Report on

FISH SPAWN PROSPECTING INVESTIGATIONS

1970

ASSAM BIHAR WEST BENGAL
AND UTTAR PRADESH

BULLETIN NO 17
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CENTRAL INLAND CAPTURE FISHERIES RESEARCH INSTITUTE
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BARRACKPORE - 743 101 WEST BENGAL INDIA

REPORT ON FISH SPAWN PROSPECTING INVESTIGATIONS, 1970 ASSAM, BIHAR, WEST BENGAL AND UTTAR PRADESH

by

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FOREWORD

Spawn prospecting investigations, initiated in 1964 by the Central Inland Fisheries Research Institute mainly for locating new productive spawn collection centres, were continued during the year 1970 in the States of Assam, Bihar and West Bengal, in addition to the continuation of certain long term investigations at Mahewapatti on R. Yamuna near Allahabad in Uttar Pradesh. In the former three States, the work was carried out in collaboration with the respective State Governments, while the work at Mahewapatti was carried out solely by the staff of this Institute.

The investigations were carried out under the overall supervision and guidance of Shri H.P.C. Shetty, the Officer-in-Charge of the Riverine Division of the Institute at Allahabad. He was assisted by Shri K.K. Ghosh in the initial planning of the programme. The report in its present consolidated form has been prepared by Shri H.P.C. Shetty, on the basis of initial detailed sanctioned reports written by the respective teams, which worked in the field and analysed the data. The State technical personnel participated only in field work.

Shri R.K. Saxena of this Institute is responsible for the preparation of all the illustrations included in this report.

Co-operation received in full measure from the Directors and other regional officers of the concerned State Government is gratefully acknowledged here.

V.G. Jhingran

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CONTENTS

1 INTRODUCTION

The spawn prospecting investigations, initiated by the Central Inland Fisheries Research Institute in 1964 and since carried out every year in different parts of the country, have fully proved their usefulness in the location of additional spawn collection centres and towards evolving optimum spawn collection nets for operation under different sets of hydrological conditions (Anon, 1965; Malhotra et al., 1966; Shetty, 1967; Shetty et al., MS.$_1$; Shetty et al., MS.$_2$; Shetty et al., MS.$_3$, Malhotra et al., MS.; Shetty et al., MS.$_4$; Ghosh and Sinha, MS.; Ghosh, Sinha and Srivastava. MS.). In view of the continued acute shortage of fish seed in the country, these investigations were continued during the year 1970, in the Ganga-Brahmaputra river complex in the States of Assam, Bihar and West Bengal. These three States were chosen with a view to carry out simultaneous investigations in the middle and lower stretches of the Ganga River System and the connected Brahmaputra river. The centres selected for detailed investigations were, Hamidabad on River Brahmaputra in Assam, Ahirauli on River Ganga in Bihar and Pairachali on R. Kangsabati in West Bengal. In addition to the above, the long term investigations initiated in 1968 at Mahewapatti on R. Yamuna in Uttar Pradesh for understanding in depth the occurrence and drift of spawn in relation to meteorological and hydrodynamical factors and for studying the selection characteristics of spawn collection nets towards evolving optimum nets for operation under varying sets of hydrological conditions, were continued.

The work in Assam, Bihar and West Bengal centres was carried out in collaboration with the respective State Governments, the pattern of collaboration being as in the previous years. The work at Mahewapatti was carried out solely by the Institute staff.

The results of these investigations are embodied in this report.

2 PREMONSOON SURVEY AND SELECTION OF STRETCHES AND SITES

To start with, a detailed premonsoon survey was carried out of R. Brahmaputra along the districts of Kamrup and Goalpara, the uppermost stretch of R. Ganga within Bihar down to Patna and the upper stretches of R. Kangsabati along the

districts of Purulia and Bankura, for selecting suitable stretches for prospecting and sites for detailed investigations.

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

3. MATERIAL AND METHODS

3.1 Gear Used

3.1.1 Gear for assessing site potentiality

As in the previous years, the provisional 'standard net' (1/8" meshed Midnapore-type spawn net) was employed at all the centres for assessing their spawn yielding potentiality, in order to get comparable data over the years.

3.1.2 Gear for assessing effect of net size and mesh size on catching efficiency.

In addition to the above, specially fabricated experimental nets of different meshes and sizes were operated at Mahewapatti on R. Yamuna, and Hamidabad on R. Brahmaputra and Ahirauli on R. Ganga, to test the effect of mesh size and net size on catching efficiency. At Mahewapatti, standard-type 10 m 1/12" and 1/16" meshed spawn nets were operated alongside the standard net, for ascertaining the rate of filtration of water through them and their requirement of stretching force to keep them from sagging. Similar 10 m, 1/12" and 1/16" meshed experimental nets were also employed at Ahirauli on the Ganga, in addition to employing the standard net and 1/8" meshed 6 m, 14 m and 18 m nets, for testing the effect of net size and mesh size on net efficiency. At Hamidabad on the other hand, 12 nets, consisting of combinations of 4 dimensions (6 m, 10 m, 14 m and 18 m) and 3 mesh sizes (1/8", 1/12" and 1/16") were employed for the same purpose.

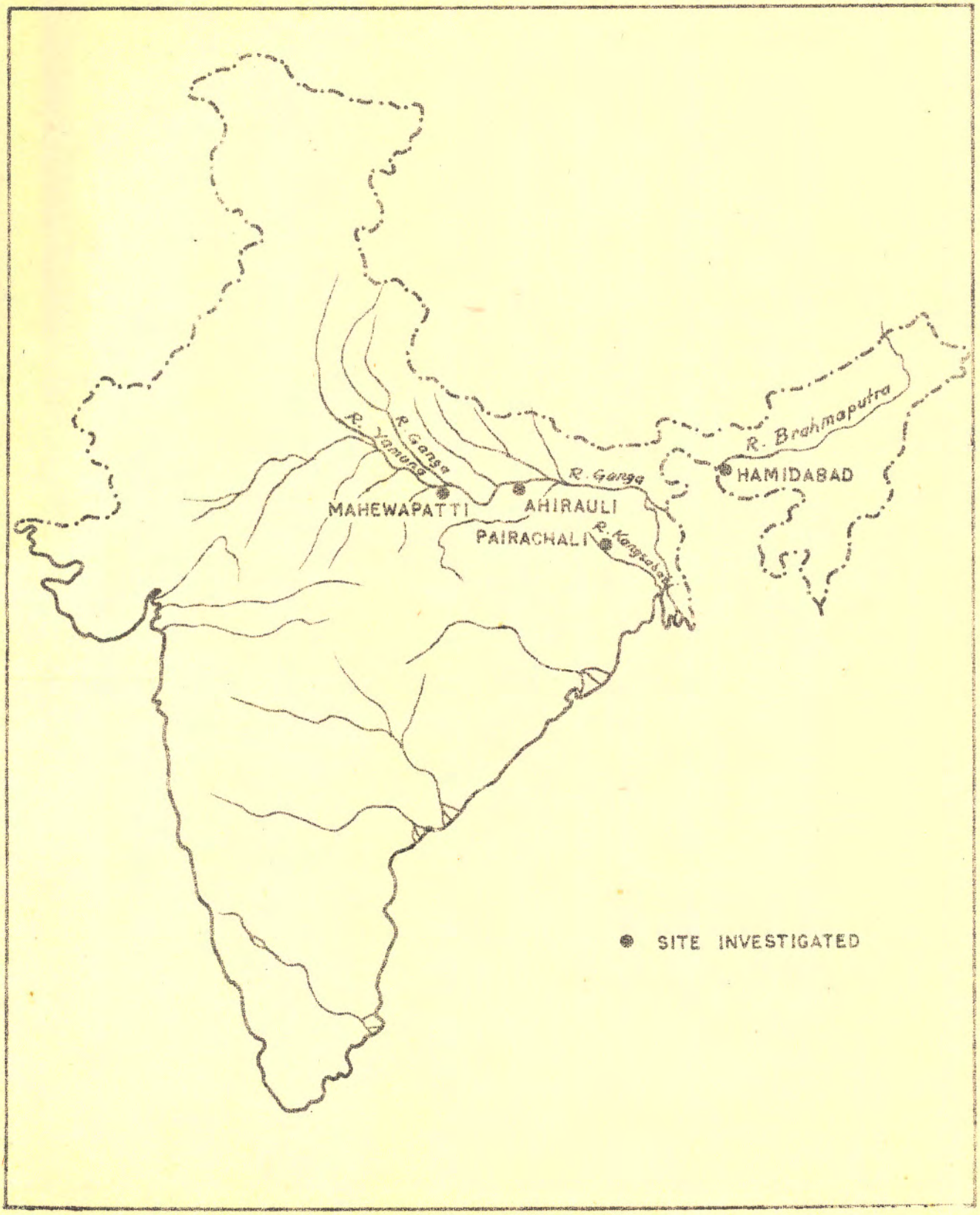


FIG. 1. MAP OF INDIA, SHOWING LOCATION OF SITES INVESTIGATED DURING FISH SPAWN PROSPECTING, 1970.

Table 1

Stretches and sites surveyed in the Premonsoon Survey and selected for prospecting investigations

River	SURVEYED								SELECTED FOR PROSPECTING			
	STRETCH				SITE				STRETCH			Main site for investigation
	From	To	Length in km	Bank	Name	Suitability (S/US)*	Justification for acceptance/ rejection		From	To	Distance in km	
1	2	3	4	5	6	7	8		9	10	11	12
Brahmaputra	Gauhati (Kamrup)	Dhubri (Goalpara)	385	S	1. Chandrapur (Tatimara)	US	Limited area for net operation and suitable only for short period.		Dologoma	Bhasharierchar	125	Hamidabad
				S	2. Dompara	US	Uneven and flat bank - unsuitable.					
				S	3. Khanamuk (Garigam)	S	Exploited by State Govt. monsoon barricades put by irrigation department on the bank and in the river - may result in changing the current pattern.					
				N	4. Amingaon	US	Presence of large number of boats at the site and water traffic may hamper the work.					
				S	5. Palasbari	US	Unsuitable during high floods.					

contd.....

1	2	3	4	5	6	7	8	9	10	11	12
				S	6. Nagarbera	US	Poor accessibility and limited operational area.				
				N	7. Bamundi	S	Good accessibility and current pattern.				
				N	8. Kurna	US	Unsuitable during high floods.				
				S	9. Dologoma (Jayantipur)	S	Exploited by State Govt. Excellent accessibility and favourable current pattern.				
				N	10. Tilapara	US	Chances of back current.				
				S	11. Hamidabad	S	Wide expanse of area available for net operation and favourable current.				
				N	12. Bhashanirachar	US	Due to severe erosion it has become unsuitable.				
Ganga	Chausa (Shahavad)	Deedarganj (Patna)	150	S	1. Chausa	S	Good accessibility and operational area.	Chausa	Suihaghat	80	Ahirauli
				S	2. Ahirauli	S	Good accessibility and good operational site and better than Chausa.				
				S	3. Neazipur/Sri Ranipurghat	US	Inaccessible.				

contd.....

1	2	3	4	5	6	7	8	9	10	11	12
				S	4. Tribhuanighat	US	Inaccessible				
				S	5. Suihaghat	S	Good site but no transport available.				
				S	6. Kurji	S	Already under exploitation by commercial parties.				
				S.	7. Budhghat	S	-do-				
				S.	8. Collectorate-ghat	US	Steep bank				
				S.	9. Ranihat	US	Steep bank				
				S.	10. Sukumarpur	S	Already under exploitation by commercial parties.				
				S.	11. Deedarganj	S	-do-				
Kangsabati	Purulia Road Bridge	Lapang/ Bhedua	75	E & W	1. Pairachali	S	Good accessibility and operational area.	Purulia Road Bridge	Raipur	100	Pairachali
				W	2. Budbudghat	US	Rocky bed.				
				E & W	3. Purulia	US	Major carp fauna not available in the vicinity. No deep pools before the reservoir.				

* S = Suitable
US = Unsuitable

Table 2

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

River	Brahmaputra	Ganga	Kangsabati
Stretch (From - To)	Dologoma - Bhashanir	Chausa - Sinhaghat	Purulia road bridge - Raipur
Selected site	Hamidabad	Ahirauli	Pairachali
Bank	South	South	East
Tehsil/Taluk/ Sub-Division	Dhubri	Buxar	Sadar
Police Station	South Salmora	Buxar	Manbazar
District/State	Goalpara (Assam)	Shahabad (Bihar)	Purulia (W. Bengal)
Nearest Post Office	Fakirganj	Ahirauli	Pairachali
Distance	5 km	½ km	½ km
Telegraph Office	South Salmara	Buxar	Manbazar
Distance	15 km	5 km	10 km
Telephone	Do	Do	Do
Nearest all weather road at	Fakirganj	Buxar-Arrah	Manbazar
Distance	5 km	3 km	1 km
Nearest Railway Station	Dhubri N.E. Rly.	Buxar N.R. Rly.	Purulia
Distance	20 km	-	52 km
Area available for nets at different flood levels	More than 60 nets can be operated	Upto 9 m 100 nets can be operated	Upto 4 m 60 nets 4-6 m 80 nets

3.1.3 Gear for assessing spawn escapement

In order to study the rate of escapement from 1/8" and 1/12" meshed nettings, specially fabricated 6 m, 1/8" and 1/12" 'covered nets', (Fig. 2) with their posterior half provided with a cover made of 1/12" and 1/16" meshed nettings respectively, were employed at Mahewapatti. The 10 m, 1/8", 1/12" and 1/16" nets were also employed in escapement studies, for making an assessment of absolute escapement after releasing a known number of marked live spawn at net mouth.

