
Flood No.	Phase	Commencement Date / Hour	Total hours	Date hour	Level in metres	No.	Commencement Date / hours	Duration in hrs.	No. of nets	Total catch in ml	Catch per net hour in ml	No. of nets	Total catch in ml / no.	Catch per net-hour in ml	C/N/H(State) / C/N/H(Standard)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
I	Rising	2.7.66 / 6	24	3.7.66 / 6	0.87	-	-	-	1	nil	-	-	-	-	-
	Receding	3.7.66 / 6	28			1	3.7.66 / 14	10.0	5	1602 / 560700	32.04 / 11214	3	109 / 38150	3.3 / 1155	0.103
Vacillation phase		4.7.66 / 10	508						1	nil	-	-	-	-	-
II	Rising	25.7.66 / 14	12	25.7.66 / 2	2.33	-	-	-	1	nil	-	-	-	-	-
	Receding	25.7.66 / 2	16	No spawn appeared in the nets, but about 50,500 ml of fertilised carp eggs, all of minor carps, were collected by one net in 20 hours.											
	Rising	26.7.66 / 18	12	27.7.66 / 6	2.29	-	-	-	1	nil	-	-	-	-	-
	Receding	27.7.66 / 6	42			2	27.7.66 / 8	34.0	5	22762 / 7966700	162.6 / 56905	1-3	395 / 129250	10.8 / 3780	0.066
Vacillation phase		28.7.66 / 24	78						1	nil	-	-	-	-	-

contd....

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	Rising	1.8.66 / 6	12	1.8.66 / 18	1.69	-	-	-	1	nil	-	-	-	-	-
III	Receding	1.8.66 / 18	24	-	-	-	-	-	1	nil	-	-	-	-	-
	Vacillation phase	2.8.66 / 18	100						1	nil	-	-	-	-	-
	Rising	6.8.66 / 22	8	7.8.66 / 6	2.22	-	-	-	1	nil	-	-	-	-	-
IV	Receding	7.8.66 / 6	46			3	8.8.66 / 8	22.0	5	3980 / 1393000	36.2 / 12664	-	-	-	-
	Vacillation phase	8.8.66 / 4	162						1	nil	-	-	-	-	-
	Rising	15.8.66 / 22	8	16.8.66	1.92	-	-	-	1	nil	-	-	-	-	-
V	Receding	16.8.66 / 6	28			-	-	-	1	nil	-	-	-	-	-
	Vacillation phase	17.8.66 / 10	68						1	nil	-	-	-	-	-
	Rising	20.8.66 / 6	8	20.8.66 / 14	1.54	-	-	-	1	nil	-	-	-	-	-
VI	Receding	20.8.66 / 14	24			-	-	-	1	nil	-	-	-	-	-
	Vacillation phase	21.8.66 / 14	418						1	nil	-	-	-	-	-

Spawn was available at Loduwal for a total period of 74 hours, of which 64 hours yielded desirable spawn. In the season as a whole, five standard nets collected 26,742 ml of desirable spawn, which accounted for 94.3% of the season's total spawn yield. In addition to this, the II flood also yielded 50,500 ml of fertilised minor carp eggs in one single net.

Spurt 1 of 10 hours' duration, which occurred in the receding phase of flood I, yielded 1602 ml of only undesirable spawn in five standard nets and another 109 ml in 3 state nets. The second spurt, which accounted for 85.1% of the total catch of desirable spawn at the centre, lasted for 42 hours during the receding phase of flood II. This flood had a subsidiary peak (2.29 m) following the main peak (2.33 m), and while the spawn occurred in the receding phase of the subsidiary peak, the receding phase of the main peak yielded 50,500 ml of fertilised minor carp eggs in only one standard net in 20 hours' time. The third spawn spurt of 20 hours' duration occurred in the receding phase of flood III, and contributed to 14.9% of the entire yield of desirable spawn.

Spawn spurts 2 and 3 accounted for all the desirable spawn caught during the season. Average catches per net-hour during these two spurts were 162.6 ml and 36.2 ml respectively. However, spawn was available in much greater abundance during spells of 20 hours and 10 hours respectively within the 2nd and 3rd spurts, the catch per net-hour during these spells being 203.8 ml and 67.8 ml respectively (Table 27). Cumulatively the catch made during these two spells accounted for 88.8% of the season's total catch of desirable spawn. The spells commenced 22 hours and 2 hours respectively after the initial appearance of spawn during the 2nd and 3rd spurts.

