REPORT ON FISH SPAWN PROSPECTING INVESTIGATIONS, 1964

1. Uttar Pradesh and Gujarat

Bulletin No. 4
March, 1965.

CENTRAL INLAND FISHERIES RESEARCH INSTITUTE
BARRACKPORE, WEST BENGAL,
INDIA

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I N D I A

FOREWORD

At present considerable attention is being paid towards development of inland fisheries all over India. Availability of the required quantity of quality fish seed for stocking the vast areas of inland waters is the most important requisite for achieving the fish production target. The present collection of fish seed from riverine sources and fish seed production by induced breeding is very inadequate compared to the actual requirement in the country. To achieve self sufficiency in regard to fish seed, it is necessary to find out new areas of availability of quality fish seed in sufficiently large quantities. With a view to achieve this object a pilot scheme to prospect areas of occurrence of quality fish seed was undertaken by this Institute in collaboration with the Departments of Fisheries of Uttar Pradesh and Gujarat during the fish breeding season (June-August) 1964.

This report embodies the results of investigations carried out in this connection by the Riverine Sub-station of this Institute at Allahabad, mainly in the Ganga river system in U.P. and partly in the Narbada river system in Gujarat. The investigations were carried out by a team of workers under the supervision and guidance of Dr. V.G. Jhingran assisted by Shri J.C. Malhotra, Research Officer at Allahabad Sub-station. The report has been prepared by Dr. V.G. Jhingran who was in overall charge of the investigations. The names of persons who carried out the work and subsequent laboratory analysis of material and data are as shown below:

1. Shri S.J. Karamchandani, Research Officer (Camp-in-Charge, Sisodra)
2. Shri K.K. Ghosh, Assistant Research Officer (Camp-in-Charge, Kishanpur)
3. Shri Ravish Chandra, Assistant Research Officer (Camp-in-Charge, Gonribaba)
4. Shri H.A. Khan, Assistant Research Officer (Camp-in-Charge, Mahewa/Jamunapur)
5. Shri A.G. Jhingran, Assistant Research Officer (Camp-in-Charge, Tajpur, Moradabad)
6. Shri D.V. Pahwa, Senior Research Assistant (Camp-in-Charge, Sardarnagar, Bareilly)

7. Shri S.P. Singh, Senior Survey Assistant
8. Shri M.J. Bhagat, Senior Survey Assistant
9. Shri C.B. Srivastava, Senior Survey Assistant
10. Shri K.P. Srivastava, Survey Assistant
11. Shri S. Jena, Research Assistant
12. Shri R.K. Saxena, Survey Assistant
13. Shri S.K. Wishard, Survey Assistant
14. Shri G.N. Srivastava, Survey Assistant
15. Shri M.D. Pisolkar, Survey Assistant
16. Shri V.R. Desai, Research Assistant (Camp-in-Charge, Rania)
17. Shri S.N. Mehrotra, Research Assistant
18. Shri M.Y. Kamal, Research Assistant
19. Shri M.R. Sinha, Research Assistant
20. Shri J.K. Verma, Research Assistant
21. Shri N.K. Srivastava, Junior Survey Assistant
22. Shri D.N. Srivastava, Junior Survey Assistant
23. Shri B. Ghosh, Junior Survey Assistant
24. Shri A.K. Chatterji, Junior Survey Assistant

Staff of the Fisheries Extension Unit, Allahabad:

25. Shri H.G. Hingorani, Assistant Fisheries Extension Officer (Camp-in-Charge, Baluha).
26. Shri B.K. Sharma, Fisheries Extension Assistant

The Staff of the Department of Fisheries Uttar Pradesh who participated in the field investigations were:

27. Shri Ram Phal, Fisheries Inspector
28. Shri B.D. Agarwal, Fisheries Inspector
29. Shri B.L. Shah, Fisheries Inspector
30. Shri A.H. Khan, Fisheries Development Worker

31. Shri V.K. Saxena, Fisheries Development Worker

The Staff of the Department of Fisheries, Gujarat who participated in the field investigations were:

32. Shri Gopal Krishna, Fisheries Officer
33. Shri R.M. Vyas, Fisheries Assistant
34. Shri K.V. Mathewa, Fisheries Assistant
35. Shri I.S. Mansuri, Fisheries Assistant
36. Shri K.V. Thampan, Fisheries Assistant
37. Shri Chandy, Fisheries Assistant

In addition, seventeen members of the subordinate survices of this Institute and the Fisheries Extension Unit, Allahabad, six fishermen, each appointed by the Department of Fisheries, Uttar Pradesh and Gujarat helped in the work. The following eight spawn collectors from Midnapore District of West Bengal were specially recruited to assist in this work with their empirical knowledge gathered through generations of professional field experience.

38. Shri Surendra Nath Burman - Vill. Rajnagar, P.O. Putputia, Dist. Midnapore, West Bengal.
39. Shri Balram Burman -do-
40. Shri Atul Burman -do-
41. Shri Sudharsan Kumar Burman -do-
42. Shri Niranjan Kumar Burman -do-
43. Shri Banshi Bhanja -do-
44. Shri Prodyat Kumar Bhanja -do-
45. Shri Gour Hari Bhanja -do-

These investigations have contributed considerably not only in locating a few very good sources of quality fish seed, which, if exploited commercially by the States concerned, will augment fish production by culture operations but also by elucidating the environmental factors responsible for the occurrence and concentration of fish seed in rivers in time and space, and by laying down an

uniform pattern of future spawn prospecting and collection operations by Centre and the States with a view to achieving a fuller appraisal of the riverine fish seed resources on a nationwide basis. Such an approach is essential in piloting a planned fisheries development of the country. Another achievement of these operations has been the training of several State Department personnel and local fishermen in spawn collection technique to create an incentive in scientific fish seed collection.

These investigations were carried out with the effective co-operation from the Departments of Fisheries, Uttar Pradesh and Gujarat who spared staff and material for successful implementation of the project. It is hoped that this report will be helpful to those who are engaged in prospecting areas of occurrence of quality fish seed and establishment of effective spawn collection centres in different parts of the country. It is a privilege to place on record the big lead given in this work by Shri G.N. Mitra, Fisheries Development Adviser, with his valuable suggestions, encouragement and assistance throughout the course of this work.

B.S. Bhimachar
DIRECTOR

March 5, 1965
Central Inland Fisheries
Research Institute,
Barrackpore.

C O N T E N T S

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I. INTRODUCTION

Hatchlings and early fry of the major carps, Labeo rohita, Catla catla, Cirrhina mrigala and Labeo calbasu, commonly called spawn or fish seed, are collected during the South-West monsoon months for pisciculture from most of the rivers of the country where these species occur. As the breeding season of major carps is common with many other species of fish, especially the minor carps, the riverine spawn often comprises a mixture of species both desirable and undesirable from the point of view of fish culture. While intensive collection of spawn is made in certain sections of many rivers of the country, a systematic comprehensive survey of spawn resources, except in the case of River Mahanadi in Orissa, is not known to have been done. The industry is largely in private hands in Eastern India and neither the spawn collection nets (shooting nets) nor the methods of collection and measurement of spawn are as yet standardised. There is also no adequate administrative machinery to compile and maintain nation-wide spawn collection estimates. Knowledge of the behaviour of spawn with reference to the hydrodynamics of the river concerned and its availability in time, space, quality and quantity with reference to physico-chemical, hydro-biological and meteorological conditions is also very meagre.

II. AIMS AND OBJECTS

1. To prospect for new sources of fish seed in the rivers and streams of the country to privide a fillip to fish culture.

2. To train local fishermen and other personnel in riverine spawn collection technique.

3. To elucidate factors responsible for fluctuations in abundance of quality fish seed and to predict its availability in time and space.

4. To evolve and standardise spawn collection nets and the technique of collecting, and measuring fish seed on all-India basis suitable to different current, depth and hydrographical conditions, a process essential for building up country-wide estimates of spawn yield, and its fluctuations from year to year which have an obvious advantage in piloting a planned development of the fisheries of the country.

III. PRE-MONSOON SURVEY AND CENTRES CHOSEN FOR INVESTIGATION IN 1964

Investigations were taken up in the States of Uttar Pradesh and Gujarat in 1964 and the guiding principle in the choice of centres was two fold viz.:

1. A systematic spawn survey of the River Jumna commencing in 1964 from the confluence of Jumna with the River Ganga.

2. Areas where the States would like their spawn collection centres to be located to suit their needs in fisheries development plan.

An essential pre-requisite to choose potentially successful centres for spawn survey both from the points of view of the bulk availability of quality fish seed as well as from their physical approach and accessibility for fisheries development, is to ascertain, in advance, the fish fauna of the region and the nature of riparian terrain and drainage. To channalise effort along lines likely to prove fruitful, river stretches, within which spawn collection centres were to be located, were first selected and the exact choice of centres was made after a pre-monsoon survey of the selected stretches. Figure 1 shows on a map of India the geographical location of river stretches surveyed and the centres where spawn prospecting investigations were conducted. The details of river stretches surveyed, sites preliminarily examined and centres finally chosen for investigation are presented in Table 1.

Column 2 of this table shows the river stretches surveyed and column 3 the sites in the River stretches which were examined in detail as to their technical suitability such as bank contour, proximity to village, rail and road connections with neighbouring towns and cities, post and telegraph communications, community development block in which located and availability of ditches and ponds in the vicinity to serve as rearing pits, nurseries etc. The above data in respect of these sites has been catalogued in the Allahabad Sub-station of the Central Inland Fisheries Research Institute and is not reproduced here. Column 4 of Table 1 shows the sites finally selected for investigation in the 1964 monsoon months (June-September).

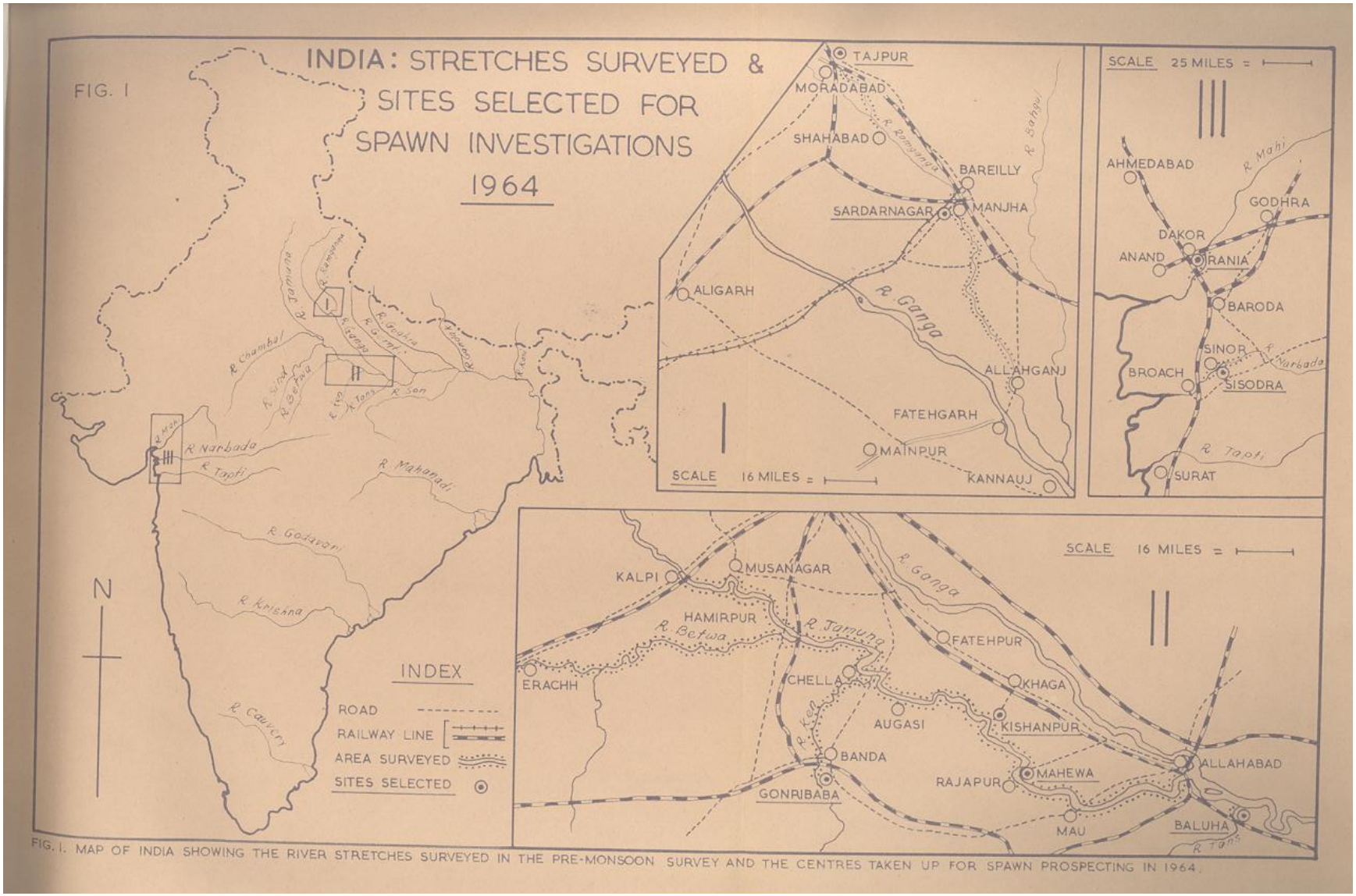

FIG. I. MAP OF INDIA SHOWING THE RIVER STRETCHES SURVEYED IN THE PRE-MONSOON SURVEY AND THE CENTRES TAKEN UP FOR SPAWN PROSPECTING IN 1964.

A total of 714 km. in eight stretches of seven rivers, as detailed in Table 1, were covered in the pre-monsoon survey in the States of Uttar Pradesh and Gujarat. 41 sites were examined in detail in all the eight river stretches surveyed and finally eight centres were selected for spawn prospecting. The topographical and geographical details of each centre investigated are given in the account under relevant centres.

IV. MATERIAL AND METHODS

Method of Collection of spawn

Nets of 3 mesh sizes viz. 1/8", 1/16" and combination of 1/8" and 1/16" (front half 1/16" and rear half 1/8" mesh) each of the dimensions: length 320 cm. width at mouth 312 cm., height of mouth 61 cm. and ring diameter 23 cm., called here Midnapore nets*1, were used alongwith the State Department nets (Uttar Pradesh nets in U.P. Centres and Gujarat nets in Gujarat Centres) for spawn collection. The tail piece (Gamcha) of Midnapore nets were made of handloom square netting cloth and measured: Length 168 cm. Height 62 cm. and Width at rear end 44 cm. The details of shape, design, placings of cut pieces and positions of seams of Midnapore nets to impart to it a stream lined shape, alongwith Gamcha, are shown in Panel A of Figure 2a. Panel B of this figure shows a U.P. State net and Panel C a Gujarat net of the type used at Sisodra. The pattern of weave and twist in twine of each net is shown in Figure 2b. The nets were operated round the clock(twenty four hours) during the entire season. 3-5 departmental, 3 Midnapore of 1/8" and one each of 1/16" and 1/8"-1/16" nets were used during periods of spawn availability. There was a heavy wear and tear of nets due to their continuous round the clock operation. Occasionally due to nonavailability of replacements the net numbers under operation varied which has been duly taken into account,

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*1 Obtained in 1964 from M/s.National Fishery Equipments Manufacturing Co., 139 R.N.Guha Road, Calcutta-28. The cost of 1/8" netting was 0.69 p. per yard; of 1/16" 0.83 p. per yard and of Gamcha cloth 1.05 p. per yard. Also obtainable from fisheries equipment dealers in W.Bengal notably Fish Seed Syndicate Ltd. 5,Dobson Lane(New C.I.T. Road), Howrah, and General Marketing Co. 12, Netaji Road, Calcutta-1.

TABLE 1.

Pre-monsoon survey: River stretches surveyed, sites examined and centres selected for investigation

Name of River	River stretch surveyed*	Sites examined*	Centres selected for investigation in 1964.
1	2	3	4
I GANGA RIVER SYSTEM River Jamuna(The main tributary of River Ganga).	About 300 km from Musanagar to its confluence with the River Ganga.(Figure 1 Insect II).	1.Musanagar. 4.Mahewa. 2.Augasi. 5.Mau. 3.Kishanpur	1. Kishanpur. 2. Mahewa.
River Ramganga(A tributary of the River Ganga from its Northern drainage).	a.About 70 km from Moradabad to Shahabad(Figure 1 Insect I) b.About 80 km from Bareilly to Allahganj(Figure 1 Insect I).	a.1.Tajpur. 5.Sithauli-Kolaghat. 2.Harthala. 6.Saidpur. 3.Shahabad. 7.Manjha. b.4.Garhi-Aurangabad. 8.Sardarnagar.	3. Tajpur(Moradabad) 4. Sardarnagar(Bareilly).
River Tons(A tributary of River Ganga)from its Southern drainage).	About 15 km from the railroad bridge at Katka to its comfluence with Ganga (Figure 1 Insect II).	1.Baluha 2.Samahan.	5. Baluha.
River Betwa(A tributary of the River Jamuna from its Southern drainage).	About 130 km from Errach to its confluence with the River Jamuna.(Figure 1 Insect II).	1.Errach. 6.Kotra. 2.Dhitauli. 7.Mohava. 3.Dhora. 8.Thar. 4.Dursonda. 9.Chandaut. 5.Saidnagar.10.Bheri. 11.Hamirpur.	X
River Ken(A tributary of the River Jamuna from its Southern drainage).	About 55 km from Banda to its confluence with the River Jamuna(Figure 1 Insect II).	1.Shurangarh (Banda) 4.Khaptiha. 2.Aooraud. 5.Kalan. 3.Alona. 6.Pailani. 7.Chilla 8.Gonribaba	6. Gonribaba.

Contd....

Name of River	River stretch surveyed*	Sites examined*		Centres selected for investigation in 1964.
1	2	3		4
II.River Narbada.	About 40 km between Sisodra & Kalugam (Figure 1 Insect III).	1.Sisodra. 2.Indor.	3.Volugam 4.Narkeshwar.	7. Sisodra.
III.River Mahi.	About 24 km between Vasad and Rania. (Figure 1 Insect III).	1.Rania 2.Vasad.	3.Kherda.	8. Rania.
TOTAL:	714 km	41 sites		8 centres.

*Report of the pre-monsoon survey as well as sketches showing details of topography, river course etc. in respect of all centres covered in the pre-monsoon survey are documented in the Central Inland Fisheries Research Sub-station, Allahabad.

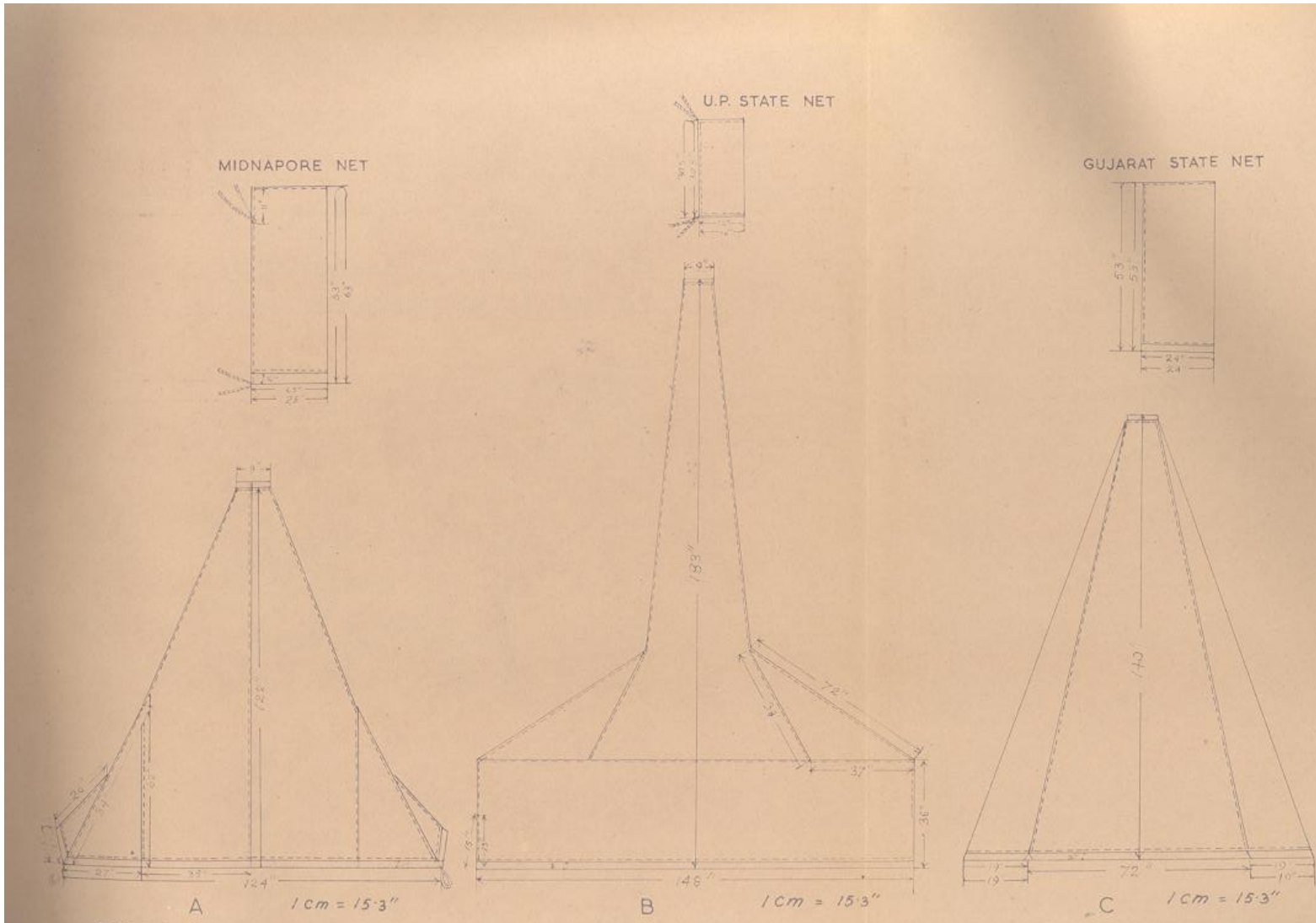

FIG. 2 a

A. MIDNAPORE 1/8" MESHED NET.

B. UTTAR PRADESH STATE NET.

C. GUJARAT STATE NET.

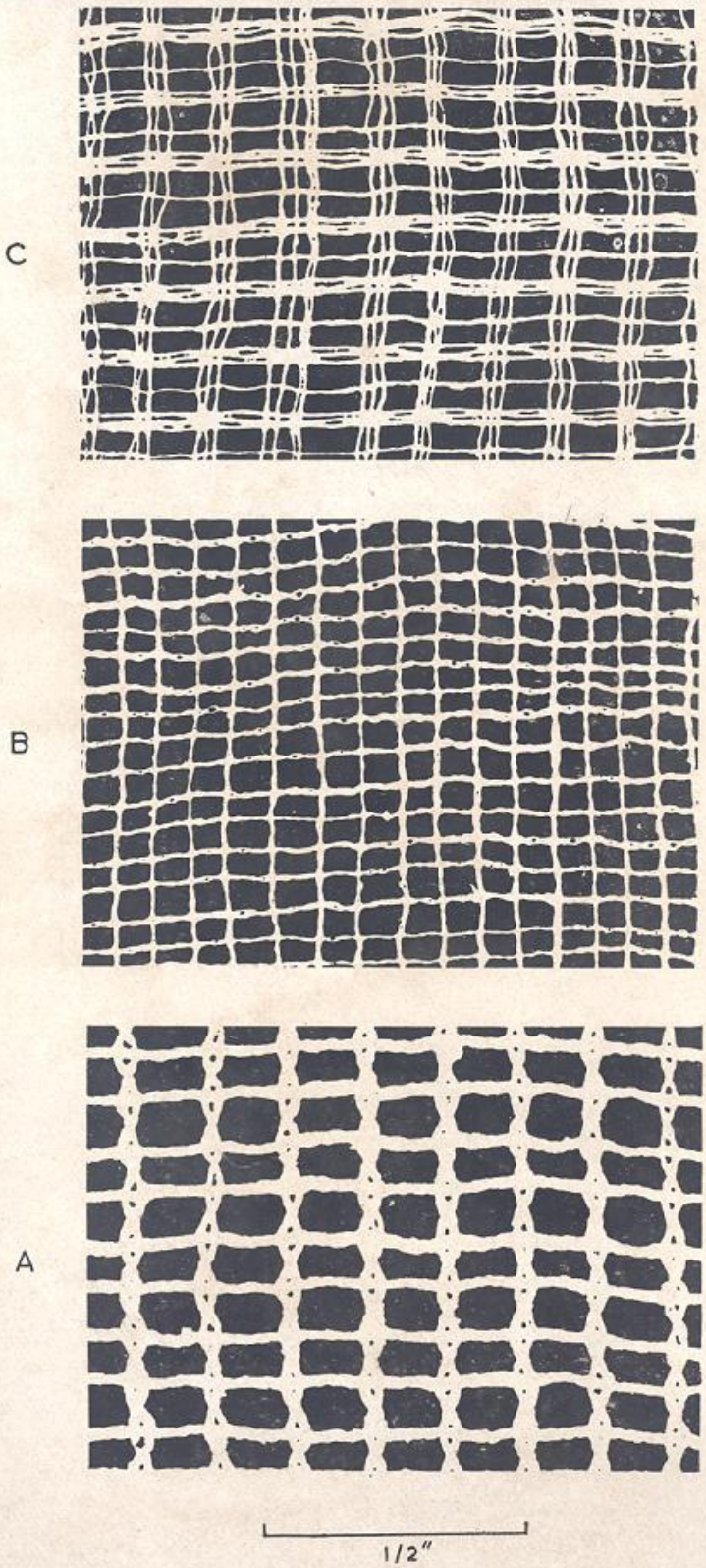

FIG. 2b. MESH AND WEAVE PATTERN OF A. MIDNAPORE 1/8" MESHED NET
B. UTTAR PRADESH STATE NET C. GUJARAT STATE NET

whenever it occurred, in computing catch per unit of effort. All nets in U.P. centre were tanned with "Gab". The position of Midnapore and Departmental nets were randomly staggered from day to day to render a comparison of the catching efficiency between Midnapore and Departmental nets as well as among the Midnapore nets of various meshes possible. The nets were suitably orientated at angles of optimum current every two hours or earlier. The current direction was adjudged by floating a meter long twine at the end of which a cork was tied. The twine was fixed to a pole which was placed in front of the centre of the net mouth. The record of current direction was made in degrees with reference to North using a magnetic compass. For scooping, the contents of the tail piece were accumulated at its rear extremity by gently moving the arm below the tail piece down the direction of the current. The spawn was then scooped immediately in an aluminium scooping cup of appropriate size. The periodicity of scooping depended on the intensity of collection. In extremely heavy collection scoopings were done every ten minutes.

Method of Measuring Spawn

Collections were measured in 6 ozs.(170.4 ml.), 3 ozs. (85.2 ml.), 1½ ozs.(42.6 ml.), ½ ozs.(14.2 ml.), 0.23 oz.(6.5 ml.), 0.042 oz.(1.2 ml.) perforated aluminium measuring cups, depending upon their bulk, by the following method.

As soon as a collection was removed from the net it was strained through two sieves placed one above the other. The upper one was a large meshed sieve and the lower one made of muslin. The spawn was collected in the muslin sieve and measured by scooping with the appropriate measuring cup filled upto the brim, the mass looking like jelly. Two hourly records of spawn collected in each of the four types of nets viz.Midnapore nets of 3 meshes and departmental nets, were maintained, and from the data thus obtained, daily catch per net-hour was computed. Catch per net hour has been used as a measure of abundance of spawn. For mutual comparison of the spawn yield of different centres, even on different river systems, by a single index, seasonal catch per net taken by 1/8" meshed Midnapore net has been derived. Such an index would prove useful as a measure of seasonal abundance of spawn in future on all India basis if the shooting nets are standardised and adopted by all states uniformly.

Method of Transporting Spawn

For packing in alkathene bags under oxygen, ½ of the bag of the dimension 74 x 46 cm. and of capacity 31000 ml. was filled with river water and 3 ozs. cup measure of spawn liberated in the bag for journeys exceeding 24 hours. For journeys upto 24 hours 6 ozs. cup measure were packed in alkathene bags. The existing air above the water level was expelled by pressing the bag. The bag was then placed in the packing tin (4 gallon kerosin oil tin with a lid) and kept close to the oxygen cylinder. The tubing of the cylinder, with a glass tube attached, was then inserted in the bag and gas gently let in. When the walls of the bag fully bloated up and began touching the tin sides the mouth of the bag was tied air tight in the manner as done in a foot-ball bladder.

The number of hatchlings or early fry which a standard measuring cup can hold naturally depends upon their size. To determine the number of fry which are contained in an ounce of spawn (without loose water in the measuring cup), 21 cup measures of spawn were preserved in 4% formalin in the field and their number per ounce physically enumerated. The average length of fry counted was also computed. The number of hatchlings per ounce of spawn alongwith their average size or length range are shown in Appendix 1. The average number of hatchlings (size: about 6 mm.) per ounce worked out to be approximately 10,000.

Method of Spawn quality Analysis

Spawn quality has been determined by two methods viz. microscopic examination at spawn stage and by rearing in earthen pots and/or improvised rearing pits and/or State nurseries. For microscopic examination a special slide, measuring 90 x 55 mm. showing 6-10 mm. markings with a double row was prepared. Figure 3 shows the slide. The fry were arranged with their heads touching the glass wall or the index line in the middle of the slide, the posterior extremities of their tails showing the length in millimetres.

The criteria for identifying hatchlings, larvae and post-larvae of carps from non-carps and further, of major carps from minor carps were as under.

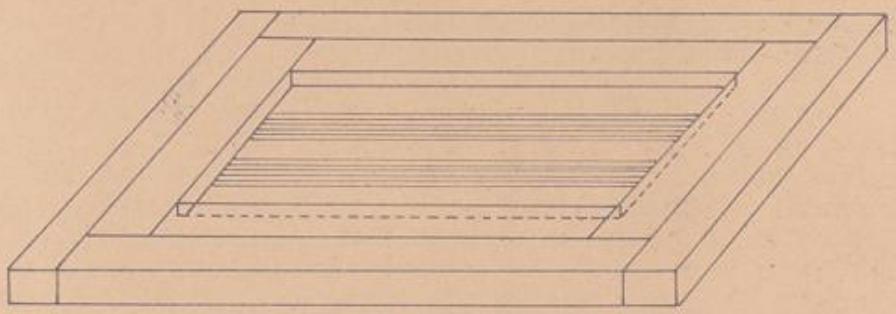

FIG. 3 — MICROSCOPIC SLIDE SHOWING 5-10 MM. MARKINGS IN DOUBLE ROW.

The shape of yolk sac; presence or absence of segmentation and oil globules in yolk; presence or absence of barbels; position of paired and unpaired fins in addition to body profile and manner of locomotion of live fry were the main characters on the basis of which fish groups were identified. Carps were further identified into major and minor carps by the following characters.

At about 6 mm. long stage if the hatchlings had oval, posteriorly elongated yolk sac, they were regarded as pertaining to major carps.

At $>$ 6 mm. long stage persistence of yolk sac, of the shape characteristic of carps, was taken as a distinguishing feature of major carps. Since minor carps develop a dorsal fin at this stage, fry with undeveloped dorsal fin though with yolk sac absorbed, were still taken as major carps. Further, fry with a developed dorsal fin but having more than 11 undivided rays were also included among major carps.

At $<$ 6 mm. long stage presence of an oval, posteriorly elongated yolk sac was taken as a character typical of carps (major or minor) and, in the absence of any authentic characters to identify them, those with broad yolk sac at the anterior end at the size between 5.5-6 mm. length were taken as major carps and those with narrow(disappearing) yolk sac at that point were treated as minor carps. Considering the present state of knowledge categorisation of carp hatchlings smaller than 5.5 mm. long was not possible and all such cases were relegated in the category of "minor carps". This procedure is likely to underestimate the major carp percentage and correspondingly overestimate the minor carps, a process considered safe in view of the ultimate utility of the investigation in the commercial exploitation of sites.

The identification of major and minor carps upto species at the hatchling stage was not possible due to lacunae in scientific knowledge. The species composition of the spawn collected was determined by rearing spawn samples, independently for each flood as far as possible, upto identifiable stages. However, it may be borne in mind that the species composition determined by rearing spawn does not reflect the true composition of the spawn owing to the well known phenomenon of differential mortalities which different species are subjected to in different nurseries.

Generally, on account of reasons stated above, microscopic examination of spawn underestimated major carps in the collection and nursery rearing resulted in much higher percentage value of major carps. Till such time as spawn quality, taking into account differential mortality in nursery, can be predicted in advance, practical consideration deem a definition of spawn quality to be made only in terms of nursery rearings. This definition has been adopted here for the present. The higher the percentage of major carps in nursery rearings the superior the spawn quality was considered to be.

Hydrodynamical characters

Flood level

If a Public Works Department or Railway gauge was not available in the vicinity of site, water level was recorded every two hours to the nearest cm. by means of an 3 M. long pole with a rounded wooden disc fixed at a distance of about half a meter from bottom and marked in metric system from disc to top. It was necessary to shift the pole frequently and recaliberate it every time it was shifted. As relative measure of change in water level was of significance rather than its absolute value in terms of mean sea level either the pole reading taken on the first day of observation was taken as zero or in case where a gauge was available the readings of the latter were recorded as they were.

Current Velocity

Current velocity of surface water at collection site was approximately measured by means of a cork float(Top diameter 2", bottom diameter 1" and height $1\frac{1}{2}$") set a drift in the current. The time taken for the cork to drift 50 ft. was recorded. On account of interference with wind this method yielded unsatisfactory results especially on windy days. At Sisodra centre on River Narbada sub-surface water velocity was determined by inserting into the cork a spinning needle riveted on a brass base. The Sisodra values of sub-surface current velocity are, therefore, not comparable with other centres but furnish a satisfactory relative idea of water velocity for that centre.

Current Direction

(Method described earlier under "Method of collection of spawn" in context with net fixation).

Chemical Characters

Turbidity

Turbiduty was recorded with a seechi disc which was lowered into the river water with the help of a rope and the depth at which it just became invisible was recorded. The disc was then slightly lifted so that it just reappeared. The average of these two recordings was taken as the limit of visibility against which turbidity was recorded in ppm with reference to appropriate conversion table.

pH

B.D.H. test papers of the ranges 2.0 to 10.5 pH (Broad range) and 7.0 to 8.5 pH (Narrow range) were used. The paper, held in hand, was dipped in water and the changed colour matched with indices supplied by the manufacturers.

Dissolved Oxygen

Dissolved oxygen was determined by Winkler's method once in every three days.

Hydrobiological Factors

Associates

Samples of filtered off Associates of carp fry were preserved from two hourly catches for subsequent laboratory examination for species-wise size composition and gut content analysis. Only gross gut content analysis was attempted for which the gut contents of each species in a collection were pooled and analysed quantitatively on a Sedgwick Rafter type counting cell.

Plankton

50 litres of river water was collected with a plastic pail of known capacity and filtered through a plankton net of organdy attached with a bucket. The organisms collected in the bucket were preserved in 4% formalin and quantitatively examined groupwise in the laboratory with the aid of a counting cell.

Meteorological Characters

Temperature

Air and water temperatures were recorded in degrees centigrade carefully avoiding parallax error. Air temperature was noted in shade over the water with the sun at the back of the observer, care being taken to keep the thermometer bulb dry. For recording water temperature a bucket was filled with river water and water temperature recorded immediately thereafter by immersing the thermometer bulb in the bucket.

State of Weather

Whether the day was sunny or cloudy or rainy, and the wind stormy or gentle or calm was recorded every two hours.

Periodicity of Observations

The periodicity of observations on the various hydrodynamical (flood level, current velocity and direction), Chemical (turbidity, pH, and dissolved oxygen), hydrobiological (spawn Associates and plankton) and meteorological (air and water temperature and weather), for which a set of four proformae were used, was as under.

I. Two hourly round the clock observations

(a) Catches of spawn and Associates in State department and 3 types of Midnapore nets recorded separately for each type.

(b) Flood level.

(c) Air temperature.

(d) Water temperature.

(e) Weather.

II. Two hourly observations between 6 A.M. & 6 P.M.

(f) Turbidity.

(g) Current direction.

(h) Current velocity.

III. Twice a day observation

(i) pH at 6 A.M. and 6 P.M.

IV. Once a day observation

(j) Plankton collection at 6 A.M.

V. Once every three day's observation

(k) Dissolved oxygen at 6 A.M.

VI. Before and after major flood peaks(as far as possible)

(l) Rearing of collected spawn in earthen pots/pits/ nurseries etc.

Definitions adopted in these investigations

The following definitions were arbitrarily adopted in these investigations.

1. Day	6 A.M. of the calendar day to 4 A.M. of the following calendar day.
2. Day time hours	6 A.M. to 6 P.M. of the same day.
3. Night time hours	6 P.M. to 6 A.M. on the following calendar day.
4. Seasonal spawn index	Total catch of spawn in ounces taken by one Midnapore net of 1/8" mesh in the course of the entire season generally based on average of many identical nets.
5. Catch per unit of effort	Catch per net-hour.
6. Period of spawn availability	Days when more than three ounces of spawn were collected.
7. Period of spawn non-availability	Days when less than three ounce of spawn were collected.

V A. KISHANPUR ON RIVER JAMUNA

ABSTRACT

In the spawn prospecting investigations lasting from July 1 to September 14, 1964, a total of 1385 ounces of spawn, estimated at over one crore hatchlings, were collected from River Jamuna at Kishanpur in eight spawn collection nets.. 93% of the spawn was collected in 12 days of the receding phase of floods II and IV, which (out of 5 floods in all) were the only major floods of the 1964 season. Spawn analysis showed 44.4% and 67.7% major carp content in these floods respectively but rearing experiments in nurseries revealed major carp percentage as 96.6% in Flood II and 74% in Flood IV, the disparity arising out of differential mortality in nurseries among different species of fish and lack of full knowledge at present on the identification of carp fry below 6 mm length stage. Midnapore nets were on the average found to be 6 times more efficient at this centre than the Departmental nets, a difference highly significant as revealed by "t" test analysis. To make even the experimental investigations useful for fisheries development 756 ozs of spawn were lifted by State Fisheries Department for stocking purposes. Spawn quantity in relation to hydrodynamical, chemical, meteorological and hydrobiological characters have been discussed. Quantity and quality of filtered off associates and their gut contents have been analysed and presented.

LOCATION AND FACILITIES

Kishanpur is a town situated on the North bank of the River Jamuna in the District of Fatehpur in U.P., 16 km South of Khaga (Figure 1). It lies 17 km South of the Grand Trunk Road and is connected with Khaga by a metalled road. At Kishanpur itself there are post, telegraph and telephone offices and the nearest railway station, Khaga, on the Northern Railway, is at a distance of 17 km from the site . The village Ashat, in the immediate vicinity of Kishanpur, where the spawn collection site was located and where the investigations were actually conducted, falls in the

Bijaipur Block, the distance between Ashat and the Block Headquarters at Bijaipur, by metalled road, being 9 km. The river course at Kishanpur as well as the general terrain and topography of the area are shown in Figure JK1-4.*

OBSERVATIONS AND RESULTS

The duration of observations at Kishanpur was from 1.7.64 to 14.9.64. Table JK1-2 shows the day to day mean of the two hourly observations (6 A.M. to 4 A.M. of the following calender date), called here daily average observations, in respect of flood level, turbidity, air and water temperatures, pH and dissolved oxygen and total catch of spawn in ounces over the entire period of observations.

Spawn quantity in relation to environmental factors

Figure JK2-5 shows date-wise total spawn catches at Kishanpur taken in all the nets irrespective of their types and mesh in the 1964 monsoon season. The break up between Midnapore and departmental nets has also been differentiated in this figure. The relative contributions of these nets is, however, discussed later in this report. Table JK2-3 shows flood-wise record of spawn collected at Kishanpur alongwith dates, hour of commencement of spawn availability, quantities collected in rising or receding phase of the floods and whether taken in day or night.

A total of 1385 ounces of spawn were collected during the entire monsoon season in eight experimental spawn collection nets at this centre. Almost cent per cent of the spawn was collected at Kishanpur in five floods ranging in duration individually from 5 to 11 days, of which two (number II & IV) accounted for 93% of the centre's total seasonal catch and that too made, in its entirety, on only 12 days. The days of peak catch in each flood contributed 61%, 30%, 63%, 38% and 93% of the collections

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* 'J' - stands for River Jamuna

'K' - stands for Kishanpur

The first number in Tables and Figures depicts the number in the chapter and second in the report as a whole.

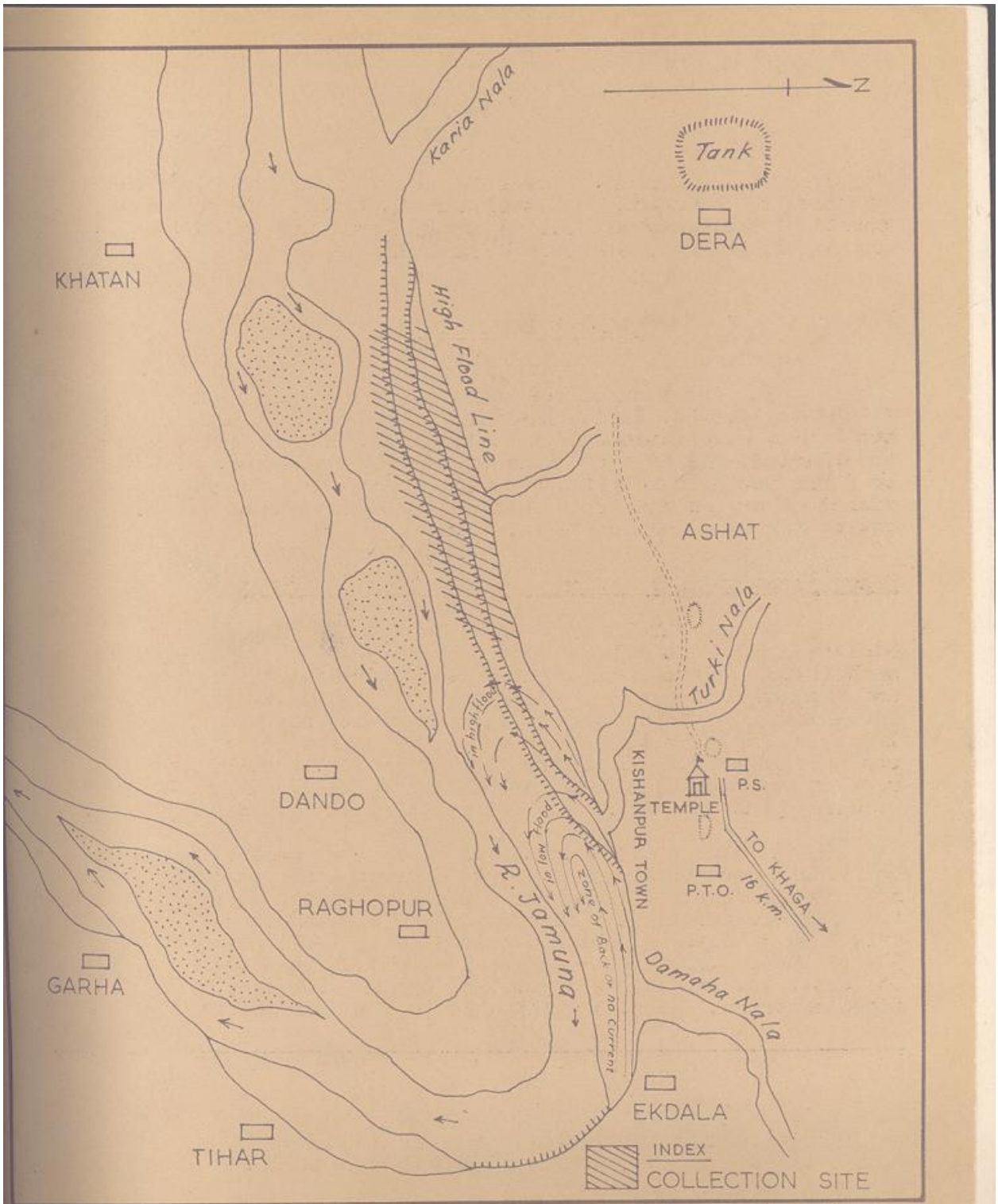

FIG. JK1-4. THE RIVER COURSE, GENERAL TERRAIN AND TOPOGRAPHY OF RIVER JAMUNA AT KISHANPUR.

Table JK1-2

Daily averages of flood level, turbidity, air and water temp., pH, D.O. and total spawn catch in the river Jamuna at Kishanpur.

Date year 1964	Flood level in Metres	Turbidity in ppm	Air Temp. / water temp. in °C	pH	D.O. in ppm	Total catch of spawn in ozs	Floodwise spawn in ozs and percentage in total.
1	2	3	4	5	6	7	8
July							
1	0.00	<100	31.7/31.6	7.8	5.7	nil	
2	0.19	<100	32.4/32.3	7.9	-	nil	
3	1.46	205	32.9/32.0	8.5	-	few	
4	1.69	400	31.3/31.2	8.5	3.5	14.4	26.5 (2.5%)
5	1.73	330	30.6/30.4	9.0	-	22.1	
6	1.71	330	29.5/30.8	7.8	-	nil	
7	1.80	330	31.3/30.5	8.8	4.0	nil	
8	2.84	385	31.0/29.9	9.0	-	nil	
9	3.66	411	28.4/29.3	9.0	-	few	
10	5.19	389	27.4/29.0	9.0	4.8	nil	
11	6.20	343	29.6/28.6	8.9	-	nil	
12	5.95	650	27.8/29.0	8.8	-	79.0	
13	5.55	1143	28.9/28.3	8.5	4.8	37.0	
14	3.41	1050	27.7/28.1	8.5	-	53.0	443.0 (32.0%)
15	5.08	1157	28.3/28.6	8.2	-	68.0	
16	4.66	857	29.9/29.5	8.5	5.7	nil	
17	4.36	1117	30.1/30.1	8.4	-	75.0	
18	4.02	900	30.1/29.6	8.5	-	131.0	
19	3.73	593	28.5/29.8	8.1	4.4	few	
20	3.49	464	31.0/31.3	8.5	-	few	
21	3.32	450	31.8/31.8	8.4	-	few	
22	3.24	534	31.4/31.8	8.4	4.4	few	
23	3.31	514	29.0/30.8	8.4	-	few	
24	3.22	800	28.1/29.5	8.6	-	nil	
25	2.81	497	30.2/31.1	9.0	5.7	nil	
26	2.23	567	30.3/31.3	8.5	-	nil	
27	2.77	443	28.5/30.5	8.4	-	nil	
28	2.85	708	28.5/30.1	8.1	4.4	nil	
29	3.50	921	29.5/30.4	8.2	-	nil	13.5 (1.0%)
30	4.31	771	29.7/30.4	8.2	-	nil	
31	4.50	836	30.1/30.5	8.4	3.5	8.5	

1	2	3	4	5	6	7	8
August							
1	4.29	836	30.9/30.9	8.2	-	5.0	
2	4.02	771	31.2/31.1	8.5	-	nil	
3	3.76	836	30.8/31.5	8.4	4.4	nil	13.5
4	3.48	857	32.2/31.2	8.4	-	nil	(1.0%)
5	3.23	730	31.3/31.4	8.2	-	nil	
6	3.02	820	30.4/31.2	8.2	4.4	nil	
7	2.82	950	30.6/31.2	7.6	-	nil	
8	2.62	900	31.3/31.1	7.5	-	nil	
9	2.36	750	31.5/31.3	7.6	6.2	nil	
10	2.08	814	30.1/31.8	7.6	-	nil	
11	1.78	650	30.7/31.9	7.6	-	nil	
12	1.82	679	28.8/30.8	7.6	6.6	nil	
13	2.45	511	29.8/30.5	8.0	-	nil	
14	2.59	743	27.8/29.9	7.6	-	nil	
15	4.24	880	30.1/30.3	8.5	5.3	few	
16	6.48	1114	29.8/30.1	8.5	-	few	
17	8.99	1029	29.0/29.7	8.5	-	few	
18	10.48	943	25.8/28.6	8.0	6.2	nil	
19	10.17	857	30.2/29.3	8.3	-	84.0	851.0
20	8.96	1200	29.8/28.8	8.6	-	266.0	(61.5%)
21	7.78	1157	29.7/29.9	8.5	6.2	327.0	
22	7.24	921	30.0/30.2	8.3	-	129.0	
23	7.48	871	29.5/30.3	8.2	-	45.0	
24	8.61	686	31.1/30.8	8.5	6.3	few	
25	8.91	1114	29.1/30.1	7.7	-	few	
26	9.00	1114	29.0/29.7	8.0	-	nil	
27	9.79	836	29.3/29.7	8.5	4.6	nil	
28	10.58	490	29.0/28.8	8.3	-	nil	
29	11.22	500	30.0/31.0	8.5	-	nil	
30	10.07	440	29.6/29.3	8.4	4.7	38.0	41.0
31	8.98	440	27.7/29.1	8.2	-	3.0	(3.0%)
September							
1	8.26	507	27.8/28.8	8.2	-	nil	
2	8.09	419	27.5/29.3	7.8	-	nil	
3	8.94	411	27.7/29.6	8.1	4.6	nil	
4	9.82	417	29.1/29.6	7.9	-	nil	
5	9.92	388	28.8/29.6	8.4	-	nil	
6	9.51	394	28.9/29.8	8.1	4.7	nil	
7	8.44	394	29.0/30.2	8.1	-	nil	
8	7.55	390	28.4/29.8	8.2	-	nil	

1	2	3	4	5	6	7	8
September							
9	6.53	400	28.8/29.8	7.9	4.6	nil	
10	6.89	406	28.2/29.5	8.2	-	nil	
11	6.64	536	29.8/30.2	8.2	-	nil	
12	6.33	400	30.3/30.8	7.9	-	nil	
13	6.06	383	30.7/30.4	7.8	-	nil	
14	5.90	400	30.5/30.2	8.2	-	nil	

1. Flood levels have been measured with reference to summer level, taking July 1, 6 A.M. reading as zero.

2 The averages of flood level, air temperature and water temperature are based on 12 observations taken every two hours from 6 A.M. to 4 A.M. next calender day.