3.1.4 Floating spawn net for assessing mid-stream spawn flow

A floating spawn net was developed for ascertaining mid-stream spawn flow in deeper waters. The net was kept floating by means of two very buoyant air filled plastic baloons, while its shape was sustained by means of a bamboo frame work. The entire structure was allowed to drift along the current and stretch itself with the help of a rope from an anchored boat.

3.1.5 Modified experimental gamchas (tail pieces)

Two new types of gamchas were designed, aimed at the automatic sieving and segregation of spawn, by providing inner partitions to the ordinary triangular gamcha in use with the standard net. In one type, meant for automatic sieving, an inner gamcha of round-meshed mosquito netting was provided. The other type, meant for automatic segregation, was provided with two vertical partitions and are horizontal partition. While the horizontal partition was made of round-meshed mosquito netting, the anterior vertical partition was made of 1/8" meshed netting and the posterior vertical partition of ordinary gamcha cloth of 1/24" mesh (Fig. 3).

3.2 Mass marking of live spawn

In order to study spawn escapement from nets and the dynamics of riverine spawn, it was felt necessary to develop

a method of quick marking of a large number of spawn. Out of the five biological stains tested on riverine mixed collection, common carp spawn and mixed spawn of rohu and catla, Bismark Brown Y at a concentration of 1:50,000 was found to be best tolerated by spawn when exposed for five hours. The resulting colour was retained by the spawn for 30 hours under riverine conditions. Neutral red, at a concentration of 1:1,00,000 produced good results in one hour of immersion, but the hatchlings died in about 24 hours.

3.3 Techniques of collection and analyses of spawn and for determination of hydrographical and meteorological factors.

The techniques employed for the collection, measurement and qualitative analyses of spawn and for the determination of selected hydrographical and meteorological factors were the same as those adopted since 1965 (Malhotra et al., 1966; Shetty, 1967), except that for determination of current velocity. The current velocity of the river water was determined by means of a 50 cm long wooden rod floats, having a diameter of 1 cm. It was made to float vertically by fixing iron bolts of requisite weight to its bottom end. It was allowed to drift over a distance of 25 m in the river. This is expected to give a better picture of average current velocity of the water column than the cork float. However, the results obtained from the rod float were found to be under estimations when compared to those obtained from a current meter.

For measuring current velocity at net mouth for determining filtration rates through the spawn nets, a vertical-spindle-cup type of current meter was used at four points, 6 cm & at another four points, 40 cm below the surface. The filtration rate was estimated by taking into consideration the area of net mouth and the velocity of water estimating it. The relationship of filtration rate and current velocity, turbidity, etc. may be taken to be represented by the simple mathematical models:

$$\frac{dF}{dt} = bV,$$

and

$$\frac{dF}{dt} = - b'T$$

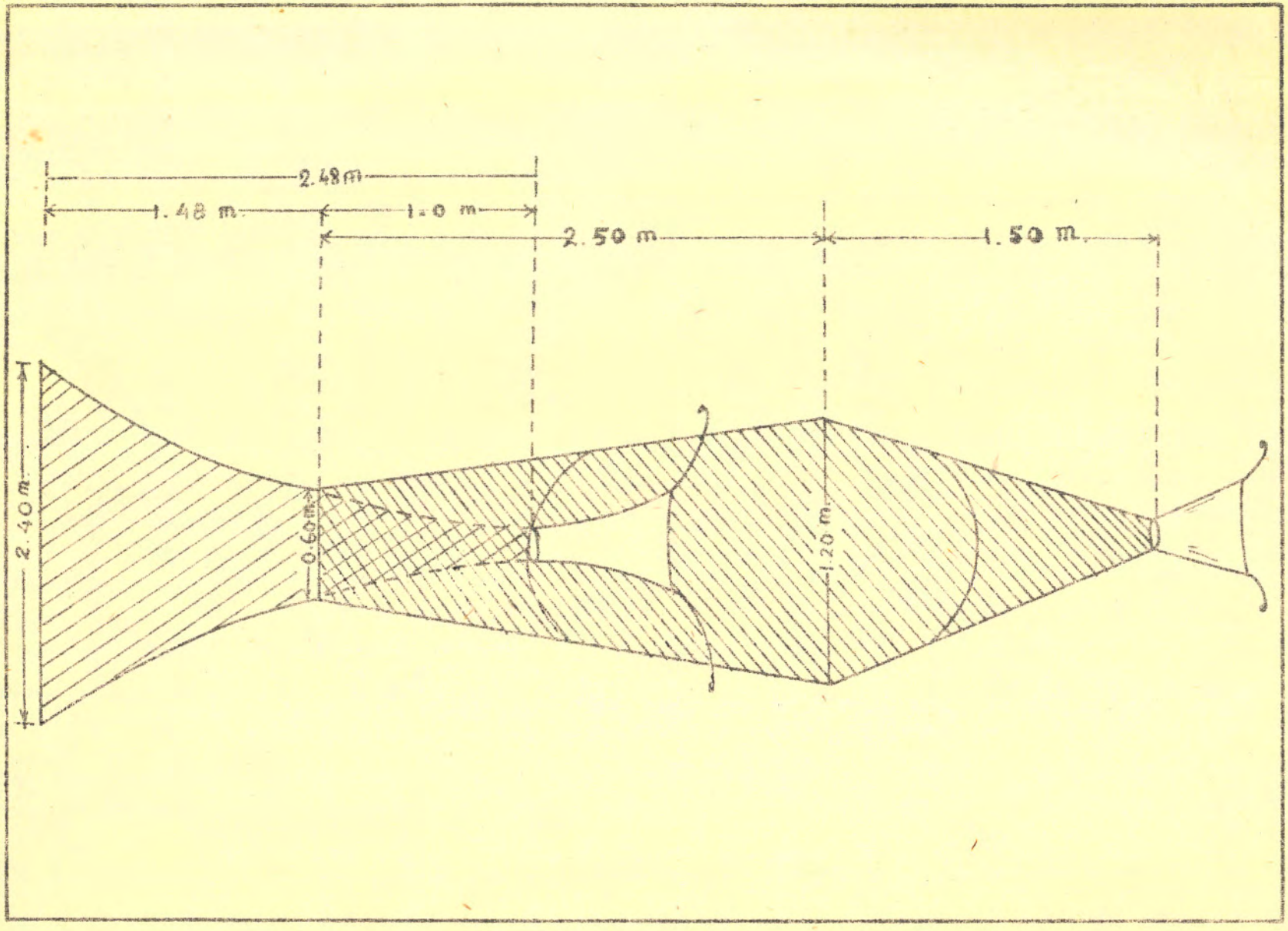
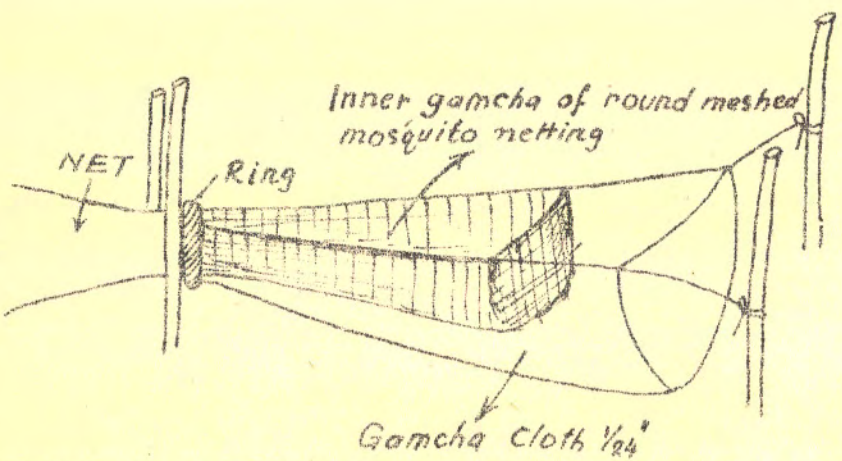
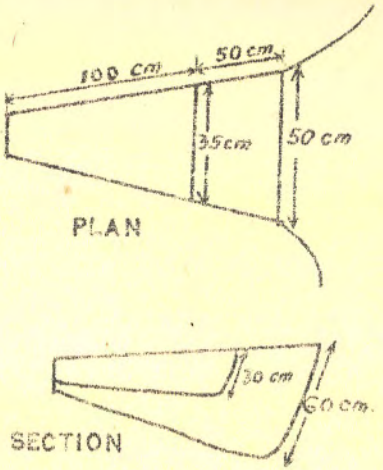


FIG. 2. THE DESIGN OF THE COD-END COVERED SPAWN NET (PLAN VIEW).

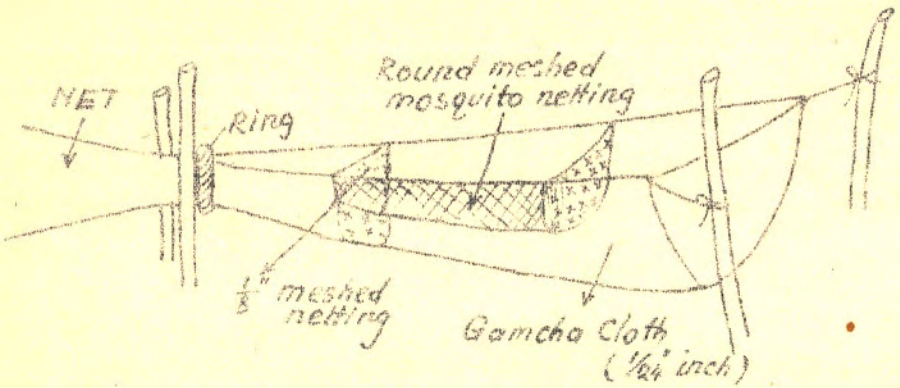


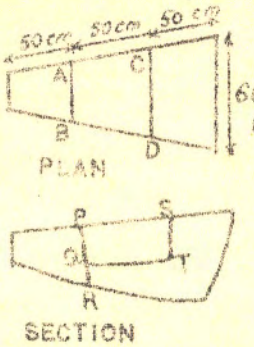
GAMCHA DESIGN FOR AUTOMATIC SIEVING



Inner gamcha of round meshed mosquito netting

Outer gamcha of 1/24" inch handloom netting.





(i) Horizontal inner ABDC of round meshed mosquito netting.

(ii) Section vertical AB of 1/8" mesh and gamcha cloth (1/24") and CD of gamcha cloth.

PQ of 1/8" mesh = 30 cm
QR of gamcha cloth = 10 cm
ST of gamcha cloth
QT of round meshed mosquito netting

GAMCHA DESIGN FOR AUTOMATIC SEGREGATION

FIG. 3. THE DESIGN OF THE EXPERIMENTAL GAMCHAS USED.

where $\frac{dF}{dt}$ is the filtration rate, V - velocity of flow

and T - turbidity. b and b' are constants, which may not be independent.

Turbidity measurements were made by means of a Jackson's Turbidimeter also at Mahewapatti, in addition to those arrived at from transparency data determined by Secchi's disc, in order to evaluate the validity of the later method, that is usually adopted in these investigations.

The frequency of observations was as in the previous years.

4 DEFINITIONS

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

5 OBSERVATIONS

5.1 Quantitative and qualitative spawn yielding potentiality of selected river stretches

5.1.1 Hamidabad stretch of River Brahmaputra

Participants

1. Dr. A.G. Jhingran (Leader)	Central Inland Fisheries Res. Institute. (I.C.A.R.)
2. Shri A.G. Godbole	
3. Shri R. Brahma	Govt. of Assam.

Hamidabad, selected for detailed round the clock spawn prospecting investigations, is situated on the south bank of river Brahmaputra in south Salmara Police Station of Goalpara

district of Assam. It is well connected with Dhubri town, the district headquarters of Goalpara district, across the river by a regular ferry service. The Brahmaputra, after making its way through hilly terrain and dense forests upto Kamrup district, enters the plains in Goalpara district, carrying with it water from about seventy six tributaries draining into this river on both the banks. The river at the site flows in an east to west direction, while downstream of Dhubri, it takes a sharp turn and flows in a north to south direction as river Yamuna, ultimately joining the river Padma in Bangla Desh. The river has a wide expanse of about 10-16 km in the region of this site.

During the pre-monsoon survey, the river bank at Hamidabad presented a large, gradually sloping, sandy area of about 2-3 km, suitable for operation of more than 100 spawn nets (Fig. 4). However, on reaching the site on 22.5.70 for initiating the monsoon investigations, it was observed that the first major flood, appearing early in the season, had caused considerable damage to the site, heavily eroding the bank and leaving it shorn of the propitious bank contour and ideal current pattern. This unfavourable transformation of the site is depicted in Fig. 5, showing various channels carved out in the bank.