(ii) Quality of spawn collected

Analyses of 2-hourly spawn samples made during the various spawn spurts revealed an average major carp content of 5.2 (range 4-12), 42.1 (range 12-84) and 42.2 (range 24-58)% respectively in spawn spurts 1, 2 and 3 (Table 27). The quality of spawn during spells of peak availability in spurts 2 and 3 was almost the same as during the spurts as a whole (Table 27).

Table 27.

Quality of spawn obtained during spurts and during spells of maximum availability within spurts at Loduwal on the Sutlej, 1966.

Spurt details			Spawn Quality (percentage)										Period of maximum spawn availability						
			By spawn analysis			By rearing							Duration		Catch in ml	Catch per net-hour in ml	Quality		
Spurt no.	Desirability	Catch in ml	Major carps	Minor carps	Others	Major carps					Minor carps	Others	Commencement Date hour	Total hours			Major	Minor	Others
						Catla	Rohu	Mrigal	Calbasu	Total									
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	D	nil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	UD	1,602	5.2	94.8	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	-	-	-	-	-	-	-
2	D	22,762	42.1	57.7	0.2	0.6	1.0	1.0	0.0	2.6	93.2	4.2	28.7.66 04.00	20	20,380	203.8	43.4	56.6	0.0
	UD	nil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	D	3,980	42.2	57.8	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	8.8.66 10.00	10	3,375	84.8	40.4	59.6	0.0
	UD	nil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

D = Desirable UD = Undesirable

To determine spurt-wise species composition, spawn samples of spurts 1, 2 and 3 were reared in nursery ponds. As shown in Table 27, this revealed that major carps were totally absent in the samples of spurts 1 and 3 and were represented to the extent of only 2.6% in the samples of spurt 2 (weighted average of three rearings). The major carp species represented in the samples were Labeo rohita, Cirrhinus mrigala and Catla catla, of which the first two had a slightly higher percentage than the third. The widely differing results obtained by spawn analyses and nursery rearings may be partly explained by the differential rates of mortality of the various species in different nurseries.

The index of spawn quantity at Loduwal was estimated at 5,560 ml and of quality 2.6% major carps, 93.2% minor carps and 4.2% 'others'.

(iii) Spawn availability at prospected sites

One site at Gidderpindi to the west of Loduwal and two other sites at Mattewara and Rupar to the east of Loduwal were occasionally prospected for adjudging their potentiality for spawn collection (Fig.17). While the site at Rupar was found unsuitable for operating shooting nets because of steep banks, that at Mattewara, though suitable for shooting net operation and did record some spawn in trial netting, had very poor accessibility. On the other hand, the site at Gidderpindi was found to be quite promising, in that in trial netting conducted there during the first spawn spurt it yielded 50.0 ml per net-hour, as against 83.7 ml during the same period at Loduwal.

In addition to the above centres, prospecting in greater detail was conducted at Sultanpur Lodi (Fig.17) on the eastern bank of Western Beyin (Kali Beyin), a tributary of river Sutlej, from July 25 to August 13, 1966. A total of 74,035 ml of advanced fry and 905 ml of spawn could be collected there during the above period in 1-4 standard nets. All the fry were collected on the first four days, when the catch per net-hour averaged 771.2 ml. The respective percentages of major carps, minor carps and others in the fry catch were 70, 25 and 5. Catla formed about 57% of the major carp content, the other species being rohu, calbasu and mrigal in the order mentioned. The percentage composition of spawn, all of which were obtained during the period 31.7.66 to 13.8.66, was 38% major carps and 62% minor carps.

The availability of advanced fry in the W. Beyin may be attributed to the occurrence of heavy floods simultaneously in the W. Beyin and Beas. In addition to flooding the areas adjoining its eastern embankment, the Beas waters extended the area of the Harike reservoir along the Sutlej, beyond the point where the W. Beyin joins it. As a result of this the water level rose appreciably in the Sutlej, preventing any discharge of water into it from the W. Beyin. Thus the inundation of major carp breeding grounds along the banks of the W. Beyin was prolonged, with the result that hatchlings grew to fry stage before being drifted into the stream. In view of the high major carp content obtaining in the W. Beyin spawn and fry catches, it is necessary to investigate this stretch fully for locating suitable spawn collection centres.