3. The averages of turbidity are based on 7 observations taken every two hours from 6 A.M. to 6 P.M.

4. The averages of pH are based on 2 observations taken twice every day at 6 A.M. & 6 P.M.

5. Dissolved oxygen was estimated every third day at 6 A.M.

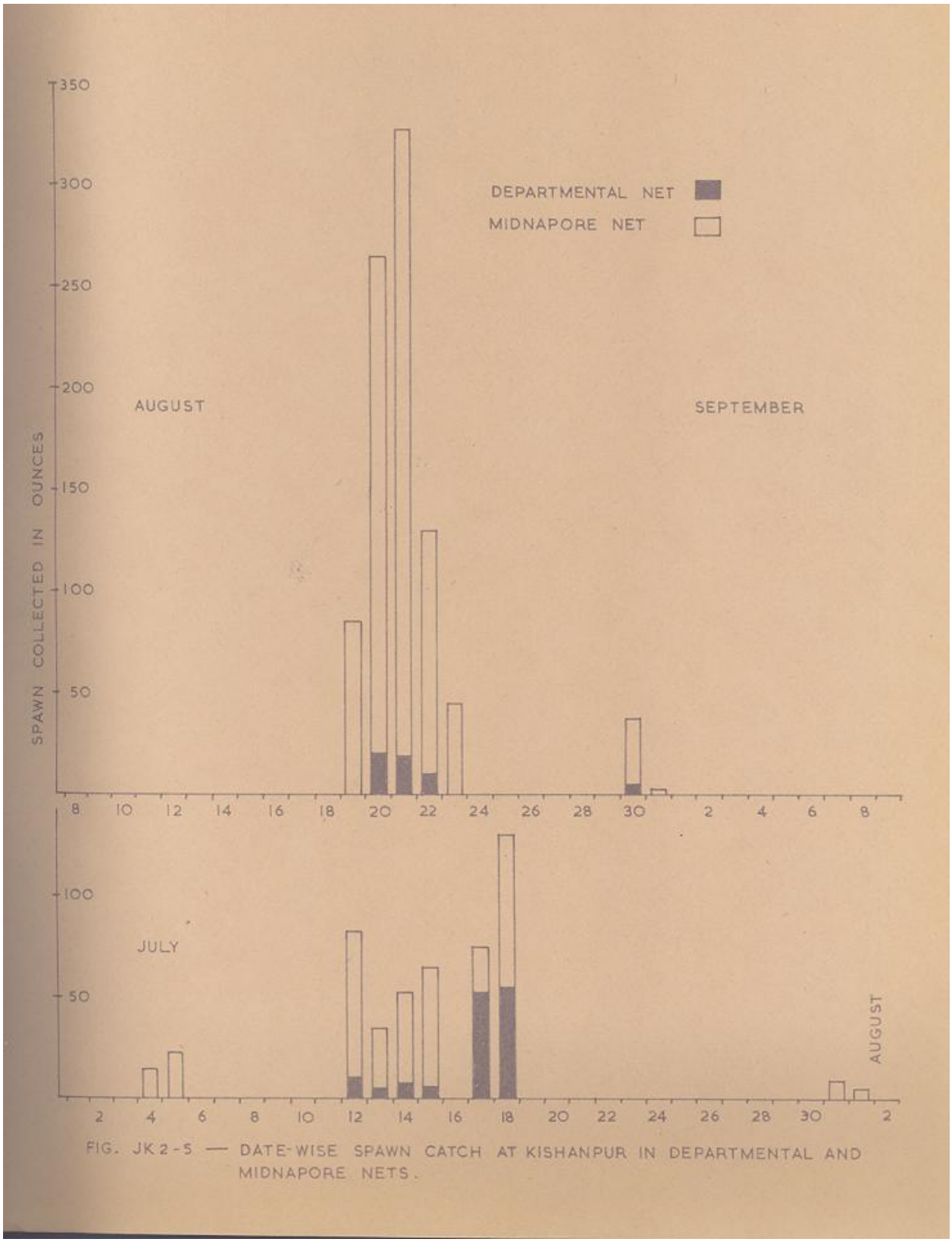

FIG. JK 2-5 — DATE-WISE SPAWN CATCH AT KISHANPUR IN DEPARTMENTAL AND MIDNAPORE NETS.

Table JK2-3

Details of spawn collection in relation to different floods ir jamuna at kishanpur

Flood No.	Duration of flood in 1964		Flood peak			Commencement of spawn availability			Day of peak catch with collection				Total catch of spawn in the flood in ozs			
	Rising phase	Receding phase	Date in 1964	Hour	Flood level in metres	Date in 1964	Hour	Flood level in metres	Date in 1964	Quantity in ozs: Day. 6 A.M. to 6 P.M.	Night 6 P.M. to 6 A.M.	Total	Rising phase	Receding phase: Day 6 A.M. to 6 P.M.	Night 6 P.M. to 6 A.M.	Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
I	2/7 to 4/7	4/7 to 7/7	4/7	22	1.78	4/7	22	1.78	5/7	2.1	20.0	22.1	neg.	2.3	34.2	36.5
II	9/7 to 11/7	11/7 to 19/7	11/7	24	6.26	12/7	14	6.14	18/7	104.0	27.0	131.0	neg.	353.0	443.0	443.0
III	28/7 to 31/7	31/7 to 6/8	31/7	16 to 22	4.58	31/7	22	4.47	31/7	nil	8.5	8.5	neg.	nil	13.5	13.5
IV	15/8 to 18/8	19/8 to 24/8	18/8	22 to 4	10.68	19/8	20	10.00	21/8	138.5	188.5	327.0	neg.	360.5	490.5	851.0
V	25/8 to 29/8	29/8 to 4/9	29/8	16	11.38	30/8	20	9.86	30/8	nil	38.0	38.0	neg.	2.5	38.5	41.0
TOTAL										244.6	282.0	526.6	neg.	618.3	766.7	1385.0

neg. - negligible catch

in respective floods and cumulatively accounted for 39% of the total spawn yield. Table JK2-3 further reveals that only two days' catch, viz the peak days of Floods II & IV on 18.7.64 and 21.8.64, contributed 34% of the total yield from the site. The night catches were seen to have slight edge over the day catches. Of the 526.6 ozs of spawn collected on the 5 flood peak days, 244.6 ozs of spawn were collected in day (6 A.M. to 6 P.M.) as against 282.0 ozs taken in night (6 P.M. to 6 A.M.). In the overall catch of 1385 ozs at the centre the night catch contributed 53%. However, once the availability of spawn had commenced its appearance continued day and night.

A detailed analysis and discussion of the effects of the various hydrodynemical, chemical, meteorological and hydrobiological factors on the availability of spawn follows immediately.

Hydrodynamical characters

Flood level

Figure JK3-6 shows fluctuations in average daily flood level with the spawn yield on the days of its availability superimposed thereon. As is evident in Figure JK3-6 and Table JK2-3 that in no flood was measurable spawn collected in the rising phase, almost the entire collection being made in their receding phases. Though the commencement of appearance of spawn synchronised with the peak hour of the first flood, subsequently in all floods the first availability of spawn, except stray specimens, in the relevant flood was delayed by hours after the attainment of flood peak. Actually spawn was available after 14 hours, 6 hours, 22 hours and 28 hours in the II, III, IV & V floods respectively after the flood had touched its peak. The time lapse between the flood peak and the appearance of spawn was associated with a fall of 12 cm, 11 cm, 68 cm and 52 cm in the four floods respectively. A significant feature noticed was that of the commencement of spawn availability which first showed up on or after 8 P.M. in the case of four floods. Only once did the availability of spawn commence during day time hours and that was at 2 P.M. in Flood II.

Figure JK3-6 also shows that though 5 floods can be discerned in Jamuna at Kishanpur in 1964, the two real floods of the season were the II and IV with which, as stated already,

93% of the spawn was associated. In these floods the water level of Jamuna rose from 2.90 m to 6.26 m and from 3.06 m to 10.68 m. The rise of water level in the remaining floods, however, did not exceed 2.40 m.

Current velocity

The limitations of current velocity measurement in these investigations have already been mentioned under 'Material and Methods'. However, bearing such limitations in mind it may be stated that the pattern of river course has a great deal to do in determining the current velocity at a particular site and the availability of spawn there. It was observed that the river at Kishanpur had a disproportionately low current at the bank, compared to the main current in the midstream, due to back current generated at the horse shoe bend which the river has to negotiate slightly downstream of Kishanpur (Figure JK1-4). With the rising flood the zone of no or back current extended itself further upstream necessitating shifting of the collection site upstream to Ashat bank of the Jamuna from Kishanpur proper.

Chemical characters

Turbidity

It may be seen in Figures JK3-6 & JK4-7 that the availability of spawn is apparently positively correlated both with flood level and turbidity but in reality the correlation between spawn and flood is genuine and between spawn and turbidity rather spurious. It is true that in general, floods are associated with rise in turbidity of the water when spawn is also generally available but turbidity alone, in the absence of flood, may not lead to appearance of riverine spawn in the spawning season of the Indian major carps. Nor has absolute value of turbidity any correlation with spawn, if at all, it is the relative value of turbidity which may matter. To illustrate the point it may be stated that the first flood spawn was available between the turbidity values of 205 to 400 ppm whereas no spawn was available at the turbidity values of 800 ppm on July 24 and negligible spawn was available at the turbidity value of 1114 ppm on August 16 and 25. Again, spawn was not available at the turbidity value of 1114 ppm on August 26.

In flood I, the relatively low turbidity of 330 ppm was found on the day of maximum catch of spawn (July 5 with catch

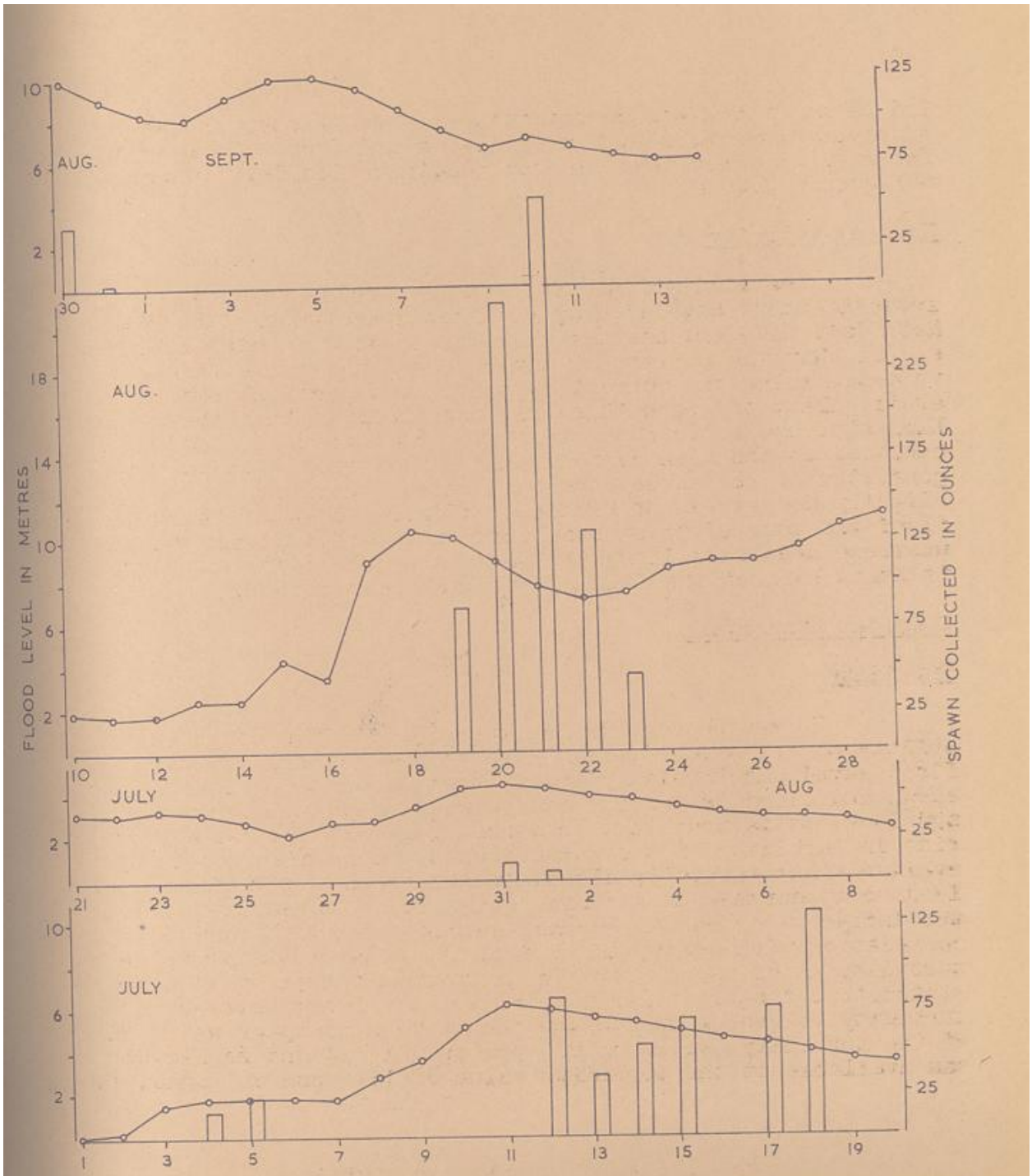

FIG. JK3-6 — FLUCTUATIONS IN AVERAGE DAILY FLOOD LEVEL OF RIVER JAMUNA AT KISHANPUR WITH SPAWN QUANTITY SUPERIMPOSED ON THE DAYS OF AVAILABILITY .

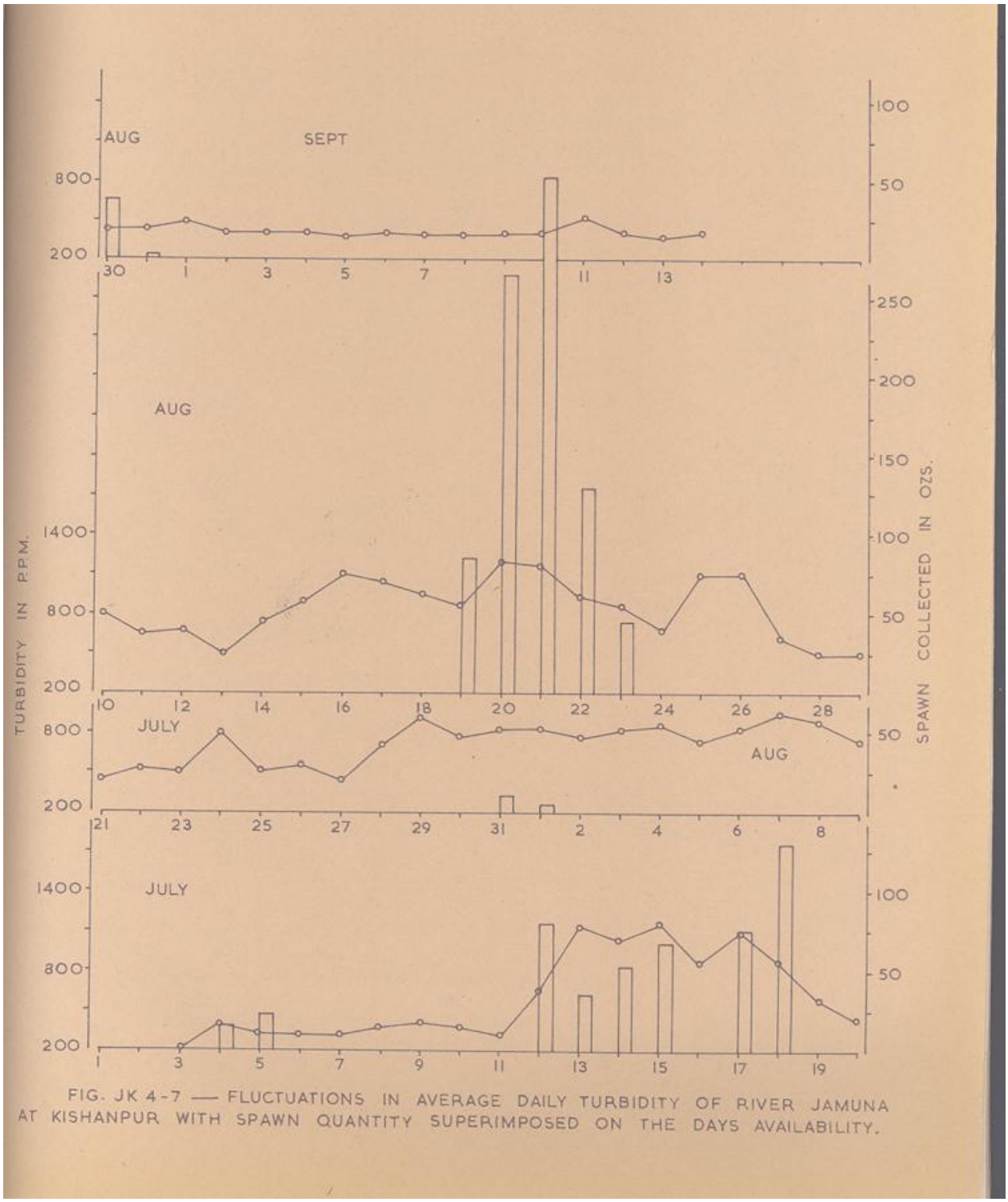

FIG. JK 4-7 — FLUCTUATIONS IN AVERAGE DAILY TURBIDITY OF RIVER JAMUNA AT KISHANPUR WITH SPAWN QUANTITY SUPERIMPOSED ON THE DAYS AVAILABILITY.

22.1 ozs). The same pattern is discernible in Flood II when turbidity value was 900 ppm on July 18 with the corresponding spawn catch being 131 ozs as against 1117 ppm on the previous day when the spawn catch was only 75 ozs. Other floods also present the same pattern, when absolute values of turbidities do not appear to be correlated with spawn catch except when viewed with the phase and level of flood.

Hydrogen ion concentration

No correlation is noticed between the availability of spawn and pH. As may be seen in Table JK1-2 the pH values varied between 7.5 and 9.0 at Kishanpur in the course of the investigations and spawn was available over the entire range of pH values between 7.6 and 9.0. These values of pH are also equally associated with the periods when spawn was not available.

Dissolved oxygen

The dissolved oxygen content, estimated every third day, of the Jamuna varied between 3.5 ppm to 6.6 ppm at Kishanpur (table JK1-2). There appears to be no correlation between D.O. and spawn availability as is emply demonstrated by the fact that spawn was available at D.O. values of 3.5 ppm as well as 6.2 ppm.

Meteorological characters

Tbale JK3-4 shows daily mean air and water temperatures for the entire duration of spawn catch in each of the five floods which occurred in the Jamuna at Kishanpur, covering as well, thre days preceding the period of spawn availability. The state of weather in respect of sky, wind speed and direction alongwith daily spawn yield and current direction are also shown in the table. It is a well known fact that unless the rainfall is widespread its precipitation locally has no effect on raising the water level of the river to any extent. As confirmed by meteorological data such widespread rainfall occurred preceding the Floods II & IV. It may be recalled that these floods accounted for 93% of the seasonal catch of spawn at Kishanpur. The average air and water temperatures for preceding, during the following collection periods in respect of Floods II & IV are shown in Table JK4-5 which shows that both air and water temperatures were slightly lower in pre-spawn period in each flood, evidently due t rains and cloudy weather prevailing at that time.

Table JK4-5

Average Air & Water temperature in preceding, during and following spawn collection periods

Period Identity	II FLOOD			IV FLOOD		
	No. of days	Average temperature in °C		No. of days	Average temperature in °C	
		Air	Water		Air	Water
1	2	3	4	5	6	7
Preceding spawn availability	3	28.47	28.97	3	29.53	29.47
During spawn availability	7	28.97	29.03	5	29.90	29.70
Following spawn availability	3	30.43	30.94	3	29.73	30.20

The wind direction was mostly 270° and at times 90° and the current direction ranged between 310° - 315°. Nets were placed facing the current. Gentle wind was found conducive to spawn availability in appreciable quantities.

Table JK3-4

Daily arithmetic or modal averages of meteorological characters for relevant days in different floods along with spawn catch & current direction in Jamuna at Kishanpur

Date 1964	Flood		Quantity of spawn collected in ozs	Temperature in centigrade		Weather condition			Current direction from north
	No.	Phase		Air	Water	Sky	Wind speed	Wind direction from north	
1	2	3	4	5	6	7	8	9	10
1.7	I	Stationary	nil	31.7	31.6	Cloudy	High	90°	315°
2.7		Rising	nil	32.4	32.3	Cloudy	gentle	90°	315°
3.7		Rising	Few	32.9	32.0	Clear	gentle	90°	315°

1	2	3	4	5	6	7	8	9	10
4.7		Peak	14.4	31.2	31.2	Cloudy	gentle	270°	315°
5.7		Receding	22.1	30.6	30.4	Raining	High	90°	315°
9.7	II	Rising	Few	28.4	29.3	Cloudy	gentle	315°	315°
10.7		-do-	nil	27.4	29.0	Raining	High	270°	315°
11.7		Peak	nil	29.6	28.6	Raining	Stormy	270°	310°
12.7		Receding	79.0	27.9	29.0	Cloudy	gentle	270°	315°
13.7		-do-	37.0	28.9	28.3	-do-	calm		315°
14.7		-do-	53.0	27.7	28.1	-do-	calm		315°
15.7		-do-	68.0	28.2	28.6	-do-	gentle	270°	310°
16.7		-do-	nil	29.9	29.5	-do-	gentle	270°	310°
17.7		-do-	75.0	30.1	30.1	-do-	-do-	270°	320°
18.7		-do-	131.0	30.1	29.6	-do-	-do-	270°	315°
28.7	III	Rising	nil	28.5	30.1	Cloudy	High	270°	315°
29.7		-do-	nil	29.5	30.4	-do-	Stormy	270°	310°
30.7		-do-	nil	29.7	30.4	-do-	gentle	270°	315°
31.7		Peak	8.5	30.1	30.5	-do-	High	270°	310°
1.8		Receding	5.0	30.9	30.9	Clear	gentle	270°	315°
16.8		Rising	Few	29.8	30.1	Cloudy	gentle	90°	320°
17.8		-do-	Few	29.0	29.7	-do-	-do-	90°	320°
18.8		Peak	nil	29.8	28.8	-do-	-do-	90°	Two way current
19.8	IV	Receding	84.0	30.2	29.3	Clear	-do-	90°	-do-
20.8		-do-	266.0	29.8	28.8	Cloudy	-do-	270°	-do-
21.8		-do-	327.0	29.7	29.9	-do-	-do-	270°	315°
22.8		-do-	129.0	30.3	30.2	-do-	-do-	270°	315°
23.8		-do-	45.0	29.5	30.3	-do-	-do-	270°	315°
27.8	V	Rising	nil	29.3	29.7	Clear	gentle	90°	Two way current
28.8		-do-	nil	29.0	28.8	-do-	-do-	270°	-do-
29.8		Peak	nil	30.0	31.0	-do-	-do-	270°	-do-
30.8		Receding	38.0	29.6	29.3	Cloudy	-do-	90°	315°
31.8		-do-	3.0	27.7	29.1	Raining	-do-	90°	315°

Hydrobiological characters

Table JK5-6 shows average plankton density in numbers per litre of water and average catch per day in ounces of spawn associates, shown separately for days when spawn was available and when it was not, in each of the five floods of Jamuna at Kishanpur. Whereas plankters ranged from 0.2 to 0.48 per litre of water and showed no correlation with spawn, the associates showed some significant pattern with advancing season. In the later three, i.e. Floods III, IV & V, associates were negligible. Especially in - Flood IV the spawn quantity was high and quality excellent, and it was possible to oxygen pack spawn in polythene bags directly from the shooting nets. In other floods spawn associates were abundant. Flood II presented a striking picture when spawn availability was correlated with extremely high catches of Associates resulting in choking of tail pieces of nets within short durations. Qualitative abundance of Associates with spawn quality is discussed later in this report.

Table JK5-6

Floodwise quantitative abundances of plankton and spawn associates split up into days of spawn availability and otherwise

Flood no. etc.	Dates in 1964	Average plankton density in nos. per litre		Average catch per day of spawn associates in ozs.	
		On days of spawn availability.	Otherwise	On days of spawn availability.	Otherwise
1	2	3	4	5	6
I	2/7 to 7/7	5.50	2.45	183.5	20.1
II	9/7 to 19/7	0.42	0.48	413.1	53.5
Period between floods.	20/7 to 22/7	-	0.28	-	21.7

1	2	3	4	5	6
III	28/7 to 6/8	0.35	0.38	11.3	2.0
Period between floods.	7/8 to 14/8	-	0.34	-	negligible
IV	15/8 to 24/8	0.38	0.32	negligible	2.6
V	25/8 to 4/9	0.20	0.20	nil	negligible
Later period.	5/9 to 14/9	-	0.36	-	nil

Spawn quality in relation to environmental factors

Spawn quality derived from spawn analysis

Table JK6-7 shows flood-wise percentage distribution of major and minor carps and 'others' in two hourly spawn samples collected from Jamuna at Kishanpur. The daily averages shown in column 17 of this table are the arithmetic means of percentage of two-hourly samples of the day (6 A.M. to 4 A.M. of the next calender date). A description of spawn quality, as estimated from two-hourly samples, for each flood follows immediately.

Flood I: Spawn was available only on two days viz. July 4 and 5 in this flood when 14.4 and 22.1 ozs were collected. In this flood major carp spawn was mostly absent except for occasional spurts accounting for 2.6% to 20.7% by number among the two hourly collections, their daily average percentage being 6.2 on July 4 and 4.3 on July 5. The percentage of minor carps was consistently high in the two hourly collections resulting in daily average of 77.3 on July 4 and 71.6 on July 5.

Flood II: Spawn was available in this flood from July 12 to 18 in three spurts, the first commencing at 16 hours on July 12 and ending at 4 hours on July 13; the second beginning at 16 hours on July 14 and ending at 22 hours on July 15 and the last spurt beginning at 14 hours on July 17 and ending at 4 hours on July 18. The major carp percentage remained fairly stable over the first two spurts ranging from 40.8% to 60.7% in 28 two-hourly collections our of 33. Only on July 14 and 15 very low major carp

Table JK6-7

Floodwise percentage distribution of Major and Minor carps and others in two-hourly spawn samples from Jamuna at Kishanpur

Flood No.	Phase	Date in 1964	Percentage of	HOURS OF OBSERVATION 6	8	10	12	14	16	18	20	22	0	2	4	Average age for the day	Spawn catch in (ozs.)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Rising	nil															
			Mj	20.7	0	0	0	0	12.0	16.3	0	0	0	12.0	13.2	6.2)	
	Peak	Jul.4	Mi	69.3	80.0	67.0	58.0	70.0	88.0	74.7	72.0	90.0	90.0	88.0	80.8	77.3)	14.4
I			0	10.0	20.0	33.0	42.0	30.0	0	9.0	28.0	10.0	10.0	0	6.0	16.5)	
			Mj	20.7	0	10.7	0	0	-	-	0	0	-	2.6	-	4.3)	
	Receding	Jul.5	Mi	73.3	66.0	86.3	56.0	75.0	-	-	72.0	62.0	-	82.4	-	71.6)	22.1
			0	6.0	34.0	3.0	44.0	25.0	-	-	28.0	38.0	-	15.0	-	24.1)	
	Rising	nil															
	Peak	nil															
			Mj	-	-	-	-	-	53.0	59.8	53.1	60.7	31.0	51.7	34.0	51.9	
		Jul.12	Mi	-	-	-	-	-	40.0	28.2	36.9	31.3	37.0	42.3	51.0	38.1	79.0
			0	-	-	-	-	-	7.0	12.0	10.0	8.0	12.0	6.0	19.0	10.0	
			Mj	49.4	49.8	43.2	43.5	36.5	-	43.3	39.6	49.9	47.5	42.3	48.5	44.9	
		Jul.13	Mi	45.6	39.2	36.8	38.5	46.5	-	41.7	48.4	36.1	40.5	47.7	36.5	41.6	37.0
			0	5.0	11.0	20.0	18.0	17.0	-	15.0	12.0	14.0	12.0	10.0	15.0	13.5	
			Mj	-	-	-	-	-	44.0	40.8	10.7	39.4	40.3	69.3	64.4	45.4	
II	Receding	Jul.14	Mi	-	-	-	-	-	36.0	44.2	15.3	42.6	35.7	20.7	22.6	31.0	53.0
			0	-	-	-	-	-	20.0	15.0	74.0	18.0	15.0	10.0	13.0	23.6	
			Mj	56.7	-	76.8	57.2	14.4	9.6	49.6	51.3	51.9	-	-	-	58.4	
		Jul.15	Mi	33.3	-	9.2	30.8	30.6	38.4	37.4	38.7	36.1	-	-	-	19.3	68.0
			0	10.0	-	14.0	12.0	55.0	52.0	13.0	10.0	12.0	-	-	-	22.3	
			Mj	-	-	-	-	-	43.6	21.9	27.2	26.6	28.7	21.3	28.4	28.2	
		Jul.17	Mi	-	-	-	-	-	33.4	51.1	57.8	56.4	53.3	57.7	52.5	50.4	75.0
			0	-	-	-	-	-	33.0	27.0	15.0	17.0	18.0	21.0	19.0	21.4	
			Mj	20.4	24.8	24.0	34.0	50.0	37.2	23.5	26.0	30.0	52.0	42.3	29.5	33.6	
		Jul.18	Mi	68.6	67.2	76.0	66.0	50.0	61.8	74.5	74.0	70.0	48.0	49.7	52.5	63.1	131.0
			0	2.0	8.0	0	0	0	2.0	2.0	0	0	0	8.0	18.0	3.3	

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percentage was encountered in three collections (10.7% at 20 hours on July 14; 14.4% and 9.6% at 14 and 16 hours on July 15 respectively) when the dominant catch consisted of, not minor carps, but 'others', overwhelmingly comprising prawn larvae (74%, 55% and 52% in the aforesaid three collections). In the third spawn spurt of this flood, which followed 40 hours after the cessation of the second spurt, the dominance of major carps was largely eclipsed by minor carps, the percentage of the former ranging from 24 to 43.6 and that of the latter 33.4 to 74.5. In all the twelve collections of July 18 'others' represented an extremely low percentage of occurrence.

Flood III: Like the first, this flood was a minor one and the spawn collected contributed merely 1% of the season's total (Table JK1-2). However, the quality of spawn, as assessed by major carp content thereof, was fairly high and consistent though discontinuous in availability. At 22 hours on July 31 and between 14 to 4 hours (except at 20 and 22 hours on August 1) the collections were nil. Major carps were 43.3% and 58.5% on July 31 and August 1 respectively.

Flood IV: Spawn collection commenced in Flood IV at 4 hours on August 19 and uninterruptedly continued till 22 hours on August 23 yielding 851 ozs of spawn which formed 61.5% of the seasonal total. The quality of spawn was consistently good, even touching 88% major carp content. The remarkable feature of this flood was that the major carp spawn was not mixed much with minor carps and the frequency of 'others' was negligible. It may be recalled that Associates were also negligible in the period of spawn availability in this flood. There was a slight decline in spawn quality on the last day of collection viz August 23 when the day's average of major carp was 55.6%, the availability ceasing altogether from 0 hour.

Flood V: This was the last flood of the season and spawn was available only during the period: 16 hours on August 30 to same hour on August 31. The collection of 16-20 hours on August 30 showed high percentage of major carps after which their occurrence dwindled to disappearance on August 31. The minor carp percentage was extremely high, occasionally cent per cent, consisting mainly of Chela sp.

Table JK7-8

Floodwise percentage distribution of spawn quality determined from spawn samples

Flood No.	PERCENTAGE OF		
	Major carps	Minor carps	Others
I	5.1	73.8	21.1
II	44.4	41.8	13.8
III	48.9	53.1	8.0
IV	67.7	29.6	2.7
V	25.7	72.9	1.4

Table JK7-8 depicts the distribution of major carps, minor carps and 'others' in different floods. They were derived by weighing each day's percentage (column 17 of JK6-7) with corresponding spawn catch. Figure JK5-8 presents the fluctuations in spawn quality from flood to flood as well as the scatter of daily average for the days of spawn availability. The trend of major carp spawn is towards increase in successive floods till Flood IV, resulting in a somewhat negatively skewed curve; that of minor carps a bimodal distribution having peaks at the beginning and late in monsoon. The trend in the case of 'others' is that of a highly positive skewness with modality lying early in the season. In the two major floods of the season (II & IV) when the spawn availability was spread over a number of days (7 and 5 days respectively) in their receding phase, the spawn quality seemed to decline with the subsidence of flood. This is seen in Figure JK5-8 by the clustering of major carp average at a high level in the first four days of both the above floods notwithstanding the spawn quantity.

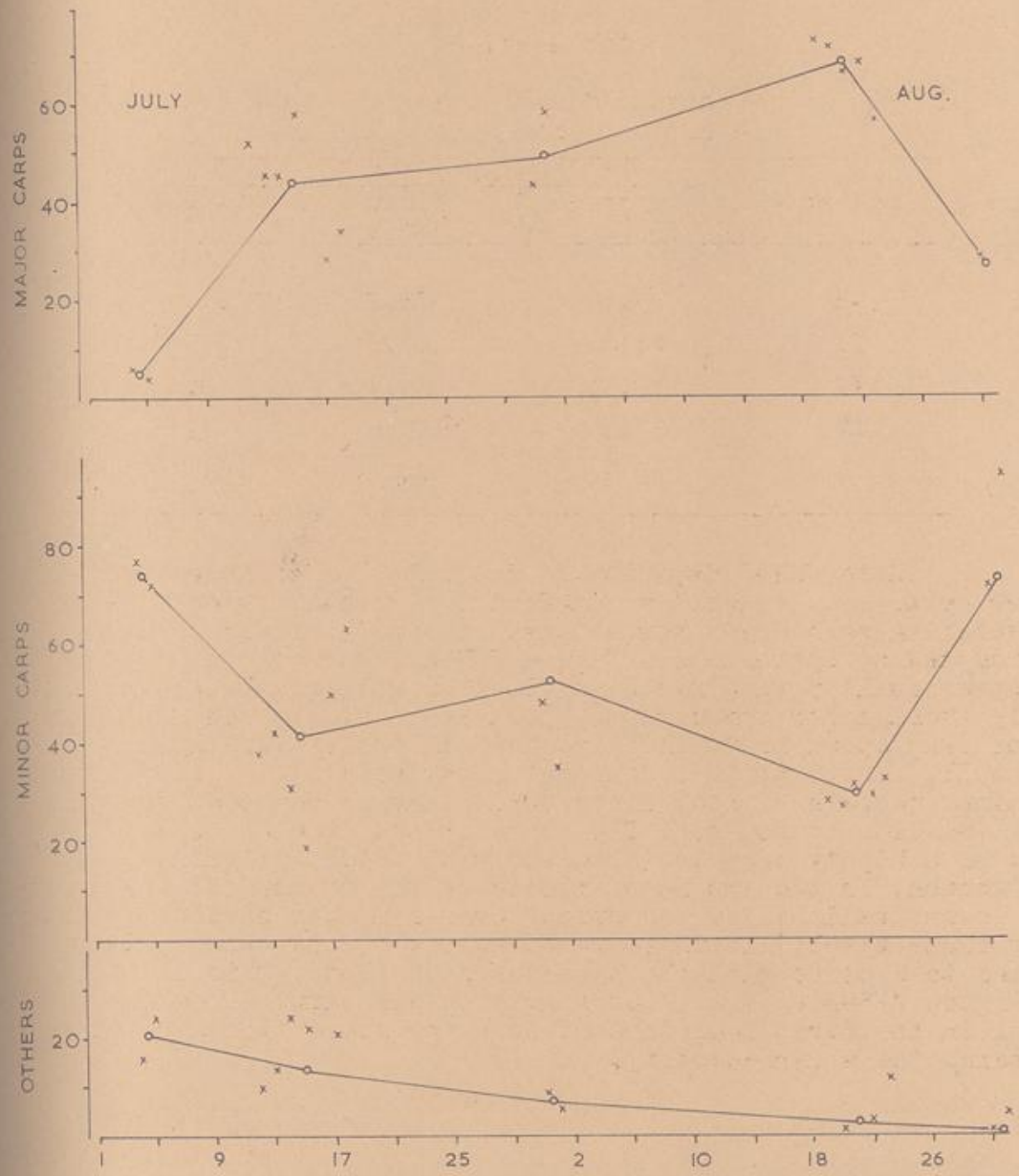

FIG. JK 5-8 — DISTRIBUTION OF PERCENTAGE CONTENT OF 'MAJOR CARPS', 'MINOR CARPS' AND 'OTHERS' IN DIFFERENT FLOODS ALONG-WITH THEIR DAILY SCATTER.

Table JK8-9

Percentage distribution of spawn quality as determined from ditch rearings for two major floods II and IV

Flood No.	Sample No.	Sample Size	Nursery No.	PERCENTAGE OF Major carps Catla	Rohu	Mrigal	Calbasu	Total	Minor carps	Others
II	1	184	1	53	11	28	0	92	8	0
	2	281	2	30	10	51	0	93	7	0
	3	1126	2	27	13	58	0	98	2	0
	4	187	3	23	4	72	0	99	1	0
Weighted Average				30.2	11.2	55.2	0	96.6	3.4	0
IV	1	290	4	32	39.7	2	0.3	74	25.7	0.3
	2	305	4	31	39	4	0	74	26	0
Weighted Average				31.6	39.5	2.7	0.2	74	25.8	0.2

Spawn quality derived from rearing

Table JK8-9 shows the species composition as revealed by the survivors in nurseries in respect of the spawn of the two major floods which contributed 93% of the total seasonal catch. 1778 specimens in four samples from three nurseries, where the spawn of Flood II was released, revealed 96.6% major carps and 3.4 % minor carps. The major carps consisted of 55.2, 30.2 and 11.2 percentage of Mrigal, Catla and Rohu respectively.

The dates of releasing spawn in 3 nurseries (at Kishanpur) were July 13, 14 and 16 and the dates of sample collection were August 3 and 15, September 15 and August 12 for the four samples respectively stated in column (4) of table JK8-9.

In the case of Flood IV the dates of releasing spawn were August 21 & 22 in Nursery No.4 (at Khaga). The dates of collection of the two samples (1 & 2 of column 2 table JK8-9) by Jaunpur type of hand seine were September 15 & 18. These samples show 74% major carps and 25.7 and 26% minor carps. The Mrigal content of major carps was found to be as low as 2 and 4% respectively in these samples attributed to ineffectiveness of Jaunpur

net to sample pond bottom in more than about 3 ft deep water. Another sample, with a fingerling dragnet, was taken on December 26 which showed 55% Mrigal amongst the major carps with the latter forming only 42% of the total sample of 645 specimens. In the period intervening between September 18 and December 26, 1964 the State Department removed 1, 18, 000 major carp fingerlings comprising 15% Catla, 35% Rohu and 50% Mrigal on ten occasions as revealed from their records. This selective removal accounts for the low major carp content of 42% in the netting done on December 26, 1964.

The incompatibility of the spawn quality as revealed by analysis of spawn and reared samples depicted in table JK7-8 and JK8-9 respectively is glaringly conspicuous. The causative factors for the inconsistency, as mentioned earlier, probably are underestimation of major carp content at spawn stage and differential mortalities among fish species in nurseries.

Filtered off Associates

Associates' quantity in relation to floods

Table JK9-10 shows the catch per net per day of filtered off associates over the duration of floods I to V and of the

Table JK9-10

Catch per net per day of associates in ounces

Flood No. etc	Midnapore nets			Departmental nets
	1/8"	1/16"	1/8-1/16"	
I	Average pooled = 16.3 ozs			4.1
II	Average pooled = 35.7 "			25.5
Period between floods II & III	4.9	-	-	5.6
III	0.8	1.3	2.0	1.2
Period between floods III & IV	Few	-	-	Few
IV	0.9	Few	Few	0.4
V	Few	-	-	Few
Later period	Nil	-	-	Nil

intervening periods whenever there was a time lag between the end and the commencement of successive floods. The relative abundance of Associates in Midnapore and Departmental nets is also brought out in Table JK9-10 showing that except for the early part of the season during the first two floods, when the Associates were captured by Midnapore nets in greater quantities, they were about equal in both the net types. It is further seen in Table JK9-10 that the Associate abundance dwindled to insignificance with the advancement of monsoon.

Associates' quality in relation to floods

The occurrence by numbers of Associates consisting of 53 species of fish and prawns within the two-hourly collections in nets of different meshes in different floods was studied. Their distribution was further divided into periods of spawn availability (A) and non-availability (A) within each flood. In Flood I Puntius ticto, Ambassis ranga and prawns formed 79.2 and 87.7% of the Associates in the periods of spawn availability and non-availability respectively. In Flood II prawns dominated overwhelmingly forming 95 and 82.1% in the above stated two periods of the flood. In the period intervening Floods II & III, though prawns continued to dominate (75.6%), the collection of Associates was characterised by five species of Puntius (12.3%) viz P.chola, P.conchonius, P.sophore, P.ticto and P.filamentosus. Flood III was characterised by the occurrence of a wide-variety of species with the percentage of prawns dominating in the spawn non-availability period (83.1%). In the spawn availability period of Flood III, Chela bacaila dominated (45.8%) followed by prawns (37.9%). In the period between Floods III & IV the dominance of Chela bacaila and prawns continued (39.5 and 30.3% respectively). In Flood IV, as stated earlier, Associates were negligible. The available species comprised 40.9% Rohtee cotio, 24.7% Ailia coila and 9.8% Mugil cascasia in the period of spawn availability. In Flood V in the phase of spawn availability and in post-flood V period no Associate was come across at all.

Gut contents of Associates

The gut contents' analysis of 52 species of Associates in respect of spawn, fish matter, plankton, insect matter and debris during periods of availability and non-availability of spawn showed that in floods I & II the stomach contents of Associates generally consisted of prawns, fish matter and debris in the order stated. In Floods III & IV spawn became the dominant

food item especially during the period of spawn availability. There appears to be little selectivity in matter of choice of food by different species of Associates, the dominant forms in the environment, either prawn or fish hatchlings, determining the item ingested as food.

Net Selectivity

Net selectivity of spawn

Table JK10-11

Total spawn catch in ozs by different nets

Flood No.	Total catch in ozs in nets							
	M1		M2		M1-2		D	
	Catch	No. of nets	Catch	No. of nets	Catch	No. of nets	Catch	No. of nets
I	Pooled Total of 5 nets (3 of M_1 : 1 of M_2 & 1 of M_{1-2})				34.9		1.6	3
II					310.0		133.0	3
III	8.0	3	2.5	1	3.0	1	few	3
IV	316.0	3	167.0	1	118.5	1	49.5	3
V	35.5	3	-	-	-	-	5.5	3

It has been mentioned before that in these investigations Midnapore nets of three meshes (1/8", 1/16" & 1/8-1/16 inches) and the State Department nets of a single mesh were experimented with, the positions of which were staggered in their day to day placings to nullify and bias arising out of the relative positions of the nets among themselves as well as in relation to river current distance from bank etc. Table JK10-11 presents catches taken by Midnapore nets of the above stated meshes and the Departmental nets, called here M_1, M_2, M_{1-2}, and D respectively, in different floods and the entire season in ounces.

Table JK11-12

Spawn catch (by numbers) per net per hour of different nets

Flood No.	Catch per net per hour in numbers							
	M1		M2		M12		D	
	Day	Night	Day	Night	Day	Night	Day	Night
I	Based on 5 Nets' catch (3 of M_1, 1 of M_2 & 1 of M_{1-2})				Day=208 Night=3333		28	417
II					Day=5618 Night=3293		2778	2500
III	Few	1111	Few	1042	Few	1250	Few	Few
IV	13288	17134	13018	15480	9804	10260	1034	1875
V	469	7244	-	-	-	-	Few	1125

Table JK11-12 shows the catch per net per hour, derived from the data presented in Table JK10-11 further split up into catches taken in day (6 A.M. to 6 P.M.) and night (6 P.M. to 6 A.M.). The catch ratio between Departmental and Midnapore nets was 1:12, 1:1.7, 1:10 and 1:7 in Floods I, II, IV & V respectively. Nil catches were recorded in Departmental nets in Flood III. Taking the season as a whole the Midnapore nets were found to be 6 times more efficient than the Departmental nets.

The relative catching efficiencies of the 3 types of Midnapore nets were studied by considering State Department net as standard (Unit=1) and matching the relative catch of other nets therewith and testing the significance of the observed differences statistically by applying the Parrish and Keir Method using the 't' test criterion for testing the equality hypothesis. This statistical treatment has been done in respect of 3 days' catch viz August 20-22 during Flood IV when 722 ozs of spawn were collected.

The ratio of spawn catches between D and M_1, M_2 & M_{1-2} was found to be:

$D:M_1:M_2:M_{1-2} = 1:10.41:10.12:7.15.$

The 't' test gave the following results

M_1 & M_2 t = 0.852 on 35 d.f. p. = 0.4 (Not significant)
M_1 & M_{1-2} t = 3.526 on 35 d.f. p. 0.005 (highly significant)
M_2 & M_{1-2} t = 3.071 on 35 d.f. p. 0.005 (-- do --)

From the above it is inferred that the catching efficiencies of 1/8" and 1/16" meshed Midnapore nets do not mutually differ significantly and the combined 1/8-1/16" meshed nets have a lower efficiency than the other Midnapore nets. Taking M_1 & M_2 as having identical catching power, the generalised catching efficiencies of the nets may be placed as shown in table JK12-13.

Table JK12-13

Catching efficiency of nets

Departmental net	Midnapore nets	
	M_1 or M_2	M_{1-2}
1	10.34	7.15
0.14	1.44	1
0.09	1	0.7

Net Selectivity of Associates

Table JK13-14

Associate catch in ozs per net per hour

Flood No.	Catch per net per hour in ozs							
	M1		M2		M12		D	
	Day	Night	Day	Night	Day	Night	Day	Night
I	3 nets of M1, 1 of M2, 1 of M12, pooled				Day = 0.90 Night = 1.71		0.49	0.08
II	-do-		-do-		Day = 2.02 Night = 2.12		0.99	2.04
III	0.06	0.06	0.05	0.06	0.06	0.10	0.13	0.19
IV	Neg	Neg	Nil	Neg	Neg	Neg	Neg	Neg
V	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil

Neg = Negligible

Table JK13-14 shows catch per net per hour in ozs of the Associates taken in different nets in different floods. In Floods I & II it is seen that the Associate content of Midnapore nets is approximately 2 to 3 fold that of Departmental nets. The corresponding spawn catching ratio between Midnapore and Departmental net as seen in table JK13-14 is also about 3 fold. In Flood III, when spawn collections were of a lower magnitude (1% of season's total) the Departmental nets have collected slightly more Associates than the Midnapore nets. In subsequent floods the capture of Associates by any net was either negligible or nil. The collection of Associates when viewed in conjuction with that of spawn points to the overall efficiency of Midnapore nets over the Departmental nets.

V B. MAHEWA-JAMUNAPUR ON RIVER JAMUNA

ABSTRACT

During spawn prospecting investigations from July 1 to September 15, 1964, a total of 819 ozs of spawn, estimated 81 lakh hatchlings, were collected from river Jamuna at Mahewa. 97.3% of the season's total spawn was collected during six floods that occurred in Jamuna in 1964. The rising phases of Floods II and IV only and the receding phases of all the six floods shared 2.8 and 94.5 percent of spawn respectively. The major Floods II, III and IV contributed 91.4% of the total spawn collected during the entire period of investigation. Spawn analysis revealed 8.5, 31.9 and 40.1% Major carp content in these floods respectively. Nursery reared samples showed Major carp percentage as 94.8% in Floods III and IV in one sample and 43.4 and 73.3% in two samples of Flood IV. Qualitative and quantitative studies of Associates and their gut contents were made. Midnapore nets were, on an average, found to be about 6 times more efficient than State Department nets. 557 ozs of spawn were lifted by the State Fisheries Department for stocking purposes. The bearing of various hydrodynamical, chemical, meteorological and hydrobiological characters on the availability of spawn has been discussed.

LOCATION AND FACILITIES

Mahewa is a small village situated on the Northern bank of the River Jamuna in the district of Allahabad in Uttar Pradesh, 78 km West of Allahabad and is approachable by a metalled road. It lies 55 km downstream of Kishanpur earlier Reported spawn. Jamunapur, at the banks of which the spawn collection site was shifted to, in the mid-season, lies 5 km upstream of Mahewa on the same bank. It is connected with a metalled road by a footpath orginating near the village Bairagipurwa. Both the villages Mahewa and Jamunapur lack post and telegraph offices. The post office at Shahpur, telegraph office at Manjhanpur and block headquarters at Sarsawan are 5, 31 and 16 kms respectively away from Mahewa. The nearest railway station, Bharwari, is 43 km away and is connected with

Mahewa by a metalled road. The river course at Mahewa and Jamunapur as well as the general terrain and topography of the areas are shown in Fig.JM1-9.

OBSERVATIONS AND RESULTS

The duration of observations at Mahewa/Jamunapur lasted, from July 1 to September 15(from July 1 to July 31 at Mahewa and thereafter at Jamunapur). The day to day means of two-hourly observations in respect of flood level, turbidity, air and water temperatures, pH and dissolved oxygen and total spawn catch in ounces over the entire period of observations are furnished in Table JM1-16.

Spawn quality in relation to environmental factors.

The spawn collected flood-wise with dates, hour of commencement of availability; the quantity collected in rising and receding phases of floods and whether taken in day or night are shown in Table JM2-17. Figure JM2-10 portrays date-wise total spawn catches at Mahewa in all nets, irrespective of their types and mesh, in 1964 monsoon season. The aportionment between Midnapore and Departmental nets has also been demarcated in Figure JM2-10. The relative contributions of these nets are, however, discussed later in this report.

At Mahewa 819 ozs. of spawn were collected during the entire period of observations. Table JM2-17 reveals that six floods were encountered in which 796 ozs. of spawn were collected. It also shows that 97.3% of season's total spawn was shared by these six floods ranging individually from 5 to 16 days. Floods II, III and IV contributed 91.4% of spawn taken in 14 days only. Floods I, V and VI yielded only 5.9% of the season's catch. Six peak spawn collection days in all floods yielded 45.1% of the season's total spawn and individually contributed 100, 62.7, 54, 40.6, 77.6 and 49.3% of the spawn catch of the respective floods. The peak catch days of Floods II, III and IV, which fell on July 17 and August 1 and 21, produced 40.7% of the total spawn collected. Commencement of spawn availability in relation to flood peak differed in individual floods.

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* 'J' stands for River Jamuna, 'M' stands for Mahewa-Jamunapur. The first number in the Tables and Figures depicts the number in the chapter and the second in the report as a whole.