A characteristic feature of the Brahmaputra was the very frequent changes in current pattern and direction and reshaping of the bank contour with each flood, so that no specific spot could remain suitable for net operation throughout the season, or for that matter even during a single flood phase. On account of the presence of under-currents, appearance of whirlpools and occurrence of erratic current patterns were a perpetual feature, with the result that trial nets had to be fixed at more than one spot to safeguard against missing the spawn spurt in case one spot failed to detect it due to generation of unfavourable currents there.

The observations at this site lasted from 24th May to 6th July, 1970. In addition to detailed round the clock observations made at Hamidabad, periodic prospecting for spawn was also done at two centres, viz. Dolgoma and Bhashanir Char, up and down stream of the main site respectively, thus covering a river stretch of about 125 km in the Goalpara district of Assam.

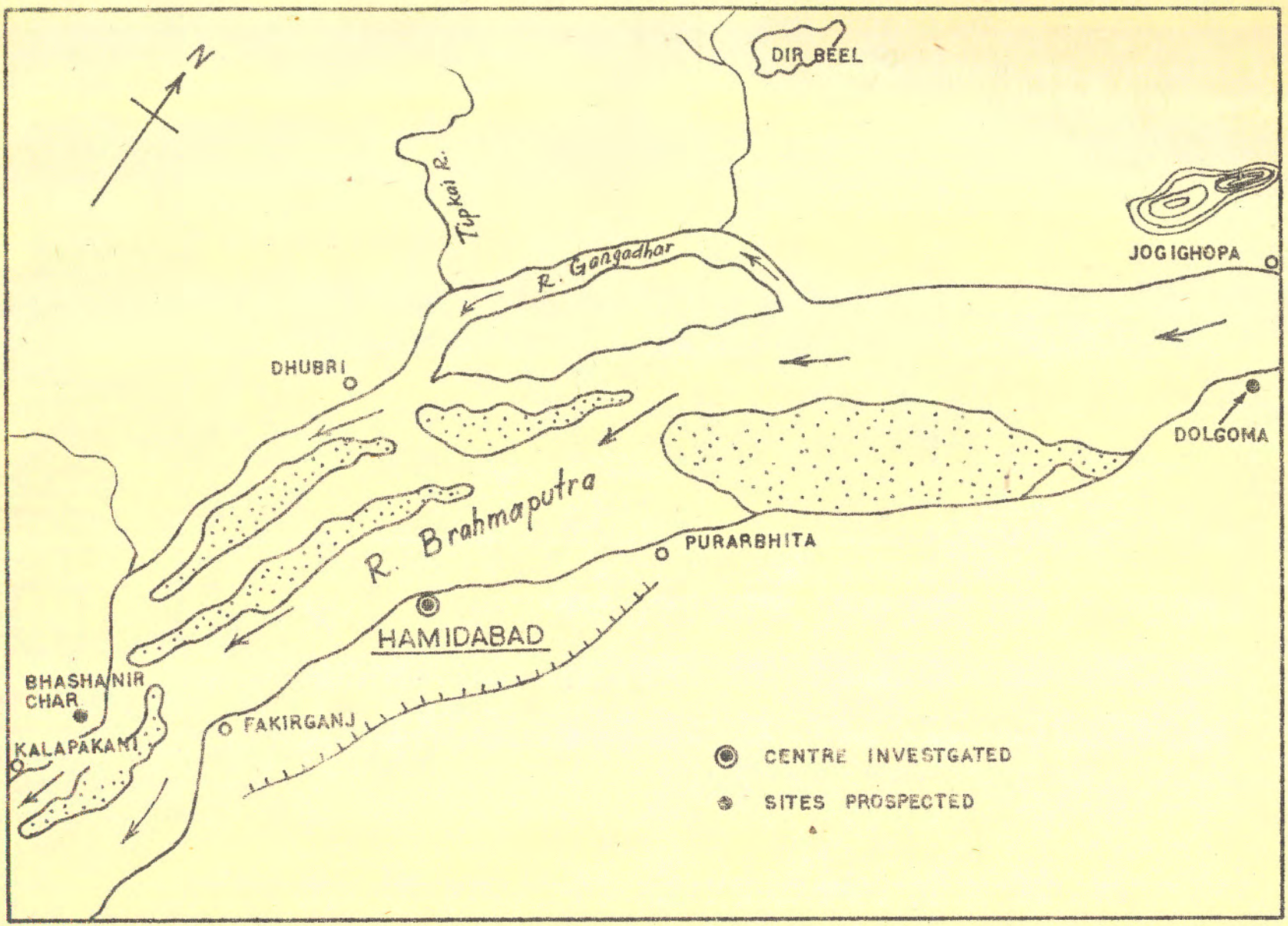


FIG. 4. HAMIDABAD STRETCH OF RIVER BRAHMAPUTRA SHOWING SITES PROSPECTED AND CENTRE INVESTIGATED.

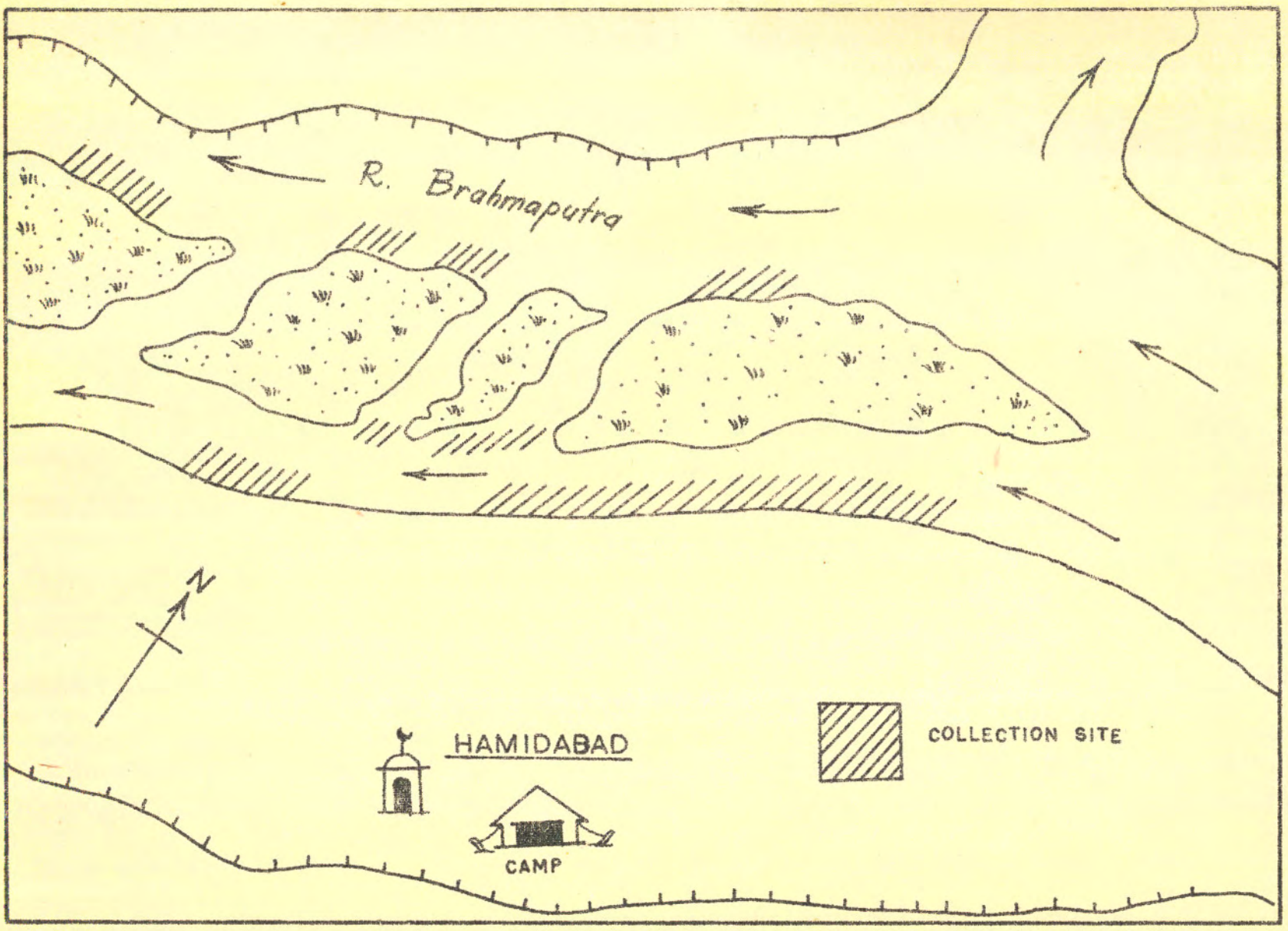


FIG. 5. THE COURSE, GENERAL TERRAIN AND TOPOGRAPHY OF RIVER BRAHMAPUTRA AT HAMIDABAD.

Occurrence of spawn spurts and areas of occurrence:

A total of 12,785.5 ml of spawn, estimated at about 6,392.750 hatchlings, was collected in 1-14 experimental nets in the course of two major floods encountered by the team at Hamidabad.

The first flood, appearing early in the season in the second week of May, 1970, was totally missed, as on reaching the site on 22.5.70 the receding phase of the first flood was waning. However, the evidence of the first flood having yielded a sizeable quantity of quality fish seed was furnished by the isolated pools in Hamidabad village which had got connected with the river during the first flood. With the recession of the flood waters, the spawn of the first flood got arrested in these water bodies. Advanced fry of all the four major carps were collected from these water pockets, which showed preponderance of catla in them. Later in July, fishing was done in these water bodies and fingerlings of catla, rohu and mrigal, in order of abundance, were collected, ranging in total length from 7.5-15.0 cm (3-6").

The river experienced its second flood on 30.5.70 at 6 hrs and the rising phase of the flood continued till 6 hrs of 14.6.70, covering a duration of 15 days. The flood peak of 2.25 m was attained on 13.6.70, when the channel between the camping site and the first row of islands began flowing. The entire collection of spawn of the season was made in three spurts during the rising phase of this flood by operating nets in this channel as well as the channels connecting this channel with the main stream. First traces of spawn were noticed in the net on 8.6.70 at 14 hrs. 2 to 2.5 ml of spawn continued to accumulate in the tail piece of the net every four-hours until 2 hrs on 8.6.70. On 9.6.70, the morning collection at 6 hrs showed 10 ml of spawn and immediately a battery of 12 nets (of four dimensions viz., 6 m, 10 m, 14 m and 18 m, each dimension having nets of three mesh-types i.e. 1/8", 1/12" and 1/16") was operated. This spurt lasted for 22 hrs, yielding 9,940 ml of spawn. The second spurt, also in the rising phase of the flood, commenced on 10.6.70. Lasting for 30 hrs, this spurt yielded 2,385.5 ml of spawn. The third and the last spurt commenced in the rising phase on 11.6.70 and lasted for only 8 hrs, yielding 204 ml of spawn.

Details of occurrence, duration, quality and quantity of spawn spurts recorded at Hamidabad are given in Table 3.

The third flood commenced on 20.6.70 and lasted till 6.7.70. A flood peak of 3.14 m was attained on 26.6.70 and thereafter the water level started receding. No spawn was encountered in this flood. Even after the second flood, spent specimens of major carps were frequently seen at Dhubri ghat.

Quality of fish seed collected:

Qualitative percentage composition of spawn collected during different spurts, based on two-hourly sample analyses, is given in Table 4. The table depicts that all the three spawn spurts had a fairly high percentage of major carps in them. Considering the fact that the percentage of major carps in the spawn catches made during earlier years by the state Govt. varied from 30-40%, the results achieved were promising, especially so when the first flood, known to be most remunerative both in quantity and quality, was totally lost.

Table 4

Spurt-wise quality of spawn

Spurt No.	Percentage composition										
	By microscopical analysis of spawn samples			By analysis of nursery reared samples							Desirability (D/UD)*
	Major	Minor	Other	Catla	Rohu	Mrigal	Calbasu	Total Major carps	Minor	Others	
1	42.40	55.70	1.90	6.25	36.60	Nil	1.78	44.63	55.34	0.03	D
2	36.25	61.25	2.50	0.55	42.23	Nil	0.55	43.33	52.03	4.64	D
3	42.0	56.50	1.50	Sample could not be drawn							D

* D = Desirable

UD = Undesirable.