(iv) Spawn availability in relation to hydrographical and biotic factors

Flood level and phase

The 760 feet high Bhakra Dam, constructed at about 130 km upstream of Lodhwal, is almost completely controlling the occurrence of floods in the Sutlej. It is further controlled by the Sirhind Canal Headworks at Rupar. The floods caused by the release of water from the reservoir show a sudden rise and a very abrupt receding phase. The damming of the river has prevented the formation of deep pools in the river, consequent to which a greater part of the major carp population of River Sutlej is likely to take shelter in the Harike reservoir during the pre- and postmonsoon periods. Harike Headworks is just downstream of the confluence of Beas and Sutlej. A little above the confluence the Sutlej is joined by Western Beyin, a small seasonal stream. It is likely that during the monsoon season the carps in Harike reservoir migrate to the stream into which the freshets flow first. During the 1966 season, the W. Beyin had its first flood at about the middle of June and these fishes did migrate into this stream and breed. The occurrence of subsequent floods in the Sutlej were also later than in the W. Beyin. This probably accounts for the comparatively low major carp content in the spawn of Sutlej, specially during spawn spurt 1. Therefore, it may be safe to assume that in case of early release of water from the Bhakra Dam, sometime during the early or middle part of June, resulting in the Sutlej experiencing its first flood as also the subsequent floods earlier than in W. Beyin, the major carps may migrate from Harike Reservoir into the Sutlej for breeding.

All the spawn spurts occurred only during the receding phase of the floods. Non-occurrence of spawn during the V and VI floods in the third week of August might have been due to the absence of breeders so late in the season. The third flood rose and receded far too abruptly to induce the migration of breeders. A steady rise and a gradual decrease in flood level seemed to favour the migration and breeding of carps in the Sutlej, affording sufficient time for the eggs to hatch out before flowing down into the main stream, as during the I flood and the second part of the II flood. An abrupt receding of the flood might not give sufficient time for the eggs to hatch out, as happened during the first part of the II flood, when heavy catches were made of fertilised carp eggs.

As can be seen from Table 26, desirable spawn was available in the Sutlej only when the flood level went beyond 0.87 m over the summer level. It can, therefore, be assumed that major carp breeding grounds are located at an elevation of over 0.87 m above the summer level.

Current velocity

Apart from determining the concentration of spawn in certain pockets along the river bank, the current pattern was found to affect the catching efficiency of the net as well. It was observed that current velocity below one km per hour was not conducive to the collection of spawn in nets. The current velocity ranged from 0.98 to 3.60 km/hour during periods of spawn availability, while during spells of maximum availability in spurts 2 and 3 it ranged between from 1.05 - 2.44 and 1.14 - 1.63 km/hr respectively (Table 28).

Turbidity, temperature and weather

It can be made out from Table 28, that the observed ranges of turbidity, and water and air temperatures did not seem to have any noticeable effect on spawn availability at Lodhwal. Even the catching efficiency of the net did not appear to have been affected by the observed higher ranges of turbidity. Overcast sky, with or without slight drizzle, coupled with gentle breeze was found ideal for spawn collection, while stormy weather was found to be unfavourable for spawn collection, possibly because of the generation of disorderly currents.

Table 28.

Range of environmental factors during spurts and during spells of maximum spawn availability at Lodhwal on the Sutlej, 1966.

Spurt No.	Desirability	Catch in ml	Range of environmental factors during entire spurt				Range of environmental factors during spells of maximum availability			
			Turbidity in ppm	Current velocity in km/hr	Air temp. in °C	Water temp. in °C	Turbidity in ppm	Current velocity in km/hr.	Flood level	Rate of fall of flood level in cm/hr.
1	2	3	4	5	6	7	8	9	10	11
1	D	nil	-	-	-	-	-	-	-	-
	UD	1,602		0.98 to 1.543	27.0 to 30.5	28.5 to 28.7	-	-	-	-
	D	22,762	255 to 1200	1.05 to 2.44	26.0 to 34.0	26.0 to 33.0	255 to 330	1.05 to 2.44	1.07 to 0.88	1.0
2	UD	nil	-	-	-	-	-	-	-	-
	D	3,980	330 to 1200	1.14 to 1.91	27.0 to 33.5	27.5 to 30.5	330 to 550	1.14 to 1.63	0.94 to 0.87	1.0
3	UD	nil	-	-	-	-	-	-	-	-

D = Desirable UD = Undesirable

Spawn associates

No indicator species among the associates could be made out at Lodhwal. During the spawn availability period the associates were available only in negligible qunatities and as such they did not excercise any adverse effect on the spawn during segregation.