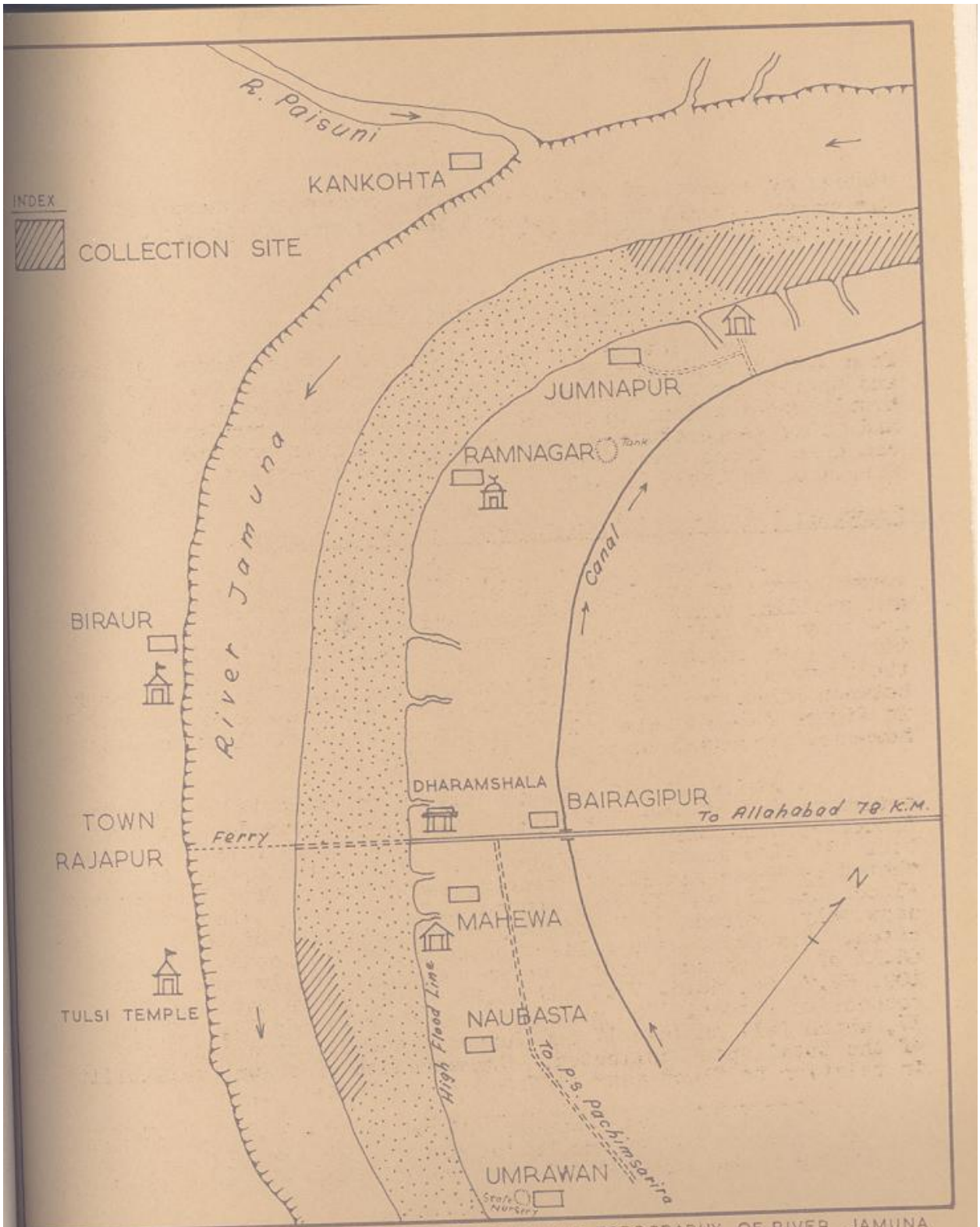

FIG. JM I-9. THE RIVER COURSE, GENERAL TERRAIN AND TOPOGRAPHY OF RIVER JAMUNA AT MAHEWA-JUMNAPUR.

Table JM1-16

Daily averages of flood level, turbidity, air and water temperatures, pH, D.O. and total spawn catch in the River Jamuna at Mahewa

Date year 1964.	Flood level in metres.	Turbidity in ppm.	Air Temp. water temp. in C.	pH.	D.O. in ppm.	Total catch of spawn in ozs.	Flood-wise spawn in ozs. & percentage in total	Flood No.
1	2	3	4	5	6	7	8	9
Jul.1	1.30	231	32/30.9	7.9	5.3	nil		
" 2	1.40	131	31.0/33.1	8.1	-	nil		
" 3	3.02	135	32.7/32.8	8.0	-	nil	2.7	
" 4	3.84	349	30.5/31.4	7.8	5.8	nil	0.3%	I
" 5	4.68	366	29.7/30.6	7.9	-	nil		
" 6	4.06	304	29.2/30.4	7.8	-	2.7		
" 7	4.16	205	31.0/31.0	7.9	6.1	4.0		
" 8	5.14	184	30.7/31.0	7.9	-	1.0		
" 9	5.95	252	28.7/29.4	8.0	-	0.2		
" 10	7.08	377	28.7/29.0	7.9	6.1	nil		
" 11	8.23	421	27.7/28.7	7.9	-	nil		
" 12	8.28	697	27.8/28.4	7.8	-	nil		
" 13	7.86	557	29.0/28.2	7.8	6.1	7.0		
" 14	7.61	586	28.9/29.0	8.1	-	3.0	97.0	
" 15	7.34	630	29.8/29.3	8.0	-	nil	11.9%	II
" 16	6.90	664	29.3/29.0	7.9	6.6	3.0		
" 17	6.23	636	29.4/29.3	7.9	-	60.2		
" 18	6.24	621	29.3/29.5	7.9	-	12.0		
" 19	5.95	650	31.2/31.4	7.9	6.1	6.5		
" 20	5.63	447	31.6/31.5	8.0	-	nil		
" 21	5.40	437	27.5/29.5	8.0	-	nil		
" 22	5.25	436	30.1/30.0	8.0	6.5	nil		
" 23	5.23	483	29.0/30.8	7.8	-	0.3		
" 24	5.29	533	27.8/29.7	7.8	-	nil		
" 25	4.98	793	29.3/30.8	7.8	6.6	0.7		
" 26	4.69	547	28.1/29.5	7.9	-	nil		
" 27	4.72	547	29.9/29.7	7.9	-	nil		
" 28	4.88	503	29.3/30.8	7.9	6.6	nil	64.8	
" 29	5.30	535	28.1/29.5	7.7	-	nil	7.9%	III
" 30	5.89	504	29.9/29.7	7.7	-	nil		
" 31	6.59	608	30.5/31.1	7.8	-	nil		

Table JM1-16

Daily averages of flood level, turbidity, air and water temperatures, pH, D.O. and total spawn catch in the River Jamuna at Mahewa

Date year 1964.	Flood level in metres.	Turbidity in ppm.	Air Temp. water temp. in C.	pH.	D.O. in ppm.	Total catch of spawn in ozs.	Flood-wise spawn in ozs. & percentage in total	Flood No.
1	2	3	4	5	6	7	8	9
Jul.1	1.30	231	32/30.9	7.9	5.3	nil		
" 2	1.40	131	31.0/33.1	8.1	-	nil		
" 3	3.02	135	32.7/32.8	8.0	-	nil	2.7	
" 4	3.84	349	30.5/31.4	7.8	5.8	nil	0.3%	I
" 5	4.68	366	29.7/30.6	7.9	-	nil		
" 6	4.06	304	29.2/30.4	7.8	-	2.7		
" 7	4.16	205	31.0/31.0	7.9	6.1	4.0		
" 8	5.14	184	30.7/31.0	7.9	-	1.0		
" 9	5.95	252	28.7/29.4	8.0	-	0.2		
" 10	7.08	377	28.7/29.0	7.9	6.1	nil		
" 11	8.23	421	27.7/28.7	7.9	-	nil		
" 12	8.28	697	27.8/28.4	7.8	-	nil		
" 13	7.86	557	29.0/28.2	7.8	6.1	7.0		
" 14	7.61	586	28.9/29.0	8.1	-	3.0	97.0	
" 15	7.34	630	29.8/29.3	8.0	-	nil	11.9%	II
" 16	6.90	664	29.3/29.0	7.9	6.6	3.0		
" 17	6.23	636	29.4/29.3	7.9	-	60.2		
" 18	6.24	621	29.3/29.5	7.9	-	12.0		
" 19	5.95	650	31.2/31.4	7.9	6.1	6.5		
" 20	5.63	447	31.6/31.5	8.0	-	nil		
" 21	5.40	437	27.5/29.5	8.0	-	nil		
" 22	5.25	436	30.1/30.0	8.0	6.5	nil		
" 23	5.23	483	29.0/30.8	7.8	-	0.3		
" 24	5.29	533	27.8/29.7	7.8	-	nil		
" 25	4.98	793	29.3/30.8	7.8	6.6	0.7		
" 26	4.69	547	28.1/29.5	7.9	-	nil		
" 27	4.72	547	29.9/29.7	7.9	-	nil		
" 28	4.88	503	29.3/30.8	7.9	6.6	nil	64.8	
" 29	5.30	635	28.1/29.5	7.7	-	nil	7.9%	III
" 30	5.89	504	29.9/29.7	7.7	-	nil		
" 31	6.59	608	30.5/31.1	7.8	-	nil		

1	2	3	4	5	6	7	8
August 1	6.56	400	28.5/29.0	7.9	6.6	35.0	
" 2	6.38	500	31.0/31.0	7.9	-	15.0	
" 3	6.10	650	31.5/31.1	8.2	-	10.0	
" 4	5.75	678	32.7/31.1	7.9	6.2	1.5	
" 5	5.28	493	31.0/31.0	7.6	-	2.3	64.8
" 6	5.01	430	31.2/30.6	7.9	-	1.0	7.9%
" 7	4.79	707	30.8/30.4	7.9	6.2	nil	
" 8	4.58	592	31.1/30.7	7.9	-	nil	
" 9	4.27	620	31.2/30.9	7.9	-	nil	
" 10	3.87	664	32.4/31.1	7.9	6.2	nil	
" 11	3.56	430	29.7/30.2	7.8	-	nil	
" 12	3.39	406	28.3/29.8	7.8	-	nil	
" 13	3.91	368	28.3/30.1	7.8	6.2	nil	
" 14	4.19	361	27.5/29.0	7.8	-	10.0	
" 15	5.37	437	29.1/29.9	7.6	-	nil	
" 16	7.68	871	29.9/30.0	7.6	5.4	nil	
" 17	10.30	2357	28.4/29.0	7.6	-	4.7	586.0
" 18	11.82	1285	30.0/28.5	7.6	-	3.0	71.6%
" 19	11.64	1028	28.5/29.0	7.6	5.3	36.5	
" 20	10.31	1029	29.0/29.3	7.5	-	186.0	
" 21	9.25	1157	28.5/28.5	7.4	-	238.0	
" 22	8.63	1157	29.5/29.9	7.6	5.3	107.8	
" 23	8.71	1200	29.5/30.0	7.4	-	7.0	
" 24	9.75	1114	26.5/29.0	7.6	-	1.0	
" 25	10.14	1071	28.4/29.3	7.4	5.2	7.8	
" 26	10.21	1000	29.0/29.3	7.4	-	4.3	
" 27	10.93	1071	29.0/29.2	7.3	-	nil	
" 28	11.59	1007	28.3/29.1	7.3	5.2	nil	40.3
" 29	12.35	900	29.1/29.1	7.3	-	1.0	5.0%
" 30	10.66	779	29.0/29.0	7.3	-	31.3	
" 31	10.41	864	28.3/28.8	7.3	5.6	5.0	
Sept. 1	8.73	879	28.0/28.5	7.3	-	2.7	
" 2	8.31	785	27.0/29.0	7.3	-	0.3	
" 3	9.03	879	27.4/29.1	7.3	5.2	nil	
" 4	9.92	793	28.6/29.4	7.3	-	nil	
" 5	10.08	764	27.8/29.3	7.3	-	2.5	
" 6	9.70	836	28.5/29.4	7.3	5.2	1.5	
" 7	8.53	814	28.9/29.5	7.3	-	1.0	5.2
" 8	8.08	693	28.1/29.6	7.3	-	0.2	0.5%
" 9	7.39	679	27.5/29.6	7.3	5.2	nil	

1	2	3	4	5	6	7	8	9
Sept.10	7.21	693	27.8/29.9	7.3	-	nil		
" 11	6.88	793	29.3/30.0	7.3	-	0.7		
" 12	6.74	707	29.8/30.3	7.4	5.2	1.0		
" 13	6.54	564	29.9/30.4	7.3	-	nil		
" 14	6.39	564	29.7/30.4	7.3	-	nil		
" 15	6.10	636	26.9/30.0		5.2	nil		

1. Flood levels have been measured in reference to those marked on gauge staff installed by Irrigation Department near Tulsi Temple on the opposite bank of the collection site at Mahewa.
2. The averages of flood level, Air & Water temperatures are based on 12 observations taken every two hours from 6 A.M. to 4 A.M. next calender day.
3. The averages of turbidity are based on seven observations taken every two hours from 6 A.M. to 6 P.M.
4. The averages of pH are based on 2 observations taken twice every day at 6 A.M. and 6 P.M.
5. Dissolved oxygen was estimated every third day at 6 A.M.

Table JM2-17

Details of spawn collection in relation to different floods in Jamuna at Mahewa

Flood No.	Duration of flood in 1964		Flood peak			Commencement of spawn availability			Days of peak collection	Quantity in ozs			Total catch of spawn in ozs			
	Rising phase	Receding phase	Date in 1964	Hour	Flood level in metres	Date in 1964	Hour	Flood level in metres	Date in 1964	Day 6 A.M. to 6 P.M.	Night 6 P.M. to 6 A.M.	Total	Rising phase	Receding phase: Day 6 A.M. to 6 P.M.	Receding phase: Night 6 P.M. to 6 A.M.	Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
I	2/7 4 hrs to 5/7 0 "	5/7 2 hrs to 6/7 20 "	5/7	0	4.11	6/7	8	4.06	6/7	1.3	1.4	2.7		1.3	1.4	2.7
II	7/7 14 " to 11/7 2 "	12/7 6 " to 22/7 6 "	11/7	2	8.45	7/7 13/7 16/7	22 22 8	4.20 7.64 7.05	17/7	39.8	21.0	60.2		50.7	41.0	91.7
III	27/7 2 " to 31/7 20 "	31/7 0 " to 12/8 8 "	31/7	20	6.62	1/8	14	6.56	1/8	10.0	25.0	35.0		29.2	35.6	64.8
IV	12/8 4 " to 18/8 0 "	18/8 2 " to 22/8 4 "	18/8	0	12.01	14/8 17/8 19/8 21/8	16 10 10 6	4.14 9.21 11.92 9.51	21/8	119.0	119.0	238	On 17.7.64 & 21.8.64 in the rising phase of the flood, 1.1 & 4.1 oz & 7.7 & 10.0 oz of spawn were collected in the day and night hours respectively.	292.5	275.7	568.2
V	26/8 16 " to 29/8 14 "	29/8 18 " to 2/9 10 "	29/8	14	12.44	29/8	20	12.34	30/8	14.5	16.6	31.3		21.3	19.0	40.3
VI	2/9 22 " to 5/9 10 "	5/9 20 " to 9/9 20 "	5/9	10	10.10	5/9	10	10.10	5/9	2.5	-	2.5		5.2	-	5.2
TOTAL										186.5	183.8	369.7		400.2	372.7	772.9

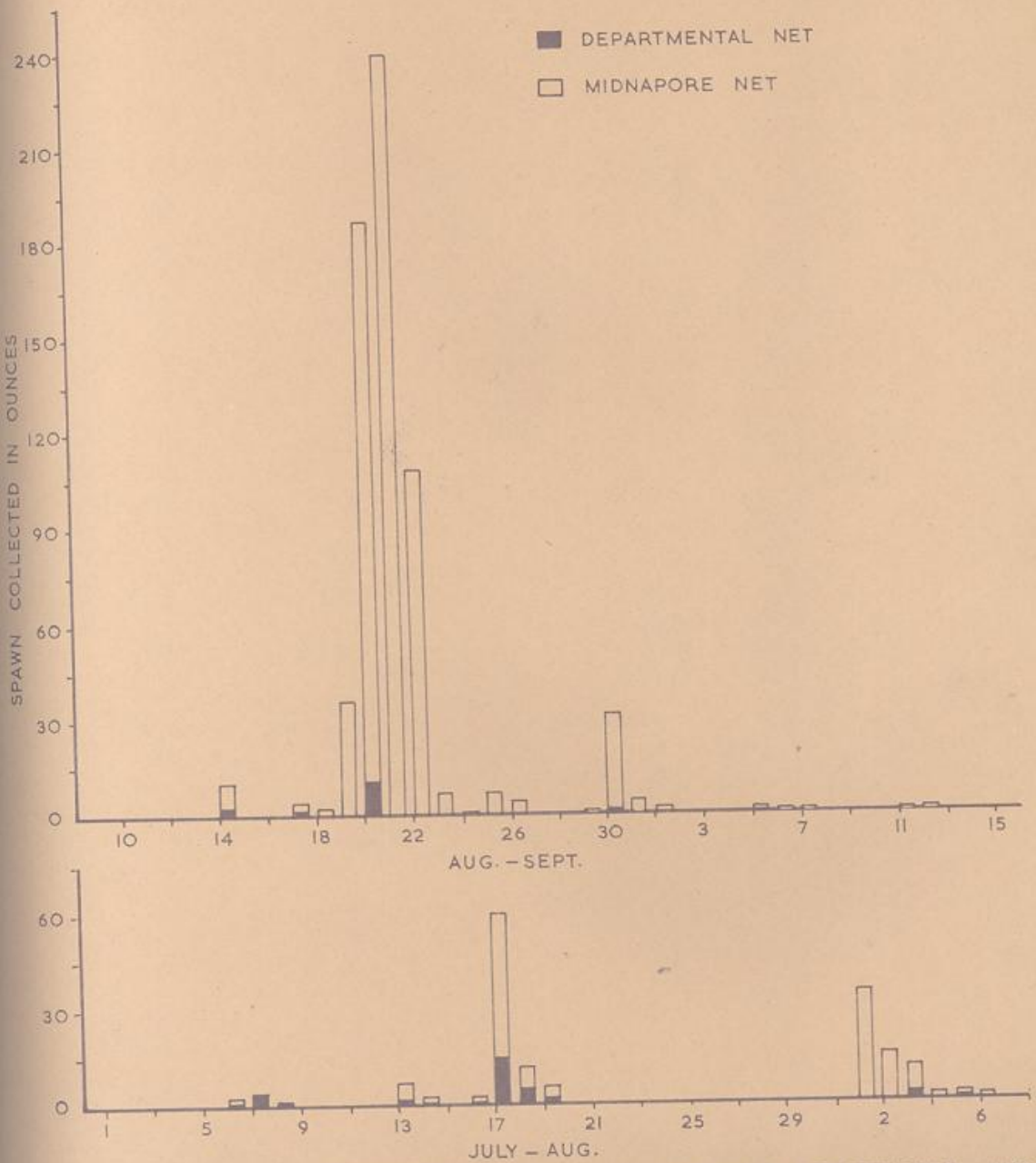

FIG. JM 2-10 — DATE-WISE SPAWN CATCH AT MAHEWA IN DEPARTMENTAL AND MIDNAPORE NETS.

In flood I, when 2.7 ozs. of spawn were collected, the spawn made its first appearance in receding phase, 8 hrs. after the attainment of flood peak. Flood II lasted from July 7 to 22 with the peak falling at 2 hrs. on July 11. Spawn availability commenced (at 22 hrs. on July 7) in the rising phase of this flood, 92 hours before the flood peak was reached. Between July 7 to 16, a total of 18.2 ozs. of spawn were collected. Bulk collection of the flood (60.2 ozs.), however, was made on July 17, 122 hours after the flood peak. The collection from July 18 to 22 yielded 18.5 ozs. of spawn only. In Flood III, spawn availability commenced 18 hrs. after the peak flood hour. In Flood IV, which alone contributed 71.6% of the season's total, the commencement of spawn availability was 98 hrs. earlier than the attainment of the peak of the flood, the rising phase yielding, however, 17.7 ozs. which formed 3.0% of the spawn of the flood. The receding phase of Flood IV began 10 hrs. after the flood peak hour but the maximum spawn was available 54 hours after the peak hour. In Flood V a period of 6 hours elasped between the flood peak hour and commencement of spawn availability. In Flood VI the flood peak and spawn availability hours synchronised. A comparison of the data shown in the corresponding tables in respect of Mahewa and Kishanpur, detailed in Table JM3-18, reveals that there was not much difference between the two centres in the pattern of relationship between floods, their peaks and bulk availability of spawn in each flood. The long delay in the appearance of bulk spawn in Flood II at both the centres probably suggests that in relation to flood peaks, Major carps take longer to breed in the early part of the season than in floods occurring after the monsoon has advanced. In advanced season the gonads are probably ripe enough and breeding commences with the advent of high floods.

A detailed analysis and discussion of the effects of various hydrodynamical, chemical meteorological and hydrobiological factors on the availability of spawn is given below :

Hydrodynamical characters.

Flood level

Fluctuations in average daily flood level and the spawn yield on days of its availability have been presented in Figure JM3-11. It is gathered from this figure and

Table JM3-18

A comparison of dates and hours of flood peak and spawn collection between Kishanpur and Mahewa Centres.

Flood No.	KISHANPUR							MAHEWA					
	Flood peak			Peak collection of spawn				Flood peak			Peak collection of spawn		
	Date	Hour	Flood level (m)	Commencement of spawn availability. Date	Hour	Flood level (m)	Total spawn in ozs.	Date	Hour	Flood level (m)	Commencement of spawn availability. Date	Hour	Flood level	Total spawn in ozs.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
I	4/7	22	1.78	5/7	22 (4/7)	1.78 (4/7)	22.1	5/7	0	4.11	6/7	8	4.06	2.7
II	11/7	0	6.26	12/7	14 (12/7)	6.14 (12/7)	131	11/7	2	8.45	17/7	6	6.72	60.2
III	31/7	16 to 22	4.58	31/7	22	4.47	8.5	31/7	20	6.62	1/8	14	6.56	35.0
IV	18/8	22 to 4	10.68	21/8	20 (19/8)	10.0 (19/8)	327	18/8	0	12.01	21/8	6	9.65	238
V	29/8	16	11.38	30/8	20	9.86	38	29/8	14	12.44	30/8	6	12.01	31.3
VI	-	-	-	-	-	-	-	5/9	10	10.10	5/9	10	10.10	2.5

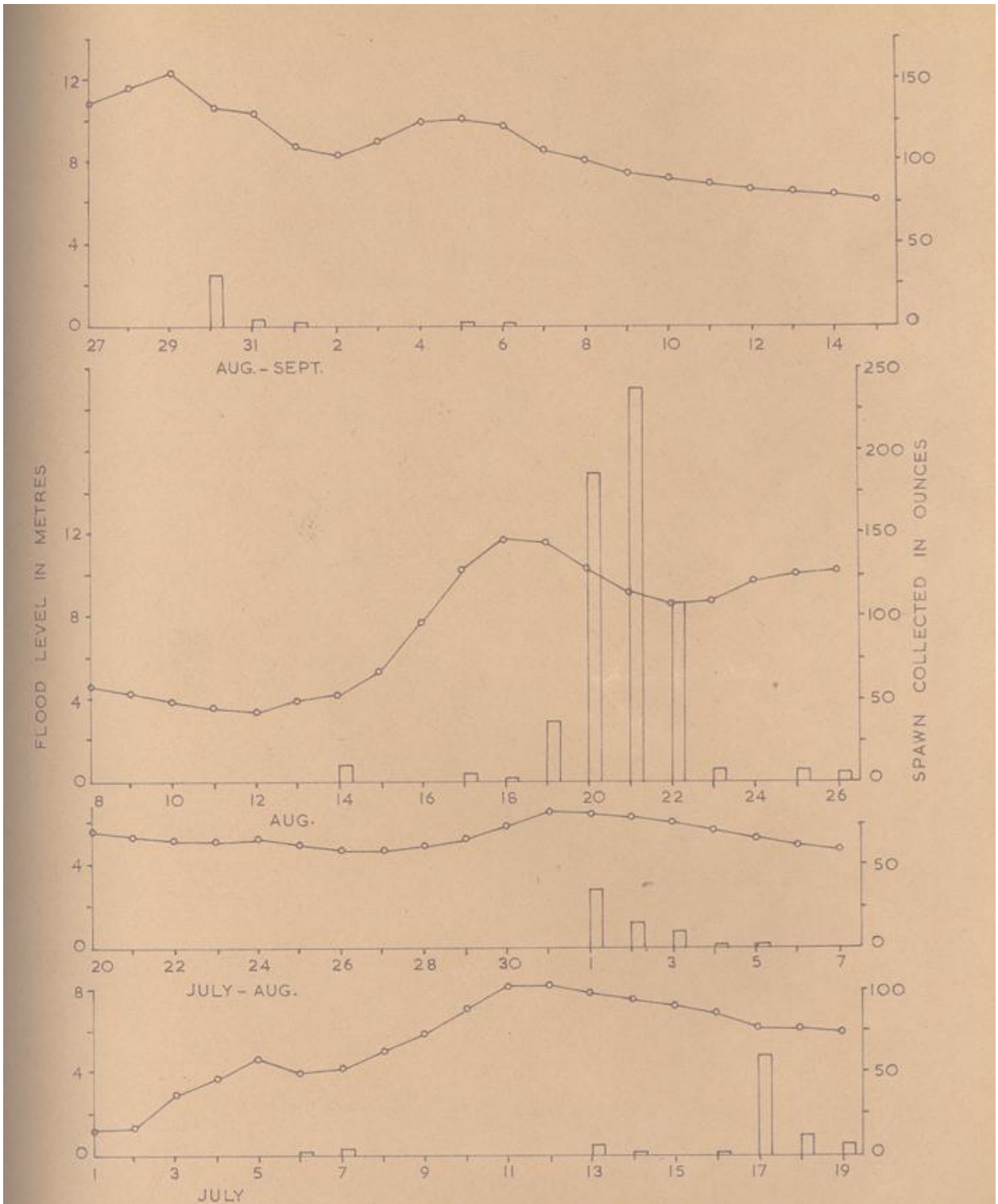

FIG. JM 3-11 — FLUCTUATIONS IN AVERAGE DAILY FLOOD LEVEL OF RIVER JAMUNA AT MAHEWA WITH SPAWN QUANTITY SUPERIMPOSED ON THE DAYS OF AVAILABILITY.

Table JM2-17 that little spawn was available in rising and vacillating phases of floods forming only 2.8 and 2.7% of the total spawn yield respectively. The rising phase of Floods (II and IV only yielded spawn in rising phase) showed 2.8% (1.1% in day and 1.7% in night) and the receding phase of all floods including those of Floods II and IV, 94.5% (49.0% in day and 45.5% in night).

The rise in water level between 'base' and Flood I peak was 2.74 m. (spawn yield of Flood I = 2.7 ozs.); between post-Flood-1 'low' and Flood II peak was 4.45 m. (spawn yield of Flood II = 97 ozs.); between post-Flood-II 'low' and Flood III peak was 1.98 m. (spawn yield of Flood III = 64.8 ozs.); between post-Flood-III 'low' and Flood IV peak was 8.68 m. (spawn yield of Flood IV = 586 ozs.); between post-Flood-IV 'low' and Flood V peak was 2.39 m. (spawn yield of Flood V = 40.3 ozs.) and between post-Flood-V 'low' and Flood V I peak was 1.86 m. (spawn yield in Flood VI = 5.2 ozs.). The above establishes a direct correlation between spawn abundance and rise in water level in different floods, maximum spawn yielding Flood, viz. IV, II and III in the order stated, registering a rise of 8.68, 4.45 and 1.98 m respectively (except Flood I where water level rose by 2.74 m).

Mahewa, as stated earlier, is located about 55 km downstream of Kishanpur. The rise in flood levels at Kishanpur in Floods IV and II were 7.62 and 3.36 m respectively and the spawn yields were 61.5 and 32% of the season. The slight higher magnitude of flood at Mahewa is explained by its location downstream of Kishanpur.

It is of significance from the point of view of field operation to note that the time of commencement of spawn in relation to six floods recorded at Mahewa were 8, 22, 14, 16, 20 and 10 hrs. respectively, justifying round the clock spawn collection operations at a centre.

Current velocity

The collection site at Mahewa was located almost exactly opposite a fast eroding precipitous bank. The current velocity in this 'shadow zone' ranged between 0.21 to 0.96 km per hour and 0.51 to 1.22 km per hour in Floods I and II respectively.

The collection site having been shifted to Jamunapur (lying outside the shadow zone) on August 1, different current velocity was encountered there. It varied between 0.43 to 0.77; 0.64 to 2.96; 1.49 to 2.04 and 1.58 to 2.0 km per hour in Floods III, IV, V and VI respectively. The latter centre proved quite productive in spawn.

Chemical characters.

Turbidity

As shown in Figure JM4-12 in Flood I, 2.7 ozs. of spawn were got in 304 ppm turbidity, the maximum of the flood being 366 ppm on July 5. In Flood II 60.2 ozs. of spawn were collected in turbidity value of 636 ppm whereas in higher turbidity value of 697 ppm on July 12 no spawn was available. In Flood III, 35 ozs. of spawn were collected on a day of 400 ppm turbidity, whereas 707 ppm turbidity on August 7 yielded no spawn. In Flood IV, a turbidity of 2357 ppm was associated only with 4.7 ozs. of spawn, whereas in the turbidity range of 1029 to 1157 as much as 531.8 ozs. of spawn were collected during August 20-22. Other examples of similar nature in the rest of the floods prove that singly any absolute value of turbidity has no correlation with spawn but in association with flood turbidity has a somewhat positive correlation with spawn.

Hydrogenion concentration

The average daily pH values ranged between 7.3 to 8.2 in the season. Its value generally was 7.7 or above before August 13, but it decreased, remaining almost constant at 7.3, from August 27 to September 14, 586 ozs. of spawn were collected in the pH value 7.4 to 7.8. There is no correlation between pH and spawn as spawn was available in all pH values within the range 7.3 to 8.2.

Dissolved oxygen

Dissolved oxygen content varied between 5.2 ppm to 6.6 ppm. The D.O. content values were generally higher during July and upto middle of August (5.8 to 6.6 ppm) and later decreased (5.2 to 5.4 ppm). No correlation can be established between values of dissolved oxygen and spawn availability as the later was obtainable at all values of D.O. in the range 5.2-6.6 ppm.

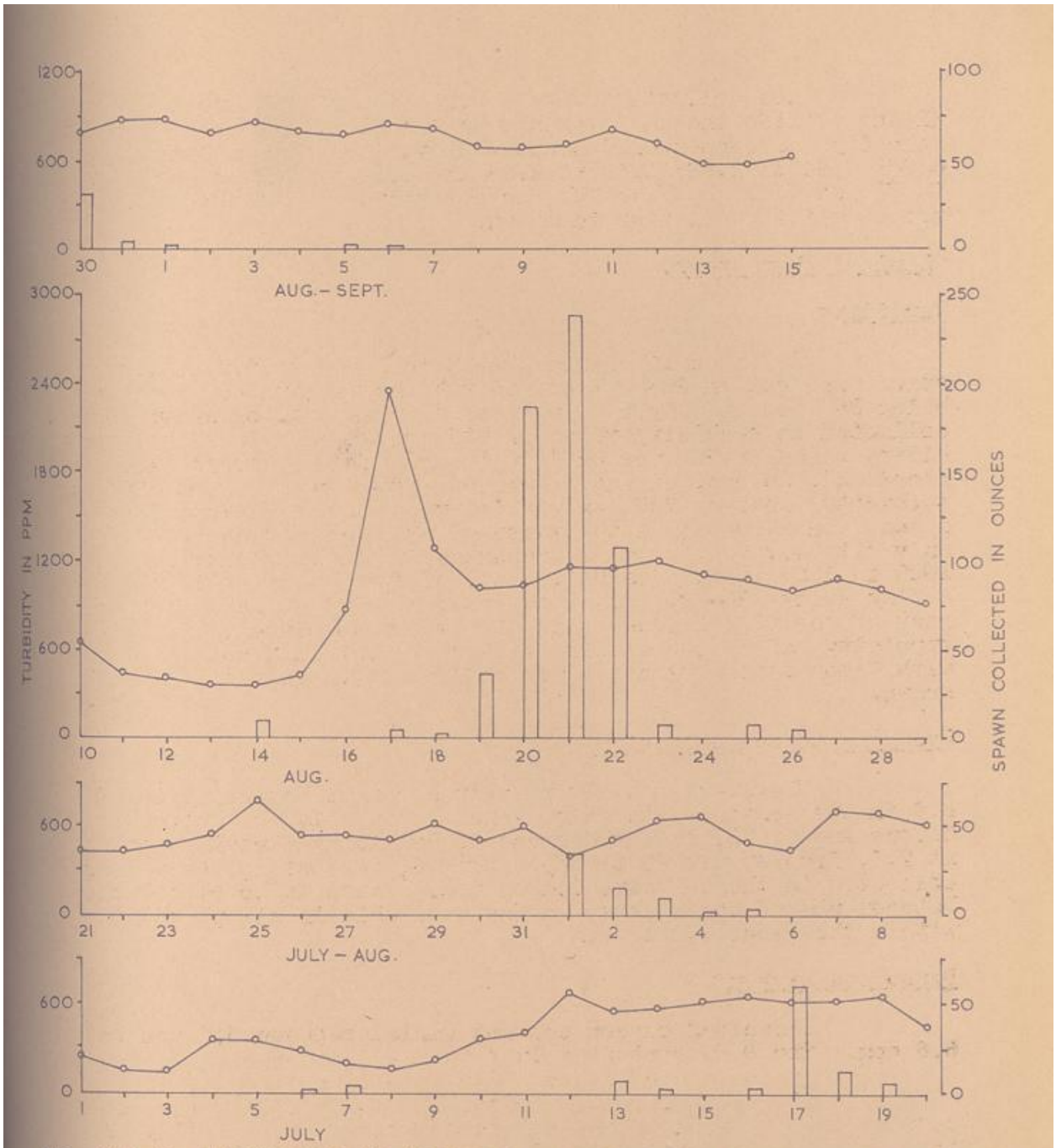

FIG. JM 4–12 FLUCTUATIONS IN AVERAGE DAILY TURBIDITY OF RIVER JAMUNA AT MAHEWA WITH SPAWN QUANTITY SUPERIMPOSED ON THE DAYS OF AVAILABILITY .

Table JM4-19

Daily arithmetic or modal averages of meteorological characters for relevant days in different floods along with spawn catch & current direction in Jamuna at Mahewa.

Date 1964	Flood No.	Phase	Quantity of spawn collected in ozs.	Temperature in centigrade. Air	Water	Weather condition Sky	Wind speed	Wind direction from north.	Current direction from north.
1	2	3	4	5	6	7	8	9	10
Jul.3	I	Rising	nil	32.7	32.8	Clear	High	140°	0°
" 4		Rising	"	30.5	31.4	Cloudy	Gentle	315	320
" 5		Peak	"	29.7	30.6	Cloudy	Gentle	40	320
" 6		Receding	2.7	29.2	30.4	Cloudy	Gentle	270	320
" 7	II	Rising	4.0	31.0	31.0	Cloudy	Gentle	180	320
" 8		Rising	1.0	30.7	31.0	Clear	Gentle	270	320
" 9		Rising	0.2	28.7	29.4	Cloudy	Stormy	270	Could not be recorded
" 13		Receding	7.0	29.0	28.2	Cloudy	High	270	320
" 14		Receding	3.0	28.6	28.3	Cloudy	High	270	320
" 15		Receding	nil	28.9	29.0	Cloudy	High	315	Could not be recorded.
" 16		Receding	3.0	29.8	29.3	Clear	Stormy	270	"
" 17		Receding	60.3	29.3	29.0	Clear	Stormy	270	"
" 18		Receding	12.0	29.4	29.3	Cloudy	Stormy	270	"
" 19		Receding	6.5	29.3	29.5	Cloudy	Stormy	270	"
" 29	III	Rising	nil	28.1	29.5	Cloudy	Stormy	270	"
" 30		Rising	nil	29.9	29.7	Cloudy	Stormy	270	"
" 31		Peak	nil	30.5	31.1	Cloudy	Stormy	270	"
Aug.1		Receding	35.0	28.5	29.0	Clear	Stormy	270	"
" 2		Receding	15.0	31	31	Cloudy	Stormy	270	"
" 3		Receding	10.0	31.5	31.1	Clear	Stormy	180	"
" 4		Receding	1.5	32.7	31.1	Clear	Stormy	180	"
" 5		Receding	2.0	31	31	Clear	Stormy	40	"
" 6		Receding	1.0	31.2	30.6	Clear	Stormy	40	"
" 12	IV	Rising	nil	28.3	29.8	Cloudy	Stormy	90	"
" 13		Rising	nil	28.3	30	Cloudy	Stormy	90	"
" 14		Rising	10.0	27.5	29	Cloudy	Stormy	270	"
" 15		Rising	nil	29.1	29.9	Cloudy	Stormy	90	"
" 16		Rising	nil	29.9	30	Clear	Gentle	40	220

1	2	3	4	5	6	7	8	9	10
Aug.17		Rising	4.7	28.4	29	Cloudy	Gentle	90	220
" 18		Peak	3.0	30	28.5	Cloudy	Gentle	90	220
" 19		Receding	36.5	28.5	29	Cloudy	Gentle	90	220
" 20		Receding	186.0	29	29.3	Clear	High	270	220
" 21		Receding	238.0	28.5	28.5	Clear	High	270	Could not be recorded.
" 22		Receding	107.8	29.5	29.9	Cloudy	High	270	"
" 29	V	Receding	1.0	29.1	29.1	Cloudy	Gentle	270	220
" 30		Receding	31.3	29	29	Cloudy	Gentle	270	220
" 31		Receding	5.0	28.3	28.8	Cloudy	Gentle	90	220
Sept.1		Receding	2.7	28	28.5	Cloudy	Gentle	90	220
" 2		Receding	0.3	27	29	Cloudy	High	180	Could not be recorded
" 3	VI	Rising	nil	27.4	29.1	Cloudy	High	270	"
" 4		Rising	nil	28.6	29.4	Clear	High	270	"
" 5		Receding	2.5	27.8	29.3	Cloudy	High	270	"
" 6		Receding	1.5	28.5	29.4	Clear	High	270	"
" 7		Receding	1.0	28.9	29.5	Clear	High	270	"
" 8		Receding	0.2	28.1	29.6	Clear	High	270	220

Meteorological characters

The daily mean air and water temperatures for the entire duration of spawn catch in each of the six floods, as well as for three days, preceding the period of spawn availability; state of weather, wind intensity and direction alongwith spawn yield and current direction are shown in Table JM4-19.

Table JM5-20 shows the mean air and water temperatures for the period of spawn availability and 3 days preceding and 3 days following spawn availability periods in respect of Floods II, III and IV.

Table JM5-20

Average Air and Water temperatures in preceding, following and flood spawn collection periods.

Period Identity	Flood II			Flood III			Flood IV		
	No. of days	Temperature °C		No. of days.	Temperature °C		No. of days	Temperature °C	
		Air	Water		Air	Water		Air	Water
1	2	3	4	5	6	7	8	9	10
Preceding spawn availability.	3	28.0	28.7	3	29.5	30.0	3	28.6	29.6
During spawn availability	7	29.2	28.9	6	31.5	30.9	6	29.4	29.1
Following spawn availability	3	31.0	31.1	3	31.1	30.7	3	28.8	29.7

The above table shows that the temperatures in pre- and spawn availability periods are generally lower than in the post spawn availability periods, those of pre-spawn availability period being lower in general than during spawn availability phase. These observations indicate that spawning is associated with lower temperatures which appear during spells of widespread rain causing floods. In Flood I associated, however, with 0.3% of season's spawn (that also mostly of Minor carps) no such lowering of temperature in pre-spawn availability period was observed.

Current direction

The flow of the river at Mahewa was approximately from N.W. to S.E. and the current direction generally was 320°. At Jamunapur, owing to bends in the river, the current direction was roughly from S.W. to N.E.(220°).

Wind speed and Wind direction

The wind direction varied greatly but was mostly 270° and at times 90°. During peak spawn collection days in Floods II and III the wind intensity was very high adversely affecting the availability of spawn(tended to uproot poles and throw tail pieces of nets out of water) and resulted in low catch. Gentle wind during spawn collection days in Flood IV aided spawn collection in appreciable quantitites.

Hydrobiological characters.

Table JM6-21 shows average plankton density in numbers per litre of water and average catch per day when spawn was available and when it was not, in each of the six floods at Mahewa. The plankters ranged from 0.1 to 20.2 per litre in the season and showed no correlation with spawn. In Floods I and II the average catch per day of Associates(in numbers) during days of availability of spawn and otherwise were 397 and 3950 and 265 and 2224 respectively. In floods III, IV, V and VI average Associate catches per day were 346, 17, 738 and 14 respectively on days of spawn availability. In the period of spawn non-availability catches were 113 and 4, in Floods III and IV and nil in Floods V and VI. This shows that Associates showed some definite pattern with advancing season. They were predominant in Floods I and II and later dwindled to negligibility. In Flood IV the Associates were available only on August 19 and later disappeared when the spawn quantity was high and quality superior.

Spawn Quality in relation to environmental factors.
Spawn quality derived from spawn analysis.

Table JM7-22 shows flood-wise percentage distribution of Major and Minor carps and 'Others' in two-hourly samples collected from Jamuna at Mahewa. The daily averages shown in column 17 of this table are the arithmetic means of percentages of two-hourly samples of the day. The spawn quality, as estimated from two-hourly samples, for each flood is described below.

Table JM6-21

Flood-wise quantitative abundance of plankton and spawn Associates split up into days of spawn availability and otherwise

Flood No.	Date in 1964	Average plankton densities in no/litre		Average catch per day of spawn Associates in no.	
		On days of spawn availability.	Otherwise.	On days of spawn availability.	Otherwise.
1	2	3	4	5	6
I	July 2 to 5	-	6.2	-	265
	July 6	20.2	-	397	-
II	July 7 to 9, 13,14,16 & 19	2.3	-	3950	-
	July 10 to 12,15,20 to 22	-	4.8	-	2224
Period between Floods II&III	July 23 & 25	nil	-	1012	-
	July 24 & 26	-	0.1	-	986
III	July 27 to 31,Aug.7 to 11	-	0.4	-	113
	Aug.1 to 6	0.3	-	346	-
IV	Aug.12,13, 15 & 16	-	0.1	-	4
	Aug.14& 17 to 22	0.6	-	17	-
Period between Floods IV & V	Aug.23 to 26	0.5	-	-	-
V	Aug.27 & 28	-	nil	-	nil
	Aug.29 to Sept.2	0.3	-	738	-

1	2	3	4	5	6
VI	Sept.3,4 and 9	-	0.1	-	nil
	Sept.5 to 8	0.7	-	14	-
Post-Flood-VI period	Sept.10,13 to 15	-	nil	-	nil
	Sept.11 and 12	1.2	-	80	-

Table J.7

Floodwise percentage distribution of Major and Minor carps and 'others' in two-hourly spawn samples from Jamuna at Mahewa.

Flood No.	Phase	Date in 1964	Percentage of	HOURS OF OBSERVATIONS 6	8	10	12	14	16	18	20	22	0	2	4	Average percentage for the day	Spawn catch in (ozs)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
I	Receding	July 6	Mj	-	1.0	-	nil	-	-	nil	-	-	-	-	2.7	0.9	
			Mi	-	99.0	-	100.0	-	-	100.0	-	-	-	-	89.7	97.2	2.7
			O	-	nil	-	nil	-	-	nil	-	-	-	-	7.6	1.9	
	Rising	July 7	Mj	-	-	-	-	-	-	-	-	11.6	nil	1.9	nil	3.4	
			Mi	-	-	-	-	-	-	-	-	83.9	100.0	98.1	95.2	94.3	4.0
			O	-	-	-	-	-	-	-	-	4.5	nil	nil	4.8	2.4	
	Rising	July 8	Mj	-	-	-	-	-	-	nil	-	-	-	-	-	nil	
			Mi	-	-	-	-	-	-	91.1	-	-	-	-	-	91.1	1.0
			O	-	-	-	-	-	-	8.9	-	-	-	-	-	8.9	
	Rising	July 9	Mj	-	nil	0.7	nil	nil	nil	nil	nil	nil	3.1	-	6.4	1.0	
			Mi	-	25.6	50.7	51.5	100.0	77.5	70.9	79.9	16.9	27.1	-	52.1	55.2	0.2
			O	-	74.4	48.5	48.5	nil	22.5	29.1	20.1	83.1	69.8	-	41.5	43.8	
	Receding	July 13	Mj	-	nil	23.0	19.4	-	-	-	-	-	-	-	-	14.1	
			Mi	-	95.2	75.4	77.1	*	*	*	*	-	-	-	-	82.6	7.0
			O	-	4.8	1.6	3.5	-	-	-	-	-	-	-	-	3.3	
II	"	July 14	Mj	-	-	-	-	-	-	-	-	nil	-	nil	13.5	4.5	
			Mi	-	-	-	-	-	-	-	-	16.0	-	31.4	85.7	44.4	3.0
			O	-	-	-	-	-	-	-	-	84.0	-	68.6	0.8	51.1	
	"	July 16	Mj	-	5.8	nil	-	-	-	-	-	-	-	-	nil	1.9	
			Mi	-	88.2	95.5	-	-	-	-	-	-	-	-	100.0	94.6	3.0
			O	-	6.0	4.5	-	-	-	-	-	-	-	-	nil	3.5	
	"	July 17	Mj	14.1	-	23.5	-	20.9	-	11.2	-	18.9	*	*	*	17.7	
			Mi	70.3	-	73.1	-	69.0	-	84.9	-	78.9	-	-	-	75.2	60.2
			O	15.6	-	3.4	-	10.1	-	3.9	-	2.2	-	-	-	7.1	

Table J.7

Floodwise percentage distribution of Major and Minor carps and 'others' in two-hourly spawn samples from Jamuna at Mahewa.

Flood No.	Phase	Date in 1964	Percentage of	HOURS OF OBSERVATIONS 6	8	10	12	14	16	18	20	22	0	2	4	Average percentage for the day	Spawn catch in (ozs)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
I	Receding	July 6	Mj	-	1.0	-	nil	-	-	nil	-	-	-	-	2.7	0.9	
			Mi	-	99.0	-	100.0	-	-	100.0	-	-	-	-	89.7	97.2	2.7
			O	-	nil	-	nil	-	-	nil	-	-	-	-	7.6	1.9	
	Rising	July 7	Mj	-	-	-	-	-	-	-	-	11.6	nil	1.9	nil	3.4	
			Mi	-	-	-	-	-	-	-	-	83.9	100.0	98.1	95.2	94.3	4.0
			O	-	-	-	-	-	-	-	-	4.5	nil	nil	4.8	2.4	
	Rising	July 8	Mj	-	-	-	-	-	-	nil	-	-	-	-	-	nil	
			Mi	-	-	-	-	-	-	91.1	-	-	-	-	-	91.1	1.0
			O	-	-	-	-	-	-	8.9	-	-	-	-	-	8.9	
	Rising	July 9	Mj	-	nil	0.7	nil	nil	nil	nil	nil	nil	3.1	-	6.4	1.0	
			Mi	-	25.6	50.7	51.5	100.0	77.5	70.9	79.9	16.9	27.1	-	52.1	55.2	0.2
			O	-	74.4	48.5	48.5	nil	22.5	29.1	20.1	83.1	69.8	-	41.5	43.8	
	Receding	July 13	Mj	-	nil	23.0	19.4	-	-	-	-	-	-	-	-	14.1	
			Mi	-	95.2	75.4	77.1	*	*	*	*	-	-	-	-	82.6	7.0
			O	-	4.8	1.6	3.5	-	-	-	-	-	-	-	-	3.3	
II	"	July 14	Mj	-	-	-	-	-	-	-	-	nil	-	nil	13.5	4.5	
			Mi	-	-	-	-	-	-	-	-	16.0	-	31.4	85.7	44.4	3.0
			O	-	-	-	-	-	-	-	-	84.0	-	68.6	0.8	51.1	
	"	July 16	Mj	-	5.8	nil	-	-	-	-	-	-	-	-	nil	1.9	
			Mi	-	88.2	95.5	-	-	-	-	-	-	-	-	100.0	94.6	3.0
			O	-	6.0	4.5	-	-	-	-	-	-	-	-	nil	3.5	
	"	July 17	Mj	14.1	-	23.5	-	20.9	-	11.2	-	18.9	*	*	*	17.7	
			Mi	70.3	-	73.1	-	69.0	-	84.9	-	78.9	-	-	-	75.2	60.2
			O	15.6	-	3.4	-	10.1	-	3.9	-	2.2	-	-	-	7.1	

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Receding	July 18	Mj	-	-	-	13.3	-	-	-	-	*	*	-	-	13.3	
			Mi	-	-	-	74.2	-	-	-	-	-	-	-	-	74.2	12.
			O	-	-	-	12.5	-	-	-	-	-	-	-	-	12.5	
	"	July 19	Mj	-	-	-	-	-	-	-	-	-	-	-	-	19.6	
			Mi	-	-	-	-	-	-	-	-	-	*	19.6	*	80.4	6.
			O	-	-	-	-	-	-	-	-	-	-	nil	-	nil	
	Receding	Aug. 1	Mj	-	-	-	-	-	7.0	30.4	-	-	-	-	-	18.7	
			Mi	-	-	-	-	-	93.0	64.3	-	-	-	-	-	78.6	35.
			O	-	-	-	-	-	nil	5.3	-	-	-	-	-	2.7	
III	Receding	Aug. 2	Mj	-	-	-	-	28.0	-	28.9	-	30.5	34.2	-	-	30.1	
			Mi	-	-	-	-	71.8	-	67.4	-	65.8	62.1	-	-	66.3	15.
			O	-	-	-	-	1.9	-	4.6	-	3.7	3.7	-	-	3.3	
	"	Aug. 3	Mj	-	-	-	-	-	*	38.3	*	31.7	32.2	30.7	*	33.3	
			Mi	-	-	-	-	-	-	59.2	-	66.4	33.2	62.7	-	62.9	10.
			O	-	-	-	-	-	-	2.2	-	1.9	4.6	3.6	-	3.8	
	"	Aug. 4	Mj	-	-	19.3	*	*	-	-	*	nil	-	1.9	-	7.1	
			Mi	-	-	78.1	-	-	-	-	-	100.0	-	96.3	-	91.8	1.
			O	-	-	1.6	-	-	-	-	-	nil	-	1.8	-	1.1	
	"	Aug. 5	Mj	-	31.5	42.4	39.6	41.1	45.8	-	-	44.0	-	-	-	40.7	
			Mi	-	66.7	50.0	59.5	55.0	50.5	-	-	53.0	-	-	-	55.5	2.
			O	-	1.8	7.6	0.9	3.9	3.7	-	-	3.0	-	-	-	3.5	
	"	Aug. 6	Mj	61.8	-	-	-	-	-	-	-	-	-	-	-	31.8	
			Mi	37.3	-	-	-	-	-	-	-	-	-	-	-	37.3	1.
			O	0.9	-	-	-	-	-	-	-	-	-	-	-	0.9	
	Rising	Aug. 14	Mj	-	-	-	-	-	35.3	-	-	-	-	-	*	35.3	
			Mi	-	-	-	-	-	43.2	-	-	-	-	-	-	43.2	10.
			O	-	-	-	-	-	21.2	-	-	-	-	-	-	21.2	
	"	Aug..17	Mj	-	-	*	-	-	40.2	-	30.0	-	-	-	63.3	54.5	
			Mi	-	-	-	-	-	45.0	-	38.9	-	-	-	30.3	38.1	4.
			O	-	-	-	-	-	14.8	-	1.1	-	-	-	6.4	7.4	
IV	"	Aug. 18	Mj	-	-	-	-	-	17.4	-	28.9	21.0	26.7	-	-	23.5	
			Mi	-	-	-	-	-	69.6	-	31.4	74.4	32.9	-	-	67.1	3.
			O	-	-	-	-	-	13.1	-	9.7	4.3	10.4	-	-	9.4	
	Receding	Aug..19	Mj	-	-	33.0	25.7	25.7	-	-	-	-	32.9	42.0	54.7	39.8	
			Mi	-	-	58.0	74.3	74.3	-	-	-	-	32.8	48.0	39.3	53.1	36.
			O	-	-	4.0	nil	nil	-	-	-	-	4.3	10.0	5.0	4.1	

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
			Mj	39.2	49.5	41.7	45.1	43.6	52.0	41.6	42.2	43.6	52.4	48.6	44.8	45.4	
	Receding	Aug. 20	Mi	59.0	50.5	53.7	53.9	55.5	48.0	53.3	53.9	53.8	42.8	48.6	50.4	51.9	186.0
			O	1.9	nil	4.6	1.0	0.9	nil	5.1	3.9	2.6	4.8	2.8	4.8	2.7	
			Mj	56.5	30.1	43.1	43.0	43.2	43.0	46.8	50.9	36.6	46.6	38.1	36.6	42.9	
	"	Aug. 21	Mi	36.1	58.6	55.0	50.5	46.9	57.0	44.9	38.4	52.7	50.5	57.1	52.7	50.0	238.0
			O	7.4	11.3	1.9	6.5	9.9	nil	8.3	10.7	10.7	2.9	4.8	10.7	7.1	
			Mj	31.8	42.7	40.0	37.5	45.5	47.4	37.5	49.5	43.6	36.3	30.6	21.9	39.2	
	"	Aug. 22	Mi	63.5	35.6	58.9	59.7	50.5	61.6	54.8	43.6	52.5	61.8	65.8	73.3	56.0	107.8
			O	4.7	15.7	1.1	2.8	4.0	1.0	7.7	6.9	3.9	1.9	3.6	4.8	4.8	
			Mj	-	-	-	-	-	-	-	9.6	10.1	12.5	-	13.5	11.4	
		Aug. 29	Mi	-	-	-	-	-	-	-	86.6	81.3	83.7	-	82.7	83.3	1.0
			O	-	-	-	-	-	-	-	3.8	8.3	3.8	-	3.8	5.0	
			Mj	9.4	8.6	10.6	14.6	6.7	-	7.8	-	17.1	23.0	34.7	33.3	16.6	
		Aug. 30	Mi	84.9	85.7	85.6	82.5	89.4	-	89.3	-	78.1	77.0	53.2	63.8	79.0	31.3
			O	5.7	4.7	3.8	2.9	3.9	-	2.9	-	4.8	nil	12.1	2.9	4.4	
			Mj	-	-	34.2	20.9	12.7	-	-	-	11.8	-	-	-	19.9	
		Aug. 31	Mi	-	-	60.4	67.3	76.4	-	-	-	75.3	-	-	-	69.9	5.0
			O	-	-	5.4	11.8	10.9	-	-	-	12.6	-	-	-	10.2	
			Mj	-	23.8	4.0	18.0	-	10.8	-	18.9	-	-	-	-	15.5	
		Sept. 1	Mi	-	71.4	96.0	77.2	-	70.2	-	77.4	-	-	-	-	78.4	2.7
			O	-	4.8	nil	4.7	-	19.0	-	3.7	-	-	-	-	6.1	
			Mj	-	-	0.9	-	-	-	-	-	-	-	-	-	0.9	
		Sept. 2	Mi	-	-	96.2	-	-	-	-	-	-	-	-	-	96.2	0.3
			O	-	-	2.9	-	-	-	-	-	-	-	-	-	2.9	
			Mj	-	18.5	26.4	-	-	-	-	-	-	-	-	-	22.4	
		Sept. 5	Mi	-	71.5	66.3	-	-	-	-	-	-	-	-	-	68.9	2.5
			O	-	10.0	7.3	-	-	-	-	-	-	-	-	-	8.7	
			Mj	-	21.4	-	-	-	-	-	-	-	-	-	-	21.4	
		Sept. 6	Mi	-	54.9	-	-	-	-	-	-	-	-	-	-	54.9	1.5
VI			O	-	23.7	-	-	-	-	-	-	-	-	-	-	23.7	

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
			Mj	-	-	12.6	-	-	-	-	-	-	-	-	-	12.6	
		Sept. 7	Mi	-	-	84.5	-	-	-	-	-	-	-	-	-	84.5	1.0
			0	-	-	2.9	-	-	-	-	-	-	-	-	-	2.9	
			Mj	-	-	16.2	-	-	-	-	-	-	-	-	-	16.2	
		Sept. 8	Mi	-	-	79.0	-	-	-	-	-	-	-	-	-	79.0	0.2
			0	-	-	4.8	-	-	-	-	-	-	-	-	-	4.8	

* Sample destroyed in transit due to breakage of tube.