Table 3

Occurrence, duration and magnitude of floods and spawn at Hamidabad on the R. Brahmaputra

Flood No.	Phase	From Date	From Hour	Duration in days	Peak flood level Date	Peak flood level Hour	Peak flood level Flood level in m	Spawn spurt Spurt No.	Spawn spurt Commencement Date	Spawn spurt Commencement Hour	Spawn catch Duration in hrs.	Spawn catch Quantity in ml	Spawn catch No. of Std. nets	Spawn catch Catch in ml	Spawn catch Catch in lakhs	Spawn catch Catch/net/hour in Nos.	Quality Desirable in ml	Quality Undesirable in ml
								1	9.6.70	6.0 hrs	22	9940	1	525	2,62500	11,932	4210.4	5729.6
I	Rising	30.5.70	6 hrs.	15	13.6.70	2.0	2.25	2	10.6.70	6.0 hrs	30	2385.5	1	325	1,62500	6,250	864.74	1520.76
II								3	11.6.70	2.0 hrs	8	204.0	1	17	0.085	1,062	85.68	118.32
	Receding	14.6.70	10 hrs	$8\frac{1}{4}$	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Rising	20.6.70	22 hrs	$5\frac{1}{3}$	26.6.70	6.0	3.14	-	-	-	-	-	-	-	-	-	-	-
III	Receding	26.6.70	10 hrs	$10\frac{5}{6}$	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Samples from the three spawn spurts were also reared in three State Govt. nurseries, viz., Agamoni, Kokrajhar and Tura, fully prepared by the State Govt. in advance to receive the spawn. The quality of samples drawn from the first two nurseries pertaining to spurts 1 and 2 are given in Table 4. Samples of the 3rd spurt stocked in Tura could not be obtained due to unforeseen reasons. The results of spurts 1 and 2 showed an almost identical percentage of major carps. Both the spurts showed an abundance of rohu in the samples. Catla followed rohu in the first spurt, followed in its turn by Kalbasu. However, in the second spurt, only rohu stood out at the dominant species among major carps, the percentage of catla going down from 6.25 in the first spurt to 0.55. Mrigal was conspicuous by its absence in both the spurts.

No marked differences in the results of qualitative composition of spawn were noticed as obtained by microscopical analyses and rearing experiments.

The indices of spawn quantity and quality for Hamidabad were estimated to be 970 ml, and 43.98%. Minor carps constituted 53.70%.

Spawn availability at prospected sites:

Spawn prospecting was carried out during different spawn availability periods at Dolgoma, situated upstream of Hamidabad on the south bank and at Bhashanir char situated downstream on the north bank. At Dolgoma, the availability of spawn was noticed on 6.6.70. Though a vast, gradually sloping, sandy-cum-clayey bank is available at the site, the presence of a steep bank projecting towards the river slightly upstream of the site directed the current towards the islands in the river, away from the bank, thus leaving at the site a shadow zone with absolutely no current. Secondly, on account of the bi-weekly markets held near the site, the entire bank line at the site, an area of about 1 to 1.5 km was seen utilized for mooring the boats, the latter juxtaposing each other and leaving no space for operation of nets. However, about a mile downstream where the river takes a bend, a small patch of suitable net operational area was available.

At Bhashanir char, the Fisheries Dept. of the Assam Govt. set up its camp, leasing out the site to private fishermen from Bihar. A comparative study of the quantity of spawn collected at Bhashnir char and Hamidabad revealed that the latter was a more favourable site. The former did not have an extensive net operational area and being situated on the north bank of the river directly faced the high easterly winds and gale which were a common feature, so much so that at times the nets did not stay in water and had to be taken out.

In the vacillation period of the rising phase of Flood II, a spawn spurt that was encountered at Bhashanir char did not show up at Hamidabad. It is likely that this spurt might have resulted from breeding of major carps in the river Gangadhar draining into the Brahmaputra at Dhubri opposite Hamidabad. On account of the location of Bhashanir char downstream of this confluence and on the same arm of the Brahmaputra, the spawn showed up there. On the other hand Hamidabad located on the same point as the confluence and on the opposite bank, separated from it by a sheet of water 10-16 km wide with a number of huge islands, could never get it.

5.1.2 Ahirauli stretch of river Ganga

Participants

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2. Shri S.C. Pathak	
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The river Ganga in Shahabad district of Bihar flows in a south-west to north-east direction between Chausa and Neagipur and then west to east direction upto Sinhaghat, situated at a distance of 15 km north of Arrah, the district headquarters.

The river for its major part between Chausa and Neagipur is narrow, flowing between high banks, highly precipitous at many places between Ahirauli and Neagipur, downstream of which it is reported to spread over vast areas inundating the adjacent agricultural fields. A small rivulet, Karamnaasa, joins the Ganga on its south bank about a kilometre upstream of Chausa and the northern tributary, the Chaghara, a little downstream of Sinhaghat.

An 80 km stretch of river Ganga from Chausa in the west to Sinhaghat in the east was chosen for spawn prospecting during the period 29.6.70 to 31.8.70. Ahirauli, situated on the south bank at a distance of 4 km downstream of the sub-divisional town of Buxar and about one km downstream to the road bridge under-construction at Sarimpur, was selected for detailed round-the-clock observations. Occasional prospecting was undertaken at Chausa, Neagipur and Sinhaghat on the south bank and at Ujhiar and Bharoli on the north bank, both situated in Ballia district of Uttar Pradesh. In addition to this, a large number of villages in a 30 km stretch between Ahirauli and Neagipur on the south bank were visited, with a view to study the suitability of various sites for spawn collection.

The operational site at Ahirauli extends for a length of one km from the road bridge at Sarimpur to Ahirauli (Fig. 6). The river bank at the site slopes gradually near Sarimpur and becomes steep towards Ahirauli. The site for half of its length downstream is strewn over its entire area with large numbers of a small thorny plant, locally called 'hingua', and in view of the mooring of huge vessels just near the bridge, the slopy space in between Sarimpur and Ahirauli was utilised for the operations. The topographical features of the area are presented in Fig.7. As will be seen from the figure, the river bank is steep in the beginning, flowing by a stretch of gradually sloping area extending for about 60 m. The whole operational space is of clayey terrain.

Occurrence of spawn spurts:

During the entire period between 20.6.70 and 31.8.70, the river experienced three floods and the rising phase of the fourth flood. The first flood in its entirety lasted for a short

duration of one week between 22.6.70 and 29.6.70, with its peak on 26.6.70. The second flood was of a very long duration, its different phases occupying a span of more than a month till 4.8.70, when the river started receiving the third freshet lasting for a lesser period of twenty two days till 26.8.70 (Table 5). Due to the delayed initiation of round-the-clock observations at 18.00 hrs, on 29.6.70, the first flood could not be brought under the purview of these investigations.

Table 5

Occurrence and magnitude of floods in River Ganga

Flood No.	Duration of rising phase		Flood peak		Duration of receding phase	
	From	To	Date/ time	Rise in m above summer level	From	To
I	22.6.70	25.6.70	26.6.70 08.00	1.87	27.6.70	29.6.70
II	30.6.70	10.7.70	11.7.70 06.00	4.95	12.7.70	4.8.70
III	5.8.70	19.8.70	20.8.70 10.00	7.17	21.8.70	26.8.70
IV	27.8.70	30.8.70	31.8.70 14.00	7.09	1.9.70	-

Altogether nine spawn spurts of varied duration, ranging between eight and forty nine hours, were recorded at Ahirauli during the second and third floods. The spawn appeared for the first time on 11.7.70 at 06.00 hrs. when the flood reached its peak level and the availability continued for a period of fourteen hours through the steady phase into the receding phase, the yield being 182 ml in five standard nets. Two more spurts, bringing in a catch of 52 ml and 132 ml in five standard nets, were encountered during the receding phase of the second flood between 18.00 hrs. and 02.00 hrs. on 15.7.70 and for a duration of 18 hours commencing at 14.00 hrs. on 20.7.70 respectively.

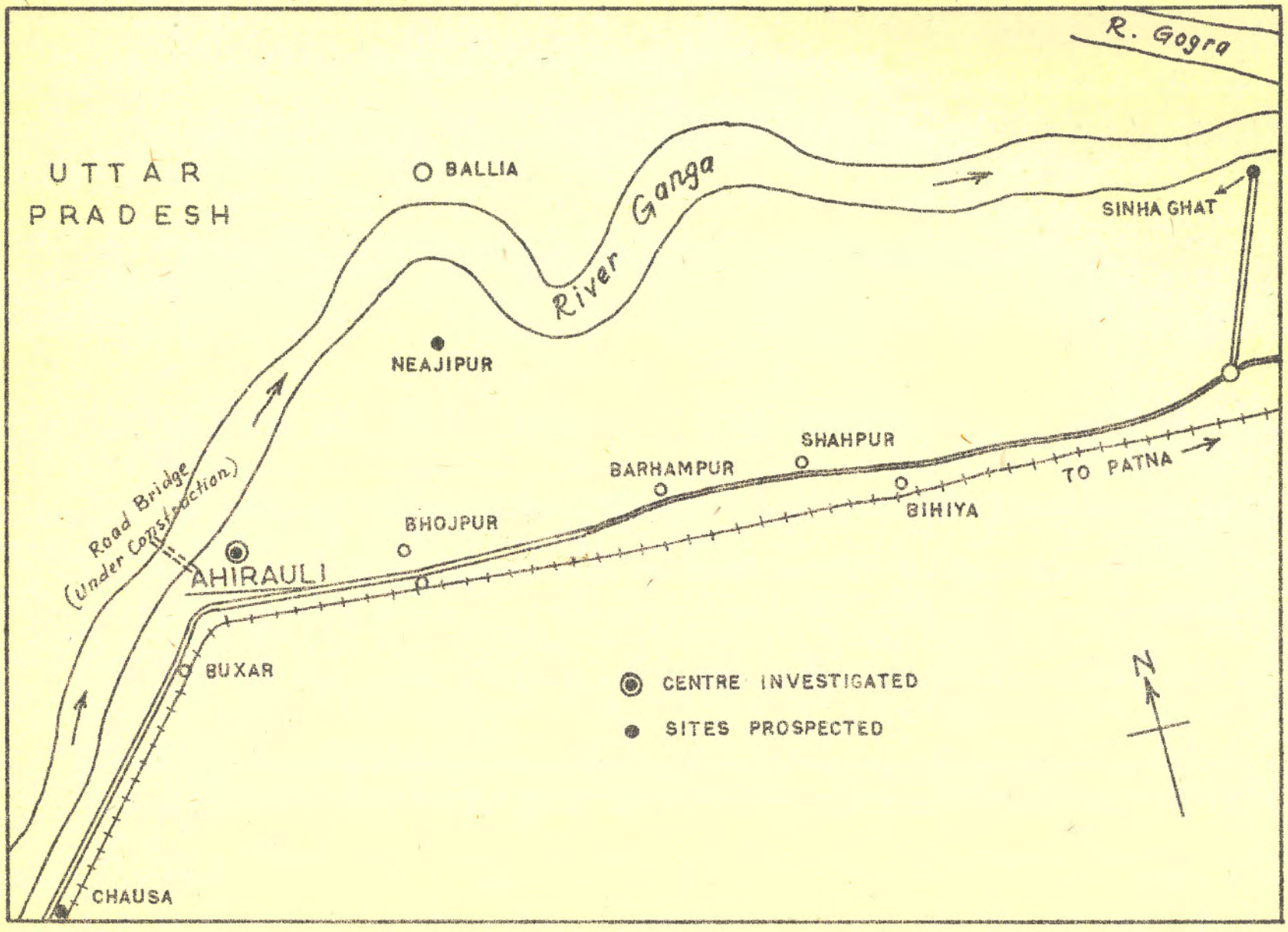

FIG. 6. AHIRAULI STRETCH OF RIVER GANGA SHOWING SITES PROSPECTED AND CENTRE INVESTIGATED.

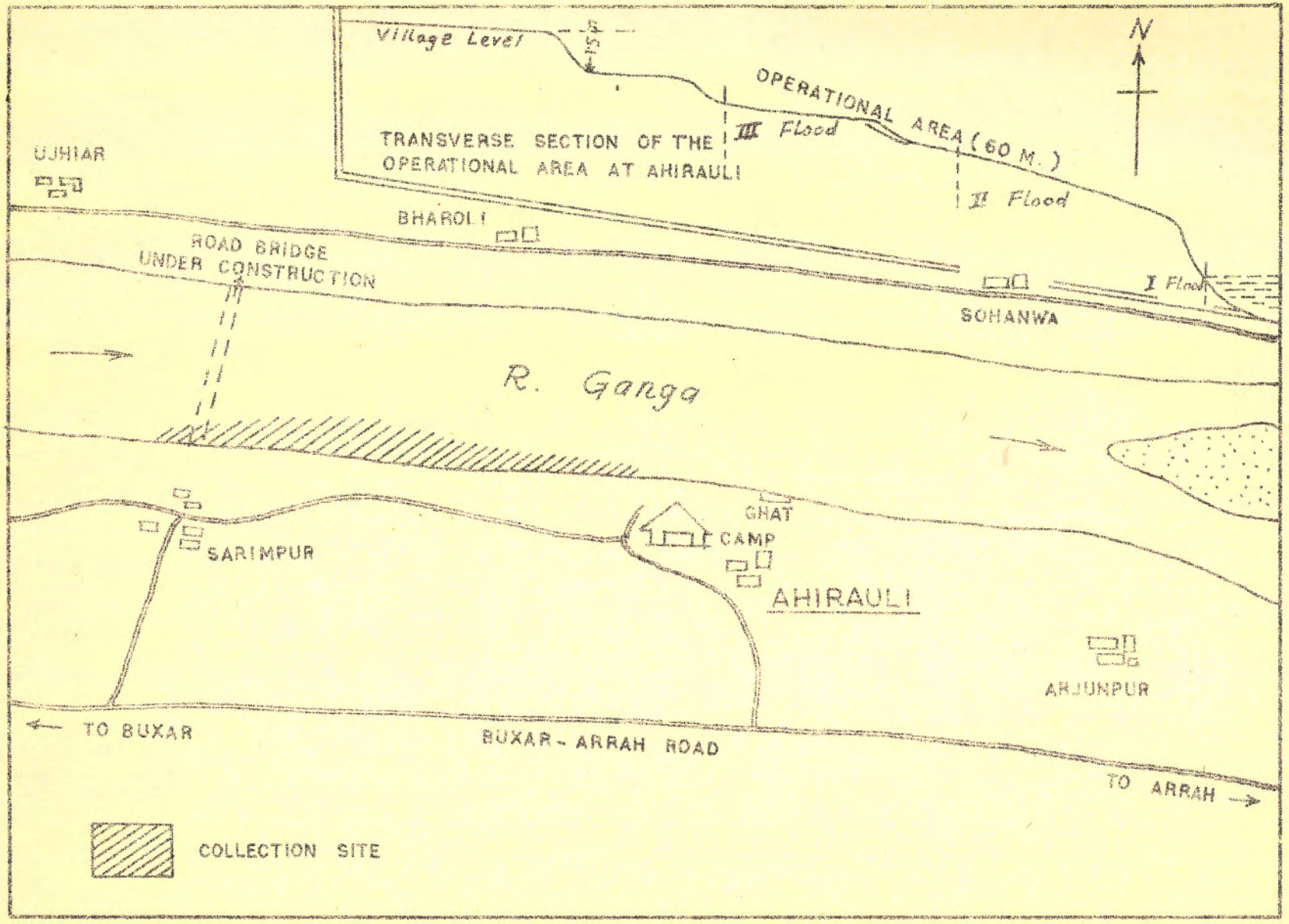

FIG. 7. THE COURSE, GENERAL TERRAIN AND TOPOGRAPHY OF RIVER GANGA AT AHIRAULI.