(v) Efficiency of state nets

Punjab state net

The structural details and defects of the net supplied by the Punjab Government have been mentioned earlier on pages 8 and 21. These nets were operated alongside the standard nets for testing their efficiency vis-a-vis the standard nets, taking care to see that their catch was not affected by their relative positions, randomly changing their position during the spawn spurt. Compared to the standard net, the efficiency of the state net was found to range from 0.0 - 19% in the first spawn spurt and from 4-106% during the second spurt, the pooled efficiencies for the two spurts being 10.3% and 6.6% respectively. The pooled efficiency for the season as a whole was estimated to be 7.2%.

Murshidabad net

The Murshidabad type of net obtained from Bihar was also tested against the standard net to determine its efficiency during the first two spawn spurts. Its efficiency was found to range from 40.6% to 51.2%, with an average of 42.9%.

(vi) Efficiency of nets of different sizes

As at Majhawali on the Yamuna, nets of four different sizes, made of 5m, 7m, 9m and 11m of 1/8" meshed Midnapore-type netting, were operated against the standard net for determining their catching efficiencies in comparison to that of the standard net. The results obtained are shown in Table 29.

Table 29.

Comparative efficiencies of nets of different sizes at Lodiwal on the Sutlej

Date	Catch per unit of effort & efficiency	5m net	7m net	9m net	11m net	14m net (standard)
3.7.66	CPUE*	3.5	10.0	12.0	14.5	32.0
	Efficiency	10.9%	31.0%	37.5%	45.8%	100%
27.7.66	CPUE	3.5	8.3	29.2	31.3	38.9
	Efficiency	8.9%	21.3%	74.9%	80.3%	100%
28.7.66	CPUE	40.3	134.7	154.7	183.6	211.9
	Efficiency	19.0%	58.9%	73.0%	86.6%	100%
8.8.66	CPUE	12.2	7.5	11.9	15.0	41.0
	Efficiency	16.2%	18.3%	29.1%	36.6%	100%
	Average efficiency	17.2%	41.5%	65.0%	76.7%	

*CPUE = Spawn catch per net per hour in ml

Again as at Majhawali, a parabolic rate of increase of efficiency was observed with the increase in size of nets. As such, it may be stated emphatically that the standard net is clearly more efficient than similar nets of 1/8" meshed Midnapore-type netting, but of smaller size.

(vii) Escapement from net made of 1/8" meshed Midnapore-type netting

To determine the extent of spawn escapement from the standard net under different hydrological conditions, a double-walled blanket-type of net was operated at this centre, as at Majhawali on the Yamuna. It was seen that the escapement rate ranged from negligible to 39.7% during the first and second spawn spurts and from negligible to 66.6% during the third spurt. No noticeable difference could be made out in the escapement rate of the net under the observed ranges of turbidity and current velocity, viz. 255-1200 ppm and 0.98-244 km/hr respectively.

VI. GENERAL DISCUSSION

(i) Potentiality of investigated sites

The pattern of spawn availability and its relation to hydrographical, biotic and meteorological factors at each of the eight centres investigated during 1966 have been elucidated in the foregoing pages under Section 5. Of the various centres, desirable spawn was encountered in sizable quantities only at Lodhwal on the Sutlej, Majhawali on the Yamuna and Babuaghat on Kosi Khanua Dhar, while appreciable quantities of fertilised major carp eggs could be collected at Mehdi Jhajha on river Badua. While spawn analyses indicated about 42% of major carps in the desirable spawn spurts at Lodhwal, the rearing experiments yielded a low major carp content of only 2.6%. This is surprising since the major carps encountered in the samples, viz. rohu, mrigal and catla, are generally known to have better survival in the nurseries than the minor carps. On the other hand, the scaling down of major carp content at Majhawali from about 48% as obtained by spawn analysis to about 18.5% by rearing, may be explained by the fact that calbasu which dominated the major carp part of the spawn had very poor survival in the nurseries. It is interesting to note that at Babuaghat on Kosi Khanua Dhar, while both the rearing experiments and spawn analyses yielded almost identical results (20% and 19.2% respectively) regarding major carp content of the first desirable spawn spurt, in the case of the second desirable spawn spurt the former method indicated a major carp content of about 40% as against 19.4% of the latter. The major carp content of the fertilised eggs collected during the first and fifth floods in river Badua ranged from 20.6 to 32.5%, while in the remaining floods their percentage was less than 10 While only approximate ideas could be obtained regarding the likely breeding grounds or source of spawn in the rivers Sutlej, Yamuna and Kosi Khanua Dhar, at Badua it was rewarding to find the major carps breeding at the investigation site itself, along with a further indication of their breeding over a much larger area during years of normal rainfall.