FLOOD I

2.7 ozs. of spawn were collected on one day viz. July 6. The Major carps were mostly absent, except for occasional occurrence accounting for 1.0 to 2.7% by numbers among the two-hourly collections. Their daily average was 0.9%. The Minor carps formed as high as 97.2% in the daily average. A noteworthy feature of Flood I was that spawn co-occurred with Ostracods which were so abundant that they practically choked the tail pieces of nets.

FLOOD II

There were two minor and one major spawn spurts in this flood, the former occurring from July 7-9 and 13-14 and the latter from July 16-19. The major spurt yielded 81.7 ozs. of spawn against 15.2 ozs. in the minor ones. The percentage of Major carps in the spawn spurt of July 16-19 varied from 13.3 to 19.6 and those of Minor carps from 74.2 to 80.4%. In this spurt 'Others' ranged in percentage from 0 to 12.5.

FLOOD III

The collection site was shifted from Mahewa to Jamunapur at the commencement of Flood III which constituted 7.9% the season's total yield of spawn. There was only one spawn spurt in Flood III lasting from August 1 to August 6. Although quantitatively spawn was collected at a diminishing pace, qualitatively the Major carp content progressively increased from 18.7% on A ugust 1 to 61.8% on August 6 except on August 4 when it was only 7.1%. This was the first flood when Major carp spawn was got in somewhat great abundance.

FLOOD IV

This was the most important flood of the centre when 71.6% of the season's total spawn was collected. In rising phase the spawn was available on August 14, 17 and 18 and consisted of Major carps showing daily average percentages of 35.6, 54.5 and 23.5 respectively. As high a percentage of Major carps as 63.3 was encountered in one of the two-hourly collections, viz. at 4 hrs. on August 17. During the receding phase of Flood IV the spawn appeared at 10 hrs. on August 19 and continued till 14 hrs.; then it discontinued and reappeared at 0 hr. of the same day. Thence it continued uninterruptedly till 4 hrs. on August 22.

The spawn quality was consistently high even touching 62.9% Major carps content. The remarkable feature of this flood was that Major carps spawn was relatively much richer. The frequency of occurrence of 'Others' was negligible. Associates were available only on one day i.e. on August 19, in this flood. The quality of spawn was very good and it could be transported away in polythene bags straightaway from the tail pieces.

FLOOD V

Spawn was available from 20 hrs. on August 29 till 4 hrs. on August 30, with occasional breaks. The percentage of Major carps declined in this flood fluctuating between 11.4 and 19.9%. On September 2 the percentage of carps declined to disappearance.

FLOOD VI

This was the last flood of the season and spawn was available in negligible quantity on September 5 and 6. The collections showed Major carp content to be 22.4 and 21.4% respectively.

From the mass of data of Table JM7-22 has been derived a flood-wise distribution of Major and Minor carps and 'Others' by weighing each day's percentage with the collection of the corresponding days.

Table JM8-23

Flood-wise percentage distribution of spawn quality determined from spawn samples.

Flood No.	Percentage of Major carps	Minor carps	Others
1	2	3	4
I	0.9	97.1	1.9
II	8.4	76.5	15.1
III	31.9	65.5	2.6
IV	40.1	51.2	8.4
V	12.8	81.0	5.7
VI	18.1	71.8	10.0

Table JM8-23 shows the trends of qualitative occurrence of spawn in the entire season. The purity of spawn in respect of Major carps steadily increased till Flood IV. 'Others' vacillated between 1.9 and 15.1%, the maximum being attained in Flood II. Figure JM5-13 shows fluctuations in spawn quality from flood to flood as well as the scatter of daily average for the days of spawn availability. The distribution of Major carps follows a negatively skewed pattern, that of Minor carps bimodality and 'Others' a rather positively skewed distribution.

Spawn quality derived from rearings

Table JM9-24 depicts the species composition as revealed by rearing in respect of Floods III and IV which contributed 79.5% of the total seasonal catch. 77 specimens in one sample from State nursery at Naini, where spawn of Floods III and IV was released, showed Major carps to be 94.8% which consisted of 55.8, 23.3 and 15.7% of Catla, Rohu and Mrigal respectively.

Table JM9-24

Percentage distribution of spawn quality as determined from ditch rearings for two major Floods III and IV

Flood No.	Sample No.	size	Nursery No.	PERCENTAGE OF C.catla.	L.rohita	C.mrigala	L.calbasu	Total Major carps	Minor carps	Others
1	2	3	4	5	6	7	8	9	10	11
III & IV	1	77	State Nursery 1	55.8	23.3	15.7	-	94.8	5.2	-
IV	1	98	2	16.3	25.5	2.0	-	43.8	56.2	-
	21166		3	26.9	21.8	23.8	0.8	73.3	26.4	0.3
Weighted average				21.5	23.7	12.9	0.4	58.5	41.3	.2

In case of Flood IV the date of release of spawn in a nursery at Mahewa and Sobatiabagh nursery at Allahabad was August 22. The nursery of Mahewa got inundated due to heavy rains and when netted out only 98 specimens could be obtained. This sample showed 43.8% Major carps. The second sample of reared fingerlings which was from Sobatiabagh nursery contained 1166 specimens and showed Major carps to be 73.3%(Catla 26.9, Mrigala, 23.8, Rohu 21.8 and Calbasu 0.8 percent).

The probable reasons for the incompatibility of spawn quality as shown by analysis of spawn and reared samples presented in Tables JM8-23 and JM9-24 respectively, might be underestimation of Major carps content at spawn stage and differential mortalities among fish species in nurseries.

Filtered off Associates.

Associates' quantity in relation to floods.

Table JM10-25 presents the catch per net per day of filtered off Associates over the duration of Floods I to VI and of the periods intervening the successive floods. This table further depicts Associates' catch according to net type showing that Associates were captured by Midnapore nets in much greater quantities than in the departmental nets. It is also observed that with the advancement of monsoon the Associates' abundance greatly declined.

Table JM10-25

Catch per net per day of Associates in numbers

Flood No.	MIDNAPORE NETS			D
	M1	M2	M1-2	
1	2	3	4	5
I	73.1	26.4	62	55
II	1130.4	229	295	564
Period between Floods II&III	513	-	-	204.7
III	96	142	-	50.4
IV	3	-	Negligible	5
Period between Flood IV&V	-	-	-	-
V	266	-	-	32.5
VI	4.3	-	-	3.1
Post-Flood-VI period	27.6	-	-	32

Associates' quality in relation to floods

The analysis of the occurrence of 48 species of fish and prawns in the two-hourly collections in nets of different meshes during the periods of availability(A) and non-availability(A)

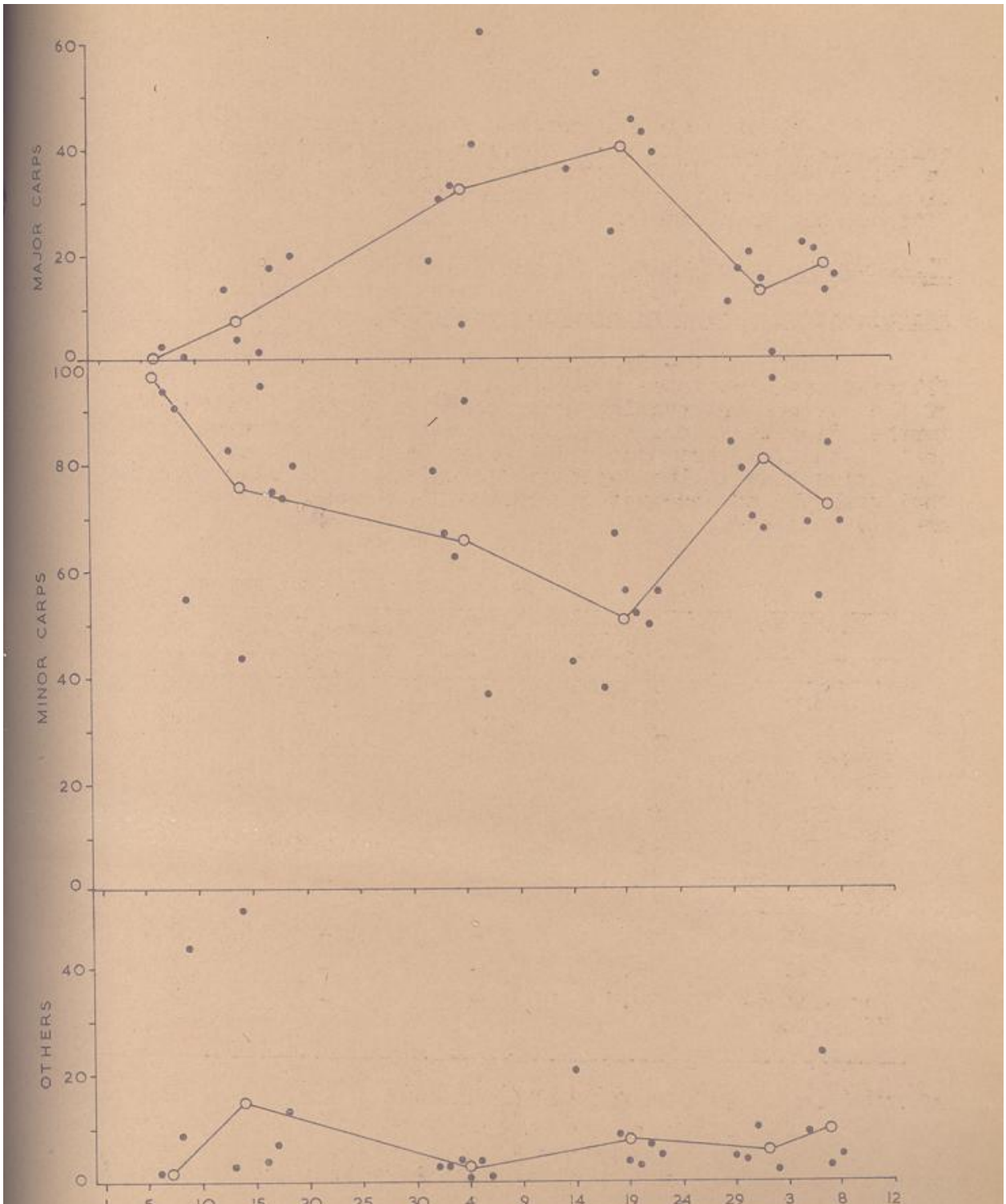

FIG. JM 5-13 — DISTRIBUTION OF PERCENTAGE CONTENT OF 'MAJOR CARPS', 'MINOR CARPS' AND 'OTHERS' IN DIFFERENT FLOODS ALONG-WITH THEIR DAILY SCATTER.

of spawn, in different floods and periods intervening the floods showed the following results.

In Flood I prawns and fish formed 43.8 and 56.2% of the Associates in spawn availability period and 51.9 and 48.1% in spawn non-availability period. In both the periods Puntius ticto was the dominant species (36.0 and 16.3%) followed by Ambassis ranga (4.8 and 8.9%) and Glassogobius giuris (3.7 and 8.9%). A total of only 7 species of fish were recorded as Associates in the flood.

In Flood II Prawns formed 47.0 and 45.7% of the Associates' catches in periods A and Ā respectively. The dominant fish species was R.corsula which formed 20.2% and 17.4% in the periods of spawn availability and non-availability in this flood. In the intervening period between Floods II and III, prawns were greatly reduced and the mullet R.corsula gained further in dominance to 47.6% and 44.6% of the catch of Associates. The total number of species of fish Associates in Flood II were 31 and 23 in periods A and Ā respectively.

In subsequent floods Prawns were of no consequence among the Associates. Predatory species like S.silondia(22%) and N.notopterus(20%) and A.coila(12%) were the dominant species.

During Flood IV the variety of species dwindled to 12 and 3 during the period of spawn availability and non-availability respectively. Predatory fishes e.g. S.silondia(22%) N.notopterus(20%) and A.coila(12%) were very common in the collections whereas R.cotio(12%) and P.filamentosus(6%) were also not unimportant.

The Associates were completely absent during the period intervening Floods IV and V and were available only in the period of spawn availability during Floods V and VI and also later. During Flood V, Prawns were completely absent and the dominant species found as filtered off Associates were C.reba (27.2%), L.rohita (25.4%) and R.rita (20.1%). In Flood VI, R.corsula again featured prominently (48.0%). Prawns were few (4%) in this flood. In the post-Flood-VI period it was observed that Cyprinids e.g. P.sophore (24%), C.reba (15%), P.ticto (9.6%), L.bata (9.6%), C.mrigala (8.4%), L.calbasu (4.8%) were of major importance among the Associates.

Gut contents of Associates

The relative abundance of spawn (s) fish matter(f), Plankton(P), prawn(p), insect matter(i), and debris(d) found in the guts of 48 species of Associates in the period of availability (A) and non-availability(Ā) of spawn in different floods and periods intervening the successive floods showed that during the periods A spawn itself was the chief food item followed by prawn in all fishes, and during non-availability period (Ā) prawns were dominant closely followed by spawn. It appears that Associates devoured all the food whatever came in their way. But in Flood V and in the later period the carp fry were found to have a preference for debris and plankton. On the days of spawn availability the stomachs of Associates were found fully gorged with entire or semidigested carp fry suggesting that the feeding had taken place in the tail pieces of nets.

NET SELECTIVITY

Net selectivity of spawn

Table JM11-26 presents catches taken by Midnapore nets of three meshes(1/8", 1/16" and 1/8-1/16") and the State Department nets of a single mesh called here M_1, M_2, M_{1-2} and D respectively.

Table JM11-26
Total spawn catch in ounces by different nets

Flood No.	Total Catch in ozs. in M1 (1/8")		M2 (1/16")		M1-2(1/8 - 1/16")		D	
	Catch	No.of nets.	Catch	No.of nets	Catch	No. of nets.	Catch	No.of nets.
1	2	3	4	5	6	7	8	9
I	nil	6	1.2	5	nil	1	1.5	15
II	52.8	26	6.0	2	5.2	2	33.0	42
Period between Floods II & III	0.6	3	-	-	-	-	0.4	12
III	60.4	22	0.8	1	-	-	3.6	25
IV	442	28	62	5	65.6	5	16.0	11

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1	2	3	4	5	6	7	8	9
Period between Floods IV & V	17.5	10	1.0	1	1.2	1	0.3	7
V	29.7	13	4.6	3	5.0	3	1.0	7
VI	4.0	7	-	-	-	-	1.2	7
Post-Flood-VI period	1.3	5	-	-	-	-	0.5	5

The catch per net per hour derived from data presented in Table JM13-30 has been shown in Table JM12-27 further split up into catches taken in day (6 A.M. to 6 P.M.) and night (6 P.M. to 6 A.M.).

Table JM12-27

Spawn catch (by numbers) per net per hour of different nets

Flood No.	Catch per net per hour by number							
	M1		M2		M1-2		D	
	Day	Night	Day	Night	Day	Night	Day	night
1	2	3	4	5	6	7	8	9
I	-	-	83	116	-	-	39	44
II	936	764	859	1354	781	1146	295	359
Period between Floods II & III	-	167	-	-	-	-	-	28
III	1118	1150	-	625	-	-	61	57
IV	7195	5833	5250	4485	5167	5073	492	757
Period between Floods IV & V	875	583	833	-	521	-	69	-
V	1058	843	625	695	695	695	-	119
VI	476	-	-	-	-	-	149	-
Post-Flood-VI period	207	-	-	-	-	-	83	-

The ratio of catch per net per hour between Departmental and Midnapore nets of different meshes in different floods is shown in Table 13-28. The ratio between Departmental and Midnapore nets as a whole works out to be 1:2.5 in Flood I; 1:3 in Flood II; 1:9 in Flood III; 1:9.3 in Flood IV; and 1:7.7 in Flood V and 1:3 in Flood VI.

Table JM13-28

Ratio of Spawn catch between Midnapore and Departmental Nets

Flood No.	Ratio of spawn catch between Deptl. net.	Midnapore Nets		
	D	M1	M2	M1-2
1	2	3	4	5
I	1	-	2.5	-
II	1	2.7	3.7	3.0
III	1	11.0	7.0	-
IV	1	10.8	8.7	8.5
V	1	9.0	6.0	7.5
VI	1	3.0	-	-

With a view to study catching efficiencies of nets during all floods (drawn by weighing averages of spawn catch of all floods of nets M_1, M_2, and M_{1-2} and D, the State Department net was taken as standard (Unit = 1) and the relative catch of other nets was mentioned therewith. The generalized catching efficiencies of nets may thus be placed as shown in Table JM14-29.

Table JM14-29

Catching efficiencies of nets

Departmental Net. D	Midnapore Nets M1	M2	M1-2
1	2	3	4
1	7.3	5.4	6.1
0.01	1	0.74	0.83
0.02	1.4	1	1.1
0.02	1.2	0.9	1

Thus 1/8" meshed Midnapore nets were on the average about 7 times more efficient than the Departmental nets and 1/16" and 1/8"-1/6" meshed Midnapore nets, which do not mutually differ significantly, were 5½ - 6 times more efficient than the State Department nets.

The significance of observed difference in catching efficiencies of nets M_1, M_2, and M_{1-2} meshes were statistically tested for the dates August 20, 21, and 22 in Flood IV by applying the 't' test criterion, which gave the following results :

M_1M_2t	=4.80 on 70 d.f.	$p < 0.01$	(Highly significant)
$M_1M_{1-2}t$	=0.18 on 70 d.f.	$p > 0.5$	(Not significant)
$M_1M_{1-2}t$	=4.80 on 70 d.f.	$p < 0.01$	(Highly significant)

From the above it is inferred that difference in the catching efficiencies of M_1 and M_2 and M_1M_{1-2} are highly significant and M_2 and M_{1-2} are not significant.

Net selectivity of Associates

Table JM 15-30 shows catch per net per hour of Associates in different nets during the entire season separately shown for day and night hours. In Floods I and II and period intervening Floods II and III the Associate content of Midnapore nets is approximately 2.5 to 3 times more than of Departmental nets. In Floods III, V and VI the Associates caught in Midnapore nets were 5.8 and 1.4 times respectively more than the Associate contents of State nets. In Flood IV the Associates caught by Midnapore nets were less than those State Department nets.

Table JM15-30

Associate catch in number per net per hour.

Flood No.	Catch per net per hour in numbers							
	M1		M2		M1-2		D	
	Day	Night	Day	Night	Day	Night	Day	Night
1	2	3	4	5	6	7	8	9
I	2.6	3.5	1.1	1.1	4.6	0.5	2.6	2
II	41	56	11	7	12	12.6	24	47
Period between Floods II & III	5	38	-	-	-	-	9.4	8

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1	2	3	4	5	6	7	8	9
III	5	5	-	6	-	-	17	37
IV	Negligible	Negligible	-	-	-	-	Negli-gible	Negli-gible
Period between Floods IV & V	-	-	-	-	-	-	-	-
V	14	8	-	-	-	-	Negli-gible	-
VI	Negligible	Negligible	-	-	-	-	Negli-gible	Negli-gible
Post-Flood-VI period	2	-	-	-	-	-	3	-

Recommendations for spawn collection in the surveyed stretch of River Jamuna

In the 300 km long stretch of the River Jamuna extending from Musanagar in the west upto its confluence with Ganga in the East, the sites examined in detail for spawn prospecting investigations in 1964 were Musanagar, Augasi, Kishanpur, Mahewa and Mau (figure 1 Inset II). The sites successfully located, where great bulk of spawn was collected in the experiental nets, were at Kishanpur and Mahewa - Jamunapur. The reason for selecting these sites was the availability of relatively more favourable road and/or rail communications in addition to postal and telegraphic facilities. In as such as the abundant occurrence of major carps in concerned entire 300 km stretch of Jamuna covered in these investigations is extremely favourable for spawn availability. It is only the physical considerations of communications and transport which weigh in favour or against a particular site in this stretch of Jamuna. If a launch is available for transporting spawn, the site at Musanagar, which becomes inaccessible by road in monsoon, can be exploited with advantage. The Northern bank of Jamuna at the village Lilra and Dewlan, about 2 km from Augasi, presents a good collections site and, with the metalling of the present fair weather road from Fatehpur to Augasi ghat, now under way, Dewlan centre would become

approachable for spawn collection even if there is no motorised water transport. The ravinous terrain at Mau presented no suitable spawn collection ground.

Exemplified by actual demonstration of copious spawn yield of excellent quality at Kishanpur and Mehawa-Jamunapur, the stretch of the River Jamuna from Musanagar to its confluence with Ganga is recommended for spawn collection. As flood and consequent hydrographical condition change from year to year such precautions as are stated in 'Discussions and conclusions' relevant to spawn collection in this report should, however, be exercised for successful spawn collection.

V C. TAJPUR (MORADABAD) ON RIVER RAMGANGA

ABSTRACT

During spawn prospecting investigations from July 1 to September 9, 1964, a total of 744 ozs of spawn, estimated at over seventy lakhs of hatchlings, were collected from the River Ramganga at Tajpur in eight spawn collection nets. Out of the four major floods that occurred in Ramganga in 1964, only the first flood yielded the entire spawn collected in the season. 29.7% of the total spawn was collected in the rising phase of the flood. Maximum spawn collections were made during day hours when 222 ozs were taken between 14 to 16 hrs on July 8. Spawn analysis revealed a very low percentage of major carps in the collections, ranging between 0.09 to 6.9. Nursery-reared samples too ratified a low major carp content in the samples. Statistical tests revealed that 1/8" meshed Midnapore nets were about thrice more efficient than State Department nets. Quantity and quality of Associates and their gut content analysis have been discussed.

LOCATION AND FACILITIES

The work-site at this centre is situated opposite to Moradabad city on the Eastern bank of the River Ramganga. The nearest habitation around the site, Tajpur village, situated 3 km North-East from the site, can be reached during pre-monsoon period by a cart-track. This village, having a post office but devoid of telegraphic and telephonic facilities, is linked with milestone IV from Moradabad on the Moradabadn Bareilly National Highway, by a metalled road. The nearest Railway station, Katghar (Right bank) on Northern and North-Eastern Railway, is about 9 km from the site, connected with the road across Ramganga by a rail-cum-road bridge. Between the village and the site a small seasonal tributary of Ramganga, the River Dhela, traverses eastwards and then taking a right angled turn at about half a mile North-East of the site, joins the Ramganga approximately 100 feet above

the bridge. The general location of the site and the topographical features of the river course are shown in Fig. RT1-14.*

OBSERVATIONS AND RESULTS

The regular two-hourly observations were started on July 1, 1964 and continued till September 9, 1964. Table RT1-32 depicts the average daily observations (6 A.M. to 4 A.M. of the following calender date) in regard to flood-level, turbidity, air and water temperatures, pH and Dissolved Oxygen together with the total catch of spawn in ounces for the entire period of observation.

Spawn quantity in relation to environmental factors

The date-wise total spawn catch at Tajpur centre, pertaining to the Departmental as well as Midnapore type nets, is shown in Fig.RT2-15 separately for each type of net. Table RT2-33 presents the flood-wise collection of spawn at Tajpur centre, also showing the hour of appearance of spawn in the river and the amount of spawn collected during different flood-phases.

A total of 744 ozs of spawn were collected from the river Ramganga at Tajpur in the entire period of observation from five State Department nets and three Midnapore type nets operated daily. It may be discerned from Table RT2-33 that out of the four major floods that occurred in Ramganga at Moradabad in 1964, only the first flood, prevailing for five days, yielded the entire spawn of the season. However, the second flood, that occurred on July 29, yielded 1.8 ozs of advanced fry. Of the total 744 ozs of spawn collected at this centre, the bulk of it (543 ozs) was collected only on one day i.e. July 8. The very first appearance of spawn was observed on July 6 at 18 hours which continued till 24 hrs of the same day after which the spawn completely disappeared. On July 7 at 10 hrs extremely rough weather prevailed and the nets had to be taken out for the day from water.

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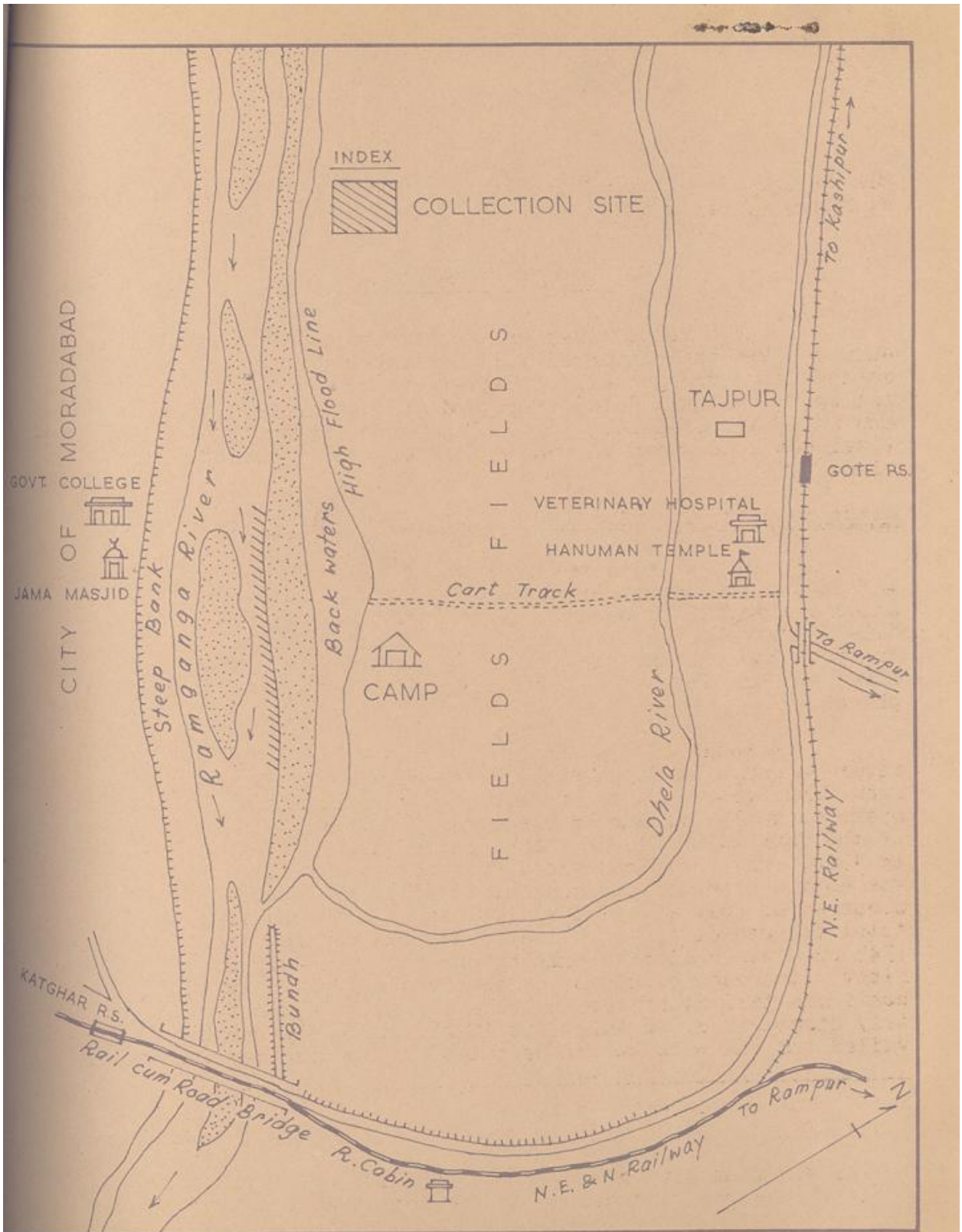
* 'R' stands for River Ramganga

'T' stands for Tajpur

The first number in the Tables and Figures depicts the number in the chapter and second in the report as a whole.



IG. RT1-14. THE RIVER COURSE, GENERAL TERRAIN AND TOPOGRAPHY OF RIVER RAMGANGA AT TAJPUR (MORADABAD).

Table RT1-32

Daily averages of flood level, turbidity, air and water temp., pH, D.O. and total spawn catch in the River Ramganga at Tajpur.

Date year 1964.	Flood level in metres.	Turbidity in p.p.m.	Air Temp. water temp in °C.	pH	D.O. in ppm.	Total catch of spawn in ozs.	Floodwise spawn in ozs and percentage in total
1	2	3	4	5	6	7	8
July							
1	0.09	400	30.6/30.6	7.6		-	-
2	0.27	550	30.5/30.1	7.6	6.1	-	-
3	0.22	440	29.8/29.5	7.6		-	-
4	0.11	347	29.2/29.2	7.6		-	-
5	0.19	270	28.4/28.3	7.9	5.7	-	-
6	0.23	500	31.4/31.0	7.6		23.3)	
7	0.66	500	26.6/27.2	7.6		-)	
8	0.63	500	26.7/27.3	7.9	5.3	543.0)	744.0 oz
9	0.49	630	27.9/28.8	8.0		126.7)	100%
10	0.20	500	27.9/28.9	7.7		28.3)	I flood
11	0.37	440	26.7/28.1	7.9	4.8	13.5)	
12	0.27	503	29.9/29.5	7.9		4.2)	
13	0.14	490	28.5/29.1	7.9		3.9)	
14	0.60	392	28.0/28.5	7.9	5.7	0.1)	
15	0.99	583	27.0/28.5	7.9		-	-
16	0.87	650	28.5/29.7	7.9		-	-
17	0.35	480	30.0/31.5	7.9	6.2	-	-
18	0.26	400	28.5/28.4	7.6		-	-
19	0.19	400	29.5/31.5	7.6		-	-
20	0.13	360	33.0/32.4	7.6	6.0	-	-
21	0.05	330	32.9/33.2	7.6		-	-
22	0.06	259	31.9/32.9	7.6		-	-
23	0.14	259	31.9/32.9	7.6		-	-
24	0.11	238	27.0/28.2	7.6		-	-
25	0.56	886	26.7/26.7	7.6		-	-
26	0.43	521	27.4/27.7	7.6	6.0	-	-
27	0.37	536	27.2/26.9	7.7		-	-
28	0.77	536	26.8/27.5	7.9		-	-
29	1.28	836	27.2/27.5	7.8	5.3	-	-
30	0.92	693	28.7/29.2	7.6		1.8 (adv.fry)	-

1	2	3	4	5	6	7	8
31	0.61	693	29.0/29.6	7.6	-	-	-
August							
1	0.39	529	30.0/28.5	7.6	5.7	-	-
2	0.40	527	31.0/30.5	7.4		-	-
3	0.43	451	30.9/30.5	7.6		-	-
4	0.36	449	30.7/30.9	7.3	4.8	-	-
5	0.33	349	29.1/28.7	7.3		-	-
6	0.70	499	26.6/28.0	7.3		-	-
7	0.74	564	30.4/30.5	7.6	5.3	-	-
8	0.55	474	31.7/31.1	7.4		-	-
9	0.53	500	30.7/31.5	7.6		-	-
10	0.49	521	29.3/30.7	7.6	5.7	-	-
11	0.47	464	29.2/31.0	7.4		-	-
12	0.53	461	29.1/29.8	7.3		-	-
13	0.45	440	30.6/30.6	7.6	5.3	-	-
14	0.48	266	27.7/29.9	7.6		-	-
15	0.80	700	27.1/28.3	7.4		-	-
16	0.65	520	29.2/30.2	7.6	6.2	-	-
17	0.71	550	27.0/28.7	7.6		-	-
18	0.71	621	28.7/29.5	7.6		-	-
19	0.65	457	30.5/30.6	7.6	5.9	-	-
20	0.66	446	30.9/31.5	7.6		-	-
21	0.68	461	28.8/30.0	7.6		-	-
22	0.74	443	29.7/30.4	7.6	6.0	-	-
23	0.71	380	28.0/29.5	7.6		-	-
24	0.79	443	28.7/30.0	7.6		-	-
25	0.85	501	28.8/32.6	7.7	6.3	-	-
26	0.80	497	29.6/30.1	7.6		-	-
27	0.77	430	29.4/28.1	7.6		-	-
28	0.74	416	29.3/30.6	7.6	6.1	-	-
29	0.65	417	30.0/31.0	7.6		-	-
30	0.64	469	28.9/30.7	7.6		-	-
31	0.79	431	26.2/28.2	7.6	5.7	-	-
September							
1	0.86	693	26.2/27.4	7.7		-	-
2	0.88	506	25.2/26.5	7.6		-	-
3	1.03	487	26.5/27.5	7.7	6.2	-	-
4	0.82	351	29.4/29.1	7.6		-	-
5	0.74	360	28.2/29.2	7.6		-	-

1	2	3	4	5	6	7	8
6	0.65	363	29.2/29.7	7.6	5.3	-	-
7	0.60	357	30.2/30.2	7.6		-	-
8	0.53	314	28.8/29.1	7.6		-	-
9	0.85	344	26.9/29.0	7.6	5.3	-	-

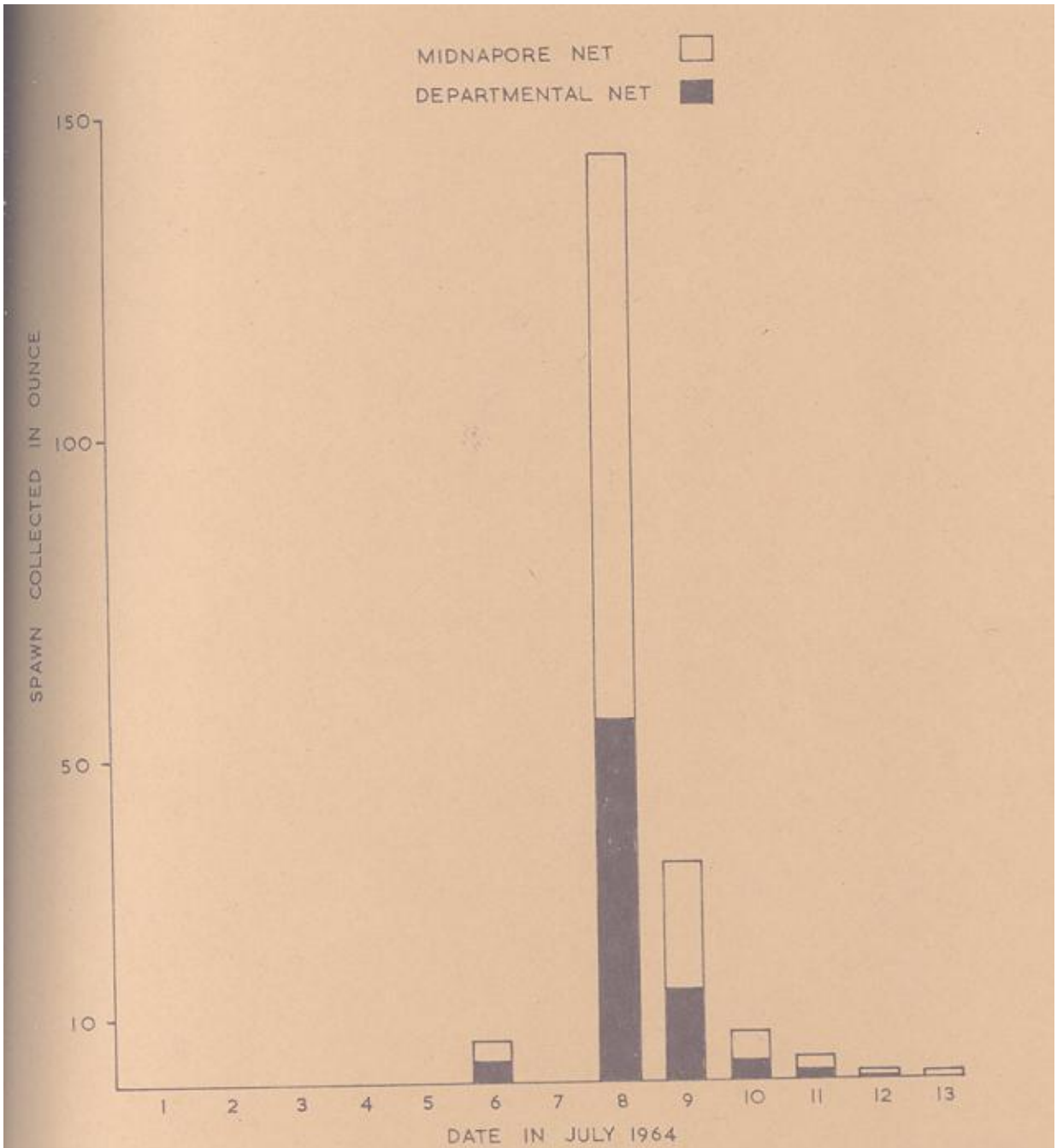


FIG. RT 2-15 — DATA-WISE SPAWN CATCH AT TAJPUR IN DEPARTMENTAL AND MIDNAPORE NETS.

Table RM2-33

Details of spawn collection in relation to different floods in Ramganga at Tajpur

Flood No.	Duration of flood in 1964		Flood peak			Commencement of spawn availability			Days of peak collection				Total catch of spawn in ozs			
	Rising phase	Receding phase	Date in 1964	Hour	Flood level in metres	Date in 1964	Hour	Flood level in metres	Date in 1964	Quantity in ozs: Day 6 A.M. to 6 P.M.	Night 6 P.M. to 6 A.M.	Total	Rising phase	Receding phase: Day 6 A.M. to 6 P.M.	Night 6 P.M. to 6 A.M.	Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
I	6/7 16 hrs to 8/7 14 "	8/7 16 hrs to 10/7 4 "	8/7	14	0.9	6/7	18	0.3	8/7	377.0	166.0	5.43	220.8	296.4	226.8	523.2
II	28/7 6 " to 29/7 16 "	29/7 18 " to 2/8 8 "	29/7	16	1.3	30/7	10	1.0	30/7	1.8 advanced fry	0.04 adv. fry	1.84	-	1.8	0.04	1.84
III	21/8 8 " to 25/8 16 "	25/8 18 " to 30/8 16 "	25/8	16	0.9	-	-	-	-	-	-	-	-	-	-	-
IV	31/8 12 " to 3/9 6 "	3/9 8 " to 9/9 8 "	3/9	6	1.2	-	-	-	-	-	-	-	-	-	-	-

The next crop of spawn could be harvested on July 8 from 6 hrs onwards. The intensity of spawn availability went on increasing, touching a maximum of 222 ozs of spawn between 14 to 16 hrs, a single 1/8" meshed Midnapore net, which happened to be placed at the very end, catching the maximum (69 ozs in 2 hrs) inspite of its rear-most position. However, from 18 hrs of July 8 a gradual decline in the intensity of spawn availability was observed which continued till July 14, on which day, the total spawn collected from all the eight nets amounted to 0.08 oz only. From July 15 the spawn completely disappeared never to show up again in the 1964 season. 296.5 ozs of spawn were collected in the day hours (6 A.M. to 6 P.M.) as against 226.8 ozs during the night hours (6 P.M. to 6 A.M.).

In the following paragraphs, the effects of various hydrodynamical, chemical, meteorological and hydrobiological factors, have been discussed.

Hydrodynamical characters

Flood level

Fig.RT3-16 shows the fluctuations in average daily flood level along with the amount of spawn collected. It is evident from Fig.RT3-16 and Table RT2-35 that 220.8 ozs of spawn were collected in the rising phase of the flood (from 18 hours of July 6 to 14 hrs of July 8). However, the bulk of the spawn (523.2 ozs) was collected in the receding phase.

Fig.RT3-16 shows as many as 12 rises in water level of Ramganga in the season. Out of these only four have been considered as major floods. The latter were gradual in rise and fall and were preceded by heavy rains in the catchment area. The rest of the 'floods' were abrupt, both in rise and fall, and may have a connection with localised heavy rain fall higher up or with snow-melt waters.

Current velocity

The average current velocity during the period of spawn availability was 1.3 km/hour ranging from 0.98 to 1.84 km/hour over the period July 6 to July 14. Owing to a combined effect of current direction in the first two floods, the topography of the collection site at Tajpur was so unfavourably transformed that it rendered the operation of nets difficult after the second flood. No spawn or advanced fry were, however, available after flood II.

Chemical characters

Turbidity

Fig.RT4-17 depicts the availability of spawn in relation to turbidity. During Flood I, in its spawn-bearing phase, turbidity ranged between 360 to 650 ppm. On the peak day of spawn collection i.e. July 8, the average turbidity value was 500 ppm. During the second major flood, that occurred on July 29, when average turbidity value touched 836 ppm, 1.8 ozs of advanced fry were collected. In the remaining two major floods, occurring on August 21 to 26 and August 31 to September 3, the average turbidity values ranged from 380 to 501 ppm and 431 to 693 ppm respectively but no spawn was available. Looking at these fluctuations in turbidity values, it may be stated that this factor has no direct bearing on the availability of spawn.

Hydrogen ion concentration

The pH ranged between 7.6 to 8.2 in the season. The pH of water, when spawn first showed up on July 6, was 7.6. This value went up to 7.9 and 8.2 on July 8 and 9 respectively when maximum spawn was available in the river. The second flood too, occurring on July 29 and yielding 1.8 ozs of advanced fry, brought about a relative increase in pH value. It can not be said with certainty whether the observed increase in pH was linked with the advent of spawn.

Dissolved oxygen

Observations on Dissolved Oxygen were recorded on every third day. Beofre the occurrence of the first flood, the D.O. was observed to be 6.1, later, with the appearance of the first flood, which yielded the entire spawn collected at this centre in 1964, the D.O. concentrations decreased ranging between 4.8 to 5.7 ppm in the duration of this flood. Its value in the remaining period ranged between 5.3 and 6.3 ppm.

Meteorological characters

The daily mean air and water temperatures covering all the four major floods that occurred in the River Ramganga at Tajpur along with the weather conditions, current direction and the daily spawn yield are shown in Table RT3-34.

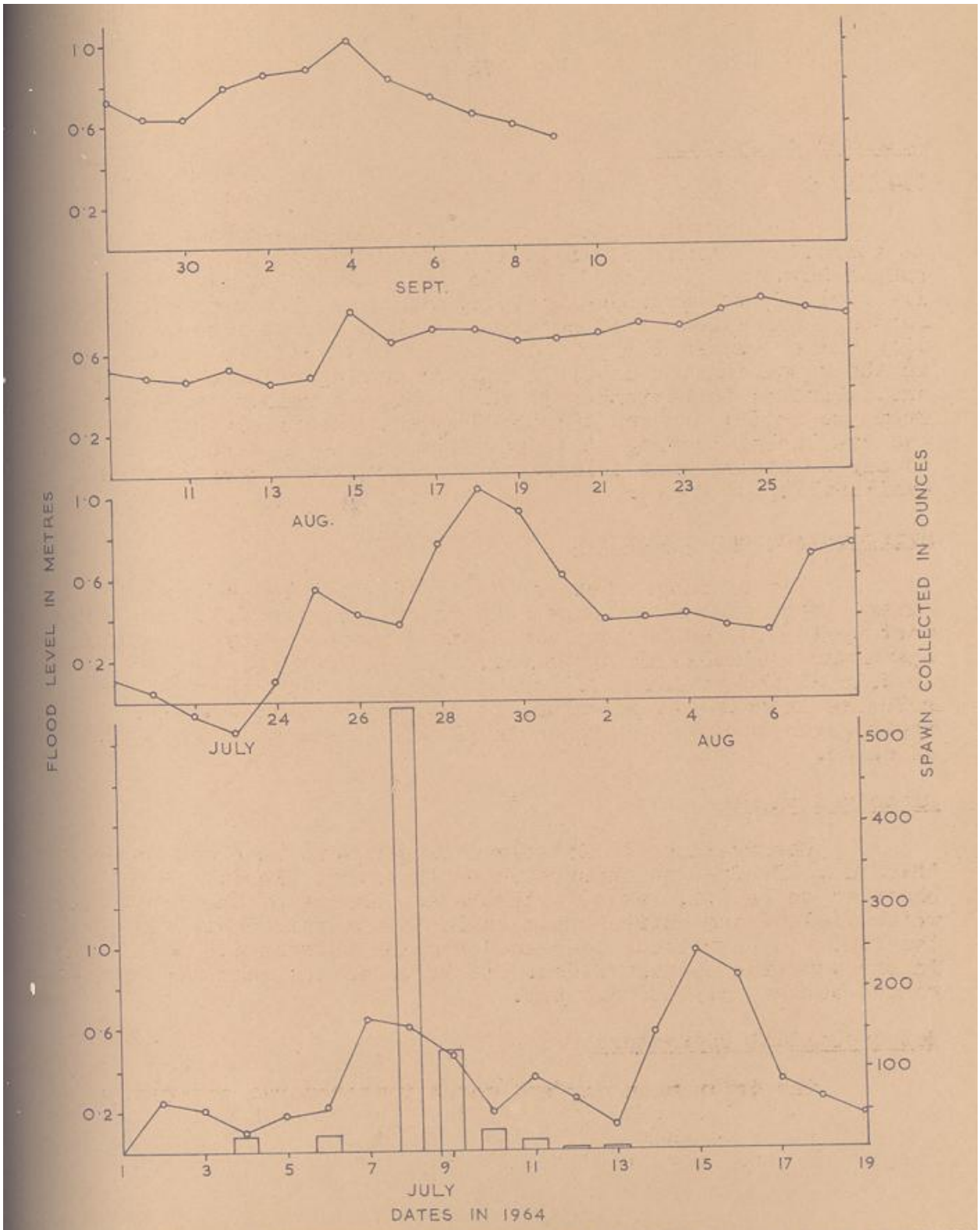


FIG. RT 3-16 — FLUCTUATIONS IN AVERAGE DAILY FLOOD LEVEL OF RIVER RAMGANGA AT TAJPUR WITH SPAWN QUANTITY SUPERIMPOSED ON THE DAYS OF AVAILABILITY.