Of the remaining six spurts, the first five were associated with the rising phase of the third flood, while the last with its receding phase on 21.8.70. The former were available during the period between 8.8.70 and 17.8.70 for a total duration of 167 hours, the individual spurts varying between 16 hours and 49 hours with intervening periods of non-availability. The total yield in five standard nets during these spurts was 2002 ml, the fifth and sixth spurts being most productive accounting for 914 ml and 536 ml respectively. The last spurt that occurred in the receding phase of the third flood lasted for 16 hours on 21.8.70 and yielded 178 ml of spawn in five standard nets. Subsequent to this, no further occurrence of spawn was recorded at Ahirauli, though the river received the fourth flood which reached its peak level on 31.8.70.

Thus, spawn was available at Ahirauli for a total duration of 223 hours in two floods and a total quantity of 2546 ml of spawn was collected in five standard nets. Out of this quantity, the second flood contributed 14.38% and the third flood accounted for the bulk of the catch, the percentage contribution being 85.62.

Details of occurrence, duration, magnitude and desirability of the spawn spurts at Ahirauli on river Ganga, alongwith their relation to the phase of the flood, are presented in Table 6.

Table 6

Occurrence, duration and magnitude of spawn spurts in R. Ganga (Standard nets)

Spurt No.	Duration: From date/ hour	Duration: To date/ hour	Duration: Period in hrs.	Catch: in ml	Catch: in lakhs	No. of nets	Flood No.	Phase of the flood	Desirability
1	2	3	4	5	6	7	8	9	10
S_1	11.7.70 06.00	11.7.70 20.00	14	182	0.91	5	II	Receding	D
S_2	15.7.70 18.00	15.7.70 02.00	8	52	0.26	5	II	"	D

contd...

1	2	3	4	5	6	7	8	9	10
S_3	20.7.70 14.00	20.7.70 08.00	18	132	0.66	5	II	Receding	D
S_4	8.8.70 10.00	9.8.70 20.00	34	255	1.28	5	III	Rising	D
S_5	10.8.70 05.00	12.8.70 06.00	49	914	4.57	5	III	"	D
S_6	12.8.70 18.00	13.8.70 04.00	34	536	2.68	5	III	"	D
S_7	14.8.70 14.00	15.8.70 00.00	34	198	0.99	5	III	"	D
S_8	16.8.70 14.00	17.8.70 06.00	16	99	0.50	5	III	"	D
S_9	21.8.70 10.00	21.8.70 02.00	16	178	0.89	5	III	Receding	D

Quality of spawn :

The quality of the spawn catches as made out through the analyses of two hourly samples of spawn and through rearing experiments in nursery pits, State Government nurseries and earthen gamlas, is delineated in Table 7. The spawn analyses revealed that all the spurts yielded desirable spawn, with their major carp content varying between 40.00 and 80.00%, the pooled average for the season being 67.49%. While the percentage of the desirable component in spawn of the second flood was 44.61, it was as high as 73.10 in the third flood. The minor carps and 'others' contributed appreciably in the individual spurts of the second flood. The latter group was of a low consequence in the collections of the succeeding flood.

The major carp content in different spurts and floods, as revealed by the rearing of spawn in nursery pits, state nurseries and earthen gamlas, was very high in the third flood, corroborating the results of spawn analyses. However, the pooled averages obtained through the rearing in earthen gamlas during the second flood did not confirm to the result obtained

Table 7

Quality of fish seed collected at Ahirauli during different spurts

Spurt No.	Quality in percentage: By spawn analysis			By rearing: Nursery pits						State nurseries						Earthern gamlas					
				Major carps				Minor carps	Others	Major carps				Minor carps	Others	Major carps				Minor carps	Others
	Major carps	Minor carps	Others	Catla	Rohu	Mrigal	Calbasu			Catla	Rohu	Mrigal	Calbasu			Catla	Rohu	Mrigal	Calbasu		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
S_1	40.00	43.55	16.45													0.80	57.26	-	1.61	32.26	8.07
S_2	45.53	37.94	16.53							2.58	49.14	-	-	48.28	-	-	71.36	-	8.18	10.00	10.46
S_3	48.28	42.72	9.00													-	75.26	-	-	23.19	1.55
Average II flood	44.61	42.06	13.33							2.58	49.14	-	-	48.28	-	0.19	69.52	-	3.72	19.89	6.69
S_4	69.63	26.63	3.74)	-	83.33	-	0.93	14.81	0.93	2.74	97.06	-	-	8.43	1.57	-	88.62	0.56	0.22	9.26	1.34
S_5	75.43	22.26	2.31)													-	85.70	-	-	14.30	-

contd.....

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
S_6	71.11	26.66	2.23	-	85.72	-	-	2.86	11.42	13.33	71.67	-	0.33	14.67							
S_7	73.24	25.23	1.53																		
S_8	72.65	25.37	1.98																		
S_9	80.00	19.19	0.81							66.82	28.57	-	-	4.61		-	83.35	-	13.32	3.33	-
Aver-age III flood	73.10	24.54	2.36	-	83.92	-	0.70	11.88	3.50	24.87	64.63	-	0.13	9.85	0.52	-	88.38	0.52	0.62	9.23	1.24
Aver-age season	67.49	27.99	4.52	-	83.92	-	0.70	11.88	3.50	21.63	63.75	-	0.11	14.06	0.45	0.03	58.85	0.18	0.22	30.61	9.12

from the State nursery. The latter was 51.7%, as against 73.43% from earthen gamlas. This wide difference in the percentage of the major carps may be due to differential mortality of individual species of carps in different rearings.

In order to determine whether waves of pure spawn of any particular species of major carps appear in the river, two hourly samples from the first, second, third and fifth spurts were reared in earthen gamlas and the results are presented in table 8. This study could not be extended to the remaining spurts due to the limited number of gamlas. As can be seen from the figures presented, L. rohita was the most dominant species among the major carps, during all the spurts. Mostly, it was the only major carp present in the samples, but pure wave of rohu was obtained only once.

The seasonal index of spawn quality as determined from the rearing in the state nurseries was found to be 85.49%. The indices obtained from spawn analyses, rearing in nursery pits and earthen gamlas were 57.49%, 84.62% and 60.27% respectively, closely corresponding to the above index. The quantitative index of Ahirauli centre was estimated to be 552 ml.

Suitability of prospected sites for spawn collection :

Chausa, 15 km upstream of Ahirauli, Meagipur, 30 km downstream and Sinhaghat, about 70 km downstream, on the south bank in Bihar and Ujhiar opposite Buxar, Dharoli opposite Ahirauli and Barakheth, a huge 'diara' about 5 km downstream, all in Uttar Pradesh, were occasionally visited for adjudging the suitability of the sites for spawn collection.

The site at Chausa consists of a flat area extending for nearly 200 m, followed by a 30 m stretch of slopy area limited in its length, the inner margin of which forms a steep wall with a height of more than 3.0 m. The site is considered suitable for operations during third flood only, when the water level rises above the steep wall flooding the slopy area.

Meagipur, situated at a distance of little more than 3 km from the water margin of the river during the non-monsoon season, presents a vast gently sloping area with sandy terrain

Table 8

Quality of two-hourly spawn samples

Spurt No.	Date	Time	Quality					
			Major carps				Minor carps	Others
			Catla	Rohu	Mrigal	Calbasu		
I	11.7.70	16:00	2.08	62.50	-	-	27.09	8.33
		18.00	-	60.87	-	-	21.74	17.39
		20.00	-	50.94	-	3.77	41.52	3.77
II	15.7.70	22.00	-	66.07	-	21.43	3.50	9.00
		00:00	-	46.43	-	21.43	21.43	10.71
		02:00	-	78.25	-	-	-	21.75
		04:00	-	92.11	-	-	-	7.89
	16.7.70	06.00	-	69.23	-	-	17.31	13.46
III	20.7.70	20:00	-	92.86	-	-	7.14	-
		22.00	-	65.00	-	-	30.00	5.00
		00:00	-	72.73	-	-	27.27	-
		02:00	-	95.65	-	-	4.35	-
		04:00	-	100.00	-	-	-	-
	21.7.70	06.00	-	40.62	-	-	56.25	3.13
		08.00	-	72.73	-	-	25.45	1.82
IV	8.8.70	16:00	-	82.28	-	-	12.65	5.07
		18:00	-	90.24	-	1.22	-	8.54
		20:00	-	95.45	-	-	4.55	-
		22:00	-	94.00	-	-	6.00	-
		00:00	-	86.07	-	-	13.93	-
		02:00	-	90.00	-	-	10.00	-
		04:00	-	82.99	1.06	-	15.95	-
	9.8.70	06:00	-	57.14	-	-	28.57	14.29
		08:00	-	79.25	-	-	20.75	-
		10:00	-	82.87	5.71	-	11.42	-
		12:00	-	75.00	25.00	-	-	-
		14:00	-	96.55	-	-	3.45	-
		16:00	-	76.20	-	-	23.80	-
		18:00	-	97.62	-	-	2.38	-
		20:00	-	96.92	-	-	3.08	-
		22.00	-	93.15	-	1.37	5.48	-

extending for an equal length. The slopy area is ideally suited for operations during the first two floods only and thereafter, when the flood inundates the extensive flat fields and small hamlets beyond the slope, the current pattern is likely to get disturbed creating back currents and shadow zones over the slopy area, rendering it unsuitable for operations. In view of its location far from the motorable Buxar-Arrah road, the transportation of the collections poses a serious problem, which could possibly be overcome by transporting the spawn by river to Ballia city, situated on the opposite bank.

Sinhaghat site, situated on the south bank 15 km north of Arrah town, resembles Neagipur site in its topography with vast operational area, suitable for net operation during the entire season. The problem of transportation of the collections from the site to Arrah city due to lack of a pucca road is felt here also.

Though no spawn was encountered in the catches during the prospecting visits to these sites, considering the current pattern in relation to different floods and the nature of the suitable slope, large scale collections of spawn are possible during some of the floods.

North bank, on which Ujhiar and Bharoli are located, presents a steep slope with high current velocity during the floods, and as such is not considered suitable for large scale operations. It is not possible to operate a number of nets in a row and a single net can be fixed at distant intervals along the bank. Spawn collection on a limited scale was resorted to at Bharoli by a few private pisciculturists for stocking their tanks and only three nets were operated at distant intervals to collect their requirement.

Besides the above, a survey of the 30 km stretch between Ahirauli and Neagipur revealed the presence of some suitable slopy operational areas of Keshopur, midway between the above places and Manikpur dera and Chutka Rajpur, a little downstream of Keshopur. Since these places are situated at a considerable distance from the motorable Buxar-Arrah road, the transportation of the collections is considered convenient by river to Buxar.

5.1.3 Pairachali stretch of river Kangsabati

Participants

1. Shri Ravish Chandra (Leader)	Central Inland Fisheries Research Instt. (I.C.A.R.)
2. Shri S.K. Das	
3. Shri A.K. Sinha	Govt. of West Bengal.
4. Shri N.M. Chakravorty	
5. Shri N.R. De.	

After a detailed premonsoon survey of a 75 km stretch of river Kangsabati, between Purulia Road Bridge and Kangsabati reservoir at Mukutmanipur, Pairachali in the district of Purulia was selected for detailed spawn prospecting investigations during 1970 (Fig.8). A detailed survey of the river revealed that except for a few miles from the Purulia road bridge and at Pairachali, the entire river course had either precipitous banks or the bed was full of stones and boulders. The only place found suitable, where nets in good numbers could be fixed, happened to be the selected site (Fig. 9). The river course below the reservoir was not considered for the selection of a site for detailed investigations, since the Deptt. of Fisheries, West Bengal, desired the location of a site above the reservoir. However, occasional prospecting for spawn was extended to the stretch below the reservoir also, upto Raipur.