The selected stretch of river Beas was found totally unsuitable for collection of major carp spawn, because of inaccessibility in its lower reaches and absence of spawn in the upper reaches. Similar was the case with river Burhi Gandak, which failed to yield any major carp spawn, the probable reasons for which have been discussed under item no (iii) on page 37.

Even though the Ghagraghat centre on river Ghagra did not yield large quantities of spawn, the only spurt encountered there yielded desirable spawn throughout its duration, with its major carp content ranging from 14 to 62%, with an average of 32.45%. Its failure to yield further quantities of quality spawn was due to the changed current pattern at the site and the insufficiency of operational area. It should be possible to make better harvests at this centre, if some suitable means can be evolved to catch spawn in the mid-stream deeper waters.

The failure of the Mant centre to yield quality spawn in quantities has been accounted for elsewhere in the report, as due to the unusual flood pattern at this centre during the year. Since this centre is located in the major carp abundant zone, it is likely that during normal seasons when floods would show comparatively brief rising phase followed by gradual fall, quality spawn may be expected to occur in quantities. This is indicated by the only occurrence of desirable spawn during a brief period of fall in the unusually long rising phase of the II flood. This catch had a very high major carp content of 56-78%, as revealed by spawn analyses. Even rearing experiments yielded a major carp content of 26.3%.

The seasonal indices of desirable spawn quantity and quality for the various centres are given below in Table 30.

Table 30.

Seasonal indices of spawn quantity and quality at various centres in 1966

Name of river	Name of centre	Index of Spawn quantity	Index of spawn quality based on nursery rearing (% of major carps)
Yamuna	Majhawali	784 ml(c.2.75 lakhs)	18.65%
"	Mant	17.3 ml (c.0.06 lakh)	26.30%
Ghagra	Ghagraghat	228.4 ml (c.0.80 lakh)	7.4%
Burhi Gandak	Khagaria	nil	nil
Kosi Khanua) Dhar	Babuaghat	664 ml(c.3.3 lakhs)	35.10%
Badua	Mehdi Jhajha	Not calculated for lack of data on effort.	26.1%
Beas	Wazir Bhullar	nil	nil
Sutlej	Loduwal	5560 ml(c.19.46 lakhs)	2.6%

From the above it can be seen that while Lodiwal, followed by Majhawali and Babuaghat led the other centres in index of quantity, Babuaghat followed by Mant, Mehdi Jhajha and Majhawali showed higher quality spawn than the rest, in the order mentioned.

(ii) Spawn availability in relation to environmental factors

Flood level and phase

As has already been pointed out in the earlier years, the availability of spawn at any site on a river is dependent on the occurrence of flood in that river and, in most of the cases, its reaching a particular level or beyond so as to flood the adjoining breeding grounds of carps situated at about that level and its receding gradually below that level. A greater portion of the spawn catch is generally obtained either in the rising or the receding phase of the floods, while the catch obtained during the vacillation periods is mostly negligible. During the year under report, spawn in quantities were collected almost wholly in the receding phases of the floods in the rivers Sutlej, Yamuna and Ghagra. Even at Wazir Bhullar on the Beas, the negligible quantity of spawn collected there occurred only in the receding phase of a flood. At Khagaria on river Burhi Gandak, the spawn occurred during both the rising and receding phases, but even there it was mostly during the latter phase. It may, therefore, be inferred that at all the above stretches breeding of carps must be very likely taking place at sites either adjoining the main river itself or the nullahs flowing into it. When the flood level reaches a particular level, it floods the adjoining breeding grounds, enabling the fishes to breed. The eggs, hatchlings or fry, depending on the time taken by the flood to recede after touching the relevant level, enter the river and drift downstream when the flood waters start receding. An unusually long rising phase, as observed at Mant on the Yamuna, comes in the way of the spawn entering the main stream of the river and results in their wide dispersal and eventual isolation in remote pools. Likewise, sharp rise and fall of a flood are also unhelpful, in that the flood would have receded before the fishes had a chance to breed. Gradual rise followed by abrupt fall, as observed at Lodiwal on the Sutlej, results in the drifting down of fertilised eggs before they have had time to hatch out.