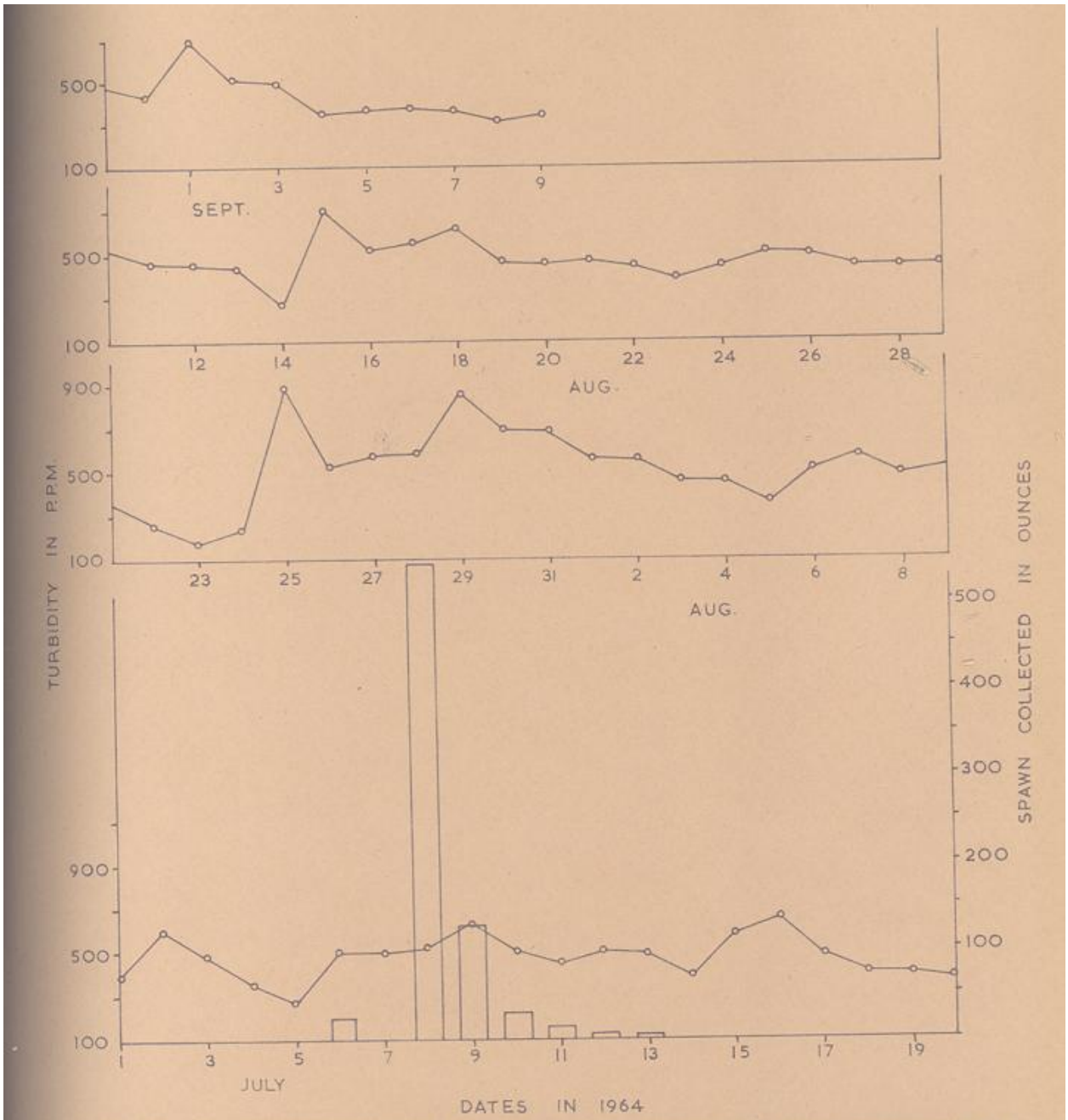


FIG. RT 4-17 — FLUCTUATIONS IN AVERAGE DAILY TURBIDITY OF RIVER RAMGANGA AT TAJPUR WITH SPAWN QUANTITY SUPERIMPOSED ON THE DAYS OF AVAILABILITY.

Table RT3-34

Daily arithmetic or modal averages of meteorological characters for relevant days in different floods along with spawn catch and current direction in Ramganga at Tajpur (Moradabad)

Date in 1964	Flood		Quantity of spawn collected in ozs	Temperature in centigrade		Weather condition			Current direction from North in degree
	No.	Phase		Air	Water	Sky	Wind speed	Wind direction from North in degree.	
1	2	3	4	5	6	7	8	9	10
July									
4			-	29.2	29.2	Fair	High	90	314
5				28.4	28.3	Rainy	High	90	320
6		)	23.3	31.4	31.0	Rainy	Stormy	90	300
7		)Rising		26.6	27.2	Rainy	Stormy	90	300
8	14 hrs	)	543.0	26.7	27.3	Rainy	Stormy	90	320
9	I	)Receding	126.7	27.9	28.8	Rainy	Stormy	90	320
10		)	28.3	27.9	28.9	Cloudy	High	90	320
11			13.5	26.7	28.1	Rainy	High	90	320
12			4.2	29.9	29.5	Fair	High	90	320
13			3.9	28.5	29.1	Cloudy	Gentle	90	320
14			0.1	28.0	28.5	Rainy	Gentle	90	310
28		)Rising	-	26.8	27.5	Cloudy	High	270	310
29		)	-	27.2	27.5	Cloudy	Gentle	270	319
30	II	)	-	28.7	29.2	Cloudy	High	270	337
31		)	-	29.0	29.6	Fair	Gentle	270	340
August		)							
1		)Receding	-	30.0	28.5	Fair	Gentle	270	340
2		)	-	31.0	30.5	Fair	Gentle	270	337
21		)	-	28.8	30.0	Cloudy	Gentle	90	330
22		)	-	29.7	30.4	Cloudy	Gentle	90	330
23		)Rising	-	28.0	29.5	Cloudy	Gentle	90	330
24		)	-	28.7	30.0	Cloudy	Gentle	90	330
25	III	)	-	28.8	32.6	Cloudy	Gentle	90	330
26		)	-	29.6	30.1	Cloudy	Gentle	90	338
27		)Receding	-	29.4	28.1	Cloudy	Gentle	90	336

1	2	3	4	5	6	7	8	9	10
28			-	29.3	30.6	Cloudy	Gentle	90	335
29			-	30.0	31.0	Cloudy	Gentle	90	326
30			-	28.9	30.7	Cloudy	Gentle	90	331
31			-	26.2	28.2	Cloudy	Gentle	90	341
September									
1			-	26.2	27.4	Cloudy	Gentle	90	341
2		Rising	-	25.2	26.5	Cloudy	High	90	342
3			-	26.5	27.5	Cloudy	Gentle	90	344
4			-	29.4	29.1	Fair	Gentle	90	335
5	IV		-	28.2	29.2	Fair	High	270	329
6		Receding	-	29.2	29.7	Fair	High	270	330
7			-	30.2	30.2	Fair	Gentle	270	343
8			-	28.8	29.1	Fair	Gentle	270	341
9			-	26.9	29.0	Fair	Gentle	90	341

The average air and water temperatures for the period July 2 to 4 (pre-spawning), July 5 to 7 (heavy spawning), July 8 to 14 (spawn availability period) and July 15 to 17 (post spawn availability period) are shown in Table RT4-35 in regard to Flood I.

Table RT4-35

Average Air and Water temperatures in pre-spawning, Heavy spawning, spawn-availability and post spawn-availability periods.

Period Identity	Dates in 1964	No.of days	Average temperature in °C	
			Air	Water
Pre-spawning	Jul.2 to Jul4	3	29.8	29.6
Heavy spawning	Jul.5 to Jul.7	3	28.8	28.8
Spawn availability	Jul.8 to Jul.14	7	27.9	28.6
Post spawn-availability	Jul.15 to Jul.17	3	28.5	29.9

Spawn appeared at Tajpur in two spurts in Flood I, the first falling at 18 hrs on July 6 and the second, a bumper one, at 6 hrs on July 8 continuing upto July 14. It is safe to presume that breeding commenced a couple of days or so before July 6 and heavy breeding took place on July 6 yielding great bulk of spawn from July 8 onwards. Observations on air and water temperatures from July 2 to 14 appear to be significant (Table RT4-35). The average air and water temperatures from July 2 to 4 were 29.8°C & respectively. On July 5, the average air and water temperatures were lower, being 28.4°C and 28.3°C respectively. On July 6, the maximum air and water temperautres were 34.5°C at 14 hrs and 32.5°C at 16 hrs. With the first really heavy downpour of the season on that day, the air and water temperatures fell down to 29.0°C and 30.0°C at 16 hrs, recording a further fall to 27.0°C and 26.5°C at 18 hrs. Heavy breeding must have occurred on July 6 resulting in the availability of large quantity of spawn on July 8. The average air and water temperatures in the spawn availability period (July 8 to 14) were 27.9°C and 28.6°C and on the three following days 28.5°C and 29.9°C respectively, reaching about the same level as in the pre-spawning period. The above stated chain of events are graphically depicted in Fig.RT5-18.

The wind direction mostly remained at 90° (Easterly). Wide fluctuations in current direction ranged from 300 to 342°N. During peak spawn availability the average current direction was observed to be 314°N.

Hydrobiological characters

Table RT5-36 shown average plankton density in numbers per litre and average catch in numbers of the spawn associates separately for the spawn availability and non-availability periods. The plankters ranged from 1.2 to 11.8 per litre in the season. Before the first flood, the plankters ranged from 10.2 to 11.8 units/litre. With the flooding of the river, they ranged only between 1.2 to 2.8 units/litre. The spawn associates were observed to follow a definite pattern. In the peak spawn availability period the average catch per day of spawn associates was 2033. With the decline in the intensity of spawn availability, the Associates too, showed a gradual decline occurring in greatly diminished numbers in the remaining floods. In the last major flood their average daily number was reduced to only 3. The qualitative abundance of spawn-associates has been dealt with later in this report.

Table RT5-36

Flood-wise quantitative abundance of plankton and spawn-associates split up into days of spawn-availability and otherwise

Flood No.	Dates in 1964	Average plankton density in numbers per litre.		Average catch per day of spawn associates in nos.	
		On days of spawn availability.	Otherwise	On days of spawn availability.	Otherwise
I	Jul.6 to Jul.10	6.9	-	2033	-
Period between I & II Flood.	Jul.11 to Jul.27	2.4	3.3	354	181
II	Jul.28 to Aug.2	-	2.0	-	286
Period between II & III Flood	Aug.3 to Aug.20	-	1.3	-	146
III	Aug.21 to Aug.30	-	0.9	-	12
IV	Aug.31 to Sept.9	-	0.7	-	3

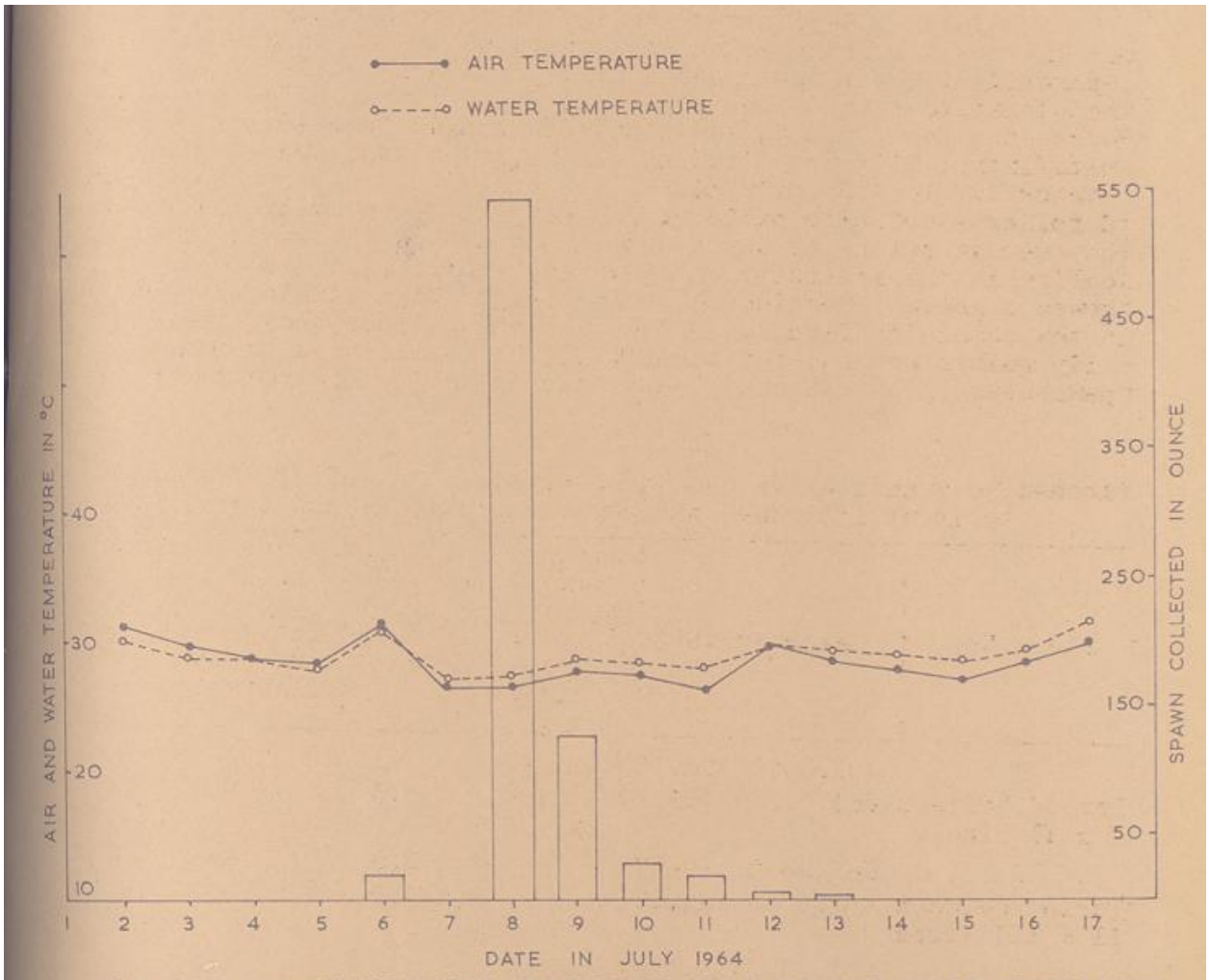


FIG. RT 5-18 — FLUCTUATIONS IN AVERAGE DAILY AIR AND WATER TEMPERATURE AT TAJPUR WITH SPAWN QUANTITY SUPERIMPOSED ON THE DAYS OF AVAILABILITY.

Spawn quality in relation to environmental factors

Spawn quality derived from spawn-analysis

The flood-wise percentage distribution of major carps, minor carps and 'Others' has been presented in Table RT6-37 showing two hourly spawn analysis. Column 17 of this Table depicts the arithmetic mean of percentage of two-hourly samples of the day (6 A.M. to 4 A.M. of the next calender date). Spawn quality, as estimated from the analysis of these samples, is discussed in the following paragraphs. It is evident from Table RT6-37 that only the first flood yielded spawn. No spawn appeared in the river in subsequent floods.

Flood I: Spawn was available during this flood from July 6 to July 14 in two spurts, the first spurt commencing at 18 hrs on July 6 and ending at 24 hrs of the same day. The second spurt, of a larger duration, showed up forst at 6 hrs on July 8 and continued till 10 hrs. of July 14. The analysis of the two hourly spawn samples revealed a very low percentage of major-carps. The average daily major-carp percentage ranged between 0.09 to 6.9. The percentage of minor carps was observed to be consistently very high, having a daily average of 59.8 on July 6 and cent percent on July 14. Out of a total of 70 two-hourly samples examined, only 34 showed major carp content (0.09-6.9%). The highest major carp percentage (29.0) was encountered in the collection at 24 hours on July 8, the day of peak collection. The spawn samples contained a relatively low percentage of occurrence of 'Others', their daily average percentage ranging from 0.27 to 37.0.

Table RT7-38 depicts the distribution of major and minor carps and 'Others' during Flood I, having been derived by weighing each day's percentage (column 17 of Table RT6-37) with corresponding spawn catch. Fig.RT6-19 shows the fluctuations in spawn quality as the percentage of daily average ever the days of spawn availability. The spawn availability was spread over a period of 7 days during Flood I and the spawn quality was observed to decline with the ebbing of the flood which is clearly brought out in Fig. RT6-19 by the relatively high percentage of major carps in the first three days of the flood, notwithstanding spawn quantity. An analysis of Fig.RT6-19 shows a rather positively skewed distribution of major carps and 'Others' and a flat-topped curve (indicating a more or less uniform occurrence) in respect of minor carps. Fig.RT7-20 shows the two-hourly distribution of major carps as observed on July 8, indicating the maximum occurrence of major carps at 24 hrs on that day.

Table RT6-37

Floodwise percentage distribution of Major and Minor carps and others in two-hourly spawn samples from Ramganga at Tajpur

Flood Phase	Date in 1964	Percentage of	HOURS OF OBSERVATION 6	8	10	12	14	16	18	20	22	24	Q2	Q4	Average % age for the day
2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
		(MJ	-	-	-	-	-	-	1.5	5.0	1.5	5.6	-	-	3.4
Rising	Jul.6	(Mi	-	-	-	-	-	-	63.5	76.0	63.5	34.4	-	-	59.8
		(O	-	-	-	-	-	-	35.0	19.0	34.0	60.0	-	-	37.0
		(MJ	3.8	7.1	3.6	2.0	8.0	9.0	5.0	7.0	5.9	29.0	-	2.0	6.9
Peak	Jul.8	(Mi	91.2	80.9	86.4	98.0	92.0	91.0	95.0	93.0	93.1	71.0	98.0	98.0	90.6
		(O	5.0	12.0	10.0	-	-	-	-	-	1.0	-	2.0	-	2.5
		(MJ	2.0	1.0	2.0	-	1.0	-	3.8	12.7	2.0	2.0	-	-	2.2
	Jul.9	(Mi	98.0	99.0	98.0	100.0	99.0	100.0	92.2	77.3	98.0	98.0	100.0	95.0	96.2
		(O	-	-	-	-	-	-	4.0	10.0	-	-	-	5.0	1.6
		(MJ	-	1.0	2.0	2.0	1.6	1.0	-	-	3.4	6.5	-	-	1.5
I	Jul.10	(Mi	97.0	99.0	98.0	98.0	78.4	99.0	87.0	90.0	78.6	85.5	91.0	60.0	88.4
Receding		(O	3.0	-	-	-	20.0	-	13.0	10.0	18.0	8.0	9.0	40.0	10.1
		(MJ	-	0.9	-	-	6.1	2.0	-	-	-	-	-	-	1.0
	Jul.11	(Mi	92.0	89.1	86.0	80.0	78.9	98.0	80.0	-	100.0	76.0	-	-	86.7
		(O	8.0	10.0	14.0	20.0	15.0	-	20.0	-	-	24.0	-	-	12.3
		(MJ	-	-	-	-	-	-	-	-	-	-	-	-	-
	Jul.12	(Mi	-	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	-	-	-	100.0
		(	-	-	-	-	-	-	-	-	-	-	-	-	-
		(MJ	-	-	-	-	-	-	-	-	-	-	1.0	-	0.09
	Jul.13	(Mi	100.0	100.0	100.0	100.0	100.0	-	100.0	97.0	100.0	100.0	100.0	100.0	99.64
		(O	-	-	-	-	-	-	-	3.0	-	-	-	-	0.27
		(MJ	-	-	-	-	-	-	-	-	-	-	-	-	-
	Jul.14	(Mi	100.0	-	100.0	-	-	-	-	-	-	-	-	-	100.0
		(O	-	-	-	-	-	-	-	-	-	-	-	-	-

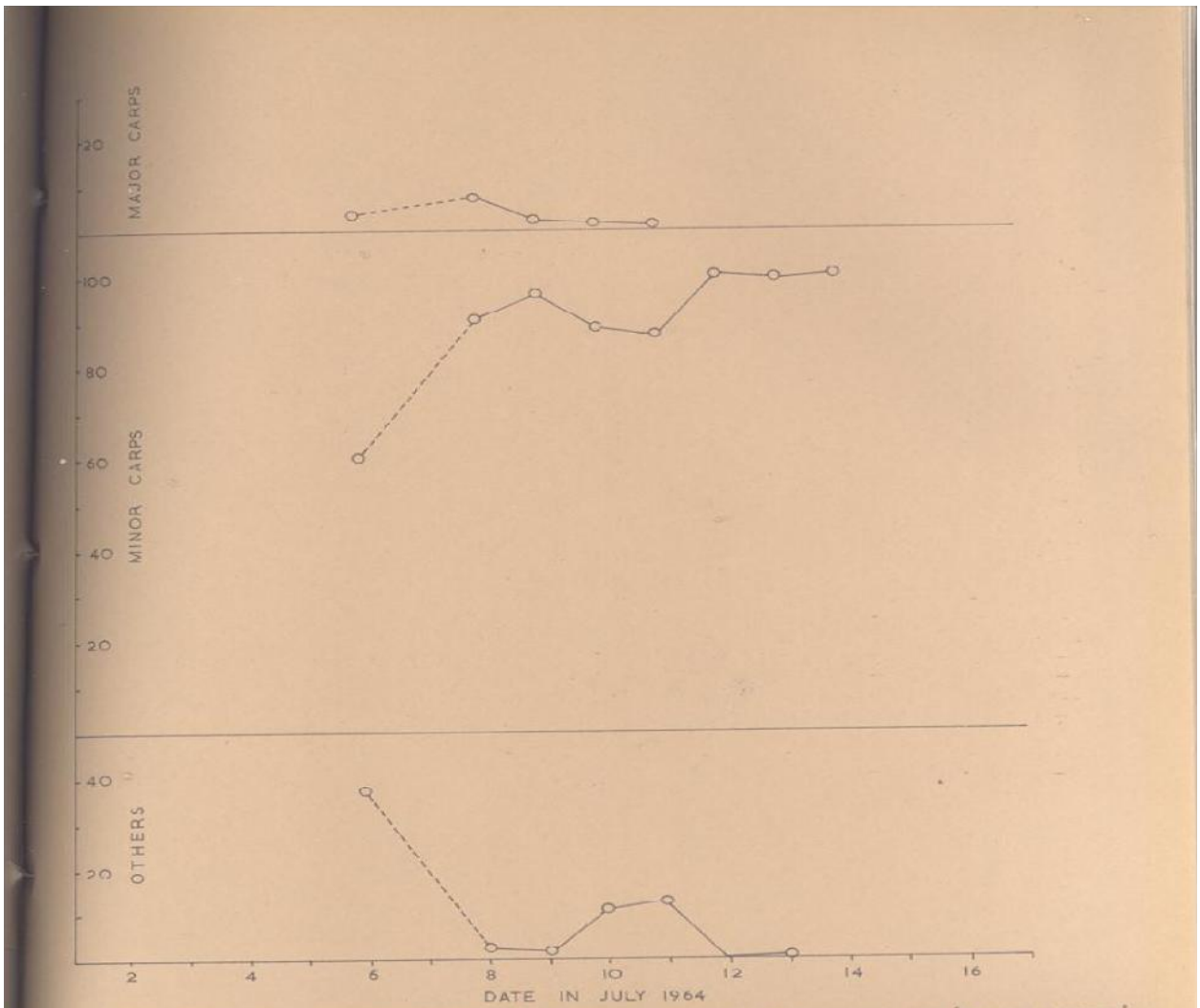


FIG. RT 6-19 — FLUCTUATIONS IN SPAWN QUALITY IN RESPECT OF 'MAJOR CARPS', 'MINOR CARPS' AND 'OTHERS' SHOWN AS PERCENTAGES OF DAILY AVERAGE OVER THE DAYS OF SPAWN AVAILABILITY.

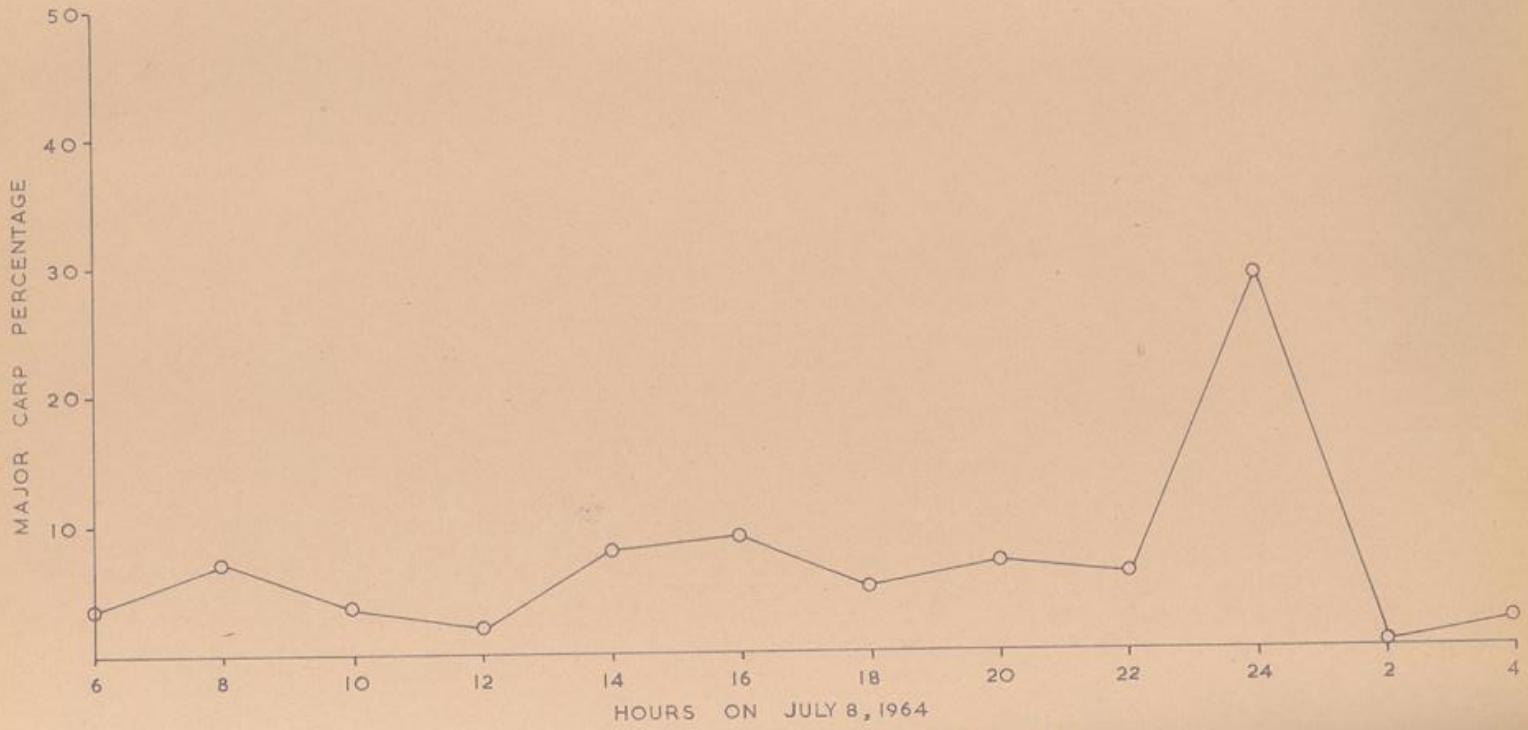


FIG. RT 7-20 — TWO-HOURLY DISTRIBUTION OF MAJOR CARPS ON JULY 8.

Table RT7-38

Flood-wise percentage distribution of spawn quality determined from spawn samples

Flood No.	PERCENTAGE OF Major carps	Minor carps	Others
I	1.8	90.2	8.0

Spawn quality derived from rearing

Table RT8-39 presents the species composition as determined by the analysis of samples drawn from the nursery and earthen gamlas. A combined total of 1450 specimens in five samples showed 2.8% major carps, 96.7% minor carps and 0.5% 'Others'. The major carps comprised 2.0, 0.6 and 0.2 percent Rohu, Calbasu and Mrigal respectively. The minor carps were dominated by Labeo bata (81.1%) and Labeo pangusia (11.8%). It was observed that the samples reared in 'gamlas' differed from those drawn from the State nursery in their species composition. In the samples from 'gamlas', the percentage of Cirrhina reba was highest (54.4) followed by Laboe bata (19.2) and Labeo pangusia (12.4). In the gamla-reared sample the percentage of major carps was also found to be higher (8.4) as compared to that drawn from State nursery (2.3). This can possibly be explained by the fact that the spawn samples reared in gamlas were drawn from July 8 collections when (as also confirmed by two-hourly analysis of spawn samples) the maximum percentage of major carps (6.9) was collected, whereas the collection released in State nursery was an admixture of the spawn collected on July 8, 9 and 10, provisionally stored in hapas fixed in the river.* It is probable that there had been definite spawning spurts of different species and the spawn collected on July 8, comprised a greater percentage of Cirrhina reba and major carps than on the following days.

* Collections of July 8 to 10 were lifted from hapas by State Department personnel on July 10 at about mid-day.

Table RT8-39

Percentage distribution of spawn quality as determined from rearing experiments for one major flood

Flood No.	Sample No.	Sample Size	Nursery No.	PERCENTAGE OF MAJOR CARPS: C.catla	L.rohita	C.mrigala	L.calbasu	Total	Minor carps	Others
I	1	250	1	-	5.6	0.8	2.0	8.4	91.6	-
	2	480	2	-	2.7	0.05	0.09	2.84	96.26	0.9
	3	200	1	-	0.5	-	1.0	1.5	98.5	-
	4	290	2	-	0.2	-	-	0.2	98.1	1.7
	5	230	1	-	1.3	-	-	1.3	98.7	-
WEIGHTED AVERAGE				-	2.0	0.2	0.6	2.8	96.7	0.5

In column 4 No.1 represents samples from earthen gamlas
No.2 " " " State Nursery.

Filtered off Associates

Associates' quantity in relation to floods

Table RT9-40 presents the catch per net per day of filtered off Associates during the four major floods that occurred in Ramganga and the period intervening the successive floods. This table also pinpoints the relative abundance of Associates in Midnapore and Departmental nets. Throughout the season, Midnapore nets captured Associates in greater quantities. The table further shows that with the advancement of monsoon the Associate abundance gradually declined.

Table RT9-40

Catch per net per day of Associates in numbers

Flood No.	Midnapore Nets. M1	M2	M1-2	Departmental nets
1	2	3	4	5
I	295	245	221	91
Period between I & II Flood	192	144	168	36

1	2	3	4	5
II	231	-	-	56
Period between II & III Flood	142	-	-	5
III	10	-	-	2
IV	13	-	-	2

Associates' quality in relation to floods

The percentage occurrence of Associates was divided into period of spawn availability (A) and non-availability (A) within each flood and the period lying between any two floods. In Flood I, Puntius ticto, Glossogobius giuris and Aspidoparia morar together constituted 61.5% of the total Associates collected in the nets of different meshes, stated in their order of abundance. In the period intervening Floods I & II Glossogobius giuris (36.9%) continued to dominate the Associates. Other important species encountered in sizeable percentages were Puntius sarana (18.1), Puntius ticto (13.6) and prawns (10.4). Glossogobius giuris together with prawns further continued to dominate during spawn non-availability phase (of the period intervening Floods I & II) constituting 23.3 and 13.1 percent respectively. In Floods II, III & IV+ and the intervening period between Floods II & III (all representing period of non-availability of spawn) Oxygaster bacaila was the most dominant species, its occurrence ranging between 17.6% to 51.5%. In Flood II Puntius sophore (14.4%) and prawns (12.0%) followed Oxygaster bacaila (17.6%) in their percentage of occurrence. The period intervening Floods II & III was characterised by high percentages of occurrence of Oxygaster bacaila (22.5) and Barilius barila (20.5). In Flood III Oxygaster bacaila alone registered 51.5% of occurrence. Prawns, having declined to 2.0% in the preceding period shot upto 23.4% in this flood. Flood IV was marked by the dominance of Oxygaster bacaila (35.0%) followed again by Puntius sophore (15.0%). Flood I and the period intervening between Floods I & II had a wide variety of species (46 and 53 respectively). During subsequent floods the number of species

+ There was no intervening period between Floods III & IV

encountered among Associates went on declining gradually so much so that in Flood IV Associates were represented by only 10 species. The sequence of the appearance of Associates in the season was roughly as: Puntius ticto, Glossogobius giuris, Oxygaster bacaila, Puntius sophore and Barilius barila, to mention only five more important species.

Gut contents of Associates

72 species of Associates were encountered. In Flood I and the period intervening between Floods I & II, spawn appeared to be the most dominant food item on which almost all the Associates subsisted. During subsequent floods and intervening period between floods plankton, debris and insect matter were found in the guts in order of their importance as food items. Associates were not found to exercise any selectivity in food, whatever present in the environment was ingested. However, in case of Laboe bata, Labeo pangusia and Cirrhina reba preference for plankton was noticed as even in periods of availability of spawn in the river in bulk, the stomachs of these fishes were found to contain a greater percentage of plankters.

Net selectivity

Net selectivity of spawn

Table RT10-41 presents spawn catches in ounces taken by Midnapore nets of three different meshes (1/8", 1/16" & 1/8"-1/16") and the State Department nets of a single mesh, called here M1, M2, M1-2 and D respectively during the entire season.

Table RT10-41

Total spawn catch in ounces by different nets

Flood No.	TOTAL CATCH IN OUNCES IN NETS							
	M1		M2		M1-2		D	
	Catch	No.of nets	Catch	No.of nets	Catch	No.of nets	Catch	No.of nets
I	165.94	7	87.76	7	99.32	7	490.98	40

Table RT11-42 illustrates the catch per net per hour of spawn, derived from the data presented in Table RT10-41, further

split up into catches taken in day (6 A.M. to 6 P.M.) and night (6 P.M. to 6 A.M.).

Table RT11-42

Spawn catch (by numbers) per net per hour of different nets

Flood No.	CATCH PER NET PER HOUR IN NUMBERS							
	M1		M2		M1-2		D	
	Day	Night	Day	Night	Day	Night	Day	Night
I	14304	5451	6542	2425	7875	3825	6125	2933

With a view to studying the catching efficiencies of nets, State Department nets were considered to be standared (Unit=1) and the relative catches of other nets were matched therewith. The significance of the observed differences in respect of catches taken from July 8-11 was tested satistically by applying 't' test criterion.

The ratio of spawn catches between D, M1, M2 and M1-2 was found to be:

D: M1: M2: M1-2 = 1; 3.1; 1.63; 1.89

The 't' test gave the following results

D & M1	t = 2.05 on 62 d.f.	p = 0.05 (significant)
D & M2	t = 1.11 on 62 d.f.	p = 0.10 (Not significant)
D & M1-2	t = 1.43 on 62 d.f.	p = 0.10 (-do-)
M1 & M2	t = 1.30 on 62 d.f.	p = 0.10 (-do-)
M2 & M1-2	t = 1.04 on 62 d.f.	p = 0.50 (-do-)

From the above it is inferred that the catching efficiencies of 1/16" and 1/8-1/16" meshed Midnapore nets do not significantly differ from that of State Department nets and the catching efficiency of 1/8" meshed Midnapore net differs significantly from that of State Department. Taking M2 and M1-2 as having identical catching powers, the generalised catching efficiencies of different nets may be placed as shown in Table RT12-43.

Table RT12-43

Catching efficiency of nets

Departmental net	Midnapore nets M1	M2 or M1-2
1	3.10	1.89
0.32	1	0.61
0.53	1.64	1

Thus 1/8" meshed Midnapore net is on the average three times more efficient than Departmental nets and slightly more than one and a half times more efficient than 1/16" or 1/8"-1/16" meshed Midnapore nets.

Net selectivity of Associates

Table RT13-44 shows catch per net per hour in numbers of Associates taken in different nets in different floods. Throughout the season the Associate content of any of the three types of Midnapore net was found to be higher than that of Departmental net. In Flood I and the period intervening Floods I & II the catching efficiency of Midnapore nets ranged between two to four times that of Departmental nets. Subsequently, it was observed to be approximately 3 to 6 fold. The corresponding spawn catching ratio of Midnapore nets to Departmental nets as depicted in Table RT11-12 is two fold.

Table RT13-44

Associate catch in numbers per net per hour

Flood No.	CATCH PER NET PER HOUR IN NUMBER							
	M1		M2		M1-2		D	
	Day	Night	Day	Night	Day	Night	Day	Night
1	2	3	4	5	6	7	8	9
I	4.2	8.1	4.1	6.1	3.8	5.4	2.5	1.3
Period between I & II Flood	4.0	4.0	3.0	3.0	4.0	3.0	0.7	0.8
II	5.1	4.5	-	-	-	-	1.2	1.1
Period between II & III Flood	5.2	0.7	-	-	-	-	0.14	0.06
III	0.3	0.1	-	-	-	-	0.06	0.02
IV	0.3	0.04	-	-	-	-	0.06	0.01

V D. SARDARNAGAR (BAREILLY) ON RIVER RAMGANGA

ABSTRACT

A total of 1158 ounces of spawn, estimated at over 100 lakh hatchlings, were collected during the investigations on carp seed resources in River Narbada at Sisodra lasting from 1.7.64 to 5.9.64. Five floods viz. II, V, VI, IX and X, out of ten, yielded 97.9% of the entire season's spawn. The highly productive floods, V and VI contributed 81.0% of the seasonal catch. The rearing of spawn from floods V, VI and IX, which contributed 83.4% of the total yield at the centre showed 70.6% major carps and the analysis of spawn from the corresponding floods revealed 67.9% major carps. Hydrodynamical, chemical, meteorological and hydrobiological characters in relation to spawn quantity and quality have been studied. In almost all the floods spawn first appeared in their rising phases and it was invariably collected in abundance during the receding phases of the floods. The first one or two days of the receding phases yielded maximum spawn containing high percentage of major carps. The floods rising above and receding below 19 meters from river bottom yielded spawn in abundance. During periods of spawn availability, high catches of spawn in the nets were governed by water velocity, turbidity and net mesh. Midnapore nets, on an average, were found to be 8.4 times more efficient than the Gujarat nets. Even at investigational stage, 917 ozs (i.e. over 90 lakh) of spawn, containing about 55 lakh major carps, were lifted from Sisodra centre by Gujarat Fisheries Department for fisheries development.

LOCATION AND FACILITIES

Sisodra is located on the West (left) bank of the River Narbada in Rajpipla Taluka of Broach District in Gujarat State. The nearest railway station is at Sinor across the river at a distance of 3 km. Silodra is conveniently connected via Sinor and Dabhoi by road and via Sinor and Miyagam by rail with Baroda, Rajpipla, Surat, Broach and other big towns of Gujarat. There is a local branch post office at Sisodra for once a day service only. The village is served by the telegraph office at Sinor. The Block office serving Sisodra is located at Rajpipla, the Taluka headquarters. The river course at Sisodra and the general location of the centre on Narbada are shown

ABSTRACT

Spawn prospecting investigations were conducted at Sardarnagar, Bareilly in River Ramganga from July 5 to September 11, 1964. 287.1 ozs of spawn were obtained during the entire season of which 247.2 ozs were collected in Flood I (July 9 to 14) and 26.1 ozs in Flood II (July 17-18) forming 81.6% and 9.1% of the total seasonal catch respectively. Spawn analysis showed an average of 1.2% major carps, attaining a maximum of 8.6% in the collection of 16 hrs on July 11 in Flood I, while the average major carps percentage of Flood II was 9.0% with a maximum of 27.0% at 16 hrs on July 17. The reared samples showed a major carp content of 5.9% in Flood I, of minor carps 94.0% and 'Others' 0.1%. Midnapore nets were, on the average, over one and half times more efficient than the Departmental nets. Efforts have been made to correlate the physico-chemical factors with the quantitative availability of spawn. Filtered off associates have been analysed as to their species composition, quantitative availability in different periods and their gut contents. If round the clock vivilance in spawn collection is maintained in the first two floods of Ramganga, appreciable major carp spawn, though mixed with minor carps, can be collected. Deep pool stocking of major carps after a faunistic survey has been recommended to build up a sizeable major carp population.

LOCATION AND FACILITIES

Sardarnagar is a village situated on the Western bank of River Ramganga about 12 kilometres West of Bareilly across the river. It lies adjacent to the Bareilly-Mathura Road, the nearest railway station, Ramganga South Cabin, being 3 kilometres North of Sardarnagar. The village has a branch post office for twice a week postal service only. No telegraphic and telephonic services are available at the village but can be had at Bareilly. The collection ground is about three kilometres North of the village in between the railway and road bridges over the river. The course of river Ramganga in the vicinity of Sardarnagar alongwith the topography of the area is shown in Figure RS1-21*.

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* 'R' stands for River Ramganga; 'S' stands for Sardarnagar.

The first number in the Tables and Figures depicts the number in the chapter and the second in the report as a whole.

OBSERVATIONS AND RESULTS

Spawn prospecting investigations were conducted at Sardarnagar from July 5 to September 11, 1964. Table RS1-46 depicts the daily two hourly observations (6 A.M. to 4 A.M. of the following calender date) in regard to flood level, turbidity, air and water temperatures, pH, dissolved oxygen, total catch of spawn in ounces and their flood-wise distribution.

Spawn quantity in relation to environmental factors

Figure RS2-22 shows day to day spawn collected from all the nets operated during the period of observation. This bar diagram also depicts the spawn catch by the Departmental and the Midnapore type of nets, the relative efficiency of which is discussed later in this report. Table RS2-47 indicates the spawn quantity obtained during the different floods alongwith the dates and hours of appearance of spawn during the rising and receding phases in each flood and the quantity obtained in day (6 A.M. to 6 P.M.) and night (6 P.M. to 6 A.M.) hours.

287.1 ozs of spawn were collected during the entire season in ten shooting nets. Of these 247.2 ozs were taken in the first flood period (July 9 to July 14, 1964) accounting for 86.1% of the total spawn yield from the site. (This excludes non-carp spawn available in rising phase of Flood I described under "spawn quality derived from spawn analysis"). Flood II, which appeared soon after the end of Flood I, contributed 26.1 ozs of spawn, amounting to 9.1% of the total catch. Peak collection days of the two floods were July 9 and July 17, 1964 when 99.9 ozs and 21.3 ozs of spawn was collected forming 44.1% and 81.6% of the catch of the respective floods. The spawn catch of July 9, alone accounted for 34.8% of the total collection of the season. Table RS2-47 shows that 122.7 ozs of spawn were collected during day hours against 124.5 ozs during night hours in the first flood period. In Flood II the day time catch was 11.9 ozs against 14.2 ozs obtained during night hours. On the peak catch day of the first flood, i.e. July 9, 67.5 ozs of spawn were obtained in night against 32.4 ozs taken in day. These observations show that nightly catches were on the whole slightly higher than the day time catches. No or negligible spawn could be obtained during the Floods III, IV & V which lasted from July 29 to August 2, August 4 to 12 and August 30 to September 8 with their peak days falling on July 30, August 7 and September 3 respectively.

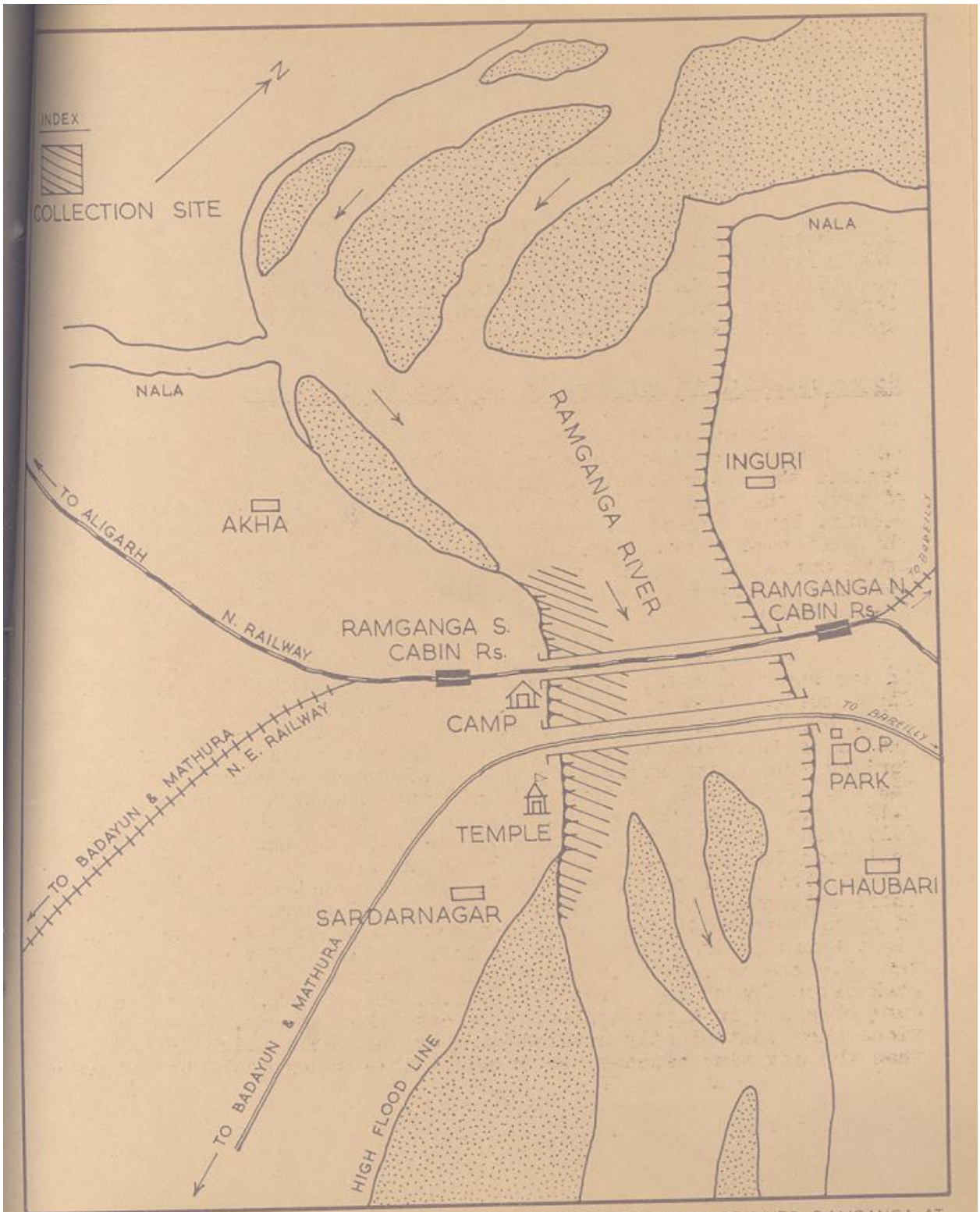


FIG. RS1-21. THE RIVER COURSE, GENERAL TERRAIN AND TOPOGRAPHY OF RIVER RAMGANGA AT SARDARNAGAR (BAREILLY)

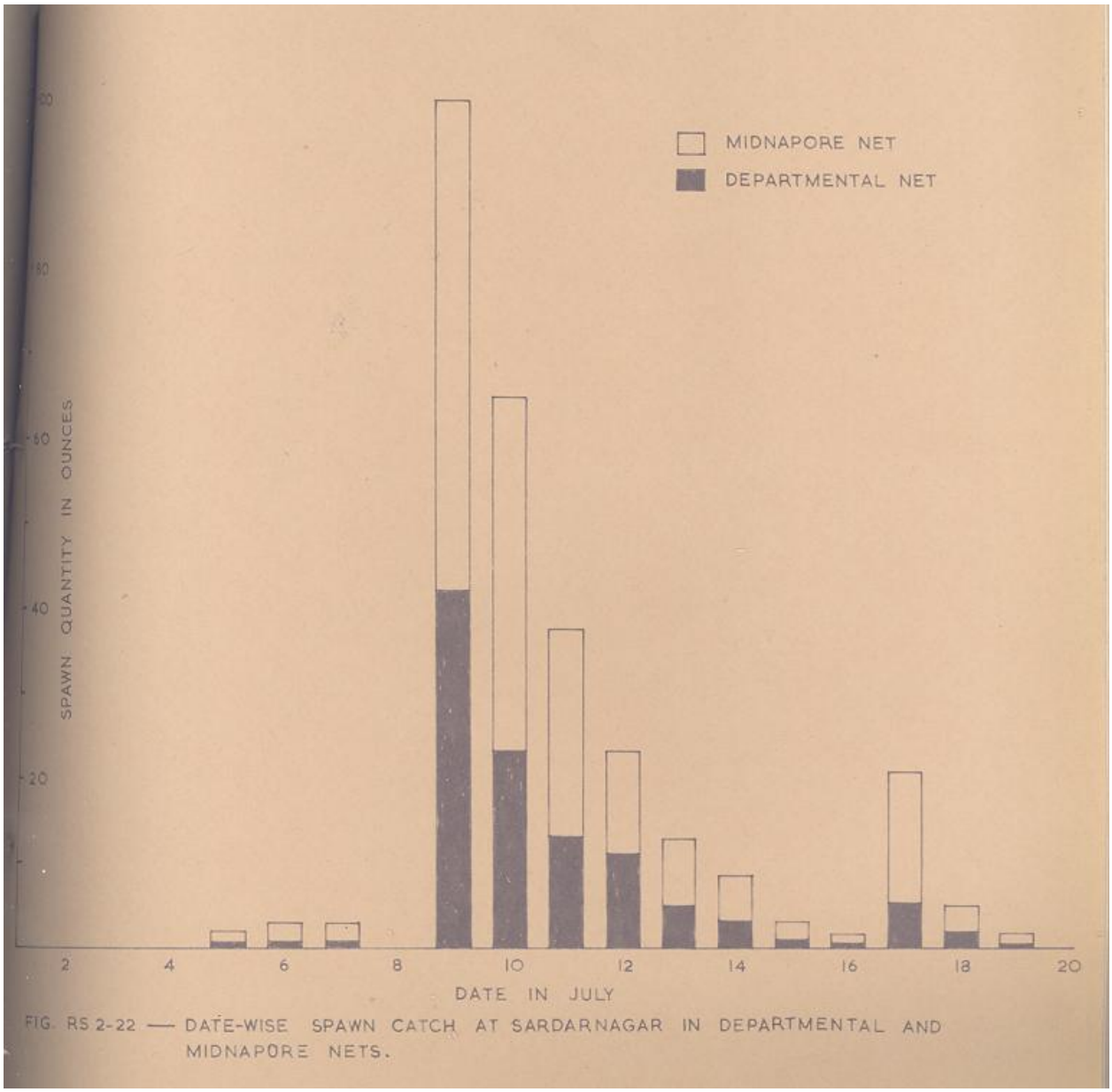


FIG. RS 2-22 — DATE-WISE SPAWN CATCH AT SARDARNAGAR IN DEPARTMENTAL AND MIDNAPORE NETS.