The observations at this site commenced on 20.6.70 and were continued till 12.8.70. Periodic observations were also made at Purulia and Raipur.

Occurrence of spawn :

During the period of observations, as many as 12 floods were encountered at Pairachali. The peak flood level reached during these floods ranged between 0.8 to 1.83 m. Only the II, V, VI, VIII and XII were of sufficiently high magnitude, when the flood level touched a mark of 1.52, 1.83, 1.48, 1.56 and

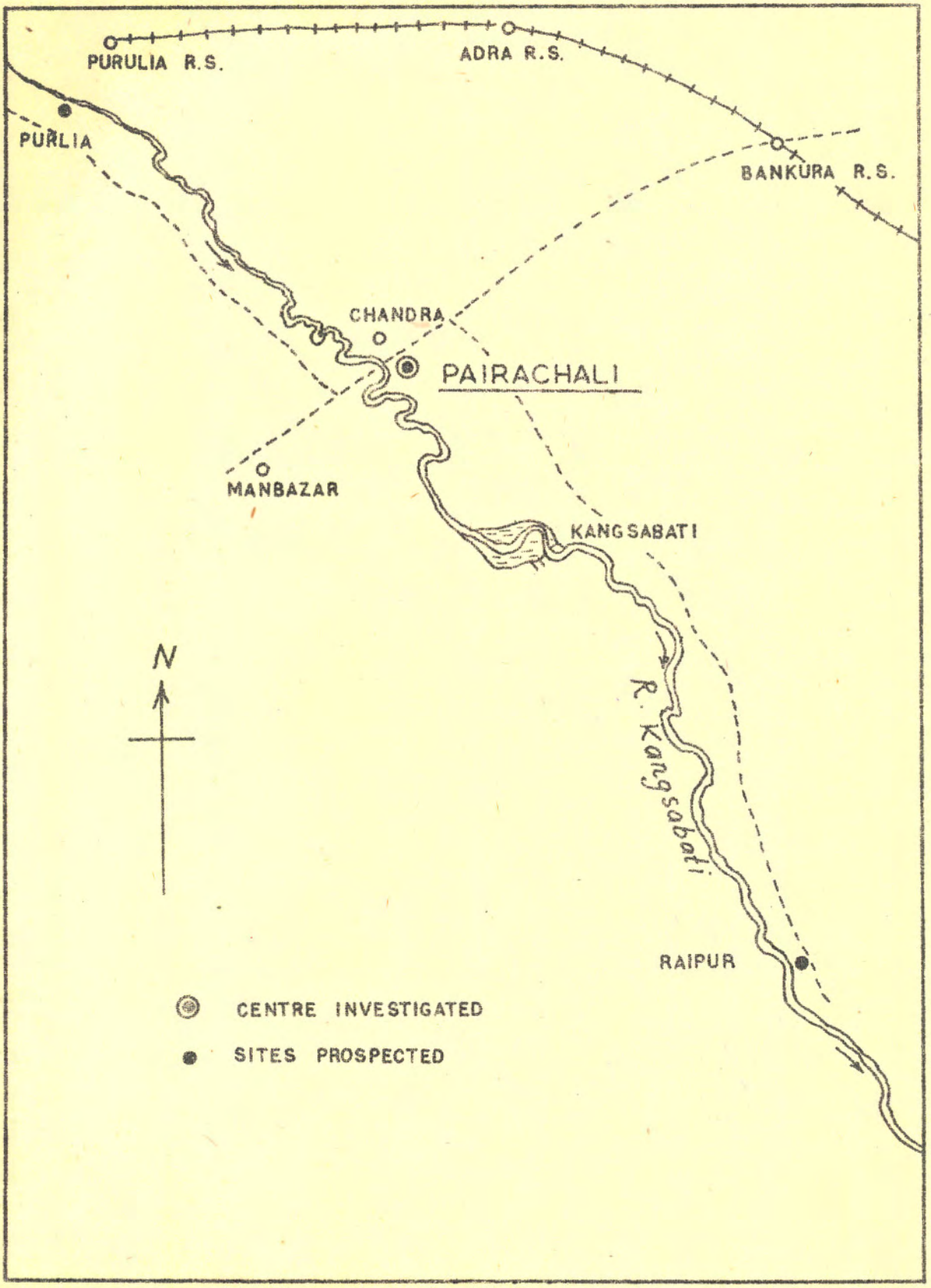

FIG. 8. PAIRACHALI STRETCH OF RIVER KANGSABATI SHOWING SITES PROSPECTED AND CENTRE INVESTIGATED.

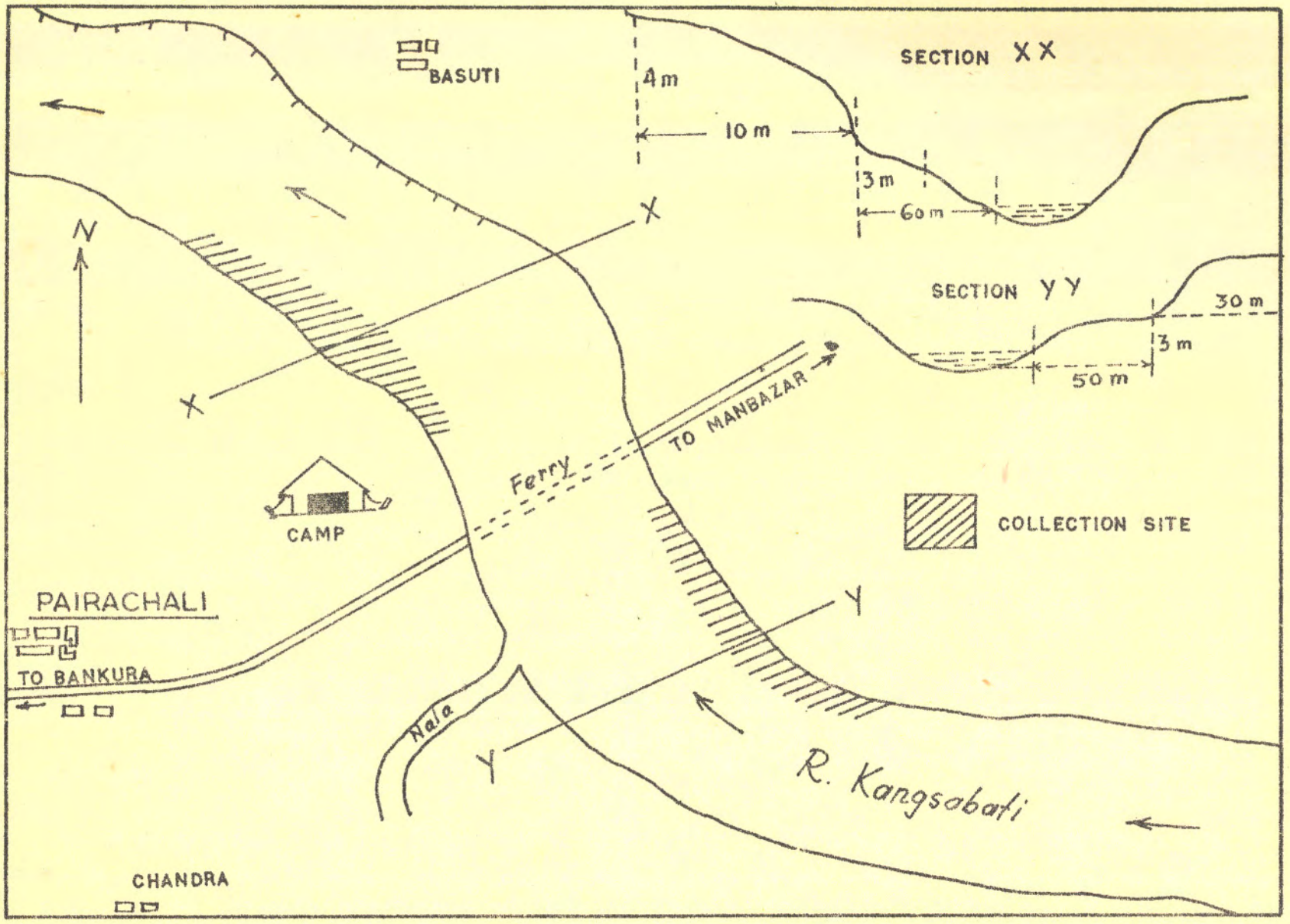

FIG. 9. THE COURSE, GENERAL TERRAIN AND TOPOGRAPHY OF RIVER KANGSABATI AT PAIRACHALI.

1.58 respectively. It was noticed that the flood started receding immediately after touching their peak, probably because of the hilly terrain and sharp gradient of the river. No spawn could be obtained during the entire season. Only a few minor carp eggs were available during the IV, V and VIII floods.

The probable reasons for the non-availability of spawn at Pairachali could be the following.

1. Indiscriminate fishing, with fixed gill-nets was found to be very prevalent in the river stretch below the site, from about a km downstream of the site right upto the reservoir. The nets were fixed in such a way that no fish could move upstream, except very small ones. Heavy landings of major carps were observed at the village bus stand, awaiting transportation.

2. The river, being in hilly terrain has a high gradient. As such, the intensity of floods encountered, probably could not inundate the breeding grounds, which might have been located above the work site. However, the site too was found to be unsuitable during high floods beyond 2 m, due to limited net operating space.

3. The fishes might have bred in the shallow marginal areas and fields, located in the vicinity of the reservoir, which got flooded during the freshets as spent fishes were also seen in the catch from the reservoir.

The seasonal indices of spawn quantity and quality for this site are, therefore, nil.

Spawn availability at prospected sites

Occasional prospecting for spawn was done at Purulia Road Bridge, Bud Bud ghat and Raipur, but no spawn was encountered. The reason for non-availability of spawn of Purulia Road bridge and Bud Bud ghat may be same as for Pairachali. Regarding Raipur, which is located below the reservoir, the reason appears to be insufficient flooding in the river, due to which fish probably could not get any opportunity to breed.

5.1.4 Mahewapatti on R. Yamuna.

Participants

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2. Shri M. Sinha	
3. Shri N.K. Srivastava	

The long term investigations initiated in 1968 at Mahewapatti, for understanding in depth the relationship between spawn occurrence and environmental factors, were continued during 1970. The observations lasted from 27th June to 2nd September. The details of location and topography of the site have already been described by Shetty et al. (MS.$_2$).

Quantity and quality:

During the year, the Yamuna received floods very early in the season and when the investigations were commenced the river had already risen by about 1 m from its summer level. The river experienced five floods during the season, with their peaks touching 76.83 m, 79.64 m, 78.57 m, 82.02 m and 82.07 m above MSL respectively, corresponding to rises of 1.17 m, 3.98 m, 2.91 m, 6.36 m and 6.41 m above the summer level. Only the IV flood yielded spawn, both in its rising and receding phases. This flood, the main flood of the season, rose above the 80 m mark, but had an inordinately long rising phase of 432 hrs. commencing from 2 hrs on 1st August, when the flood level was 76.16 m above MSL. The rate of rise was also slow, being about 32 cm per day. The rising phase had a short spell of spawn appearance on 13th August for 28 hours. The average rate of availability of spawn was only 0.87 ml/net-hour. Some more spawn was available after the flood turned to recession. This second appearance commenced 28 hours after the flood peak was touched and after a recession of 23 cm in the flood level. This availability of spawn lasted 68 hrs, and yielded a total of 309 ml of spawn at an average rate of 1.06 ml/net-hour. For most part of this availability,, the criterion of 1 ml/net-hour was not satisfied. The highest yield rate was only 2.5 ml/net-hour. The spawn available during this availability had mostly

absorbed yolk and were comparatively bigger, with the average sizes in collections mostly ranging from 5.9 to 6.2 mm. Details of occurrence and magnitude of the floods and spawn spurts are shown in Table 9.

Spawn quality:

The quality of spawn as determined by microscopical analysis was seen to be completely of the desirable type. The percentage of major carps, in the only spurt, was 82%, whereas in the total catch was estimated to be 70%. The spawn reared in small chetty pots showed the percentage of major carps as only 17.3%.

The index of spawn quantity and quality for the year were found to be 92.3 ml and 17.3% major carps, respectively. These were thus much lesser than those of 1969.