In the Kosi Khanua Dhar, all the spawn spurts occurred invariably during the rising phase of the floods. This makes it likely that these spawn entered the Kosi Khanua Dhar from the main Kosi, which in its turn might have received it from some other tributary upstream having flood of a higher magnitude than that of Kosi Khanua Dhar. This inference is further strengthened by the fact that the Kosi embankment adjoining this Dhar appears to have cut off all its possible connections to carp breeding grounds in the adjoining areas.

At river Badua also fertilised eggs occurred always in the rising phase of the flood and never in the receding phase. This was due to the fact that the entire investigation site there constituted the carp breeing ground, which depended on the breeders coming there from the Badua Reservoir during the rising phase of the flood. Since the flood waters mostly receded abruptly, only fertilised eggs could be collected.

Rainfall

Floods in rivers are mostly brought about by heavy rainfall in their catchment areas or in those of their tributaries. In the case of river Badua, the river's floods at the investigation site almost wholly depended on local rainfall, than on the rainfall in its catchment area upstream. This is evident from the fact that floods in the area almost every time coincided with local rainfall. It is again the failure of rains in the area that reduced the extent of carp breeding ground in the river, which in normal years is reported to extend from the reservoir head up to Dharara. In general the low or erratic rainfall during the year has adversely affected carp breeding and thereby the magnitude of spawn availability at most of the investigated sites.

Current velocity and direction

Apart from flood level, current velocity and direction are often the most important factors in determining the availability of spawn at any site. As in the previous years, a moderate current velocity of 1 to 3 km/hr was found to be most conducive for collection of spawn. While faster currents, like the ones that prevailed in river Badua during the floods, made it impracticable to operate the nets, currents with less than one km/hr velocity were not conducive to the collection of spawn

as observed at Loduwal. Spawn could be collected at Ghagraghat only during the first flood, when the current was flowing parallel to the bank with a velocity ranging from 1.5 - 2.8 km/hr. The picture changed drastically when with the higher subsequent floods the current got diverted towards mid-stream at a fairly sharp angle to the bank, and the subsidiary current flowing through the collection site was far too feeble. The torrential currents prevailing in river Badua during the floods made it imperative to operate the nets at the nearest point of confluence of the river with the reservoir where the current velocity was found in a substantially reduced state. This also necessitated the shifting of collection site depending on the expansion or reduction of the reservoir area during floods of different magnitudes.

Turbidity, temperature and weather

No definite correlation between spawn availability on the one hand and turbidity and temperature on the other could be made out at any of the centres. In general, overcast sky, with or without slight drizzle, coupled with gentle breeze was found to be ideal for spawn collection, while stormy weather was unfavourable for spawn collection, possibly because of the generation of disorderly currents.

Associates

The occurrence of associates also did not throw any light on their possible correlation with spawn availability. At the Yamuna centres, they occurred in larger numbers early in the season, thereby facilitating easier collection of spawn later in the season.

Spawn catch in relation to net position

At most of the centres, spawn catches were found to be heavier in the first row facing the current, and among them the one nearest the bank in shallower water yielded the maximum catch.

Efficiency of state nets

The Punjab state nets, operated at all the three centres located in the State, were found to be far inferior to the standard net and had serious constructional defects. Compared to the standard net, their efficiency was found to be

7.2% at Loduwal, about 25% at Wazir Bhullar and 40% at Majhawali.

The Murshidabad-type net operated at Loduwal showed an average efficiency of 42.9% vis-a-vis the standard net.

Efficiency of nets of different sizes

Experiments carried out at Loduwal on the Sutlej and at Majhawali on the Yamuna with nets of different sizes indicated that there is a parabolic rate of increase of efficiency with the increase in size of nets made from 5m to 14m of 1/8" meshed Midnapore-type netting.