Table RS1-46

Daily averages of flood level, turbidity, air and water temp., pH, D.O. and total spawn catch in the River Ramganga at Sardarnagar

Date year 1964	Flood level in metres	Turbidity in ppm	Air Temp. water temp. in °C	pH	D.O. in ppm	Total catch of spawn in ozs.	Floodwise spawn in ozs and percentage in total.
1	2	3	4	5	6	7	8
July							
(5,6 A.M.)	0.00						
5	0.08	170	29.9/29.9	7.9	6.2	2.0	
6	0.32	185	29.2/30.0	7.9	-	2.8	
7	1.01	270	25.4/26.9	7.6	-	3.0	
8	2.09	543	26.8/26.8	7.6	6.6	0.3	
9	2.65	850	26.5/27.2	7.6	-	99.9	)
10	2.31	900	27.0/27.0	7.6	-	65.4	)
11	2.06	835	27.7/27.8	7.6	6.6	37.6	) 247.2
12	1.99	836	28.2/28.0	7.6	-	23.2	) (86.1%)
13	1.77	793	27.4/27.5	7.9	-	12.4	)
14	1.59	750	27.5/28.0	7.9	5.7	8.7	)
15	1.81	816	28.8/28.8	7.9	-	2.6	
16	2.36	857	29.2/28.8	7.6	-	0.8	
17	2.11	857	29.9/29.4	7.6	5.7	21.3	) 26.1
18	1.59	725	31.0/30.1	7.9	-	4.8	) (9.1%)
19	1.51	564	30.8/30.8	7.9	-	1.5	
20	1.40	571	31.5/31.5	7.9	5.7	0.3	
21	1.22	555	32.5/33.2	7.9	-	Stray	
22	1.19	422	32.0/33.0	7.9	-	0.1	
23	1.16	397	27.5/30.7	7.9	5.7	0.2	
24	1.53	693	27.2/28.5	7.9	-	Stray	
25	1.82	1200	26.0/27.9	7.6	-	Stray	
26	2.03	964	27.2/28.6	7.7	6.2	0.2	
27	1.88	1028	26.8/28.3	7.6	-	Stray	
28	1.69	1028	27.8/28.3	7.6	-	Stray	
29	1.89	1028	26.2/27.8	7.6	6.2	Stray	
30	2.24	1200	30.0/29.4	7.6	-	Stray	
31	1.93	1200	30.3/30.8	7.6	-	Stray	

1	2	3	4	5	6	7	8
August							
1	1.74	1157	31.5/31.0	7.6	5.7	Stray	
2	1.63	986	31.8/32.0	7.6	-	Stray	
3	1.56	779	31.8/31.5	7.6	-	nil	
4	1.54	621	31.3/32.1	7.6	6.2	Stray	
5	1.53	664	28.7/29.9	7.6	-	nil	
6	1.79	793	27.8/29.4	7.7	-	nil	
7	2.10	1157	31.5/29.7	7.6	6.2	nil	
8	1.98	1157	31.2/30.7	7.6	-	Stray	
9	1.74	880	32.6/32.9	7.6	-	Stray	
10	1.65	878	32.8/33.3	7.6	5.7	Stray	
11	1.58	878	31.3/31.7	7.6	-	Stray	
12	1.51	750	31.0/31.2	7.6	-	Stray	
13	1.55	900	31.0/31.0	7.6	5.7	Stray	
14	1.42	900	29.6/31.1	7.7	-	nil	
15	1.59	771	29.4/30.2	7.7	-	nil	
16	1.84	1243	30.1/30.3	7.6	5.7	nil	
17	1.69	943	20.4/29.8	7.6	-	nil	
18	1.86	793	29.1/30.0	7.6	-	nil	
19	1.85	921	30.5/30.4	7.6	5.7	nil	
20	1.76	857	31.0/30.7	7.6	-	nil	
21	1.74	793	29.8/30.1	7.6	-	nil	
22	1.74	750	30.0/31.0	7.6	5.7	nil	
23	1.78	793	28.9/30.2	7.6	-	nil	
24	1.74	793	28.5/30.5	7.0	-	nil	
25	1.74	664	30.0/30.0	7.0	5.7	nil	
26	1.76	721	30.9/31.0	7.0	-	nil	
27	1.62	693	29.7/30.8	7.0	-	nil	
28	1.54	650	30.3/31.1	7.0	5.7	nil	
29	1.51	664	30.0/31.8	7.0	-	nil	
30	1.45	571	29.0/30.9	7.0	-	nil	
31	1.68	636	27.5/29.7	7.0	5.7	nil	
September							
1	2.06	665	25.8/27.4	7.6	-	nil	
2	2.21	1200	24.5/26.3	7.6	-	nil	
3	2.38	1200	26.9/27.3	7.9	6.2	nil	
4	2.32	986	27.0/27.8	7.7	-	nil	
5	2.10	900	29.8/30.7	7.6	-	nil	
6	1.90	750	29.0/30.0	7.6	5.7	nil	
7	1.70	678	28.8/29.7	7.6	-	nil	
8	1.55	491	29.6/30.7	7.6	-	nil	
9	1.66	466	26.0/28.5	7.6	5.7	nil	
10	2.12	636	26.1/27.7	7.6	-	nil	
11	2.23	900	25.3/26.7	7.6	-	nil	

Table 38-47

Details of spawn collection in relation to different floods in R.Ramganga at Sardarnagar

Flood No.	Duration of flood in 1964		Flood peak			Commencement of spawn availability			Days of peak collection				Total catch of spawn in ozs			
	Rising phase	Receding phase	Date in 1964	Hour	Flood level in metres	Date in 1964	Hour	Flood level in metres	Date in 1964	Quantity in ozs Day 6 A.M. to 6 P.M.	Night 6 P.M. to 6 A.M.	Total	Rising phase	Receding phase Day 6 A.M. to 6 P.M.	Receding phase Night 6 P.M. to 6 A.M.	Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
I	5/7 to 9/7	9/7 to 24/7	8/7	2	2.69	9/7	6	2.68	9/7	32.4	37.6	69.8	few	122.7	124.6	247.2
II	15/7 to 16/7	17/7 to 18/7	16/7	4	2.62	17/7	6	2.56	17/7	9.3	12.1	21.4	few	11.9	14.2	26.1
III	29/7 to 30/7	30/7 to 2/8	30/7	14	2.26	-	-	-	-	-	-	-	-	-	-	-
IV	4/8 to 7/8	7/8 to 12/8	7/8	20	2.14	-	-	-	-	-	-	-	-	-	-	-
V	30/8 to 3/9	4/9 to 8/9	3/9	4	2.53	-	-	-	-	-	-	-	-	-	-	-

Hydrodynamical characters

Flood level

Fluctuations in the daily average flood level have been shown in Figure RS3-23 on which the spawn catch, whenever obtained, has been superimposed. It is evident from Figure RS3-23 and Table RS2-47 that spawn was not available in appreciable quantity in the rising phase of the flood, the major collection being made during the receding phase. On July 9, when the flood level after attaining its maximum height, started receding that the appearance of spawn in bulk commenced. It was, however, observed that the spawn in both the floods showed its first appearance in bulk in the early morning hours (6 A.M.) after a lapse of two to four hours of the commencement of the receding phase.

Figure RS3-23 also indicates that though five major floods occurred during the entire season, the spawn was available in only two floods, in substantial quantity in the first and a little in the second. Practically no spawn was available in Floods III, IV & V. The maximum height of flood attained in each of these five floods was 2.69, 2.62, 2.26, 2.14 and 2.53 metres with 0.0 metres taken as on July 5, 1964, the date of commencement of operations.

Current velocity

Due to limitations in the measurement of the current velocity, no definite quantitative relationship could be established between the current velocity and the availability of spawn. It is, however, evident from Table RS3-48 that the current velocity ranged between 2.1 to 6.5 km/hour, in the first flood period but in subsequent floods it did not exceed 2.3 km/hour.

Chemical characters

Turbidity

Figure RS4-24 shows daily fluctuations in turbidity with spawn catch superimposed thereon. Turbidity, in the absence of flood, does not cause spawn to appear, though, its rise accompained by flood may have a direct bearing upon the quantitative fluctuation of spawn. For example, the average turbidity values during the five floods, mentioned earlier, were 900, 950, 1157, 1200 & 1200 ppm respectively but the spawn was available only in the relatively low turbidity values of I and II flood periods. In the absence of flood,

Table RS3-48

Daily arithmetic or modal averages of meteorological characters for relevant days in different floods along with spawn catch and current direction in Ramganga at Sardarnagar

Date 1964	Flood No.	Flood Phase	Quantity of spawn collected in ozs	Temperature in centigrade Air	Temperature in centigrade Water	Weather condition Sky*	Weather condition Wind Speed**	Weather condition Wind direction from north	Current direction from north	Current velocity in km/hr
1	2	3	4	5	6	7	8	9	10	11
July										
5		Rising	2.0	29.9	29.9	C	-	270°	320°	1.3
6		-do-	2.8	29.2	30.0	C	-	270°	320°	1.2
7		-do-	3.0	25.4	26.9	R	-	90°	320°	2.1
8	I	Peak	0.3	26.8	26.8	R	-	90°	200°	6.5
9		Receding	99.0	26.5	27.2	C	-	90°	310°	2.6
10		-do-	65.4	27.0	27.0	C	-	90°	320°	1.1
11		-do-	37.6	27.7	27.8	C	-	270°	340°	1.9
12		-do-	23.2	28.2	28.0	F	-	90°	340°	1.8
13		-do-	12.4	27.4	27.5	C	-	270°	340°	1.8
14		-do-	8.7	27.5	28.0	C	-	270°	320°	1.0
15		Rising	2.6	28.8	28.8	C	-	270°	320°	0.8
16	II	Peak	0.8	29.2	28.8	F	-	270°	340°	0.9
17		Receding	21.3	29.9	29.4	F	-	270°	300°	0.8
18		-do-	4.8	31.0	30.1	F	-	270°	320°	0.8
29		Rising	Stray	26.2	27.8	C	G	270°	310°	1.6
30		Peak	Stray	30.0	29.4	F	G	270°	340°	2.0
31	III	Receding	Stray	30.3	30.8	F	G	270°	340°	0.9
August										
1		-do-	Stray	31.5	31.0	F	G	270°	340°	1.8
2		-do-	Stray	31.8	32.0	F	G	270°	320°	1.9
4		Rising	Stray	31.3	32.1	F	H	270°	320°	1.1
5		-do-	nil	28.7	29.9	C	G	270°	320°	1.2
6		-do-	nil	27.8	29.4	C	H	90°	340°	1.1
7		Peak	nil	31.5	29.7	F	G	90°	340°	1.2
8	IV	Receding	Stray	31.2	30.7	F	G	90°	340°	1.1

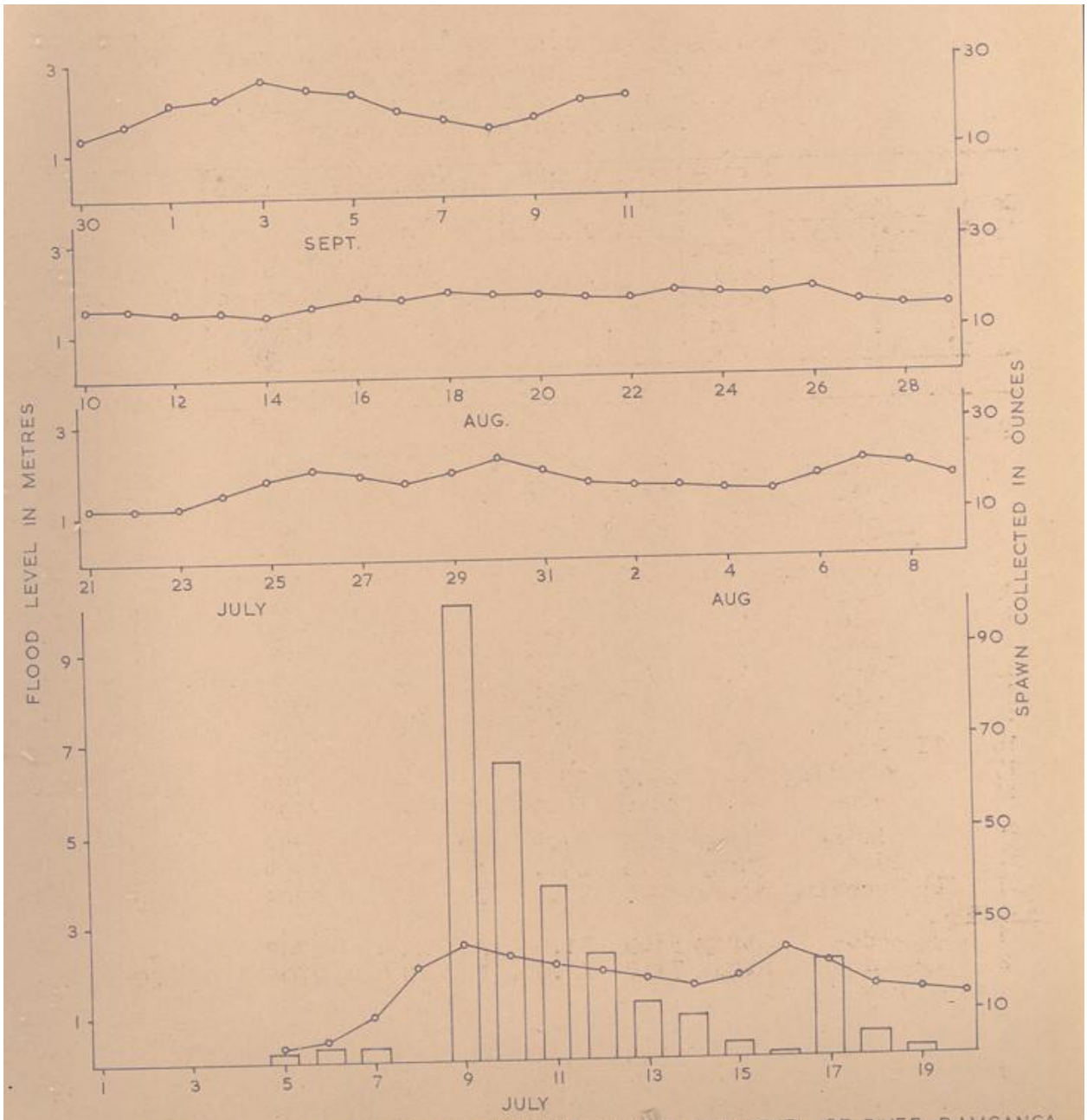


FIG. RS 3-23 — FLUCTUATIONS IN AVERAGE DAILY FLOOD LEVEL OF RIVER RAMGANGA AT SARDARNAGAR WITH SPAWN QUANTITY SUPERIMPOSED ON THE DAYS OF AVAILABILITY.

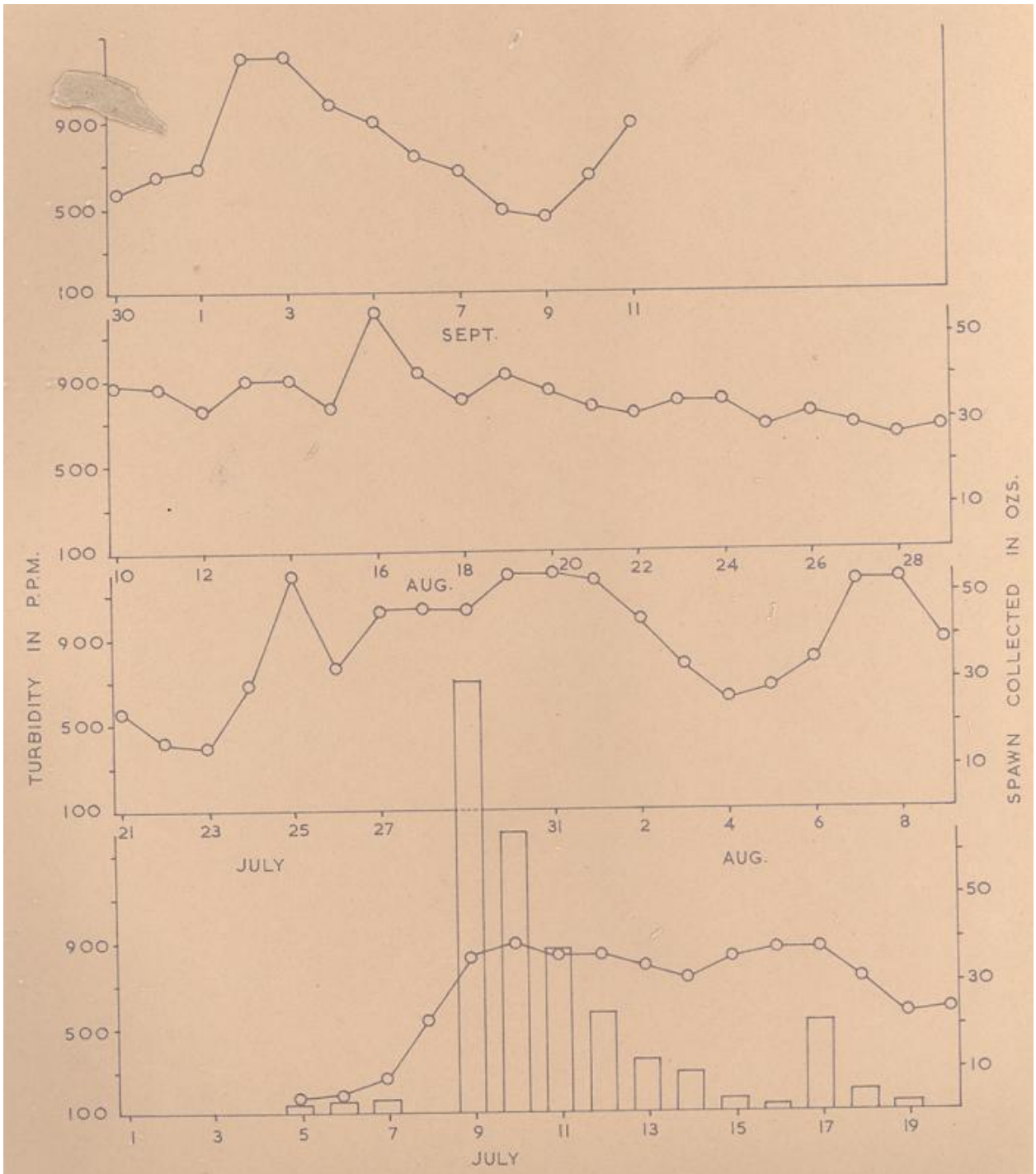


FIG. RS 4-24 — FLUCTUATIONS IN AVERAGE DAILY TURBIDITY OF RIVER RAMGANGA AT SARDARNAGAR WITH SPAWN QUANTITY SUPERIMPOSED ON THE DAYS OF AVAILABILITY.

1	2	3	4	5	6	7	8	9	10	11
9		Receding	Stray	32.6	32.9	C	G	90°	340°	1.5
10		-do-	Stray	32.8	33.3	F	G	270°	340°	2.2
11		-do-	Stray	31.3	31.7	F	G	270°	340°	1.8
12		-do-	Stray	31.0	31.2	F	G	270°	340°	1.2
30		Rising	nil	29.0	30.9	C	G	270°	300°	1.1
31		-do-	nil	27.5	29.7	C	G	270°	300°	1.5
Sept.										
1		-do-	nil	25.8	27.4	C	H	270°	340°	1.3
2	V	-do-	nil	24.5	26.3	C	G	270°	340°	2.3
3		Peak	nil	26.9	27.3	C	G	270°	340°	2.4
4		Receding	nil	27.0	27.8	F	G	270°	340°	1.4
5		-do-	nil	29.8	30.7	F	G	270°	340°	1.5
6		-do-	nil	29.0	30.0	F	G	270°	340°	1.8
7		-do-	nil	28.8	29.7	F	G	270°	340°	0.6
8		-do-	nil	29.6	30.7	F	G	270°	340°	0.9

*C - Cloudy

**G - Gentle

R - Raining

H - High

F - Fair

1	2	3	4	5	6	7	8	9	10	11
9		Receding	Stray	32.6	32.9	C	G	90°	340°	1.5
10		-do-	Stray	32.8	33.3	F	G	270°	340°	2.2
11		-do-	Stray	31.3	31.7	F	G	270°	340°	1.8
12		-do-	Stray	31.0	31.2	F	G	270°	340°	1.2
30		Rising	nil	29.0	30.9	C	G	270°	300°	1.1
31		-do-	nil	27.5	29.7	C	G	270°	300°	1.5
Sept.										
1		-do-	nil	25.8	27.4	C	H	270°	340°	1.3
2	V	-do-	nil	24.5	26.3	C	G	270°	340°	2.3
3		Peak	nil	26.9	27.3	C	G	270°	340°	2.4
4		Receding	nil	27.0	27.8	F	G	270°	340°	1.4
5		-do-	nil	29.8	30.7	F	G	270°	340°	1.5
6		-do-	nil	29.0	30.0	F	G	270°	340°	1.8
7		-do-	nil	28.8	29.7	F	G	270°	340°	0.6
8		-do-	nil	29.6	30.7	F	G	270°	340°	0.9

*C - Cloudy

**G - Gentle

R - Raining

H - High

F - Fair

when spawn was not available, the turbidity values have been found to be ranging between 422 and 1243 ppm. On the peak days of both the spawn bearing first two floods, i.e. on July 9 and July 17, the average turbidity was 850 and 857 ppm respectively.

Hydrogen-ion concentration

pH values fluctuated between 7.6 and 7.9. This narrow range of hydrogen-ion concentration was observed both during the availability of spawn and also during its non-availability periods. Hence there does not seem to exist any relationship between pH and spawn yield.

Dissolved oxygen

Dissoved oxygen value was observed to rise alongwith the appesrance of flood. During the non-flood periods the D.O. was found to be 5.7 ppm, but on the flood days it generally went upto 6.2 ppm. Only during the Flood I period, when the spawn was obtained in appreciable quantity, that the D.O. was recorded to be 6.6 ppm (on 8th and 11th July, 1964). However, in II flood, when also some spawn did appear, the D.O. value remained at 5.7 ppm (Table RS1-48). Even in subsequent floods, when no spawn was available, the D.O. value went upto 6.2 ppm. It can not, therefore, be said that the high dissolved oxygen content has anything to do with the appearance of spawn.

Meteorological characters

Table RS3-48 shows the weather conditions, daily mean air and water temperatures, current direction, wind speed and its direction along with the daily spawn yield for the rising and receding phases of all the five floods. This table reveals that in the Flood I period the days were mostly cloudy and rainy resulting in a slight fall of air and water temperatures. These conditions did not prevail during any of the other floods. The wind direction was 270° (Westerly) and at times 90° (Easterly) and the current direction ranged between 300° to 340°. Table RS4-49 shows the average air and water temperatures for the period of availability of spawn in Flood I (July 9-14) alongwith the average air and water temperature values of three preceding days (July 6-8) and two following days (July 15-16). It reveals that the air and water temperatures were slightly lower during pre-spawn availability period due to cloudy and rainy weather, the difference in air temperatures between post and pre-spawn availability periods being 1.87° and in water being 0.90°C.

Table RS4-49

Average Air and Water temperature in preceding, during and following spawn collection periods.

Period Identity	No. of days.	Period	Average Air temp. in °C.	Average water temp. in °C.
Preceding spawn availability	3	6/7 to 8/7	27.13	27.90
During first spawn availability	6	9/7 to 14/7	27.35	27.58
Following spawn availability	2	15/7 to 16/7	29.00	28.80

Table RS5-50

Floodwise quantitative abundance of plankton and spawn associates split up into days of spawn availability and otherwise in River Ramganga at Sardarnagar

Flood No. etc.	Dates in 1964	Average plankton density in nos. per litre		Average catch per net per day of spawn associates in Nos.	
		On days of spawn availability.	Otherwise.	On days of spawn availability.	Otherwise.
I	5/7 to 14/7	2.8	26.7	52.8	24.0
II	15/7 to 18/7	0.6	0.4	50.4	24.0
In between period	19/7 to 28/7	-	1.6	-	74.4
III	29/7 to 2/8	-	1.5	-	28.8
In between period	3rd August	-	2.0	-	nil
IV	4/8 to 12/8	-	1.1	-	4.8
In between period	13/8 to 29/8	-	1.2	-	2.4
V	30/8 to 8/9	-	1.0	-	4.8
Later	9/9 to 11/9	-	0.2	-	nil

Hydrobiological characters

Average plankton density in numbers per litre of water and the average number of associates per net on the days of spawn availability and non-availability have been tabulated in Table RS5-50. From an initial value of 26.7 per litre, plankton concentration came down to 0.2 per litre at the close of season. Plankton concentration does not seem to have any bearing upon spawn availability since, in the first two floods, the plankton density was 26.7 and 0.4 per litre respectively during the time of non-availability of spawn, as against 2.8 and 0.6 per litre respectively when spawn was available. Throughout the rest of the period the range of fluctuation in the plankton quantity was from 0.2 to 2.0 per litre when no spawn was available.

Table RS5-50 also indicates that the daily average number of spawn associates per net, after an initial increase, greatly declined as the season advanced. The associates were obtained in greater numbers in the first two floods during the period of spawn availability than at the time of its non-availability. In the rest of the period, when no spawn was available, the associates number gradually declined so much so that after Flood V negligible associates were available. The qualitative abundance of associates with the spawn quality is discussed later in this report.

Spawn quality in relation to environmental factors

Spawn quality derived from spawn analysis

Table RS6-51 indicates flood-wise distribution of major and minor carps and 'Others' in two-hourly spawn samples. The arithmetic means of percentage of two-hourly samples of the day (6 A.M. to 4 A.M. of the next calender day) is also shown therein. The flood-wise qualitative analysis of the spawn is given below:

Flood I: In the rising phase of the flood, i.e. from July 5 to 7, 1964, 7.8 ozs of spawn were collected. This collection was characterised by a complete absence of major carps, while 'Others' formed as much as 55.9, 51.1 and 6.9% respectively on the above stated three days. Mullets were largely responsible for this high percentage of 'Others'. On the peak flood day, i.e. July 8, only 0.3 ozs of spawn was available in which the major carps were absent, 'Others'

Table PS6-51

Floodwise percentage distribution of Major carps and others in two-hourly spawn samples from Ramganga at Sardarnagar

Flood No.	Phase	Date in 1964	Percentage of	HOURS OF OBSERVATION 6	8	10	12	14	16	18	20	22	24	2	4	Average % age for the day
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
			Mj	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Rising	Jul.5	Mi	-	74.0	27.0	47.0	42.0	56.0	21.0	42.0	38.0	44.0	42.0	43.0	44.0
			O	-	26.0	73.0	53.0	58.0	35.0	79.0	58.0	62.0	56.0	58.0	57.0	55.9
			Mj	0.0	0.0	0.0	0.0	-	0.0	0.0	-	0.0	-	-	-	0.0
		Jul.6	Mi	36.0	46.0	32.0	78.0	-	41.0	54.0	-	55.0	-	-	-	48.9
			O	64.0	54.0	68.0	22.0	-	59.0	46.0	-	45.0	-	-	-	51.1
			Mj	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Jul.7	Mi	40.0	100.0	100.0	100.0	-	96.0	100.0	95.0	100.0	100.0	97.0	96.0	93.1
			O	60.0	0.0	0.0	0.0	-	4.0	0.0	5.0	0.0	0.0	3.0	4.0	6.9
			Mj	0.0	0.0	0.0	0.0	0.0	-	-	-	-	-	-	-	0.0
	Peak	Jul.8	Mi	94.0	92.0	96.0	98.0	94.0	-	-	-	-	-	-	-	94.8
			O	6.0	8.0	4.2	2.0	6.0	-	-	-	-	-	-	-	5.2
			Mj	0.0	1.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.3
		Jul.9	Mi	100.0	98.0	100.0	100.0	100.0	100.0	96.0	100.0	98.0	98.0	100.0	95.0	98.7
			O	0.0	1.0	0.0	0.0	0.0	0.0	2.0	0.0	2.0	2.0	0.0	5.0	1.0
			Mj	0.0	6.0	3.0	3.0	1.0	0.0	0.0	3.0	3.9	0.0	0.0	0.0	1.7
I		Jul.10	Mi	100.0	93.0	97.0	97.0	99.0	97.0	96.0	97.0	93.1	97.0	94.0	96.0	96.3
			O	0.0	1.0	0.0	0.0	0.0	3.0	4.0	0.0	3.0	3.0	6.0	4.0	2.0
			Mj	6.0	1.0	0.0	1.0	0.0	8.6	7.8	0.0	0.9	4.0	2.9	0.0	2.8
	Receding	Jul.11	Mi	94.0	95.0	97.0	99.0	96.0	86.4	90.2	100.0	92.1	93.1	93.1	100.0	94.6
			O	0.0	4.0	3.0	0.0	4.0	5.0	2.0	0.0	7.0	2.0	4.0	0.0	2.6
			Mj	0.0	0.0	0.0	0.0	2.0	0.0	8.0	0.0	2.0	1.9	1.0	0.0	1.2
		Jul.12	Mi	98.0	99.0	99.0	100.0	98.0	100.0	92.0	100.0	98.0	92.1	99.0	100.0	98.0
			O	2.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0	0.0	0.0	0.8
			Mj	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Jul.13	Mi	100.0	100.0	100.0	100.0	98.0	100.0	100.0	100.0	98.0	100.0	100.0	100.0	99.7
			O	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.3
			Mj	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	3.0	0.8
		Jul.14	Mi	100.0	100.0	99.0	100.0	100.0	100.0	100.0	99.0	99.0	99.0	97.0	97.0	99.1
			O	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1

2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
		Yj	0.0	2.0	3.9	1.9	5.8	2.9	2.9	0.0	1.0	0.0	0.0	0.0	0.1
	Rising	Jul.15 Mi	100.0	98.0	93.1	94.1	90.2	98.1	92.1	98.0	96.0	96.0	96.0	96.0	95.8
		O	0.0	0.0	3.0	4.0	4.0	4.0	5.0	2.0	3.0	4.0	4.0	4.0	3.1
		Yj	4.0	2.0	-	1.0	0.0	0.0	0.0	-	1.0	0.0	0.0	5.0	1.3
	Peak	Jul.16 Mi	96.0	94.0	-	99.0	100.0	100.0	98.0	-	94.0	98.0	91.0	95.0	98.7
II		O	0.0	4.0	-	0.0	0.0	0.0	2.0	-	5.0	2.0	9.0	0.0	2.0
		Yj	12.9	24.8	16.7	24.0	16.0	27.0	21.0	15.0	26.3	8.8	5.9	2.9	16.3
		Jul.17 Mi	86.1	74.2	81.3	76.0	84.0	73.0	79.0	85.0	70.7	89.2	92.1	95.1	82.9
	Receding	O	1.0	1.0	2.0	0.0	0.0	0.0	0.0	0.0	3.0	2.0	1.0	2.0	1.0
		Yj	6.8	2.8	0.0	0.9	0.9	1.0	0.0	0.0	0.0	0.0	0.9	0.0	1.1
		Jul.18 Mi	90.2	91.2	96.0	87.1	93.1	95.0	98.0	92.0	92.0	97.0	91.0	93.0	92.7
		O	3.0	6.0	4.0	12.0	6.0	4.0	2.0	8.0	11.0	3.0	8.0	7.0	6.2

Hydrobiological characters

Average plankton density in numbers per litre of water and the average number of associates per net on the days of spawn availability and non-availability have been tabulated in Table RS5-50. From an initial value of 26.7 per litre, plankton concentration came down to 0.2 per litre at the close of season. Plankton concentration does not seem to have any bearing upon spawn availability since, in the first two floods, the plankton density was 26.7 and 0.4 per litre respectively during the time of non-availability of spawn, as against 2.8 and 0.6 per litre respectively when spawn was available. Throughout the rest of the period the range of fluctuation in the plankton quantity was from 0.2 to 2.0 per litre when no spawn was available.

Table RS5-50 also indicates that the daily average number of spawn associates per net, after an initial increase, greatly declined as the season advanced.

The associates were obtained in greater numbers in the first two floods during the period of spawn availability than at the time of its non-availability. In the rest of the period, when no spawn was available, the associates number gradually declined so much so that after Flood V negligible associates were available. The qualitative abundance of associates with the spawn quality is discussed later in this report.

Spawn quality in relation to environmental factors

Spawn quality derived from spawn analysis

Table RS6-51 indicates flood-wise distribution of major and minor carps and 'Others' in two-hourly spawn samples. The arithmetic means of percentage of two-hourly samples of the day (6 A.M. to 4 A.M. of the next calender day) is also shown therein. The flood-wise qualitative analysis of the spawn is given below:

Flood I: In the rising phase of the flood, i.e. from July 5 to 7, 1964, 7.8 ozs of spawn were collected. This collection was characterised by a complete absence of major carps, while 'Others' formed as much as 55.9, 51.1 and 6.9% respectively on the above stated three days. Mullets were largely responsible for this high percentage of 'Others'. On the peak flood day, i.e. July 8, only 0.3 ozs of spawn was available in which the major carps were absent, 'Others'

formed 5.2%, and the rest, which comprised minor carps, were represented by Chela spp. only.

During the receding phase of Flood I (July 9-14) spawn was available on six days continuously when 99.9, 65.4, 37.6, 23.2, 12.4 & 8.7 ozs were collected respectively showing a gradually decreasing trend from the first to the last day. The percentage of major carps was fairly low throughout, the maximum being on 11th July when the collection of 16 hours showed 8.6% major carps, their daily average being only 2.8%. On other days, viz on July 9, 10, 12, 13 & 14, the daily mean percentage of major carps was only 0.3, 1.7, 1.3, 0.0 and 0.8 respectively. It is, therefore, evident that the quantity of major carps in samples had gradually increased from July 9 to 11 and decreased thereafter. However, there were no major carps in the collections from 4 hours of July 12 to 20 hours of July 14. As Table RS7-52 depicts the overall percentage of major carps in Flood I was 1.2%. 'Others' contributed 1.0, 2.0, 2.6, 0.8, 0.3 & 0.1% of the daily samples of July 9 to July 14 following a similar trend of fluctuation as that of major carps though at a greatly reduced measure of abundance. The representation of minor carps in the entire collection of this flood ranged between 94.6 and 99.7%.

Flood II: Soon after the end of first flood on July 14, the second flood started appearing from July 15 which lasted till July 18. In the rising phase of this flood (July 15) and on the peak flood day (July 16) only 2.6 and 0.8 ozs of spawn were available. July 17 & 18 yielded 21.3 and 4.8 ozs of spawn respectively. It is worthy to note that on July 17 the percentage of major carps was much higher (16.8%) than on any day of the first flood period. In the two hourly collections of this day the major carps were as high as 27% at 16 hours. However, major carps quantity suddenly came down to 1.1% on July 18. The average percentage of major carps during this flood was 9.0% (Table RS7-52). 'Others' formed 1.0 and 6.2% in these two days.

Table RS7-52

Flood-wise percentage distribution of spawn quality determined from spawn samples

Flood No.	P E R C E N T A G E OF		
	Major caprs	Minor carps	Others
I	1.2	97.6	1.2
II	9.0	87.4	3.6

Flood III to V: In subsequent floods, i.e. in Floods III, IV & V the spawn collection was nil or negligible.

Figure RS5-25 presents the flood-wise fluctuations in the spawn quality as observed for major carps, minor carps and 'Others'. The curve for major carps is somewhat positively skewed, for 'Others' rather negatively skewed, and that of the minor carps, a platikurtic one.

Spawn quality derived from rearing

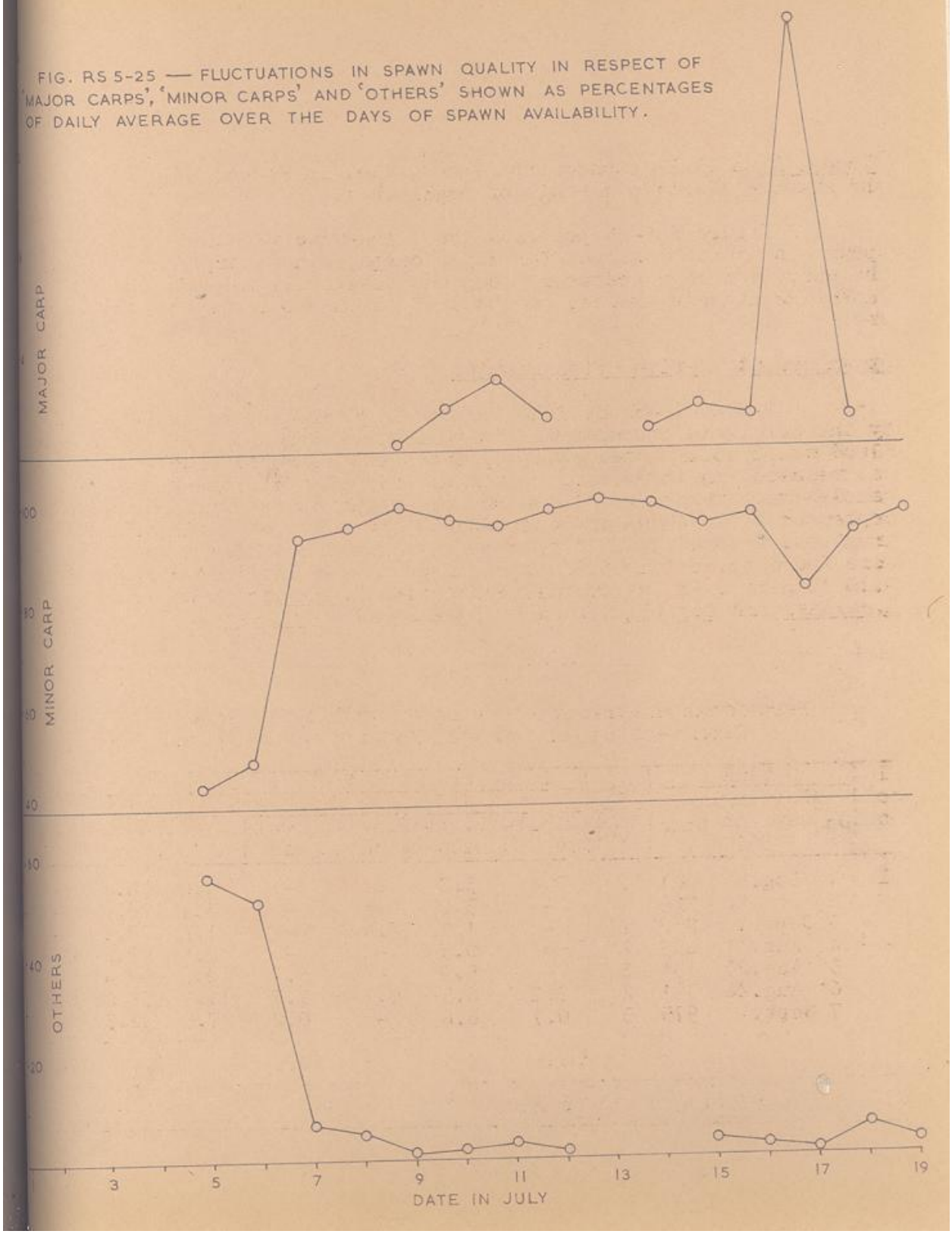
Table RS8-53 depicts the species composition as revealed by the survivors in nurseries in respect of spawn of the first major flood which contributed 86.1% of the total seasonal catch. The spawn was released in three nurseries from July 9 to 11. Seven reared samples were taken from these nurseries during the period August 8 - September 1, as shown in Table RS8-53, by means of a fingerlings drag net. A total of 2713 specimens, taken from these nurseries, were found to contain 5.9% of major carps, 94.0% minor carps and 0.1% 'Others'. In the overall collection L.rohita formed 4.5%, L.calbasu and C.catla formed 0.6% each and C.mrigala 0.2%.

Table RS8-53

Percentage distribution of spawn quality as determined from rearing experiments for two major floods

Flood No.	SAMPLE No.	Netting date in 1964	Size	Nursery No.	PERCENTAGE OF MAJOR CARPS C.catla	L.rohita	C.mrigala	L.Calbasu	Total	Minor carps	Others
I	1	Aug.8	501	1	0.4	3.2	0.3	-	3.9	96.1	-
	2	" 28	269	1	-	3.0	0.4	-	3.4	96.6	-
	3	Sept.1	258	1	-	1.1	0.8	-	1.9	98.1	-
	4	Aug.11	205	2	-	0.5	-	-	0.5	99.0	0.5
	5	Aug.20	134	2	-	5.9	-	3.7	9.6	90.4	-
	6	Aug.28	371	2	2.2	6.5	0.3	2.7	11.7	88.0	0.3
	7	Sept.1	975	3	0.7	6.6	-	0.2	7.5	92.5	-
Weighted average			2713		0.6	4.5	0.2	0.6	5.9	94.0	0.1
II	No rearing could be done										

FIG. RS 5-25 — FLUCTUATIONS IN SPAWN QUALITY IN RESPECT OF 'MAJOR CARPS', 'MINOR CARPS' AND 'OTHERS' SHOWN AS PERCENTAGES OF DAILY AVERAGE OVER THE DAYS OF SPAWN AVAILABILITY.



The not very marked difference in the spawn quality as revealed by analysis of spawn and reared samples, depicted in Tables RS7-52 and RS8-53 respectively is partly attributable to the differential mortality amongst various fish species in nurseries and partly due to the difficulty in correct identification of major and minor carps at spawn stage.

Filtered off associates

Associates quantity in relation to floods

Table RS9-54 indicates the catch per net per hour of filtered off associates in Midnapore and departmental nets during all the five floods and during the intervening periods. The table reveals that the number of associates caught by Midnapore nets were much higher than the departmental nets throughout, the ratio between Departmental and Midnapore nets varying between 1:1.2 and 1:5.6. With the advancement of the monsoon season the associates quantity decreased to a large extent.

Table RS9-54

Catch per net per day of associates in numbers

Flood period etc.	Midnapore nets	Departmental nets	Ratio of Departmental & Midnapore nets D:M.
I	55.2	26.7	1:2.1
II	50.9	24.6	1:2.1
Period between II & III Floods	135.1	84.1	1:2.8
III	31.8	25.9	1:1.2
Period between III & IV Floods	nil	nil	nil
IV	9.5	1.9	1:5.0
Period between IV & V Floods	4.8	2.0	1:2.4
V	9.4	0.6	1:5.6
Later period	nil	nil	nil
	Average ratio D : M = 1:2.3		

Associates quality in relation to floods

In Flood I, in the period of availability, Glassogobius giuris, Puntius ticto and Prawns constituted 31.9, 17.7 & 10.4% of associates respectively, while in the period of non-availability, Chela spp. Puntius ticto and Prawns formed 34.7, 21.1 and 3.6%. In Flood II, during spawn availability period the dominent form was Puntius ticto (27.7%) followed by G.giuris (15.7%), Ailia coila (10.8%) and Chela species (10.1%). Prawns formed only 2.2% in this period. During spawn non-availability period of this flood A.coila constituted 14.4%, Pseudotropius murius 13.9%, Chela spp. 11.3% and Gagata cenia 10.8%. Prawns quantity had increased upto 4.3%.

In the rest of the floods there was no period of availability of spawn. In floods III & IV Puntius sophore dominated (16.9 and 31.4% respectively) while in Flood V the dominant form was Barilius barila (18.8%). During the intervening period of second and third Floods P.sophore and G.cenia constituted 19.5 and 15.2%, while in period between Floods IV & V B.barila itself formed 43.0%.

Gut contents of associates

In Floods I & II during the spawn availability period the presence of spawn in the guts of associates was quite preminently seen than in the non-availability period. Throughout the season debris constituted the main item of gut content. After first two floods, the occurrence of debris in guts increased to a great extent with the decrease in spawn quantity. Plankton was not encountered in guts in appreciable quantity while fish matter, prawns and insects were negligible.

Net selectivity

Net selectivity for spawn

To study the relative efficiency of shooting nets, two types of nets, Midnapore (1/8" mesh) and Departmental nets (1/22" mesh) were operated simultaneously. To nullify the effect of position of any net over the others in relation to the river current and the distance from the bank, their positions were randomised from day to day. Table RS10-55 gives the floodwise catch in numbers of Midnapore and Departmental nets, further split up into catches taken in day (6 A.M. to 6 P.M.) and night (6 P.M. to 6 A.M.). The ratio derived between Departmental and Midnapore nets, shown in column 6 of Table RS10-55 reveals that in Flood I the ratio was D:M = 1:1.7 while in Flood II it was 1:2.7. The average current velocity in

Flood I was about 1.5 km/hour and Flood II 0.8 km/hour, showing that 1/8" Midnapore nets are less effective in faster current.

Table RS10-55

Spawn catch (by numbers) per net per hour of different nets

Flood No.	CATCH PER NET PER HOUR IN NOS M Day	M Night	D Day	D Night	Flood-wise ratio of Departmental and Midnapore net. D:M
I	1418	1719	827	979	1:1.7
II	542	265	155	143	1:2.7

Table RS11-56 gives the day to day catch per net in numbers for Departmental and Midnapore nets alongwith their daily ratio. It is evident that the catch ratio between the two nets fluctuated between 1:1.4 and 1:2.0 in Flood I and between 1:2.5 and 1:3.0 in Flood II.

The catching efficiency was further tested statistically for the period July 9-14 by applying the 't' test criterion for testing the equality hypothesis.

The result thus obtained were:-

D & M: 't' = 2.22 on 94 d.f. p .05. The difference being significant, it may be stated that at 5% level of significance the Midnapore net is better than the Departmental.

The last entry in column 5 of Table RS11-56 indicates the catching efficiency of the two types of nets for the entire season showing that the Midnapore nets were over one and half times more effective than the Departmental nets.

Table RS11-56

Day to day catch per net per hour by numbers

Flood No.	Date in 1964	Departmental net.	Midnapore net	Ratio between Departmental & Midnapore nets D : M
1	2	3	4	5
I	9th July	3508	4816	1:1.4
	10th July	1917	3533	1:1.8
	11th July	1100	2140	1:1.9

1	2	3	4	5
	12th July	975	1402	1:1.4
	13th July	490	986	1:2.0
	14th July	353	500	1:1.4
Weighted Average		1806	3137	1:1.7
II	17th July	300	1283	1:2.5
	18th July	100	300	1:3.0
Weighted Average		298	807	1:2.7
ENTIRE SEASON				1:1.58 or 0.63:1

Net selectivity of associates

Table RS12-57 shows the catch per net per hour in numbers of the associates taken in different nets in different floods. In Floods I and II it is observed that the associates caught in Midnapore nets were approximately twice in quantity than of the Departmental nets. In subsequent floods, when there was no spawn available the collection of associates in the two types of nets was approximately equal.

Table RS12-57

Associate catch in numbers per net per hour

Flood Nos. etc.	Catch per net per hour			
	Midnapore nets		Departmental nets	
	Day	Night	Day	Night
1	2	3	4	5
I	2.6	2.1	1.2	1.2
II	2.0	2.3	0.9	1.1
Period between II & III Floods	4.3	1.9	4.5	1.5
III	1.5	1.5	1.6	0.7
Period between III & IV Floods	nil	nil	nil	nil

1	2	3	4	5
IV	0.5	0.2	0.2	nil
Period between IV & V Floods	0.4	neg	0.2	nil
V	0.7	neg	neg	nil
Later period	nil	nil	nil	nil

Recommendations for spawn collection in the surveyed stretch of River Ramganga

In the 70 km stretch of the River Ramganga from Moradabad to Shahabad (figure I inset I) the sites examined in detail for spawn prospecting investigations in 1964 were Tajpur, Harthala and Shahabad, and in the 80 km stretch from Bareilly to Allahaganj (figure I inset I) the sites examined were Garhi-Aurangabad, Sithauli-Kulaghat, Saidpur, Manjha and Sardarnagar.

In the stretch Moradabad-Shahabad the site successfully investigated was at Tajpur, the main point favouring the selection being its proximity to an all-weather road and a large town, Moradabad. Shahabad is located at a distance of about 55 km from Moradabad on an all weather road and presents a good site for spawn collection. The site at Harthala was rejected on account of its inaccesibility from an all weather road during the monsoon.

In the stretch Bareilly to Allahaganj the site successfully located was at Sardarnagar selected due to its closeness to an all weather road and the town Bareilly. Garhi-Aurangabad is also considered a suitable site for spawn collection. It is readily accessible by an all weather road from Bareilly via Jalalabad at a distance of about 80 km. from Bareilly. The sites at Sithauli-Kalaghat and Saidpur were rejected because of their inaccessibility during the monsoon. The former is at a distance of about 13 km from Bareilly-Shahjahanpur all weather road and the latter at a distance of about 22 km from the same road. The site at Manjha was actually investigated during the early part of the season but was abandoned due to heavy bank erosion by Ramganga.

As revealed and exemplified by the spawn collection at Tajpur and Sardarnagar the sites at Shahabad and Garhi-Aurangabad are also recommended for exploitation on the River Ramganga. The quality of Ramganga seed being poor, it can be compensated by quantity to a certain extent. In view of the rather low major carp content of Ramganga spawn in the stretches Moradabad-Shahabad and Bareilly-Allahganj, it is recommending that the deep pools in both the stretches be stocked with major carps to build up a sizeable major carp population.

As flood and consequent hydrographical condition change from year to year such precautions as are stated in 'Discussions and conclusions' in this report relevant to spawn collection, should, however, be exercised for successful spawn collection.

V E. BALUHA ON RIVER TONS

ABSTRACT

Spawn prospecting investigations were conducted in River Tons at Baluha (Allahabad) from June 24 to September 9, 1964. During the entire season only 4½ ozs. of spawn were available, on three days, during Floods III & IV. Two-hourly samples were analysed for the study of spawn quality. The main reasons for non-availability of spawn have been discussed. Although results of investigations at Baluha during the season are poor, it appears likely that investigations if conducted at spots where suitable current is available on Tons, will prove fruitful.

LOCATION AND FACILITIES

Baluha is located on Tons, a tributary of River Ganga. It lies 33 km East of Allahabad on the Allahabad-Mirzapur all-weather road. The collection site is situated on the Eastern Bank of Tons. Figure TB1-26* shows the river terrain and topography within a radius of 12 km of the collection site.

OBSERVATIONS AND RESULTS

Spawn prospecting investigations, which were conducted from June 24 to September 9 at Baluha, along identical lines as at other centres, yielded only 4½ ozs. of spawn in the season. Table TB1-59 shows average daily values of flood level, turbidity air and water temperatures, pH, D.O. and flood-wise spawn yield. Five floods occurred in river Tons at Baluha in the season. The maximum levels, with reference to base level, were recorded as 5.99 m only July 13, 5.44 m on August 2, 9.68 m on August 19, 9.85 m on August 29 and 8.96 m on September 6. Spawn was available on only two days, viz. 2 ozs. on August 16 in the rising phase of Flood III and 2½ ozs on August 26-27 in rising phase of Flood IV. Figure TB2-27 shows day to day fluctuations of water level,

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* 'T' stands for river Tons. 'B' stands for Baluha.

The first number in the Tables and Figures depicts the number in the chapter and the second in the report as a whole.

turbidity and spawn collection. The salient hydrodynamical feature of river Tons in its lower reaches, where Baluha is situated, in 1964 monsoon was that although water level rose by about 10 m, negligible current was observed on most of the days except on few when it ranged between 0.26 and 1.5 km per hour. The average current velocity on August 16 and 26 and August 27, the days of spawn collection, was mild and 1.1 km/hour respectively. The value of turbidity in Tons ranged from 100 to 529 ppm recorded on August 14/15 and July 22 respectively. No spawn was collected on any of these days.

The two hourly spawn samples preserved on the days of their availability on analysis showed the daily major carp content as 7.7% on August 16, 18.5% on August 26 and 34.2% on August 27. The minor carp content of spawn on these three days was 92.3, 67.7 and 45.2% respectively. 'Others' constituted nil, 13.8% and 20.6% on the above days respectively. The two hourly analysis showing spawn quality in the three above-stated categories is shown in Table TB2-60 which shows that relatively higher major carp contents were recorded in samples collected at 20, 2 and 4 hours on August 26 and at 6,8 and 10 hours on August 27. In view of poor spawn yield at Baluha no rearing in nurseries was attempted.