5.2 Spawn availability in relation to environmental factors

5.2.1 Flood level and phase

At Mahewapatti on the Yamuna, the main flood that yields spawn of desirable quality is generally the one coming off during late July or early August. In 1969, desirable spawn was available during the above mentioned period, associated with the II and III floods, both of which had touched a peak level of about 80 m above MSL. During 1970, the II flood, which occurred very early in July, failed to yield any spawn, even though it touched a peak level of 79.64 m. The III flood occurring in the second fortnight of July also failed to yield any spawn. The fourth flood, which happened to be the main flood of the season, commenced on 1st August, but had an inordinately long and slow rising phase, with the result that it attained its peak level of 82.02 m above MSL only on 18th August. As such, spawn availability was delayed till about the middle of August and extended upto early IV week of the month. As against the normal availability of spawn during the receding phase of floods in the Yamuna, during 1970 it occurred both in the rising and receding phase of the IV flood, even though the latter phase yielded the bulk of the season's catch. The spawn obtained during the receding phase were comparatively bigger (5.9 - 6.2 mm) than

Table 9

The occurrence and magnitude of floods and spawn spurts at Mahewapatti alongwith the quantity and quality of spawn collected

Flood details					Spawn spurt No.	Spurt duration		Spawn desirability	Total spawn catch in ml	Spawn quality					
										Percentage composition by					
										* Spawn analysis			Reared sample analysis		
No.	Phase	Duration from/hr	Peak: Level above summer MSL m	Peak: Date/hour		From date/hour	Period in hour			Major carps	Minor carps	Others	Major carps	Minor carps	Others
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
I	Rising	27.6.70 / 119	1.17 / 76.83	2.7.70 / 6.22	-	-	-	-	-	-	-	-	-	-	-
	Receding	2.7.70 / 76	-	-	-	-	-	-	-	-	-	-	-	-	-
II	Rising	6.7.70 / 68	3.98 / 79.64	8.7.70 / 22	-	-	-	-	-	-	-	-	-	-	-
	Receding	8.7.70 / 172	-	-	-	-	-	-	-	-	-	-	-	-	-
III	Rising	16.7.70 / 44	2.91 / 78.57	17.7.70 to 18.7.70 / 22.6	-	-	-	-	-	-	-	-	-	-	-
	Receding	18.7.70 / 192	-	-	-	-	-	-	-	-	-	-	-	-	-

contd.....

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	Vasci-llation	26.7.70 / 140	-	-	-	-	-	-	-	-	-	-	-	-	-
IV	Rising	1.8.70 / 432	6.36 / 82.02	18.8.70 to 19.8.70 / 2.10	-	13.8.70 / 8	28	D	122	42	28	30	22	78	0
	Receding	19.8.70 / 152	-	-	1	20.8.70 / 8	68	D	309	82	16	2	15.4	84.6	0
V	Rising	25.8.70 / 104	6.41 / 82.07	29.8.70 to 30.8.70 / 2.10	-	-	-	-	-	-	-	-	-	-	-
	Receding	30.8.70 / 72	-	-	-	-	-	-	-	-	-	-	-	-	-

* This availability did not fulfil the requirements of spawn availability of 1 ml per net-hour to be called a spurt.

those obtained a week earlier in the rising phase, which suggests that breeding must have taken place earlier in the rising phase itself. The prolonged slow rate of rising must have dispersed the spawn, resulting in their low availability at the site. Further, the earlier flooding of the Ganga at Allahabad might have adversely affected spawn availability in the Yamuna, in drawing away the breeders from the Yamuna into the Ganga. This was reflected in the high percentage of major carp breeders in 1970 Ganga landings during late July and early August, while normally their percentage is much less.

At Hamidabad on the Brahmaputra, sizable quantity of good quality spawn was reportedly available during the first flood, which was missed by the investigation team due to late arrival at the site. All the 3 spawn spurts recorded at the site during the investigation period occurred during the rising phase of the second flood. This is evidently due to the spawn flowing in from the river's numerous tributaries and adjoining bheels. Similar availability of spawn during the rising phase of floods had also been noticed at North Gauhati in the upper stretch during 1969. During the II flood, the spawn first appeared at Hamidabad when the water level touched 1.49, while the I, II and III spawn spurts occurred at 1.65 m, 1.95 m and 2.08 m levels. Further rise in water level brought about the cessation of spawn flow.

At Ahirauli on the Ganga, spawn were available both during the rising and receding phases of the floods, when the average flood level stood between 487 and 814 cm. No spawn spurt was encounterd when the water level was below 487 cm, i.e. 387 cm above the summer level. It was noticed that abrupt rise in water level, as happened during the II flood when the rate of increase varied between 57 - 132 cm per day, was unfavourable for spawn availability and that all the spurts occurred when the rate of increase or decrease was gradual. While rohu was available during all the spurts, catla was available in sizable numbers only when the flood level touched 7 m above summer level.

5.2.2 Rainfall

Heavy rains occurred in the Ahirauli stretch of Ganga on several days; but apart from causing minor vacillations in flood level and accentrating the rate of rise, this local rainfall did not substantially affect the flood level, which appeared

to depend essentially on the incoming freshets caused by rainfall in the Sub-Himalayan region and other catchment areas in Uttar Pradesh. Apart from disrupting operational feasibility, heavy rains also caused total disappearance of spawn during periods of availability.

5.2.3 Turbidity

During periods of spawn availability, turbidity ranged from 230-400 in the Brahmaputra centre and from 255-550 ppm in the Ganga centre. No direct correlation could be noticed between spawn availability and turbidity, except that turbidity influenced net selectivity. Comparative studies made with Secchi's disc and Jackson's Turbidimeter indicated that turbidity values calculated from transparency values obtained through the Secchi disc are not quite valid.

5.2.4 Current velocity

As observed in the previous year, spawn availability period was marked by moderate current velocity at all the centres, ranging from 0.60-2.00 km/hr.

5.2.5 Associates

No indicator species could be made out among the associates at any of the centres. Generally, the number of associates increased during periods of spawn availability.

5.3 Catching efficiency of spawn nets

5.3.1 Effect of net size and mesh size on catching efficiency

A total of 12 nets of four dimensions (6 m, 10 m, 14 m and 18 m) and each dimension having nets of three different meshes (1/8", 1/12" and 1/16") were operated at Hamidabad, comparing their efficiencies, in order to ascertain the effect of net size and mesh size on net efficiency. The

positions of the nets were frequently interchanged to nullify bias. It was observed that the net having a dimension of 14 m with a mesh-size of 1/12" proved to be most efficient, bagging the maximum catch, irrespective of its positions. Its average catch/net/hr was estimated to be 151.3 ml. during bulk availability of spawn on 9.1.70, while that of the standard net was computed to be 38.6 ml.

At Ahirauli, 1/8" meshed 6 m, 10 m, 14 m and 18 m nets and 1/12" and 1/16" meshed 10 m nets were operated simultaneously. Under the prevailing conditions, the standard net (1/8" meshed 10 m net) was found to be superior to the 1/12" and 1/16" meshed 10 m nets. Among the 1/8" meshed nets, the catching efficiency was found to increase with the increase in net size, in that the catching efficiencies of the 14 m and 18 m nets were 124.40% and 158.95% respectively of the standard net.

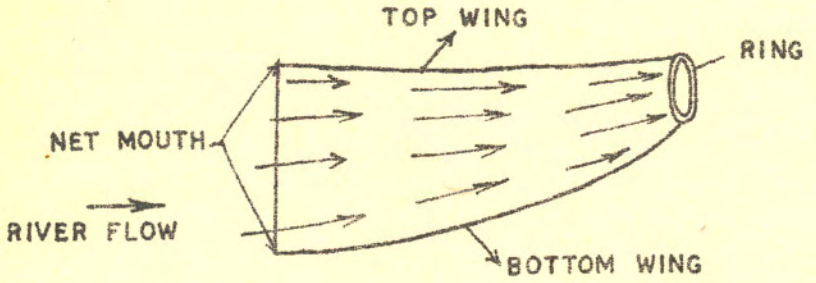
The quantity of spawn retained by a net depends on the quantum of water filtering through it. The filtration by a bag-type of net is normally estimated by the area of the mouth and the velocity of water entering it. Since nets of same size have theoretically same mouth openings, the filtration automatically becomes proportional to the velocity of water entering them. The velocity of entrance of water into the net was assessed at four points at the surface and four points located 40 cm deep, by means of a current-meter.

Since controlled experimentation was not possible on the field, effort was limited to finding the filtration rate difference when pair of nets of same size and shape specifications, but having different mesh sizes, were operated. It was seen that the fall in filtration rate was directly proportional to the fall in net mouth velocities. Since maximum filtration corresponds to no fall in net-mouth velocities, the difference of net-mouth velocities when expressed as a fraction of river velocity, gives us a measure of fall in maximum filtration rate in the net having lesser net-mouth velocities as compared to the one having higher. These experiments were confined to such conditions when river turbidity was less than 100 ppm. The additional variable of turbidity is proposed to be introduced in the subsequent years of study. For almost clear waters, the fall in filtration rate between 1/8" and 1/12" is generally lesser than that between 1/12" and 1/16", probably because of the closeness of the twines

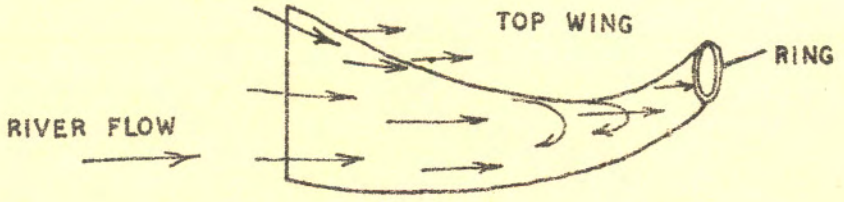
in 1/16" meshed net producing a higher relative resistance than in 1/12" meshed net. Further, the filtration was much lower for the subsurface waters entering the net, especially where the 1/16" net is involved. It is likely that the subsurface currents were not well measured by the current meter, especially when the net was long in operation. Such a contingency would have arisen if the nets had sagged heavily, resulting in back flows from the nets, since the cupt-type current meter is immune to the direction of the current on any axis. This is specifically mentioned here since in another experiment a suggestion to such a possibility existed.

The operational efficiency of a spawn net depends to a large extent on the ability of the net in creating an unrestricted convergence of the river flow through the net on to the ring end of the net. If this flow pattern is disturbed, then the filtration and flow of filtered remnants on to the gamcha is hampered. This is illustrated in Fig. 10.

In order to assess the stretching force requirements of spawn nets, a simple spring balance was used. A net was stretched fully by pulling the ring against the front bamboos of a net and the same was balanced by the spring balance by means of inelastic twine passing through a pulley (Fig. 10). The force was read off in lbs. The force of stretching was measured with the fixing of the net and at regular intervals. It was seen that the nets sagged as a result of wetting and continuous operation. The sag of the top wing of the net from the water level was measured at three points, first 1 m from the mouth of the net, second 1 m from the ring of the net and the third wherever it was maximum. Corresponding to the sag in the net, the force required to stretch it back was more. The distance by which the ring got stretched behind from its original position as a result of stretching was measured and called the "ring loosening". The idea is illustrated in Fig. 10. These measurements were done in various combination of net sizes and mesh sizes. So long as the sag of the top wing of the net is less than the lower end of the ring below water, a convergence of flow takes place. Once the sag is more, eddies in the central area of the net start forming. The practice of operation of shooting nets is such that about 25 to 50% of the ring is normally kept above water allowing only about 50 to 75% below water. The depth of



A. FULLY STRETCHED NET. DESIRABLE FORM OF FLOW PATTERN.



B. NOT FULLY STRETCHED NET. UNDESIRABLE FORM OF FLOW PATTERN.

FIG. 10. THE FLOW PATTERNS INSIDE A SHOOTING NET WHEN STRETCHED (A) AND NOT FULLY STRETCHED (B).

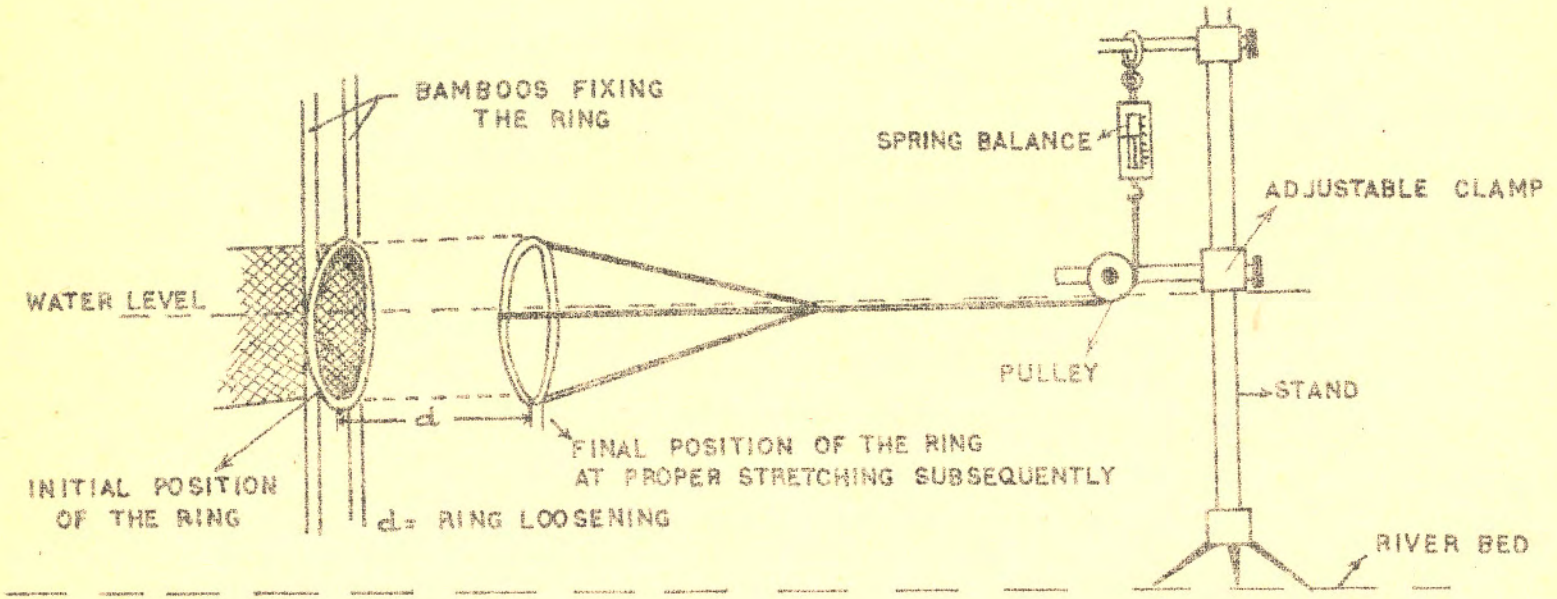


FIG. II. THE MEASUREMENT OF STRETCHING FORCE AND RING LOOSENING OF A SHOOTING NET.

immersion has been tentatively taken at 60% of the diameter of the ring in determining the critical depth beyond which the sag in top wing of the net renders the net ineffective in the sense that back currents generate within the net.