Escapement from 1/8" meshed Midnapore-type netting

Experiments carried out to determine the extent of spawn escapement from 1/8" meshed Midnapore-type netting, of which the standard net is made, indicated an escapement of 40% at Majhawali and from negligible to 66.6% at Loduwal. No noticeable difference could be made out in the escapement rate under the observed ranges of turbidity and current velocity.

VII. TRAINING OF STATE GOVERNMENT PERSONNEL AND LOCAL FISHERMAN

Before the commencement of the investigations, all the participating State Governments were requested to depute as many of their technical workers and fishermen for receiving field training in different aspects of spawn prospecting investigations at the various investigations centres.

Particulars of the various categories of personnel, who underwent training in the different States are given below in Table 31.

Table 31.

State-wise details of personnel trained in spawn collection techniques

State	State Government personnel		Private personnel
	Technical personnel	Fishermen and other field staff	
Bihar	4	3	10
Uttar Pradesh	3	1	6
Punjab	9	37	nil

In addition to the above, the fishermen and labourers engaged locally at the various centres were also trained in all aspects of spawn collection work, with a view to encouraging them to take to spawn collection as an occupation in the years to come. Similar training imparted in the earlier years has paid dividends at least at Kishanpur in Uttar Pradesh, where a party of local fishermen collected appreciable quantities of spawn for the first time and successfully raised them in nurseries to fingerling stage during the 1966 season. It is possible that similar developments might also have taken place at some of the other centres prospected by this Institute.

VIII SUMMARY

(i) During 1966, spawn prospecting investigations were carried out along eight riverine stretches in the country, two of Yamuna (one each in Uttar Pradesh and the erstwhile Punjab) and one each of Ghagra in Uttar Pradesh, Burhi Gandak, Kosi Khanua Dhar and Badua in Bihar, and Beas and Sutlej in the erstwhile Punjab.

(ii) After a thorough pre-monsoon survey of the above stretches, most of which were proposed by the respective State Governments, eight sites were selected for conducting detailed investigations, viz. Majhawali and Mant on Yamuna, Ghagraghat on Ghagra, Khagaria on Bhurhi Gandak, Babuaghat on Kosi Khanua Dhar, Mehdijhajha on Badua, Wazir Bhullar on Beas and Loduwal on Sutlej. At all these sites round the clock observations were made every two hours or 4 hours, depending on spawn availability, 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, current direction and turbidity were also similarly recorded, but only between 6 A.M. and 6 P.M.

(iii) A single trial net was operated day and night at the investigated site and the moment the trial nets catch indicated spawn availability (1 ml/net/hour), all the suitable spots in the vicinity were examined for locating the spot of maximum spawn concentration and the full battery of 5 nets was operated at the selected spot.

(iv) At Majhawali on the Yamuna, two spawn and two fry spurts were recorded. 3625 ml and 240 ml of desirable spawn, forming 97.3% and 2.7% of the season's total spawn yield, were harvested in spurts 1 and 2 respectively in only 36 hours. Of the two fry spurts, the second yielded a bumper catch of 2,07,735 ml of desirable fry (size range 7-20 mm) and 3,235 ml of undesirable fry in 3-5 standard nets in 152 hours, and accounted for 88.5% of the total fish seed catch of standard nets at the site. The indices of spawn quantity and quality for the site were estimated to be 784 ml and 18.65% respectively.

(v) 4,636.5 ml of spawn were collected at Mant on the Yamuna in 9 spurts, spread over 138 hours. This accounted for 96.7% of the season's total spawn catch and yielded only undesirable spawn. Only 38 ml of desirable spawn could be collected in the entire season. The indices of spawn quantity and quality for the site were 17.3 ml and 26.30% respectively.

(vi) 1,112 ml of desirable spawn were collected at Ghagraghat in one spurt, which lasted for only 28 hours and accounted for almost the season's entire catch. The indices of spawn quantity and quality were respectively 228.4 ml and 7.4%.

(vii) Only 178 ml of undesirable spawn could be collected at Khagaria on Burhi Gandak, which was found to be unsuitable for collection of major carp spawn.

(viii) Out of the four spawn spurts encountered at Babuaghat/Khanuaghat on Kosi Khanua Dhar, only spurts 2 and 4 yielded desirable spawn amounting to 3,320 ml in 30 hours. This formed 44.7% of the total spawn harvested at the site. The 4th spurt was the most productive and contributed to 97.6% of the total desirable spawn in 16 hours. The indices of spawn quantity and quality were 664 ml and 35.10% respectively.