Contrary to expectations Baluha on River Tons yielded poor results, the seasonal index of spawn quantity of the centre being only 1 oz.

Seeing the poor spawn yield at Baluha in July the causes were sought after and a survey of river stretch including nallas, low lying areas and back waters etc over a 20 miles stretch, upstream from the confluence of Tons with River Ganga up to village Kaurihar was conducted. The following appear to be the causes leading to the failure of Baluha as a spawn yielding centre.

i) Tons is a rivulet compared to a large river like Ganga. The location of the collection site in close proximity of the confluence of Tons and Ganga was such that the flow from Tons into Ganga depended largely upon the level of Ganga which in 1964 monsoon remained consistently higher than that of Tons.

ii) Non-generation of flow and resultant velocity was undoubtfully a major cause for non-availability of spawn. In fact 'lagoon' conditions prevailed in a stretch of over 20 miles, throughout the period of investigations converting the river into a virtual lake.

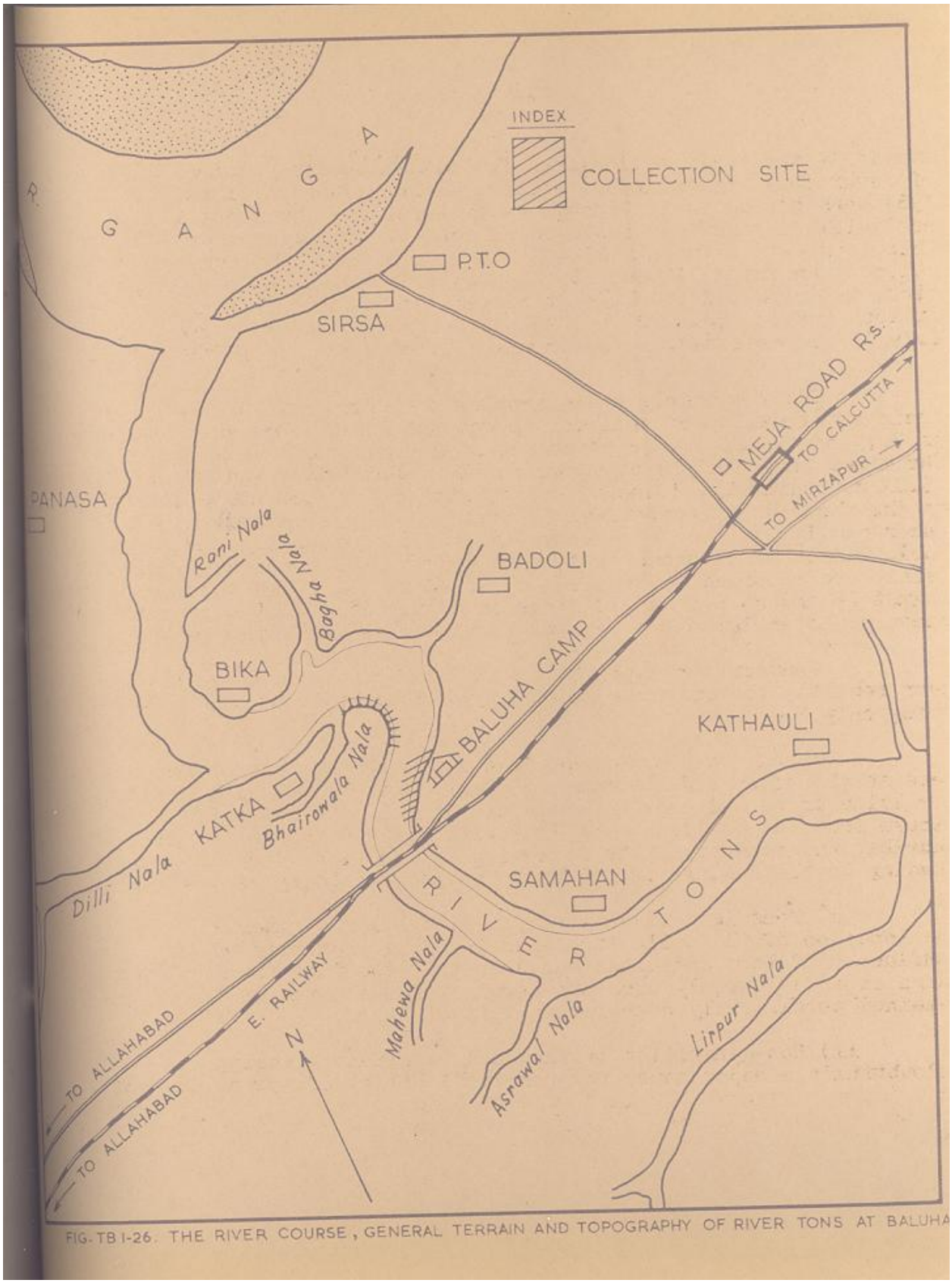

FIG. TB I-26. THE RIVER COURSE, GENERAL TERRAIN AND TOPOGRAPHY OF RIVER TONS AT BALUHA

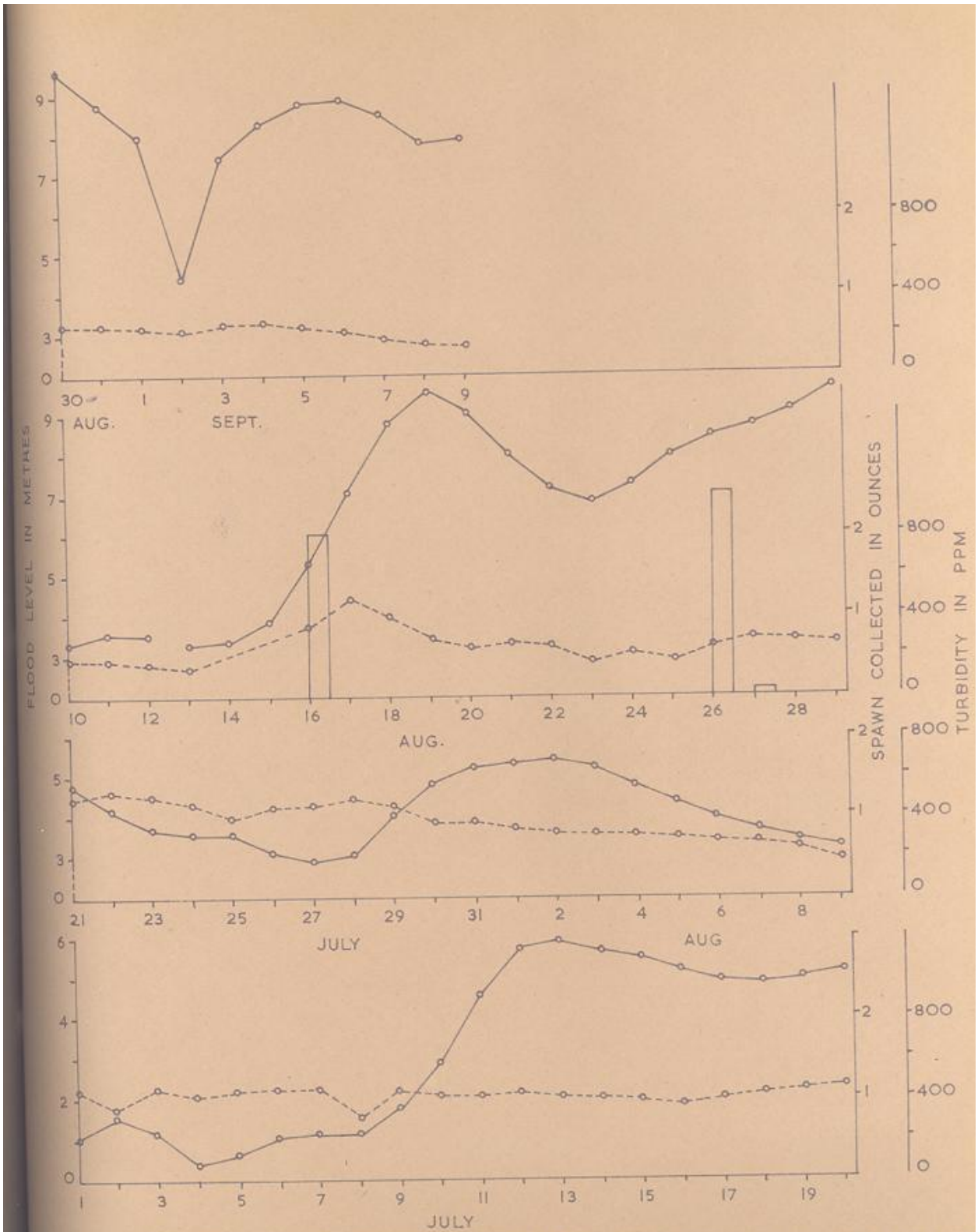

FIG. TB 2-27 — FLUCTUATIONS IN AVERAGE DAILY FLOOD LEVEL AND TURBIDIT OF RIVER TONS AT BALUHA WITH SPAWN QUANTITY SUPERIMPOSED ON THE DAYS OF AVAILABILITY.

iii) Availability of suitable breeding grounds along the river stretch is an important factor for carp breeding in a natural habitat.

The survey mentioned above shows that a portion of 2-3 miles of river bed near Chak ghat and Gau ghat (Tons Aqueduct) is rocky. Similar terrain is also reported above Chak ghat in Madhya Pradesh.

iv) Major carp landings are, however, reported from Tons regularly and were actually seen at Chak ghat on one occasion in July 1964. These fish, therefore, must be breeding at suitable spots somewhere along the river course of Tons although fingerling collections are not known.

v) The obvious conclusion from the above is that perhaps tributaries like Tons do not empty their load of spawn into the parent stream but largely retain their spawn within the limits of the stream itself. This is because the river turns into a lake due to 'algoon' conditions which prevail in the last stretch of over 20 miles, up to its confluence with Ganga, preventing the drifting movement of spawn.

For spawn investigations in Tons in 1964 Samahan and Baluha were the only sites examined in the pre-monsoon survey of which Baluha was selected due to its rather favourable situation from the point of view of communications. None of these sites are recommended for spawn collection.

Table TB1-59

Daily averages of Flood level, Turbidity, Air and Water Temp., pH and D.O. and total Spawn catch in the river Tons at Baluha.

Date year 1964	Flood level in Metres	Turbi-dity in ppm	Air Temp water temp. in °C	pH	D.O. in ppm	Total catch of spawn in ozs	Floodwise spawn in ozs and percen-tage in total
1	2	3	4	5	6	7	8
July							
1	1.09	448	30.4/29.9	7.9	5.72	nil	
2	1.56	353	29.9/29.9	7.9	-	nil	
3	1.19	448	32.5/30.3	7.9	4.84	nil	
4	0.43	417	30.5/30.1	7.9	-	nil	
5	0.69	448	29.3/30.0	7.9	5.72	nil	
6	1.05	457	28.7/29.5	7.9	-	nil	
7	1.22	466	30.7/29.7	7.9	5.72	nil	
8	1.22	319	30.6/29.6	7.9	-	nil	
9	1.81	446	29.3/29.4	6.8	5.28	nil	
10	2.95	428	28.6/29.5	6.8	-	nil	
11	4.65	423	28.4/29.5	6.8	5.28	nil	
12	5.82	448	27.8/29.4	6.8	-	nil	Nil
13	5.94	431	27.8/29.1	6.8	5.28	nil	
14	5.73	423	27.6/28.8	6.8	-	nil	
15	5.54	411	28.8/29.4	6.8	5.72	nil	
16	5.24	366	28.8/29.2	6.8	-	nil	
17	4.99	411	29.0/29.2	6.8	6.6	nil	
18	4.88	434	29.0/29.5	6.8	-	nil	
19	5.07	467	28.0/30.0	6.8	5.28	nil	
20	5.18	473	31.1/30.8	6.8	-	nil	
21	4.79	495	31.1/30.3	6.8	5.72	nil	
22	4.17	529	30.7/30.5	6.8	-	nil	
23	3.71	514	28.7/30.5	6.4	5.72	nil	
24	3.58	474	27.9/30.2	6.8	-	nil	
25	3.55	400	29.8/30.4	6.8	5.72	nil	
26	3.15	457	29.5/30.4	6.8	-	nil	
27	2.90	457	27.1/29.7	6.8	5.72	nil	
28	3.08	500	28.5/29.6	6.8	-	nil	
29	4.08	454	27.8/29.3	6.8	6.16	nil	

1	2	3	4	5	6	7	8
30	4.88	387	29.6/29.8	6.8	-	nil	
31	5.29	379	29.9/30.5	6.8	6.16	nil	
August							
1	5.33	343	30.4/31.0	7	-	nil	
2	5.41	321	30.5/30.8	7.1	6.60		
3	5.26	319	31.2/31.2	7.3	-	nil	
4	4.82	321	31.3/31.3	7.1	6.16	nil	
5	4.39	308	29.7/31.3	7.0	-	nil	Nil
6	3.99	281	31.6/31.5	7.0	6.16	nil	
7	3.68	278	31.0/30.8	7.3	-	nil	
8	3.42	261	30.7/30.5	7.3	5.82	nil	
9	3.25	187	31.7/32.3	7.3	-	nil	
10	3.35	191	31.7/32.1	7.3	5.82	nil	
11	3.59	189	29.5/31.5	7.3	-	nil	
12	3.51	170	28.7/30.6	7.3	5.82	nil	
13	3.30	146	29.6/31.0	7.3	-	nil	
14	3.38	< 100	26.5/30.0	7.3	-	nil	
15	3.86	< 100	28.8/30.4	7.9	4.95	nil	
16	5.31	347	27.0/29.1	8.2	-	2.0	
17	7.12	480	26.5/27.6	7.5	-	nil	
18	8.81	400	27.8/27.7	6.8	4.95	nil	2 ozs
19	9.59	288	27.0/28.0	6.8	-	nil	(44%)
20	9.09	240	27.9/28.4	6.8	-	nil	
21	8.04	262	28.4/29.8	6.8	4.95	nil	
22	7.18	250	28.7/29.6	6.8	-	nil	
23	6.83	175	28.8/29.7	6.8	5.72	nil	
24	7.28	223	28.0/29.5	6.8	-	nil	
25	8.00	175	26.9/29.7	6.8	5.28	nil	
26	8.49	248	27.0/29.1	6.8	-	2.5	
27	8.75	295	27.5/28.3	6.8	-	few	
28	9.05	280	27.5/28.7	6.8	5.72	nil	
29	9.68	263	28.4/29.1	6.9	-	nil	2.5 ozs
30	9.60	227	29.2/29.7	6.9	5.82	nil	(56%)
31	8.80	227	27.8/29.3	7.0	-	nil	
September							
1	7.99	248	28.1/29.7	7.0	-	nil	
2	7.42	222	27.7/30.0	6.9	5.72	nil	
3	7.47	262	27.0/29.0	7.0	-	nil	Nil
4	8.30	265	27.3/29.7	7.0	-	nil	

1	2	3	4	5	6	7	8
5	8.82	242	28.6/29.7	7.9	5.72	nil	Nil
6	8.90	221	28.5/30.2	7.1	-	nil	
7	8.51	179	29.0/30.0	7.3	-	nil	
8	7.83	153	27.6/30.0	7.3	5.30	nil	
9	7.99	142	26.8/29.8	7.3	-	nil	

1. Flood levels have been measured in reference to summer level, taking July 1, 6 AM as first reading.

2. The averages of flood level, Air temperature and water temperature, are based on 12 observations taken every two hours from 6 A.M. to 4 A.M. next calender day.

3. The averages of turbidity are based on 7 observations taken two hourly from 6 A.M. to 6 P.M.

4. The averages of pH are based on 2 observations taken every day at 6 A.M. & 6 P.M.

5. Dissolved oxygen was estimated every 2nd day from 1.7.64 and every 3rd day from 15.8.64 to 9.9.64 at 6 A.M.

Table TB2-80

Percentage distribution of Major Carps, minor carps, and others in 2 hourly Spawn Samples

Flood No.	Phase	Date in 1964	Percentage of	HOURS OF OBSERVATION 6	8	10	12	14	16	18	20	22	0	2	4	Average for the day	Spawn catch in (ozs)
III	Rising	16.7	Mj	0	0	0	0	6.0	10.0	11.0	1.0	14.0	4.0	0	0	7.7	
			Mi	0	0	0	0	94.0	90.0	89.0	99.0	86.0	96.0	0	0	92.3	2
			O	0	0	0	0	0	0	0	0	0	0	0	0	0	
IV	Rising	26.8	Mj	0	0	0	0	0	0	1.8	27.7	11	7.5	39.0	24.0	18.5	
			Mi	0	0	0	0	0	0	88.2	49.3	89	75.5	39.0	65.0	67.7	2½
			O	0	0	0	0	0	0	10.0	23.0	0	17.0	22.0	11.0	13.8	
V	Rising	27.3	Mj	42.3	21.5	38.7	0	0	0	0	0	0	0	0	0	34.2	
			Mi	49.7	36.5	49.3	0	0	0	0	0	0	0	0	0	45.2	Neg.
			O	8.0	42.0	12.0	0	0	0	0	0	0	0	0	0	20.6	

V F. GONRIBABA (BANDA) ON RIVER KEN

Spawn prospecting investigations at this centre were commenced on July 1 along identical pattern as at other centres but had to be terminated and the centre abandoned on July 28 on account of the poor spawn yield and meagre chances of success. The following paragraphs present only the significant features of the work done, results achieved and conclusions drawn from the work at Gonribaba.

Gonribaba is situated on the Eastern bank of River Ken about 7 km from Banda and is connected with it by a fair weather road passing through ravines. The river course at Gonribaba as well as the general terrain and topography of the area are shown in Fig.KG1-28*. Spawn prospecting observations at this centre, as stated above, lasted from July 1 to July 27 yielding 1½ ozs of spawn only. Daily average two-hourly observations in respect of flood level, turbidity, pH, dissolved oxygen, air and water temperatures, alongwith spawn catch, whenever taken, are shown in Table KG1-61. River Ken at Gonribaba had two major floods on July 8 and 13 when the water level rose by 4.0 and 3.28 metres from the base registering a rise of 3.43 m and 2.97 m from the previous 'low' levels respectively. Maximum amount of spawn (1.1 ozs) from the centre was collected on July 13. The maximum average turbidity (707 ppm) was recorded on July 1, when no spawn was available. The average turbidity on July 12(the day previous to spawn collection) was 515.7 ppm which was the next highest during the period of observation. Major carp hatchlings or fry were absent in the little collection which was made in the season, the overwhelming bulk of the collection consisting of minor carps (89.44%) and others (10.56%).

On critical examination of the relevant factors responsible for quality fish seed yield, it was found that mature specimens of major carps are not known to occur for considerable distance upstream of Gonribaba. Only stray yearlings of major carps, which were immatures, have been recorded. A wide variety of miscellaneous species, mostly of uneconomic varities of fish, are known to occur in

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* 'K' stands for river Ken; 'G' stands for Gonribaba;
The first no. in the Tables and Figures depicts the number in the second in the report as a whole.

the river Ken. The chances of success, if work were continued at Gonribaba, were extremely meagre. The river Ken presents characteristics of hill streams where fluctuation in water level were very abrupt and the turbidity compared to more productive Jamuna centres (Average 661 ppm), relatively much lower (Average 312.65).

Table KG1-61

Daily averages of flood level, turbidity, air and water temp., pH, D.O. and total spawn catch in the river Ken at Gonribaba (Banda).

Date year 1964	Flood level in Metres	Turbidity in p.p.m.	Air Temp. water temp. in °C	pH	D.O. in ppm	Total catch of spawn in ozs	Floodwise spawn in ozs and percentage in total
1	2	3	4	5	6	7	8
July							
1	0.77	707.11	31.0/30.0	8.0	6.16	nil	
2	0.73	380	31.43/29.5	8.0	-	nil	
3	1.27	378.57	31.12/30.0	7.0	-	nil	
4	0.64	141.28	30.2/30.0	7.15	5.5	nil	
5	0.85	265	30.3/30.0	7.15	-	nil	
6	0.69	324.2	28.0/29.5	7.3	-	nil	
7	1.15	225	29.46/29.46	7.15	6.16	nil	
8	2.93	440	29.83/29.5	7.15	-	stray	Stary
9	1.46	484.48	28.08/28.2	7.15	-	nil	
10	0.62	322.85	28.58/28.5	7.0	6.16	nil	
11	0.63	410	27.2/28.33	7.0	-	nil	
12	2.3	515.7	28.0/28.25	7.3	-	0.314	
13	2.85	354.28	29.0/28.3	7.3	6.6	1.111	1.593
14	2.37	332.8	27.5/28.13	7.0	-	0.168	(100%)
15	1.55	318.5	28.3/28.0	7.0	-	stray	
16	1.4	277.14	30.46/29.08	7.0	7.04	nil	
17	0.95	290.7	29.54/29.6	7.0	-	nil	
18	0.58	260	29.6/29.6	7.0	-	nil	
19	0.42	219.28	29.4/30.4	7.0	6.38	nil	
20	0.45	227.85	31.6/31.46	7.0	-	nil	
21	0.68	222	31.0/31.33	7.15	-	nil	

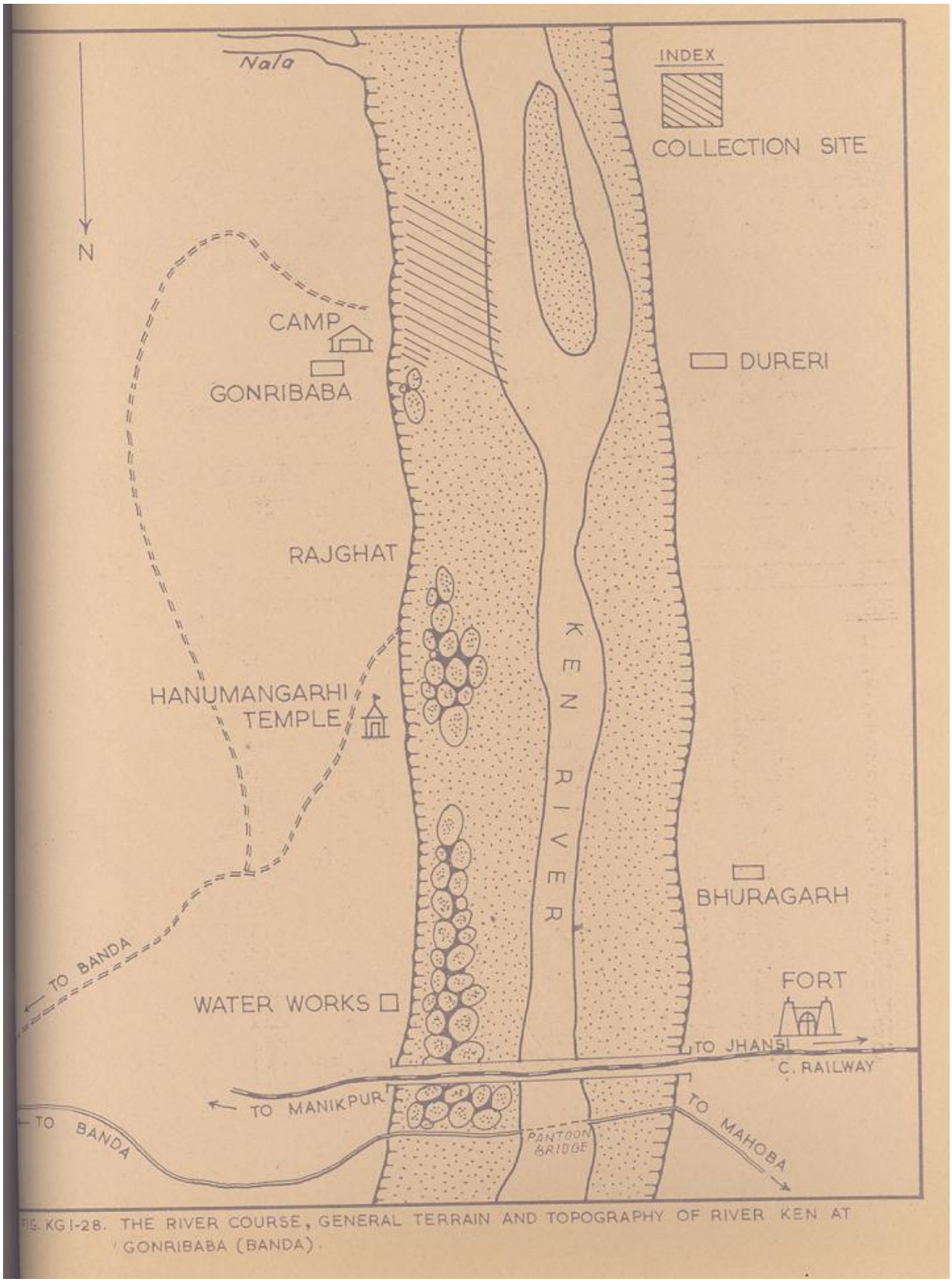

FIG. KG I-28. THE RIVER COURSE, GENERAL TERRAIN AND TOPOGRAPHY OF RIVER KEN AT GONRIBABA (BANDA).

1	2	3	4	5	6	7	8
22	0.68	230	31.0/31.0	7.0	6.16	nil	
23	0.47	255	28.8/30.0	7.15	-	nil	
24	0.76	189.57	29.54/30.5	7.0	-	nil	
25	2.03	222.3	30.25/30.97	7.0	6.16	nil	
26	1.73	205.71	28.0/28.25	7.0	-	nil	
27	1.38	212.85	30.0/28.3	7.0	-	nil	

Observations on stretches and sites on the River Ken and Betwa covered in the pre-monsoon survey.

River Ken

As no suitable spawn collection centres have so far been located on River Ken in District Banda and the area is a fishseed deficit one, an extensive premonsoon survey was conducted from May 3 to 10, 1964. A stretch of over 55 km of the river from Banda to its confluence with Jamuna, near village Chilla, was covered during the survey. It was observed that River Ken is a small, shallow and narrow (80'-200' width) stream in the above stretch, generally with 50'-60' high, steep and precipitous banks. Its bed is sandy and covered with rocks and boulders at places and is chocked with weeds, mainly Hydrilla and Vallisneria in a 5 mile stretch near Chilla. Except for seasonal rivulets Chandrawal and Gawain and Turi nala, there are no other confluences. The fish catches are reported to consist of Wallago attu, Mystus spp. and only Labeo calbasu among the carps.

Bhuragarh (Banda), Achhraund, Alona, Khaptiha-Kalan, Pailani, Chilla and Gonribaba were the sites examined during the premonsoon survey. Of these, Khaptiha-Kalan was rejected due to inaccessibility and Alona for non-availability of suitable area for operating shooting nets. Though suitable embankments were available near Pailani, Dighwat (Chilla) and Achhround, they had to be rejected as either the villages were entirely cut off or the embankments were completely under water, during monsoon. Bhuragarh (Banda) and Gonribaba sites were comparatively better and presented no unsurmountable difficulties. Gonribaba was selected for investigations in preference to Bhuragarh since the latter had already

been exploited by the state Government and reported to be unsuitable due to poor collections. However, the results obtained at Gonribaba, were so poor that the site was abandoned even during the course of 1964 season, as reported earlier. The entire stretch of river Ken from Banda to Chilla is therefore, unsuitable for spawn collection.

Rivulets Baghain (near Attara) and Paisuni (near Karvi) and Garara nala (village Murawal) and a portion of river Jamuna, on the opposite bank of Rajapur (village Mahewa) were also surveyed in District Banda. None except the site at Mahewa on Jamuna was adjudged suitable for spawn collection and Garara nala for fry and fingerling exploitation. The site Mahewa on Jamuna was investigated and its detailed account has already been given earlier in this report.

River Betwa

A similar pre-monsoon survey of a 93 km stretch of river Betwa was also conducted in District Hamirpur from April 30 to May 11, 1964. During the 12-day survey 11 centres namely Erachh ghat, Dhi-kauli ghat, Dehri ghat, Bhurasenda ghat, saidnagar, Kotra ghat, Mohana ghat, Tikar, Chandaut, Bheri and Hamirpur were examined.

Betwa is mostly rocky and covered with boulders at places and has high and precipitous banks. The average width of the river is about a mile but the water stretch in summer is only a few furlongs wide. It is a shallow river with deeper pools having 10-30' column of water. No fishing was being done at any of the above 11 centres except at Mohana ghat, where 5 fish (all C. mrigala) weighing 3-4 kg each, were caught by a few fishermen with gill nets. On inquiry it was found that 60% of catches consist of Major carps, C. mrigala forming the major fishery of the river.

Out of the above 11 villages surveyed, only three centres i.e. Erachh ghat, Mohana ghat and Hamirpur are accessible in monsoon. The remaining 8 centres which are situated in the remote interior, have no camping facilities and get cut off during rains. Of the three approachable centres, Erachh was rejected as the actual spot for spawn collection is about 4 miles down stream, in village Dheri, which is cut off in rains.

Moreover, there is no suitable or safe place for camping in Dehri. Mohana ghat is unsuitable due to 20-30' high steep banks and non-availability of embankments with gradual slope. Hamirpur centre was not considered as the site would be under water during 3rd flood. Moreover, earlier investigation by Central Fisheries at Hamirpur had yielded indifferent results.

The topography of river Betwa i.e. rocky terrain, steep and precipitous banks, covered with boulders and construction of 3 dams (i.e. Mata tilla, Sukwa-Dukwan and Parichha) up-stream, have affected the natural normal flow of the water. It is reported that the water from the catchment is first utilized in filling the above 3 dams and is released in the main river eratically. On account of the above stated undersirable conditions no site was investigated on River Betwa in 1964.

V G. SISODRA ON RIVER NARBADA

ABSTRACT

A total of 1158 ounces of spawn, estimated at over 100 lakh hatchlings, were collected during the investigations on carp seed resources in River Narbada at Sisodra lasting from 1.7.64 to 5.9.64. Five floods viz. II, V, VI, IX and X, out of ten, yielded 97.9% of the entire season's spawn. The highly productive floods, V and VI contributed 81.0% of the seasonal catch. The rearing of spawn from floods V, VI and IX, which contributed 83.4% of the total yield at the centre showed 70.6% major carps and the analysis of spawn from the corresponding floods revealed 67.9% major carps. Hydrodynamical, chemical, meteorological and hydrobiological characters in relation to spawn quantity and quality have been studied. In almost all the floods spawn first appeared in their rising phases and it was invariably collected in abundance during the receding phases of the floods. The first one or two days of the receding phases yielded maximum spawn containing high percentage of major carps. The floods rising above and receding below 19 meters from river bottom yielded spawn in abundance. During periods of spawn availability, high catches of spawn in the nets were governed by water velocity, turbidity and net mesh. Midnapore nets, on an average, were found to be 8.4 times more efficient than the Gujarat nets. Even at investigational stage, 917 ozs (i.e. over 90 lakh) of spawn, containing about 55 lakh major carps, were lifted from Sisodra centre by Gujarat Fisheries Department for fisheries development.

LOCATION AND FACILITIES

Sisodra is located on the West (left) bank of the River Narbada in Rajpipla Taluka of Broach District in Gujarat State. The nearest railway station is at Sinor across the river at a distance of 3 km. Silodra is conveniently connected via Sinor and Dabhoi by road and via Sinor and Miyagam by rail with Baroda, Rajpipla, Surat, Broach and other big towns of Gujarat. There is a local branch post office at Sisodra for once a day service only. The village is served by the telegraph office at Sinor. The Block office serving Sisodra is located at Rajpipla, the Taluka headquarters. The river course at Sisodra and the general location of the centre on Narbada are shown

in Figure NSI-29*. The bed of Narbada, on its left bank, at Sisodra is a gradually slopong sandy stretch and the East bank, opposite to Sisodra (Sinor side), is highly preciptious. A big 'nallah' joins the River Narbada on the West bank downstream of Sisodra (Figure NSI-29). In summer, the river in this stretch flows along the East bank, where it is deep. With the influx of the floods during monsoon the sandy river bed, with gradual slope, along West bank at Sisodra is inundated while the river along the East bank becomes very deep. The course of Narbada in the vicinity of Sisodra is S-shaped. The main current after striking the precipitous portion of the East bank near Kanjetha village, upstream of Sinor, follows roughly a diagonal course and strikes the West bank at village Kandod, downstream of Sisodra, where also the bank is precipitous. A portion of shallow, sandy river bed on the West bank near Sisodra (marked in Figure NSI-29), which lies adjacent to the main current, offers a suitable spawn collection ground.

OBSERVATIONS AND RESULTS

Observations on the availability of fish seed were made at Sisodra on 66 days from 1.7.64 to 5.9.64. The day-to-day averages of the two-hourly observations (6 A.M. to 4 A.M. of the following date) in respect of flood level, turbidity, air and water temperature, pH, dissolved oxygen and daily spawn yield in ounces for the entire period of observations are presented in Table NSI-62.

Spawn quantity in relation to environmental factors

The total spawn yield from all the nets (irrespective of their dimensions and mesh sizes) operated at Sisodra centre during 1964 monsoon season is shown date-wise in Figure NS2-30. The break up of the catches from Midnapore and Gujarat nets has also been depicted in this figure. T he analysis of relative yields of spawn from these two types of nets discusses elsewhere in this report.

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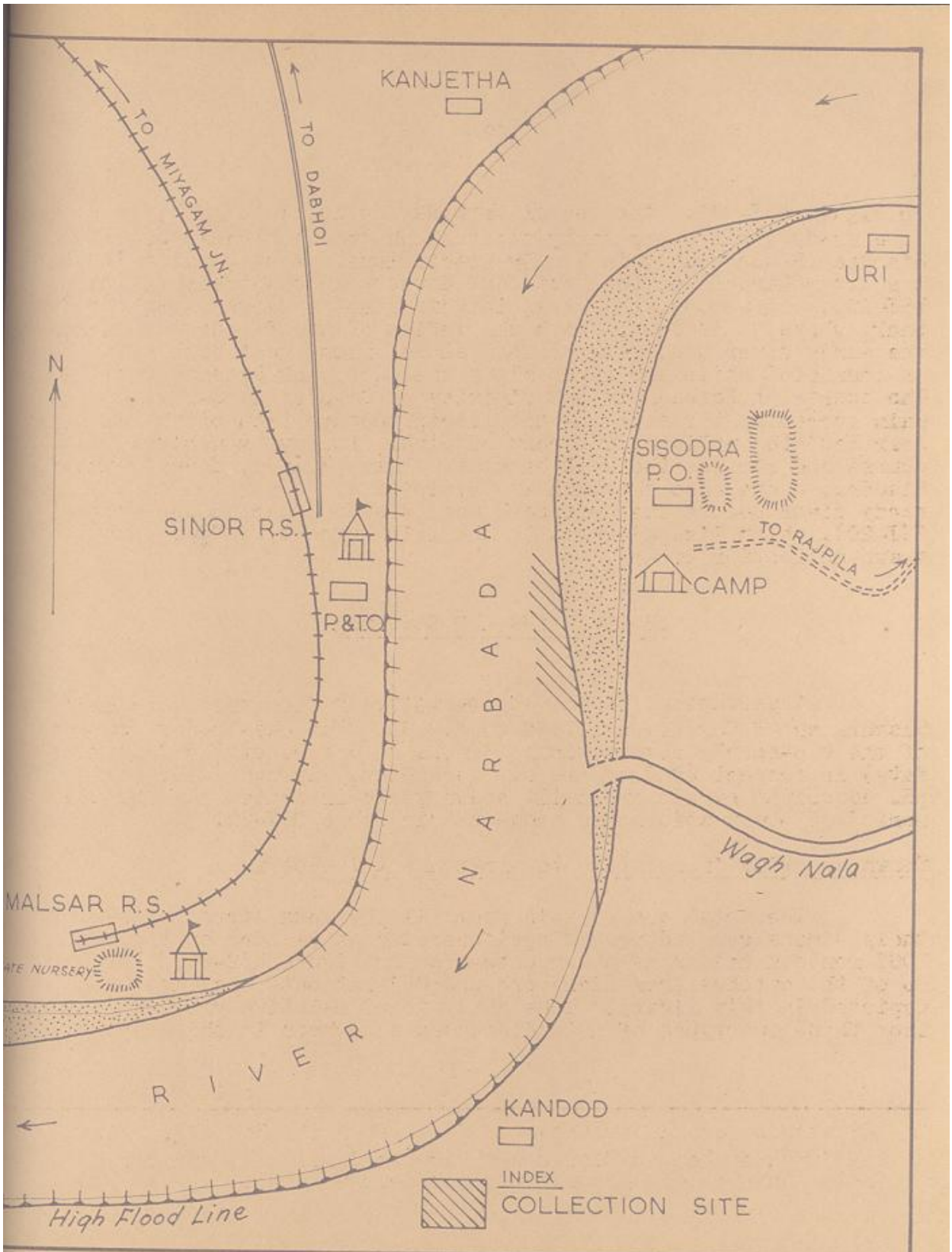
* 'N' stands for River Narbada, 'S' stands for Sisodra, the first number in Tables and Figures depicts the number in the chapter and second in the report as a whole.



SI-29. THE RIVER COURSE, GENERAL TERRAIN AND TOPOGRAPHY OF RIVER NARBADA AT SISODRA (GUJARAT)

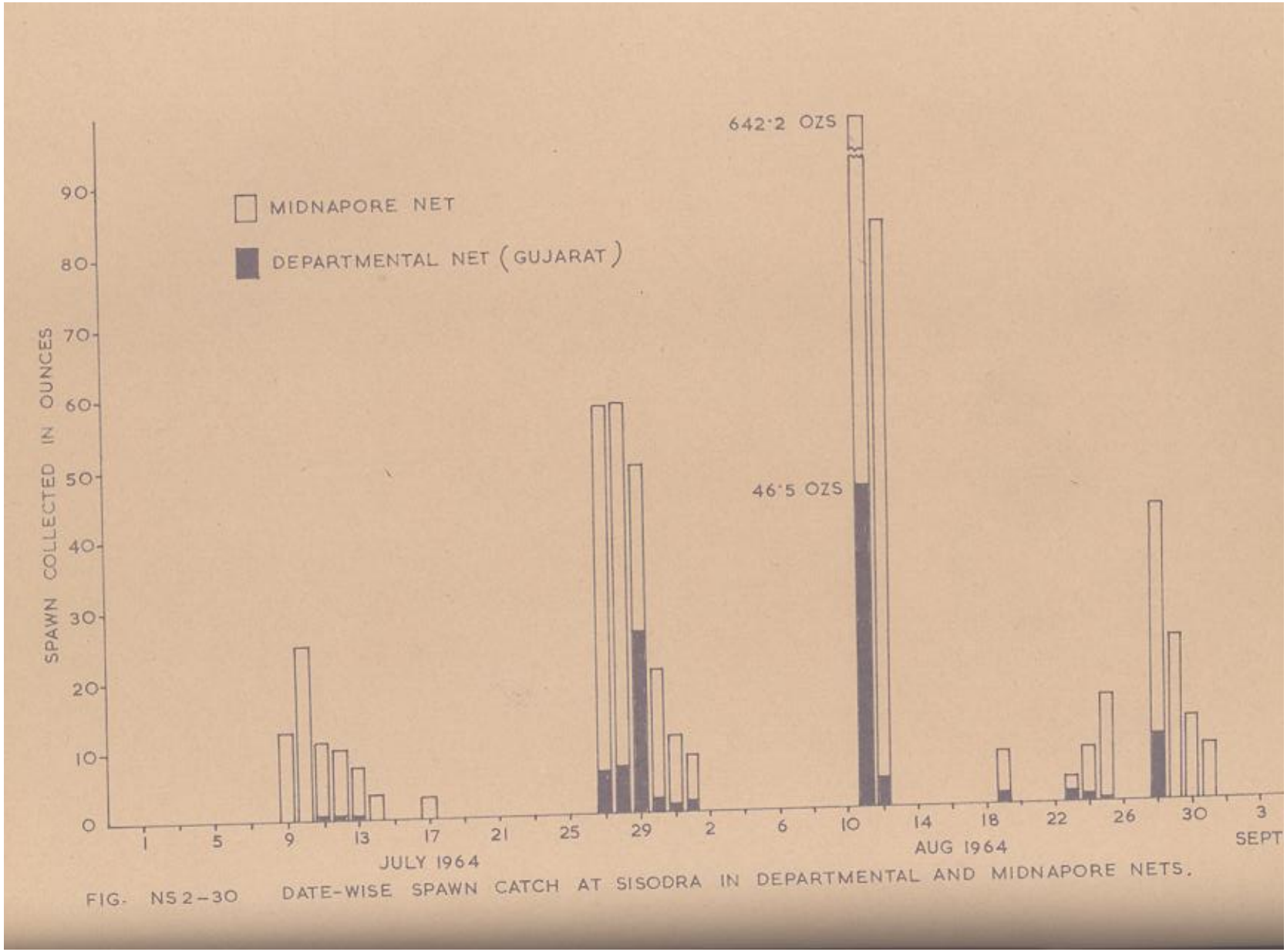


FIG. NS 2-30 DATE-WISE SPAWN CATCH AT SISODRA IN DEPARTMENTAL AND MIDNAPORE NETS.

A total of 1158 ozs of spawn were collected at Sisodra during Floods (of which 5 were major) in the 1964 monsoon season. The od-wise data on spawn collections made at Sisodra, together with duration of floods, the time of first appearance of spawn during h flood, the spawn yields during rising and receding phases of the ods end the time (day or night hours) of peak spawn collections are wn in Table NS2-63.

As seen in Tables NS1-62 and NS2-63 spawn was collected more ndently in floods II, V, VI, IX and X, the total yields during se floods being 1134.7 ozs (97.9% of the whole season's catch). e spawn yield from flood VI alone formed 62.8% of the total seaso- l catch. Floods V and VI together constituted 81.0% of the catch the season. The peak collection days of Floods II, V, VI, IX and namely July 10, 28 August, 11, 25 & 28, contributed 34.3, 28.1, .3, 55.7 and 45.8% of the collections of the respective floods and llectively accounted for 60.4% of the total yield of these five loods. The catch on August 11 in flood VI represented 55.3% of the otal yield of the season. Day time collections were of a slightly igher magnitude than the night collection. Of the 1034.3 ozs of pawn collected in the receding phases of the Floods II, V, VI, IX nd X, 618.8 ozs (59.8%) were collected during day time hours (6 A.M. o 6 P.M.) as against 415.5 ozs taken in night hours (6 P.M. to 6 A.M.). he first appearance of spawn was invariably noticed in the rising hase of the floods and mostly during morning hours (6 A.M. to 8 A.M.).

A detailed analysis of the effects of various hydrodynamical, hemical, meteorological and hydrobiological factors on the avail- bility of spawn is given below :

Hydrodynamical characters

Flood level : The fluctuations in daily average flood level, with spawn yields of the respective days superimposed thereon, are shown in Figure NS3-31. It is seen in this figure and Table NS2-63 that while some spawn was collected during the rising phase of the floods, the spawn was collected in overwhelming abundance only during receding phase. In almost all the floods, the spawn became first available as soon as water level started rising. In the floods of high magnitude the yield of spawn increased erratically in the rising phase but the maximum spawn was generally collected immediately after (during appro- ximately first 24 hours) the commencement of the receding phase, the collections thereafter progressively decline in the rest of the receding phase. An analysis of spawn abundance in relation to flood level showed that in many cases (example : Floods II, VI and X)

Table NS1-62

Daily averages of flood level, turbidity, air and water temp., pH, D.O. and total spawn catch in the river Narbada at Sisodra.

Date Year 1964	Flood level in metres	Turbidity in ppm.	Air temp. Water temp. in °C	pH	D.O.	Total catch of spawn in ozs.	Floodwise spawn in ozs, and percentage in total
1	2	3	4	5	6	7	8
July							
1	-	5,000	26.5/28.0	8.5	5.72	nil	
2	-	5,000	29.0/29.0	8.5		nil	
3	-	5,000	30.0/29.0	7.8		nil	
4	-	5,000	27.5/28.0	8.5	5.28	nil	Nil
5	18.39	5,000	27.0/27.0	8.5		nil	
6	19.09	5,000	25.0/26.5	8.5		nil	
7	17.36	900	26.5/27.0	8.5	7.02	nil	
8	15.36	900	28.0/28.0	8.5		2.640	
9	19.30	1,200	28.0/28.0	8.5		12.730	
10	10.07	1,200	27.0/27.0	8.5	6.60	25.000	72.757
11	18.51	1,200	27.5/28.5	8.5		10.570	(6.3%)
12	17.25	1,200	28.0/28.0	8.5		10.122	
13	16.68	1,200	28.0/28.5	8.5	6.60	7.468	
14	16.16	900	28.5/28.5	8.5		3.655	
15	15.91	650	29.0/29.0	8.5		0.572	
16	16.35	750	29.5/29.5	8.5	7.48	0.022	
17	17.09	650	30.5/29.5	8.5		3.029	
18	17.10	650	30.0/30.0	8.5		1.202	7.710
19	16.65	550	30.0/29.5	8.5	7.04	1.452	(0.7%)
20	16.42	550	28.5/29.5	8.5		2.005	
21	16.57	440	27.5/29.0	8.5		0.276	
22	18.17	900	28.5/29.0	8.5	7.04	2.728	4.520
23	17.99	900	29.0/29.0	8.5		1.547	(0.4%)
24	17.23	900	27.0/28.5	8.5		0.069	
25	16.98	900	28.0/28.5	8.5	6.60	0.575	
26	18.68	1,200	27.0/28.0	8.5		-	
27	18.35	1,200	28.0/29.0	8.5		53.914	
28	18.04	1,200	29.0/29.5	8.5	N.R	59.380	
29	17.48	900	29.5/29.0	8.5		50.326	
30	16.79	750	29.5/29.5	8.5		20.572	211.263
31	16.35	650	30.0/30.5	8.5	6.16	11.274	(18.2%)

1	2	3	4	5	6	7	8
August							
1	15.81	650	30.5/30.5	8.5		8.135)	
2	15.26	440	30.5/30.5	8.5		1.719)	
3	15.06	400	28.5/30.0	8.5	4.84	0.046)	
4	15.31	500	28.5/30.0	8.5		0.046)	
5	14.97	440	29.0/30.0	8.5		0.230)	
6	14.75	360	29.5/30.5	8.5	5.72	0.046)	
7	14.81	440	29.0/30.0	8.5		nil)	
8	16.15	550	28.0/29.5	8.5		nil)	
9	15.93	500	27.5/29.0	8.5	6.30	0.092)	
10	18.49	550	28.0/29.5	8.5		0.184)	727.622
11	19.68	1,200	27.0/28.0	8.5		642.150)	(62.8%)
12	19.32	1,200	26.5/27.5	8.5	6.30	85.196)	
13	23.40	1,500	28.0/27.5	8.5		-	
14	25.07	1,500	27.5/27.0	8.5		-	3.196
15	24.28	1,500	26.5/27.0	8.5	6.82	0.056)	(0.3%)
16	22.99	1,200	26.5/27.0	8.5		2.690)	
17	22.07	1,200	26.5/27.0	8.5		Neg.)	
18	22.80	814	28.0/27.0	8.5	7.26	0.046)	
19	22.43	835	27.5/27.0	8.5		7.350)	8.202
20	21.16	878	27.5/27.0	8.5		0.506)	(0.7%)
21	22.35	585	27.0/27.0	8.5	7.04	0.460)	
22	22.46	621	27.0/26.5	8.5		Neg.)	27.682
23	21.29	605	27.0/27.0	8.5		3.696)	(2.4%)
24	19.93	504	27.5/27.0	8.5	6.60	8.104)	
25	19.26	353	27.5/28.0	8.5		15.422)	
26	19.40	307	28.0/27.5	-		1.690)	
27	20.88	333	27.0/27.0	-	7.43	0.414)	
28	21.37	460	26.5/27.5	-		43.622)	
29	22.46	650	27.5/27.5	-		24.174)	
30	21.60	521	27.5/27.5	-	7.04	12.696)	95.403
31	20.77	449	27.5/27.5	-		8.248)	(8.2%)
Sept.							
1	20.13	403	28.0/28.0	-		1.075)	
2	19.96	383	28.0/28.0	-	6.38	0.552)	
3	20.15	321	28.5/28.0	-		0.690)	
4	19.81	331	29.0/27.5	-		1.644)	
5	19.33	360	29.0/29.0	-	7.92	0.598)	

Table NS2-63

Details of spawn collection in relation to different floods in Narbada at Sisodra

Flood	Duration of flood in 1964		Flood peak			Commencement of spawn availability			Days of peak collection				Total catch of spawn in ozs			
	Rising phase	Receding phase	Date in 1964	Hour	Flood level in metres	Date in 1964	Hour	Flood level in metres	Date in 1964	Quantity in ozs: Day 6 A.M. to 6 P.M.	Night 6 P.M. to 6 A.M.	Total	Rising phase	Receding phase: Day 6 A.M. to 6 P.M.	Night 6 P.M. to 6 A.M.	Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
II	2 days	6 days	9/7	20	19.50	9/7	-	19.48	10/7	20.8	4.2	25.0	18.0	39.9	14.8	54.7
III	2 "	3 "	17/7 to 18/7	2 (18/7)	17.28	17/7	6	16.85	17/7	0.7	2.6	3.3	3.6	2.5	1.5	4.0
IV	2 "	3 "	22/7	24	18.64	23/7	10	18.30	22/7	1.4	1.2	2.6	3.0	1.2	0.5	1.7
V	1 day	12 "	26/7	18	19.10	27/7	8	18.51	28/7	18.4	41.0	59.4	0.2	91.5	119.6	211.1
VI	4 days	2 "	10/8 to 11/8	4	20.03	11/8	6	20.03	11/8	200.7	441.5	642.2	6.5	462.4	258.7	721.1
VII	2 "	3 "	14/8	8	25.21	16/8	8	24.64	16/8	2.7	Nil	2.7	Nil	0.7	2.5	3.2
VII	1 day	2 "	18/8 to 18/8	2 (19/8)	23.05	19/8	10	22.81	19/8	3.1	2.6	5.7	0.0	4.8	3.4	8.2
IX	1 "	3 "	21/8 to 22/8	2 (22/8)	23.17	23/8	12	21.63	26/8	7.6	7.9	15.5	0.5	12.6	14.6	27.2
X	4 days	7 "	29/8	16	22.59	28/8	12	21.08	28/8	22.2	31.2	53.4	75.2	12.4	7.8	20.2

spawn was abundantly available only when the water level reached 18.5-21 metres mark from the river bed suggesting location of important breeding grounds of major carps at that level (Figure NS3-31). Floods of lesser magnitude yielded little spawn. In cases where minor floods occurred in quick succession the cumulative rise in water level was of significance, the spawn being available when the 21 m water was reached. This occurred in Floods III to V, Flood V yielding high catches and the preceding ones poor. Flood VII presented a unique feature. This flood was the highest of the season with water level reaching 25 m mark and was followed in quick succession by minor floods VIII and IX. The water level in the context of river topography was such that no net could be operated in the rising phase of Flood VII. Little spawn was available either in the rising or the receding phase of Floods VIII and IX till the flood level touched 21 m mark. Spawn was, however, available in larger quantity when the flood level dropped to 19 m suggesting that the breeding ground probably located at an elevation of 18.5-21 m from the river bed was getting drained into the river carrying with it the spawn deposited there.