It is seen that the tension on the ring to keep it stretched rises rather rapidly after about 4 hrs of operation. As the stretching requirements increase, the front bamboos collapse back, resulting in sagging of the net. The nets also gets elongated as a result of continuous stretching, while in operation. This factor also contributes to the sagging of the net. A measure of this sag is directly available in the maximum sag of the top wing of the net. Another measure is the stretching force required to put the net again to position of proper shape. This measure is supplied by the ring loosening, as defined earlier. Since the observations were taken over the velocity range of about 0.5 to 1.5 km/hr and turbidity range of 500 to 650 ppm, as assessed by secchi's disc transparency, they may be taken as typical of the conditions normally obtained in rivers during spawn collection. Most of the nets become operationally inefficient in about 4 hrs of continuous operation after one fixing. The sag is seen to be more in the case of 1/16" meshed nets, whereas it is of the same magnitude for the 1/8" and 1/12" meshed materials. The very small net of 6 m appears to be least disturbed in this regard, presumably because of the low tension on the ring and lesser weight of the top wing. From these studies it may be inferred that under very general conditions, the 1/12" meshed nets are operationally as efficient as 1/8" meshed nets, while the operational efficiency of 14 m nets is like that of 10 m nets. 18 m nets suffer in this regard. It may also be inferred that for obtaining the maximum efficiency performance of spawn nets, it is extremely desirable that the nets are removed and refixed every four hours.

5.3.2 Assessment of spawn escapement from 1/8" and 1/12" meshed nets

It has been recognised that escapement of hatchlings from the meshes of spawn nets is of high magnitude. In order to assess this magnitude, and to ascertain the region of escapement and mean selection lengths, certain experiments were conducted at Mahewapatti on the Yamuna with 6 m cod-end covered nets and 10 m nets of different mesh sizes.

In the case of covered nets, escapement was estimated as percentage of total catch escaping to the cover. The results are given in Table 10 below.

Table 10

The mean, standard deviation and range of escapement from 1/12" and 1/8" meshed nets

Mesh of net	No. of observations	Escapement percentage			Range of	
		Mean	Standard deviation	Range	Current velocity in cm/sec.	Turbidity in ppm
1/8"	20	37.03	18.77	5.6-86.9	20-32	700-1000
1/12"	21	21.69	15.42	0.0-50.4		

The extremely high variability within a short interval of testing suggested the possibility of different sizes of hatchlings obtaining in different hauls.

The length frequency of the catches in the net and in the cover were determined for assessing the mean selection length. Detailed analysis of the escapement data of individual selection ogives have been done. The mean selection length for 1/8" meshed net was found to be approximately 5.9 mm, with the selection range 5.0 to 7.0 mm. In the case of 1/12" meshed net, however, the selection ogive could not be well interpreted, since the length groups covered were mostly higher than the probably selection length.

An assessment of absolute escapement rate was also attempted by introducing known number of hatchlings into the net. For this study, 10 m nets of 1/8", 1/12" and 1/16" mesh were used.

Riverine spawn, marked with the vital stain Neutral Red, were released at 3 points at net mouth. Spawn were released at one point only at a time. All the three points were covered in quick succession. The spawn catch in the gamcha were removed 3 minutes after each release and counted.

It may be inferred from the results that escapement of hatchlings from all the nets was of a high order. It was seen that the escapement of hatchlings from the 1/16" meshed net was also of a high order and almost similar to those from 1/8" or 1/12" meshed nets, whenever, velocities of flow were low, suggesting the possibility of some spawn escaping from the net mouth after entering the net. The velocities when such a contingency would have contributed significantly, appear around 12-15 cm/sec (corresponding to about 0.4 km/hr). This means that the low velocities fail to wash down the spawn, which are able to resist the current and even negotiate the same.

In order to determine the region of escapement, marked spawn were released at net-mouths of the covered nets. Since only the posterior half of the net was covered, the escapement from that area was only estimated. It was seen that the escapement from cod end of the net was 42% for 1/8" meshed net. This figure agrees well with the earlier finding of 40% for a fully covered net. Therefore, it appears that the escapement from the anterior of the net is of the same magnitude as from the rear for the 1/8" meshed nets. However, for the 1/12" meshed net, no escapement was observed from the cod-end portion of the shooting net. It is likely that the stretching of the nets narrows the mesh lumen of 1/12" mesh to restrict escapement. The much lower average escapement from 1/12" mesh supports this view. More experimentation on these lines can throw further light on this problem.

5.3.3 Improvement of net efficiency through 'Gamcha' modification

In order to explore the possibility of automatically sieving spawn by the provision of proper sieves on the gamcha, a gamcha was designed having an inner gamcha made of round meshed mosquito netting. It was observed that the partitional gamcha was very effective in sieving the spawn completely from the associated fry and debris while in operation.

spawn. Another gamcha with multiple partition and having a horizontal filter was designed to examine whether spawn could be seggregated as a result of differential behaviour. The design of this gamcha is also illustrated in Figure 3.2. The catch coming in upper and lower segments of the horizontal filter were separately reared in earthen chetty pots for eight two-hourly periods. The survival being very poor in three such pairs, the data of the remaining five pairs were used for finding the species composition. The percentage composition of different species were determined for each chettypot. The percentage of each species in the two segments were determined. These are given in Table 8. From this table it appears that the Cirrhinus species were mostly retained in the upper segments, while Labeo species were more in the lower segment. However, it may be mentioned here that chettypot rearing might have significantly changed the composition of catches, and further too few specimens survived in any single chettypot.

5.4 Assessment of mid-stream spawn flow

This was tried with the help of a specially fabricated floating spawn net at Mahewapatti on the Yamuna. The availability of spawn during the year at Mahewapatti was very meagre. As such any proper assessment of the flow of spawn in the deeper regions of the river, away from banks, was not possible. This net was used at distances of about 100 m and 200 m from the river bank where depths varied from 2.90 to 5.10 m. No carp spawn was seen in the catches, during a period when spawn was available in the marginal waters at a very low rate of about 0.5 ml/net-hour.

6 DISCUSSION

Details of spawn occurrence at the various sites, its inter relationship with environmental factors, gear efficiency, etc. have been elucidated in the foregoing sections. Of the three centres selected for investigation, Hamidabad on R. Brahmaputra and Ahirauli on R. Ganga were found to be promising. While the major carp content in the Hamidabad centre was 43.48%, it was as high as 85.49% at Ahirauli, consisting mainly of rohu.

On the other hand, Pairachali on R. Kangsabati was found to be unsuitable for commercial exploitation, specially under the present condition of indiscriminate destruction of breeders ascending up the river from the reservoir. The Mahewapatti centre on R. Yamuna also yielded rather poor result during the year.

R. Brahmaputra is more difficult to exploit for spawn than the other rivers, because of very frequent and drastic changes in current pattern and consequently site suitability. All the same, the Hamidabad stretch yielded quality spawn in sizable quantities, unlike the upper stretch site at North Gauhati, which yielded only undesirable spawn in almost negligible quantities. From the results obtained during the last two years, it appears that the Brahmaputra offers better scope for spawn collection in its lower stretches in the district of Goalpara, where it enters the plains and gets connected with numerous adjoining bheels, tributaries, etc. during the monsoon months. Spawn at this centre occurred only during the early first two floods.

At Ahirauli on Ganga, quality spawn occurred during the II and III floods only, mainly during the rising phase of the III flood. A number of sites prospected in the adjoining stretches were found to be suitable, at least during some of the flood levels. Enquiries made at Chausa, Buxar and Ahirauli indicated that during monsoon months huge congregations of rohu occur in the rivulet Karamnarsa, which joins the Ganga on its south bank, about a kilometre upstream of Chausa. On the other hand, large sized catla are caught in the Ganga itself. It may be possible to trace the breeding ground of rohu in the Karamnarsa. The site at Ahirauli is ideally suited for large scale commercial exploitation during the II and III floods, when a battery of more than 100 nets can be fixed along its length of nearly a kilometre from Sarimpur and Ahirauli. Among the nets tested for their efficiency, the 14 m, 1/12" meshed net generally proved to be the best, even though the 18 m net handed better catches at Ahirauli. The fall in filtration rate between 1/8" and 1/12" was found to be less than that between 1/12" and 1/16".

That the escapement of spawn from nets is of high magnitude was confirmed again by the experiments carried out during the year at Mahewapatti.

The attempts made during the season towards improving the gamcha and evolving a suitable gear for ascertaining mid-stream spawn flow are promising. Non-availability of spawn prevented the full testing of these devices. Further, the method developed for mass marking of live spawn is a significant development, which could be made use of for studying the dynamics of riverine spawn and escapement rate from spawn nets.

7 SUMMARY

i) During 1970, spawn prospecting investigation were carried out along three riverine stretches in the country, one each in Assam, Bihar and W. Bengal on the rivers Brahmaputra, Ganga and Kangsabati respectively. In addition to the above, Mahewapatti on R. Yamuna near Allahabad was also investigated in continuation of the long term investigations initiated in 1968.

ii) The sites selected for detailed investigations after an extensive premonsoon survey were : Hamidabad on R. Brahmaputra in Assam, Ahirauli on R. Ganga in Bihar, and Pairachali on R. Kangsabati in West Bengal.

iii) Hamidabad on R. Brahmaputra was found to be a fairly lucrative centre for spawn collection. It yielded a total of 12,785 ml of spawn in 1-14 experimental nets in the course of the first two floods. The spawn occurred only in the rising phase of the flood. The site was characterised by frequent changes in current pattern and bank contours. The seasonal indices of spawn quantity and quality for the site were estimated to be 970 ml and 43.98% respectively.

iv) A total of 2,546 ml of desirable spawn was collected at Ahirauli in 5 standard nets in 9 spurts in the course of the II and III floods. Bulk of the spawn was obtained in the rising phase of the III flood. A number of sites in the stretch were found suitable for exploitation. The seasonal indices of spawn quantity and quality were 552 ml and 85.49% respectively.

v) Pairachali on R. Kangsabati failed to yield any spawn. Indiscriminate fishing of breeders, hilly terrain and breeding of the fishes in the reservoir itself possibly account for the failure of the site.

vi) Due to abnormal flood pattern, spawn availability at Mahewapatti was adversely affected. A total of only 431 ml could be collected in the entire season. The seasonal indices of spawn quantity and quality worked out to 92.3 ml and 17.3% respectively.

vii) A flood level around 80.00 m above MSL appears to be necessary for spawn availability at Mahewapatti. The prolonged slow rate of rising of the IV flood appears to have dispersed the spawn, resulting in low availability at the site. Further, the earlier flooding of the Ganga must have adversely affected the Yamuna in drawing away its breeders and pushing back the Yamuna waters.

viii) The availability of spawn at Hamidabad during only the rising phase, evidently due to the spawn flowing in from its numerous tributaries and adjoining bheels.

ix) At Ahirauli on the Ganga, spawn was available only after the flood level touched 3.87 m above the summer level. Catla was available in sizable numbers only when the flood level touched 7 m above summer level.

x) Of the various nets tried, the 14 m, 1/12" meshed net was found to be generally the most efficient. The standard net was found to be superior to the 1/12" and 1/16", 10 m nets.

xi) Rates of filtration and sagging during operation were studied with nets of different meshes. The filtration rate was found to slow down faster from 1/12" to 1/16" mesh, than from 1/8" to 1/12".

xii) The mean rates of escapement of spawn from 1/8" and 1/12" meshed nets were found to be 37.03% and 21.69% respectively. The mean selection length for 1/8" meshed net was found to be about 5-9 mm, the range being 5.0-7.0.

xiii) Two types of gamcha, one with an inner gamcha and the other with 2 vertical and one horizontal partitions were fabricated and used. The results obtained are encouraging.

xiv) A special floating type of spawn net was fabricated for ascertaining mid-stream spawn flow.

xv) An effective method of marking of live spawn was developed by using Bismark Brown Y.

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