(ix) 19,095 ml of fertilized eggs, of both major and minor carps, were collected at Mehdi Jhajha on river Badua in the rising phases of five floods. Flood I yielded the maximum quantity (16,665 ml) of fertilized eggs, with its major carp content varying from 25.0 to

32.5%. Major carps along with minor carps and other fishes were found breeding in the river at the investigation site, with the adjacent reservoir providing the breeders. The index of spawn quality for the site was found to be 26.1%.

(x) At Wazir Bhullar on river Beas, only 60 ml of undesirable spawn were collected in 4 hours during the rising phase of Flood I. The entire selected stretch of the river was found unsuitable for collection of major carp spawn.

(xi) At Loduwal on the Sutlej, three spawn spurts of 10-42 hours' duration were recorded during the receding phases of Floods I, II and IV respectively. A total of 26,742 ml of desirable spawn, accounting for 94.3% of the season's total catch, was collected in spurts 2 and 3 in only 64 hours. Of these, spurt 2 yielded 85.1% of the season's total catch of desirable spawn. In addition to the investigated site, Gidderpindi at the lower reaches of the stretch and Sultanpur Lodi on the adjacent tributary, W. Beyin, were found suitable for collection of major carp spawn. The indices of spawn quantity and quality were 5,560 ml and 2.6% respectively.

(xii) Of the various sites investigated, Loduwal, Majhawali, Babuaghat and Mehdi Jhajha yielded better results and were found suitable for collection of major carp spawn. The studies also indicated that Mant and Ghagraghat were potentially rich in major carp spawn. Wazir Bhullar and Khagaria were found to be totally unsuitable.

(xiii) In the rivers Sutlej, Yamuna, Ghagra, Beas and Burhi Gandak, the spawn occurred almost wholly or essentially in the receding phases of floods, indicating thereby the location of breeding grounds in areas adjoining the rivers themselves or the nullahs flowing into them. But in Kosi Khanua Dhar, the spawn occurred invariably in the rising phase of the floods, indicating thereby that the river must have received these spawn along with flood waters from the main Kosi. The cutting off of probable breeding grounds in the adjoining areas by the Kosi embankment further strengthens the above inference. In river Badua also

all the fertilised eggs were collected only during the rising phase of the floods. This was due to the fact that the site itself constituted the breeding ground and the breeders had to migrate there from the reservoir during the rising phase of the flood.

(xiv) While generally floods are brought about by heavy rainfall in the catchment areas of rivers, at Mehdi Jhajha on river Badua, local rainfall was mostly responsible for the occurrence of floods. Restricated local rainfall during the year appreciably reduced the extent of breeding ground along the river. In general, the low or erratic rainfall of the year adversely affected the magnitude of spawn yield at most of the sites.

(xv) A moderate current velocity ranging from about 1 to 3 km/hr was found to be most conducive for spawn collection. Change of current direction and velocity drastically altered the suitability of Ghagraghat site after the first flood and of Babuaghat site temporarily. The torrential currents prevailing in river Badua necessitated frequent changing of the collection site.

(xvi) No definite correlation could be made out in regard to the effect of turbidity and air and water temperatures on spawn availability. Overcast sky, with or without drizzle, coupled with gentle breeze was generally found ideal for spawn collection, while stormy weather was found distinctly unfavourable.

(xvii) The pattern of occurrence and quality of spawn associates did not throw any further light on their possible correlation with spawn availability.

(xviii) At most of the centres, nets in the first row facing the current yielded better catches, and among them the one nearest the bank in shallower water yielded the maximum catch.

(xix) Compared to the standard net, the efficiency of the Punjab state net was found to range between 7.2% and 40%, while that of Murshidabad net was 42.9%.

(xx) Experiments carried out at Majhawali and Loduwal with nets of different sizes made from 5m to 14m of 1/8" meshed Midnapore-type netting, indicated a parabolic rate of increase of efficiency with the increase in size of nets.

(xxi) Experiments conducted to determine the extent of spawn escapement from 1/8" meshed Midnapore-type netting indicated an escapement of 40% at Majhawali and negligible to 66.6% at Loduwal. No noticeable effect on escapement rate could be made out under the observed ranges of turbidity and current velocity.

(xxii) 16 technical personnel and 41 fishermen and other field staff of the three State Governments and 16 private fishermen were trained in the techniques of spawn collection and transport.

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