Current velocity* : Date-wise average daily current velocity and spawn yields are presented in Figure NS4-32. The range of water velocity on days shown in Table NS4-65 in Floods II, V, VI, IX and X was 0.45 to 1.2, 0.68-0.81, 0.51-0.6, 0.63-1.03 and 1.02 to 1.26 km per hour respectively. The collections of spawn in these floods on the relevant days were 65.89, 163.62, 727.35, 28.91 and 88.74 ozs respectively. These observations show that there is probably an optimum velocity for spawn capture by nets which lies within the range 0.5 to 1.0 km per hour provided flood level is such that there is spawn in the river. Observations further indicated that spawn capture by nets of different meshes (1/8" and 1/16") is governed by current velocity in conjuction with turbidity, the latter effecting net selectivity by altering the mesh dimension and thereby affecting spawn catches.

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* Sub-surface current velocity determined by inserting a spinning needle reveted on a brass base resulting in the needle floating vertically straight up when put in water. The observed current velocities are not comparable with those of other centres where only a cork was used.

Chemical characters

Turbidity : Mention has been made under "Material and Methods" that the position of different nets were altered from day to day in different floods. Careful observations on net-wise catches have tended to show the role of turbidity in conjuction with current velocity in spawn capture by nets of different meshes, especially 1/8" and 1/16". While 1/8" meshed net was found to be most efficient in the season taken as a whole, it was'nt actually so in very fast currents. The catching efficiency of 1/16" meshed net was also variable. Field observations have shown that the turbidity and the water velocity vary at different places (from shallow waters near river margin to deeper waters towards midstream) and the capture of spawn in the net depends on the types of nets and their places of operation due to variations in turbidity and water velocity. The water is relatively more turbid near river margin particularly during receding phase of the flood and the water velocity is comparatively high towards midstream away from the river margin. Observations have shown that the collection in nets of small meshes (viz. 1/16") was adversely affected when operated near river margin indicating that the deposition of silt resulted in choking of its small meshes, evidently low water velocity being unable to disslogde the silt particles. The efficiency of this net, however, increased when it was operated away from the river margin probably because the high velocity did not allow the silt to choke its meshes. The efficiency of nets with large meshes (viz. 1/8") was reversed under almost similar conditions of turbidity and water velocity in the river. The spawn yields were poorer from this net when operated in the areas away from river margin probably because the silt was washed away from the net due to high velocity, some spawn escaping from the large meshes of the net. The same type of net yielded better collection when operated near river margin evidently because silt deposition in the net helped in narrowing the mesh to some extent and silt was not washed away due to low water velocity. The above observations have shown that turbidity in conjuction with water velocity affects the spawn yields considerably when nets with different meshes are operated in places ranging from river margin to midstream.

Although the abundance of spawn in different floods in the river varies a great deal, depending upon the intensity of floods, yet the above stated interdependance between velocity, turbidity and mesh of the net is substantiated by the following observations. Table NS3-64 shows relevant facts in respect of floods II, V, VI, IX and X.

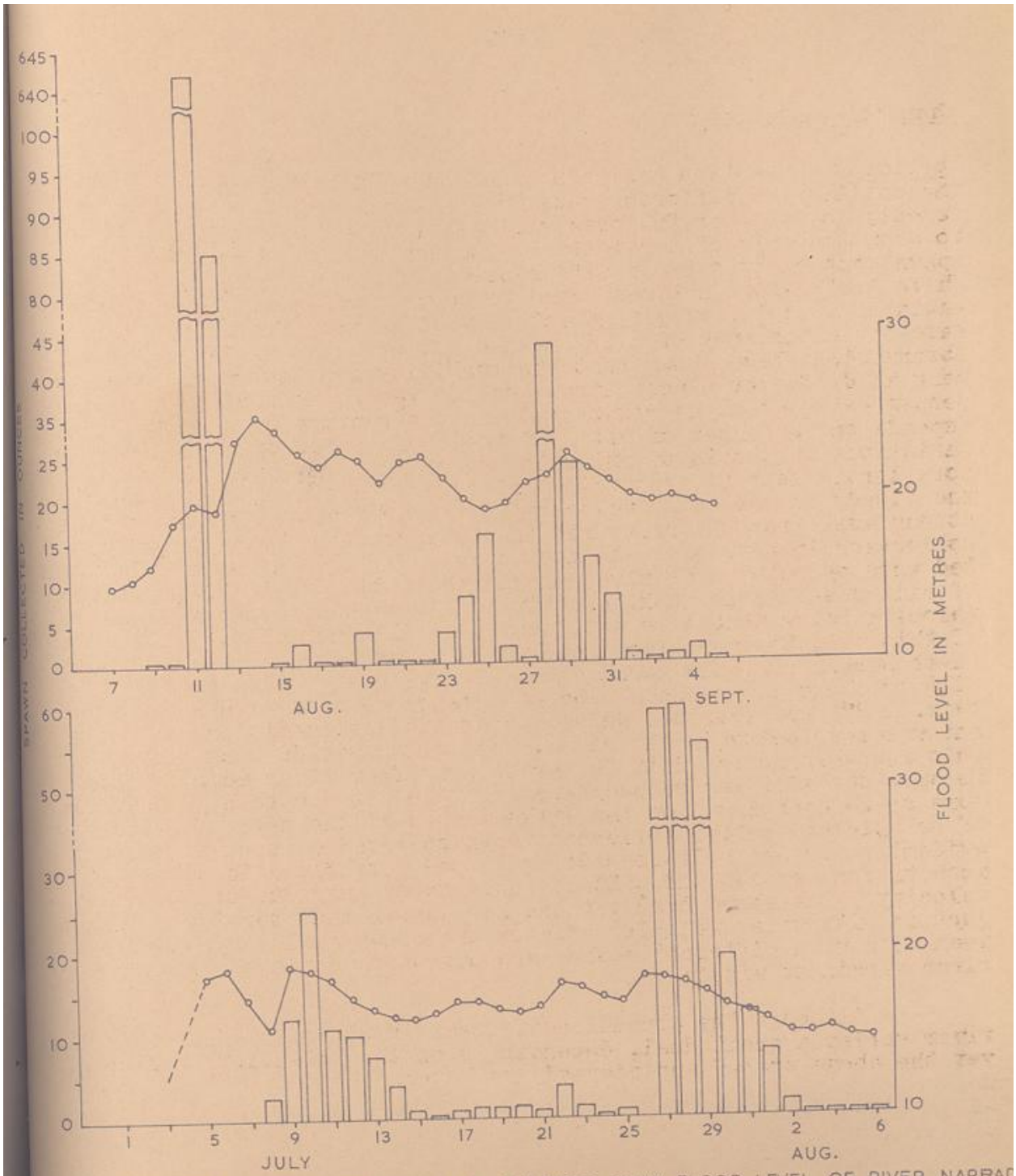

FIG. NS 3-31 — FLUCTUATIONS IN AVERAGE DAILY FLOOD LEVEL OF RIVER NARBAD
AT SISODRA WITH SPAWN QUANTITY SUPERIMPOSED ON THE DAYS OF AVAILABILITY.

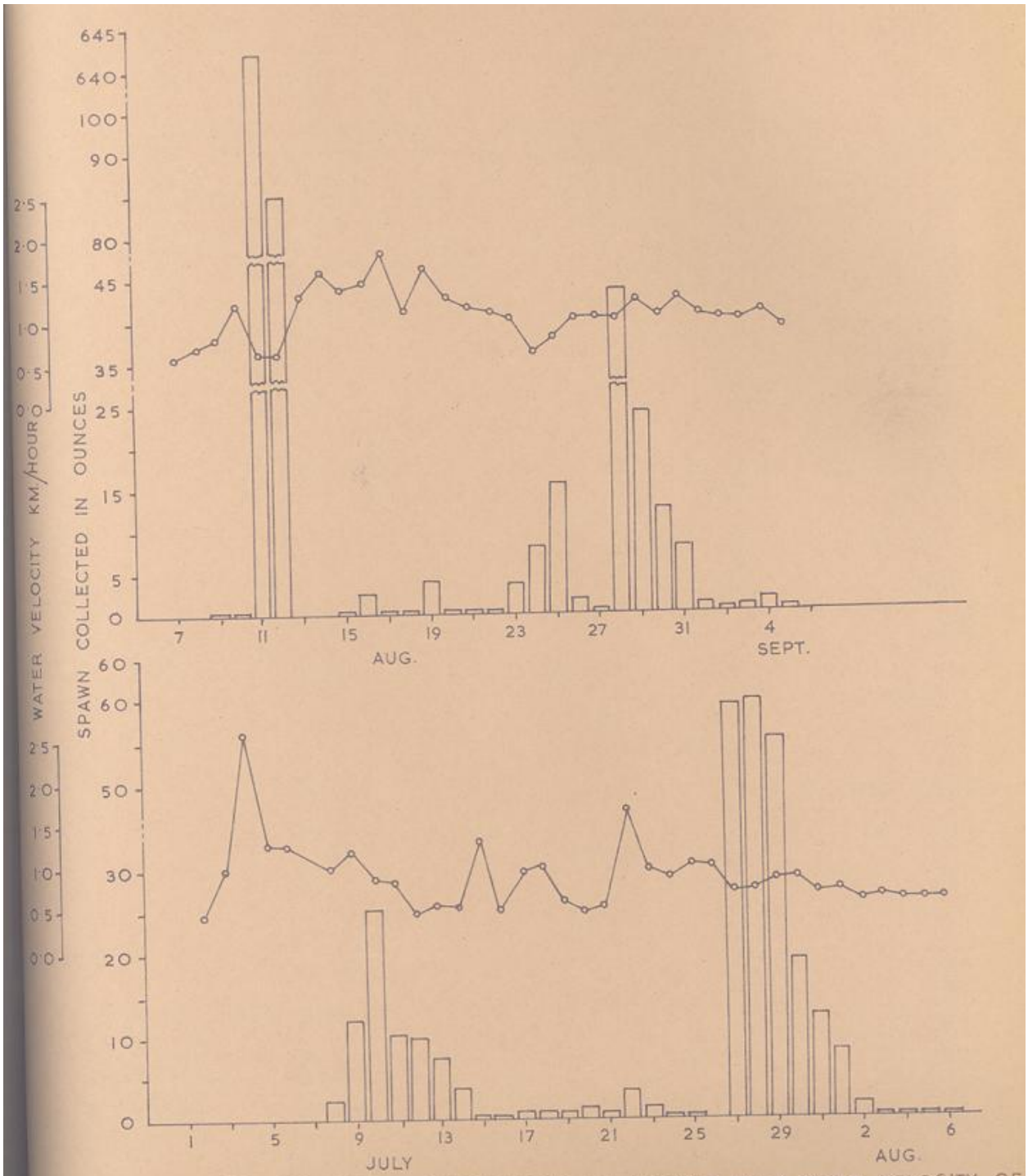

FIG. NS 4-32 — FLUCTUATIONS IN AVERAGE DAILY WATER VELOCITY OF RIVER NARBADA AT SISODRA WITH SPAWN QUANTITY SUPERIMPOSED ON THE DAYS OF AVAILABILITY.

In floods II and V, the turbidity was high being mostly 1200 ppm and the water velocity ranged between 0.45 and 1.2 km/hr. The nets with small mesh (viz. 1/16" and 1/8"-1/16") in Flood II yielded poor collections, whereas those with large mesh (viz. 1/8"), in Flood V gave comparatively high spawn yields. As in Flood V, high spawn yields were also taken in Flood VI from nets with large meshes (viz. 1/8") during the period of high turbidity. In Floods IX and X, the turbidity was extremely low, ranging between 300 and 650 ppm and water velocity varied between 0.63 and 1.26 km/hr. The catch from nets with small mesh (viz. 1/16") in Flood X was high,

Table NS3-64

Data on turbidity, current velocity and net types with spawn catches in different nets and floods

Flood No.	Period	Turbidity	Velocity	Spawn yield (ozs)	Type of nets operated
1	2	3	4	5	6
II	9.7.64 to 13.7.64	1200	0.45 to 1.2	35.89	1/16 and 1/8 + 1/16
V	27.7.64 to 29.7.64	900 to 1200	0.68 to 0.81	168.62	mostly 1/8
VI	11.8.64 to 12.8.64	1200	0.59 to 0.6	727.35	mostly 1/8
IX	23.8.64 to 26.8.64	300 to 600	0.63 to 1.03	28.91	1/8
X	28.8.64 to 31.8.64	450 to 650	1.02 to 1.26	88.74	mostly 1/16

whereas the spawn yields are comparatively poor from nets with large mesh (viz. 1/8") in Flood IX. These observations indicate that the operation of nets with 1/8" mesh during periods of high turbidity (between 900 and 1200 ppm) and those with 1/16" mesh during periods of low turbidity (between 450 and 650 ppm) should, under normal conditions in respect of water velocity yield high spawn catches.

Hydrogen ion concentration : Daily average value of pH from 1.7.64 to 25.8.64 and total spawn yields in ozs. on corresponding dates are shown in Table NS1-62. There appears to be no correlation between the availability of spawn and pH of river water, as constant pH value of 8.5 was found to be associated with periods of availability as well as non-availability of spawn during the above stated period.

Dissolved Oxygen : D.O contents of Narbada water at Sisodra varied from 5.28 to 7.42 ppm on days of bulk spawn availability. D.O. values varied from 6.1 to 6.6 ppm, mostly remaining at 6.6. Generally speaking turbidity is known to be negatively correlated with D.O. content of water, higher values of turbidity being associated with low oxygen values. Higher current velocity by the turbulance it generates offsets the above stated correlation, high current in high turbidity, showing relatively high D.O.

Meteorological Characters

Daily mean air and water temperatures for the entire period of observations from July 3 to September 5 when spawn was available at Sisodra centre are shown in Table NS4-65. Daily observations on the weather condition in respect of sky (clear, cloudy or rainy), wind speed (gentle, strong or stormy) and wind direction, together with current direction and spawn yields are also incorporated in this table.

During the entire period of observations, air and water temperatures fluctuated between 26.0° to 30.5° C. and 26.5° to 30.5°C respectively. The correlation of water temperature with spawn yields was not found to be conclusive as the water temperature fluctuated within a narrow range which was found to be associated with periods of availability and non-availability of the spawn. High concentrations of spawn were observed when the range of water temperature was 27.0 to 28.5°C, 29.0° to 30.5°C and 27.5° to 28.0°C in Floods II, V and VI respectively. During the periods of low concentrations of spawn, the water temperature mostly ranged between 28.5° and 30.0°C from 15.7.64 to 25.7.64, 29.5° and 30.5° C from 2.8.64 to 10.8.64, 26.5° and 27.0° C from 15.8.64 to 22.8.64, and 27.5° and 29.0°C from 1.9.64 to 5.9.64.

The direction of wind at Sisodra was from South-West to North-East and current direction varied from N-WN (325°) to N-EM (20°). On stormy days, the wind interfered with the proper

Table NS4-65

Daily arithmetic or modal averages of meteorological characters for relevant days in different floods alongwith spawn catch and current direction in Narbada at Sisodra.

Date 1964	Flood No	Flood Phase	Quantity of spawn collected in ozs	Temperature °C Air	Temperature °C Water	Weather condition Sky	Weather condition Wind speed	Wind direction	Current direction
1	2	3	4	5	6	7	8	9	10
July									
3	I	Rising	Nil	30.0	29.0	-	-	-	-
4	I	Receding	Nil	27.5	28.0	-	-	-	-
5	I	Receding	Nil	27.0	27.0	Cloudy	-	-	-
6	I	Receding	Nil	26.0	26.5	-do-	-	-	-
7	I	Receding	Nil	26.5	27.0	Rainy	-	-	-
8	II	Rising	2.640	23.0	28.0	-do-	-	-	-
9	II	Rising	12.730	28.0	28.0	-do-	-	-	173°
10	II	Receding	25.000	27.0	27.0	Cloudy	-	-	162°
11	II	Receding	10.570	27.5	28.5	-do-	-	-	167°
12	II	Receding	10.122	28.0	28.0	-do-	-	-	168°
13	II	Receding	7.468	28.0	28.5	Clear	-	-	168°
14	II	Receding	3.655	28.5	28.5	-do-	-	-	168°
15	II	Receding	0.572	29.0	29.0	-do-	-	South - West	168°
16	III	Rising	0.022	29.5	29.5	-do-	-	-do-	170°
17	III	Rising	3.022	30.0	29.5	-do-	Gentle	-do-	170°
18	III	Receding	1.202	30.0	30.0	-do-	-do-	-do-	181°
19	III	Receding	1.452	30.0	29.5	Cloudy	-do-	South-west & South-east	197°
20	III	Receding	2.005	28.5	29.5	Clear	High	South-west	180°
21	III	Rising	0.270	27.5	29.5	-do-	Gentle	-do-	192°
22	IV	Rising	2.278	28.5	29.0	Cloudy	Gentle	-do-	188°
23	IV	Receding	1.547	29.0	29.0	-do-	-do-	-do-	188°
24	IV	Receding	0.069	27.0	28.5	-do-	-do-	-do-	177°
25	V	Rising	0.575	28.0	26.5	-do-	High	-do-	192°
26	V	Rising	-	27.0	28.0	Clear	Gentle	-do-	171°
27	V	Receding	58.914	28.0	29.0	-do-	High	-do-	176°
28	V	Receding	59.380	29.0	29.5	-do-	-do-	-do-	174°
29	V	Receding	50.326	29.5	29.0	-do-	Gentle	-do-	176°
30	V	Receding	20.572	29.5	29.5	-do-	-do-	-do-	176°

1	2	3	4	5	6	7	8	9
31	V	Receding	11.374	30.0	30.5	Clear	Gentle	South-west
August								
1	V	Receding	8.135	30.5	30.5	-do-	-do-	-do-
2	V	Receding	1.719	30.5	30.5	-do-	-do-	-do-
3	V	Receding	0.046	28.5	30.0	-do-	-do-	-do-
4	V	Receding	0.046	28.5	30.0	-do-	-do-	-do-
5	V	Receding	0.230	29.0	30.0	Cloudy	-do-	-do-
6	V	Receding	0.046	29.5	30.5	-do-	-do-	-do-
7	VI	Rising	Nil	29.0	30.0	-do-	-do-	-do-
8	VI	Rising	Nil	28.0	29.5	Clear	-do-	-do-
9	VI	Rising	0.092	27.5	29.0	Cloudy	High	-do-
10	VI	Rising	0.184	28.0	29.5	-do-	Gentle	-do-
11	VI	Receding	342.150	27.0	28.0	-do-	-do-	-do-
12	VI	Receding	85.195	23.5	27.5	Clear	-do-	-do-
13	VII	Rising	-	23.0	27.5	-do-	-do-	-do-
14	VII	Receding	-	27.5	27.0	-do-	High	-do-
15	VII	Receding	0.056	26.5	27.0	-do-	Gentle	-do-
16	VII	Receding	2.690	26.5	27.0	-do-	-do-	-do-
17	VII	Receding	Neg.	26.0	27.0	Rainy	Stormy	-do-
18	VIII	Rising	0.046	28.0	27.0	-do-	Gentle	-do-
19	VIII	Receding	7.650	27.5	27.0	Cloudy	-do-	-do-
20	VIII	Receding	0.536	27.5	27.0	-do-	-do-	-do-
21	IX	Rising	0.450	27.0	27.0	-do-	-do-	-do-
22	IX	Receding	Neg.	27.0	26.5	-do-	-do-	-do-
23	IX	Receding	3.686	27.0	27.0	-do-	-do-	-do-
24	IX	Receding	8.104	27.5	27.0	-do-	-do-	-do-
25	IX	Receding	15.422	27.5	28.0	-do-	-do-	-do-
26	X	Rising	1.690	28.0	27.5	-do-	-do-	-do-
27	X	Rising	0.414	27.0	27.0	Clear	Gentle	-do-
28	X	Rising	43.622	26.5	27.5	Cloudy	-do-	-do-
29	X	Rising	24.174	27.5	27.5	-do-	-do-	-do-
30	X	Receding	12.690	27.5	27.5	Rainy	-do-	-do-
31	X	Receding	8.243	27.5	27.5	Cloudy	-do-	-do-
Sept.								
1	X	Receding	1.075	28.0	28.0	-do-	-do-	-do-

1	2	3	4	5	6	7	8	9	10
Sept.									
2	X	Receding	0.552	28.0	28.0	Cloudy	Gentle	South-west	164°
3	X	Receding	0.690	28.5	28.0	-do-	-do-	-do-	188°
4	X	Receding	1.644	29.0	27.5	-do-	-do-	-do-	195°
5	X	Receding	0.598	29.0	29.0	-do-	-do-	-do-	182°

operation of the nets. The stormy weather generally commenced towards the afternoon and subsided late in the evening. During this period of rough weather, thespawn yields generally dwindled considerably. This behaviour of spawn is ascribed to the turbulance of water surface as well as swaying of net and 'gamcha' and at times bloating of the net resulting in its uprooting.

Hydrobiological Characters

The average plankton density (in number) per liter of water and average catch per day of spawn-associates (in number) are shown separately for the days of spawn availability and non-availability in 10 floods in Table NS5-66. The plankters ranging from nil to 4.1 in number per liter of water showed no definite correlation with availability or non-availability of spawn, whereas spawn-associates exhibited a definite pattern in almost all the floods. The spawn-associates became available with the onset of fresh floods and were collected in abundance in the rising phase of the flood, their number declining with the fall in flood level. This pattern of occurrence of spawn-associates in rising and receding phases of the floods is attributed to the water velocity in the river which is

Table NS5-66

Flood-wise quantitative abundance of plankton and spawn associates split up into days of spawn availability and other-wise

Flood No.	Dates in 1964	Average plankton density in no.per litre		Average catch per day of spawn Associates in number	
		On day of spawn availability.	Otherwise	On day of spawn availability	Otherwise
1	2	3	4	5	6
I	July 1-7	nil	1.14	-	468
II	July 8.15	0.06	-	147	-
III	July 16-20	0.12	-	620	-
IV	July 21-24	nil	-	243	-
V	July 25 Aug.6	0.38	-	141	-
VI	Aug. 7-12	0.5	0.6	465	32
VII	Aug. 13-17	0.48	0.58	125	nil
VIII	Aug. 18-20	0.22	-	151	-
IX	Aug. 21-25	0.46	-	369	-
X	Aug. 26-Sept.5	0.72	-	377	-

high during rising phase and comparatively low during receding phase of the floods. The collection of spawn associates with fresh flood in the river is also related to the fact that the isolated pools in the river bed and the nearby ditches in which forage fishes abound get connected with river with the onset of floods and are collected in abundance in rising phase. As high concentrations of spawn and occurrence of spawn-associates in insignificant number are associated with receding phase of the floods, there appears to be inverse correlation between the spawn yields and the occurrence of spawn-associates, which is obviously of superfluous nature.

Spawn quality in relation to environmental factors

Spawn quality derived from spawn analysis

The percentage distribution of major and minor carps and 'Others' in two-hourly spawn samples are shown in Table NS6-67 in respect of the major floods II, V, VI, IX and X. The daily averages, as shown in column 17 of this table, are the arithmetic means of percentages of two-hourly samples of the day (6 A.M. to 4 A.M. of the next calendar date). The details of spawn quality, estimated from two-hourly samples for each flood are given below.

Flood I (3.7.64 to 7.7.64) Although spawn was collected at Malsar, 5 km downstream of Sisodra during this 'major' flood (upto 19.09 m mark) no spawn was collected at Sisodra. The non-availability of spawn at Sisodra is attributed to injudicious choice of collection spot. From 9.7.64 onwards, the nets were operated at a suitable collection site located about $\frac{1}{4}$ km downstream.

Flood II (8.7.64 to 15.7.64) In this 'major' flood (water level rise from 15.36 to 19.07 m) spawn was avialable on all the days. Their yields per day ranged from 0.57 to 25.0 ozs and the total spawn yield of the flood was 72.7 ozs (6.3% of the entire season's catch). The average percentage of major carps per day ranged between 8.5 and 89.9, the mean of daily average percentages being 47.55. The spawn quality was very poor (major carps 1 to 28.9%) from 8 P.M. on July 7 to 4 P.M. on July 9 during the rising phase. Exceedingly superior quality spawn (100% major carps) was collected just a few hours prior to the commencement of fall in the water level at 6 P.M. on 9.7.64, the percentage of major carps suddenly declining from 100 to 80.1 at 10 A.M. next day (10.7.64). Thereafter the quality of spawn decreased irregularly, the range of major carp

ercentage in two-hourly samples being 15 to 44.7, 13 to 50, 29 to 57, 35 to 76.2 and 25.4 to 63 from July 11 to 15 respectively during receding phase.

Floods III & IV (16.7.64 to 24.7.64) Floods III and IV were minor ones yielding only 7.7 and 4.6 ozs of spawn which constituted only 0.7 and 0.4% respectively of the seasonal catches.

Flood V (25.7.64 to 6.8.64) In this major flood (water level rise from 16.98 to 18.58 m) high catches of spawn were collected on the first six days of the receding phase viz. from July 27 to August 1, the spawn catch per day declining progressively from 59.9 to 8.1 ozs. The total yield on these days was 208.6 ozs (98.7% flood's yield). As the receding phase of the flood was unduly prolonged, the spawn yield on remaining days was exceedingly poor ranging from 0.05 to 1.7 ozs. The total spawn yield during this flood was 211.3 ozs (18.2% of the entire season's yield). The average percentage of major carps per day during this flood ranged between 24.4 and 91.2, the mean of daily average percentage being 63.1. On the first day of rising phase i.e, on July 25, the quality of spawn was poor (major carps : 17 to 55%) and on the following day of the same phase the nets were not operated. With fall in water level, the quality of spawn improved to a great extent (major carps : 67 to 97%) from 6 A.M. on 27.7.64 to 10 A.M. on 28.7.64 which coincided with period of high spawn yields. On the following day (29.7.64), the spawn quality dwindled considerably, the percentage range of major carps in two hourly samples being only 11 to 39. Subsequently, the quality of spawn improved more or less progressively from July 30 to August 1 with the percentage of major carps in two-hourly samples on these days ranging between 21.5 and 100.

Flood VI (7.8.64 to 12.8.64) In this major flood (water level rise from 14.8 to 19.68 m), spawn was available from August 9 to 12, the total spawn yield beign 727.6 ozs (62.8% of entire season's catch). The catches on two days in rising phase were insignificant, being 1.28 ozs. The bumper catch amounting to 642.15 ozs was made on August 11 immediately after the beginning of the receding phase. On the following days, however, the collections suddenly dropped to 75.2 ozs, due to rise in water level. By the unfavourably conditions caused by the flood (by suddenly rising and thereby truncating the receding phase of the flood) the continuous flow of spawn was untimely interrupted, adversely affecting the prospects of fetching exceptionaly high spawn yields during this flood. The percentage of major carps in two hourly samples from 6 A.M. on August 11 to 2 Noon on August 12 ranged between 50 and 98, the average percentage per day being 82.4.

Flood VII (13.8.64 to 17.8.64) As a result of exceedingly high floods in the river (upto 25.07 m) nets could not be operated on August 13 and 14. On the remaining days, the spawn yields were poor, the total spawn collected being only 3.2 ozs (0.3% of entire season's catch). The percentage of major carps in two-hourly samples on these days ranged between 75 and 98.

Flood VIII (18.8.64 to 20.8.64) Flood VIII yielded only 6.2 ozs of spawn which formed 0.7% of the season's catch.

Flood IX (21.8-64 to 25.8.64) The spawn yield of this flood was 27.7 ozs (2.4% of entire season's catch). Spawn was collected in negligible quantities (0.46 ozs) during rising phase on August 21 and 22. Relatively large quantity of spawn (27.2 ozs) were collected, as usual, during receding phase from August 23 to 25 but the rate of availability followed a reverse pattern in this flood as the spawn yields, instead of decreasing increased progressively, the maximum catch (15.4 ozs) being collected on the last day of receding phase when the water level reached 19.26 m. The daily average percentage of major carps per day was 40.9, 41.0, 63.8, 37.8 and 43.8 from August 21 to 25 respectively.

Flood X (26.8.64 to 5.9.64) During this major flood (water level rise from 19.4 to 22.46 m) the total spawn yield was 95.4 ozs (8.2% of entire season's catch). The spawn catches in the rising phase was poor (2.1 ozs). The maximum spawn (43.6 ozs) was collected on the first day (28.7.64) of the receding phase and thereafter the spawn yields declined progressively. The spawn catches during the last five days of the receding phase were extremely poor as the receding phase of this flood was unduly prolonged. The average percentage per day of major carps during this flood ranged between 7.9 and 73.0.

An analysis of the distribution of spawn quality in the rising and the receding phases of different floods, as borne out by the above description, reveals that there is a generalised pattern of spawn quality in different phases of a flood. The rising phase of flood generally yields minor carp spawn and the receding phase especially its early part, major carps spawn in great abundance provided there is adequate flooding of the river.

The data on flood-wise percentage distribution of major carps, minor carps and 'Others' and their yields in ozs are presented in Table NS7-68. These data were derived by weighing each day's percentage (as given in column 17 of the Table NS6-67) and the

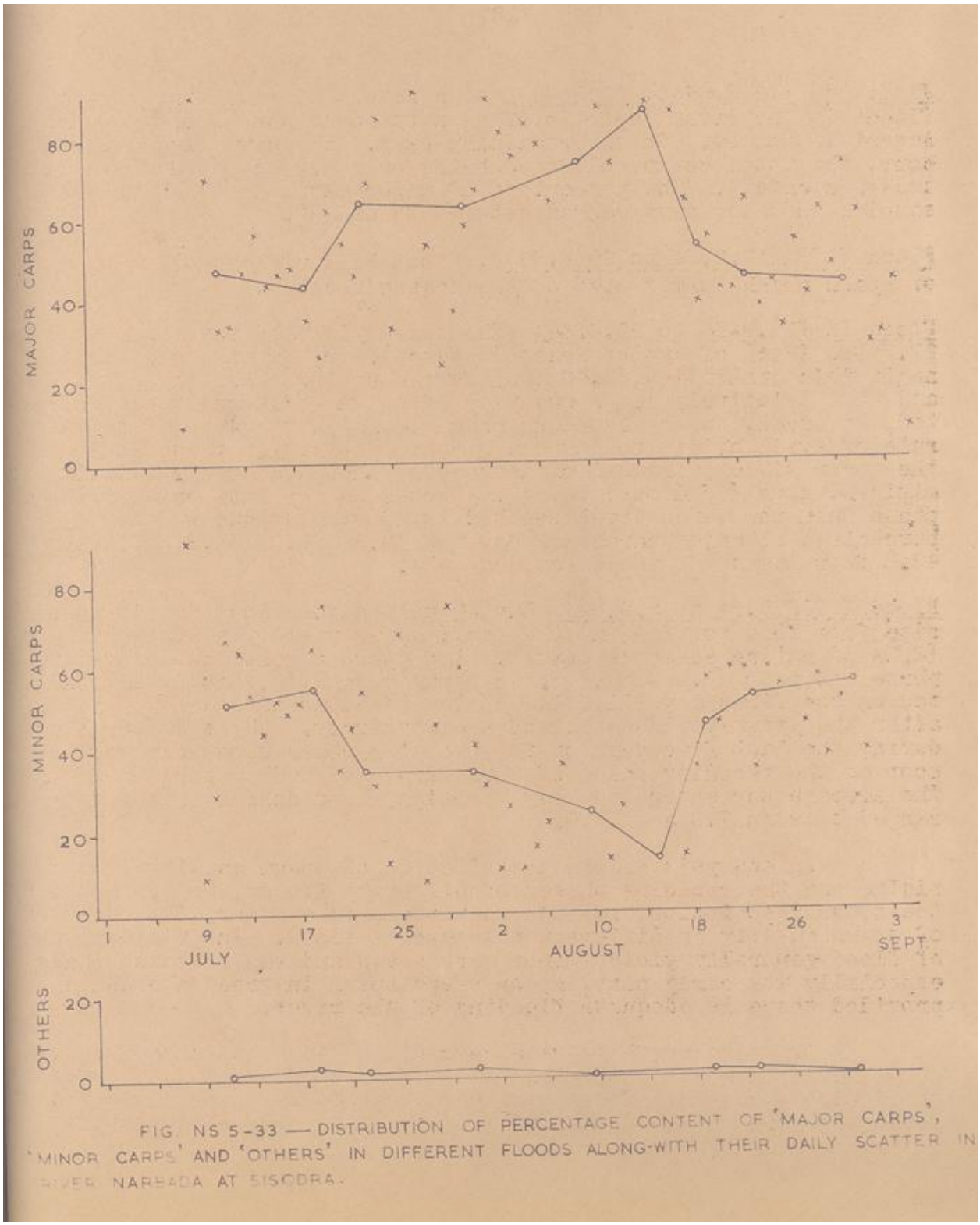

FIG. NS 5-33 — DISTRIBUTION OF PERCENTAGE CONTENT OF 'MAJOR CARPS', 'MINOR CARPS' AND 'OTHERS' IN DIFFERENT FLOODS ALONG-WITH THEIR DAILY SCATTER IN RIVER NARBADA AT SISODRA.

Table NS6-67

Floodwise percentage distribution of Major and Minor carps and others in two hourly spawn samples from Narbada at Sisodra

Sl. No.	Flood Phase	Dates in 1964	Percentage of	HOURS OF OBSERVATION 6	8	10	12	14	16	18	20	22	0	2	4	Average % for the day
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
I	Rising	8/7	(a)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	1	16	-	-	-	8.5
			(b)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	99	84	-	-	-	81.5
			(c)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	-	-	-	-	-	Nil
I	Rising	9/7	(a)	-	-	-	-	-	28.9	100	100	100	100	100	100	89.9
			(b)	-	-	-	-	-	68.1	Nil	Nil	Nil	Nil	Nil	Nil	9.7
			(c)	-	-	-	-	-	3.0	Nil	Nil	Nil	Nil	Nil	Nil	0.4
I	Receding	10/7	(a)	100	81	80.1	66	67.3			61		64	56		70.2
			(b)	Nil	19	17.7	44	31.6			39		36	48		29.4
			(c)	Nil	Nil	2.2	Nil	1.1			Nil		Nil	Nil		0.4
I	Receding	11/7	(a)	16		13	34.7	38.6	33	44		44.6	29	18	15	32.3
			(b)	84		70	64.7	50.6	67	66	54.3	54.3	71	82	85	67.5
			(c)	Nil		Nil	0.6	0.8	Nil	Nil		1.2	Nil	Nil	Nil	0.2
	Receding	12/7	(a)	39	16			24	29.2	36.7	29.1	50	33	39	47.2	34.3
			(b)	61	84			76	68.0	59.9	61.8	50	67	61	49.1	63.8
			(c)	Nil	Nil			Nil	2.8	3.4	9.1	Nil	Nil	Nil	3.7	1.9
	Receding	13/7	(a)	44.3		57			57	86.1	45.0	30	29			45.5
			(b)	54.2		43			43	12.3	43.3	70	71			59.4
			(c)	1.5		Nil			Nil	1.6	11.7	Nil	Nil			2.1

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
			(a)	35.0	53	43	69	50.2	71.6	75.2	45.7	61	44	41	73	55.3
II	Receding	14/7	(b)	65	47	57	31	41.1	25.1	22.8	45.7	39	56	59	27	43.1
			(c)	Nil	Nil	Nil	Nil	8.7	3.3	1.0	6.6	Nil	Nil	Nil	Nil	1.6
			(a)		63	45.6	35.4	46.3			35.0			48		44.4
II	Receding	15/7	(b)		37	46.5	72.3	43.1			58.3			50		51.2
			(c)		Nil	5.0	2.3	10.6			6.7			2		4.4
			(a)		48	77.4	89	93	89	96	96	97	96	95		91.2
V	Receding	27/7	(b)		16	20.3	11	7	11	4	4	3	4	5		8.5
			(c)		Nil	3.3	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil		0.3
			(a)	84	67	85	36	31	34	24	39.5	41			84	53.5
V	Receding	28/7	(b)	16	33	15	54	69	66	36	59.3	59			16	46.3
			(c)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	1.2	Nil			Nil	0.1
			(a)	20	11		30	29.2	14	20	39		19.8	26	35	24.4
V	Receding	29/7	(b)	80	87		70	68.1	86	80	61		70.3	74	65	75.2
			(c)	Nil	Nil		Nil	2.7	Nil	Nil	Nil		0.9	Nil	Nil	0.4
			(a)	21.5	44.1	43	23.6	29.9		31.6	52.3	60.1	38	26	31	36.1
V	Receding	30/7	(b)	76.3	51.8	87	57.8	66.5		64.2	44.8	38.5	64	74	69	60.4
			(c)	2.2	4.1	Nil	18.6	3.6		4.8	2.7	1.4	Nil	Nil	Nil	3.5
			(a)	41		67.4	63	56.6	62.2	35	70	75.3		42.8	59.5	57.4
V	Receding	31/7	(b)	59		30.3	37	33.2	33.6	65	30	22.5		51.5	39.7	40.1
			(c)	Nil		3.3	Nil	7.2	1.2	Nil	Nil	2.2		6.3	0.8	2.5
			(a)	63			88	70	80	100		58	42.8	66.9	23.9	65.
V	Receding	1/8	(b)	37			12	30	20	Nil		38	38.0	27.3	75.7	31.
			(c)	Nil			Nil	Nil	Nil	Nil		Nil	19.2	5.8	0.4	2.
			(a)	90		97	97	97	Nil	72	Nil	Nil	Nil	80	Nil	38.
V	Receding	2/8	(b)	10		3	2	3	Nil	88	Nil	Nil	Nil	20	Nil	11.
			(c)	Nil		Nil	1	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0.
			(a)	Nil	Nil	Nil	Nil	54.9	Nil	86	72.7	Nil	Nil	Nil	Nil	71.
V	Receding	3/8	(b)	Nil	Nil	Nil	Nil	37.6	Nil	14	27.3	Nil	Nil	Nil	Nil	25.
			(c)	Nil	Nil	Nil	Nil	7.5	Nil	Nil	Nil	Nil	Nil	Nil	Nil	3.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
V	Rising	4/8	(a)	Nil	81.8	86.3	79.1	Nil	Nil	57.4	Nil	Nil	68.6	Nil	Nil	74.6
			(b)	Nil	15.5	7.5	20.9	Nil	Nil	10.3	Nil	Nil	3.6	Nil	Nil	11.6
			(c)	Nil	2.6	6.3	Nil	Nil	Nil	32.3	Nil	Nil	27.8	Nil	Nil	13.8
V	Receding	5/8	(a)	85	81.9					88			71	81	93	83.3
			(b)	15	15.6					18			29	19	7	16.3
			(c)	Nil	2.5					Nil			Nil	Nil	Nil	0.4
V	Receding	6/8	(a)	78	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	68.3	86	77.6
			(b)	22	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	30.9	14	22.2
			(c)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	1.0	Nil	0.3
V	Rising	7/8	(a)	57.8	70.7	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	64.3
			(b)	42.2	29.3	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	35.7
			(c)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
VI	Receding	11/8	(a)	93	91	98		89	80	96	95	91	93	53.6	65.4	83.9
			(b)	7	9	2		11	20	4	5	9	7	45.6	33.7	13.9
			(c)	Nil	Nil	Nil		Nil	Nil	Nil	Nil	Nil	Nil	0.9	0.9	0.2
VI	Receding	12/8	(a)	50	70.3	80	91.1	N	E	T	S	N	O	T	)	P	E	R	A	T	E	D		72.9
			(b)	50	28.7	20	6.9				-do-			-do-				-do-						26.4
			(c)	Nil	1.0	Nil	2.0				-do-			-do-				-do-						0.7
IX	Rising	21/8	(a)	58		52		29	47	32			31.6		36.7									40.9
			(b)	42		48		71	53	68			67.3		63.3									58.9
			(c)	Nil		Nil		Nil	Nil	Nil			1.1		Nil									0.8
IX	Receding	22/8	(a)	3.6	Nil	30	74.5	29	58.8	45	38		72.8	Nil	43		25							41.0
			(b)	95.4	Nil	70	25.5	71	41.2	65	62		27.2	Nil	57		75							59.0
			(c)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil		Nil	Nil	Nil		Nil							Nil
IX	Receding	23/8	(a)	35	83	53.5	36	32.4	69.1	77	85.1		75		60		66							63.9
			(b)	65	17	45.5	64	36.6	30.9	23	13.9		14.3		40		34							34.9
			(c)	Nil	Nil	1.0	Nil	1.0	Nil	Nil	1.0		10.7		Nil		Nil							1.3
IX	Receding	24/8	(a)	49.5		41.2	55.4	23.8	49.8	43.7	47.7		36.9	22.8	25.9		Nil							37.8
			(b)	47.6		56.8	43.6	71.4	47.3	55.3	44.0		60.2	73.4	69.2									58.3
			(c)	2.9		2.0	1.0	4.8	2.9	1.0	8.3		3.9	4.8	3.9									3.4

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
IX	Receding	25/8	(a)	58		19	8	14	54.8	51	51	47.6	56.5	65.3	47.8	43.1
			(b)	42		81	92	86	41.4	49	49	47.6	25.5	43.7	44.2	53.9
			(c)	Nil		Nil	Nil	Nil	3.8	Nil	Nil	4.8	9.0	1.0	8.0	2.0
X	Rising	26/8	(a)	15	21	17	28	27	42	45.2	46.1	47	Nil	Nil	Nil	32.0
			(b)	85	79	83	72	73	58	53	52	53	Nil	Nil	Nil	67.6
			(c)	Nil	Nil	Nil	Nil	Nil	Nil	1.8	1.9	Nil	Nil	Nil	Nil	0.4
X	Rising	27/8	(a)		26		39	Nil	Nil	Nil	70	77	Nil	Nil	Nil	53.5
			(b)		78		61	Nil	Nil	Nil	30	23	Nil	Nil	Nil	46.5
			(c)		Nil		Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
X	Rising	28/8	(a)	64	58	38.2	24	35		38	24.7	49	34	27.3	58.8	31.9
			(b)	36	42	59.8	76	65		62	74.3	51	56	72.7	39.2	67.6
			(c)	Nil	Nil	2.0	Nil	Nil		Nil	1.0	Nil	Nil	Nil	2.0	0.5
X	Rising	29/8	(a)	73		61		55	61	50	63.7	63		72		62.3
			(b)	27		30		45	39	50	34.3	37		28		37.4
			(c)	Nil		Nil		Nil	Nil	Nil	2.0	Nil		Nil		0.3
X	Receding	30/8	(a)	67		63.4		61	57	70	50	32		1	23	47.3
			(b)	33		35.6		29	43	30	39.3	68		99	77	51.5
			(c)	Nil		1.0		Nil	Nil	Nil	10.7	Nil		Nil	Nil	1.2
X	Receding	31/8	(a)			75	63	75.2	25	73	82	65.4	62.4			73.0
			(b)			25	37	20.8	16	27	18	30.8	36.6			25.3
			(c)			Nil	Nil	1.0	Nil	Nil	Nil	3.5	1.0			0.7
X	Receding	1/9	(a)	36	49		47	48	27	66	19	66	9		21	61.4
			(b)	36	51		53	52	73	34	81	34	91		79	38.6
			(c)	Nil	Nil		Nil	Nil	Nil	Nil	Nil	Nil	Nil		Nil	Nil
X	Receding	2/9	(a)	9	45		13	12	23	30	34	43	38	26	34	27.4
			(b)	91	55		87	88	77	70	66	57	62	74	66	72.6
			(c)	Nil	Nil		Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
X	Receding	3/9	(a)	6	38	25	79.3		21	31	26	21	60	11	20	33.0
			(b)	94	62	75	20.7		79	69	74	79	40	89	80	67.0
			(c)	Nil	Nil	Nil	Nil		Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
X	Receding	4/9	(a)	75	56	54	31	79	6	39	36	69	16	71	15	44.7
			(b)	25	44	46	69	21	94	61	64	41	34	29	85	55.3
			(c)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
X	Receding	5/9	(a)	25		3		1		Nil	18	15	4	Nil	4	7.9
			(b)	74		97		99		100	82	35	96	100	96	92.1
			(c)	Nil		Nil		Nil		Nil	Nil	Nil	Nil	Nil	Nil	Nil

break up of spawn yields into major carps, minor carps and 'Others' was determined on the basis of their percentages in the spawn samples. The flood-wise fluctuations in the spawn quality, in terms of major carps, minor carps and others is depicted in Figure NS5-33. The quality of spawn commencing from Flood II (major carps : 47.9%) increased slightly irregularly till Flood VII (major carps : 87%) and thereafter it declined upto Flood X (major carps : 43.9%) following a rather negatively skewed distribution. The minor carps showed a bimodal frequency of occurrence being more abundant in the early and later floods. 'Others' were so few in number throughout the season that they showed no significant trend of occurrence.

Spawn quality drived from rearing

The spawn collected from Floods V, VI and IX, which contributed 83.4% in the total yield in entire season, was reared in the only available nursery at Sisodra for determining the spawn quality

Table NS7-68

Flood-wise percentage distribution of Major and Minor carps and others and their catches in ozs determined from spawn samples

Flood No.	Percentage of			Quantity in ozs		
	Major carps	Minor carps	'Others'	Major carps	Minor carps	'Others'
1	2	3	4	5	6	7
II	47.5	51.2	1.3	33.3	35.9	0.9
III	42.9	54.6	2.5	3.3	4.2	0.2
IV	63.6	35.2	1.2	2.9	1.6	0.1
V	63.2	34.7	2.1	133.5	73.3	4.4
VI	74.4	25.3	0.3	541.3	184.1	2.2
VII	87.0	13.0	nil	2.7	0.4	nil
VIII	53.0	45.6	1.4	4.4	3.7	0.1
IX	45.5	53.0	1.5	12.6	14.6	0.4
X	43.9	55.8	0.3	41.9	53.2	0.3
				775.9	371.0	8.6

from these floods. The group-wise (major carps, minor carps and 'Others') composition of the stocked spawn determined from spawn analysis of two-hourly samples and their overall percentages are shown in Table NS8-69. The species composition of spawn, as revealed by nursery rearings, is shown in Table NS9-70 Reared sample No.I, taken from nursery on August 23, pertained to spawn stocked from July 27 to 31. The spawn stocked on earlier dates (covered by sample No.I) and on August 11 and 25 was covered by reared sample No.II. It is noteworthy that the percentages of major carps, minor carps and 'Others', as revealed by nursery rearings (Table NS9-70) and analysis of the corresponding spawn, shown in Table NS8-69, are fairly comparable. The major carps covered by sample I formed 60.8% and 62.7% in reared and spawn stages respectively. In sample II the major carps made up 70.6% and corresponding spawn 67.9%. Similarly, the percentages of minor carps and 'Others' were also comparable in the reared samples and at spawn stage. In both of the samples, catla overwhelmingly dominated, (55.5% and 68.2%) in comparison to other major carps viz. Mrigal (4.1% and 1.6%), Rohu (0.8% and0.1%), L. fimbriatus (0.4% and nil) and Calbasu (nil and 0.7%).

Filtered off Associates

Associates' quantity in relation to floods

The catch per net per day of filtered off associates (excluding fry of major carps) during rising and receding phases of

Table NS8-69

Group-wise composition of stocked spawn ditermined from two-hourly sample analysis

Flood No.	Date	Spawn in ounces			
		Major carps	Minor carps	Others	Total
1	2	3	4	5	6
V	27.7.64	5.472	0.51	0.018	6.0
"	28.7.64	0.8	0.69	0.001	1.5
"	29.7.64	0.366	1.128	0.006	1.5
"	30.7.64	1.089	1.812	0.099	3.0
"	31.7.64	1.716	1.224	0.06	3.0
VI	11.8.64	10.308	1.668	0.02	12.0
IX	25.8.64	2.628	3.228	0.144	6.0

Flood V

1	2	3	4	5	6
Spawn (in ozs)		9.443	5.364	0.184	15.0
Percentage		62.66	36.05	1.3	

Floods V, VI & IX

Spawn (in ozs)		22.379	10.26	0.348	33.0
Percentage		67.9	31.2	0.9	

NS10-71.

the floods I to X is presented in Table - The Associates were generally available in relatively more abundance in rising phases of the different floods (percentage range by number in all floods : 41.9 to 95.9) than in their receding phases (percentage range by number in all floods : 4.3 to 58.1). It may be recalled here that high spawn yields were invariably noticed during receding phases of the floods. Relatively few Associates (percentage by number: 1.8 to 9.7) were encountered in the collections during floods II, V, VI, IX and X which yielded high qunatities of spawn. The percentage by number of Associates fluctuated irregularly between 1.8 and 27.2 over the duration of floods I to X in the entire monsoon season.

Associates' quality in relation to floods In the entire season, Puntius tioto, Elops sp., and Chela sp. occurred more frequently and also in abundance in the collections, their frequency of occurrence being 59.7%, 53.7% and 32.8% and their relative abundance being 12.8%, 33.9% and 31.9%. Rohtee cotio, Ambassis ranga, Mystus seenghala, Mastacembelus pancalus, Puntius sophore, Amblypharyngodon mola and Glossogobius giuris also occurred fairly frequently, their

Table NS9-70

Percentage distribution of spawn quality as determined from nursery rearings for Floods V, VI and IX

Flood No.	Sample No.	Sample Size	Nursery No.	Percentage of major carps: Catla	Rohu	Mrigal	Calbasu	Fimbriatus	Minor carps	Others
1	2	3	4	5	6	7	8	9	10	11
V	I	245	1	55.5	0.8	4.1	nil	0.4	39.2	nil
			Total major carps : 60.8%							

1	2	3	4	5	6	7	8	9	10	11
V, VI, & IX.	II	3657	1	68.2	0.1	1.6	0.7	Neg.	29.3	0.1
				Total major carps : 70.6%						

percentage of occurrence being 26.9%, 23.9%, 20.9%, 19.4% and 11.9%, but they occurred in comparatively much less abundance, their relative abundance ranging between 1.2% and 4.9%.

Table NS10-71

Catch per net per day of associates in numbers in rising and receding phases of Floods I to X

Flood No.	No. and percentage of associates*		
	Rising phase	Receding phase	Total
1	2	3	4
I	31(41.9%)	43(58.1%)	74(9.4%)
II**	67(95.7%)	3(4.3%)	70(8.9%)
III	195(91.1%)	19(8.9%)	214(27.2%)
IV	49(67.1%)	24(32.9%)	73(9.3%)
V**	10(71.4%)	4(28.6%)	14(1.8%)
VI**	54(71.1%)	22(28.9%)	76(9.7%)
VII	***	18	18(2.3%)
VIII	90(79.7%)	23(20.3%)	113(14.4%)
IX**	36(49.3%)	37(50.7%)	73(9.3%)
X**	46(75.4%)	15(24.6%)	61(7.7%)

* Excluding major carp fry.
** Floods yielding high spawn catches.
*** Nets not operated.

The frequency of encounter (En) and the occurrence in abundance (Ab) in respect of 10 important species of Associates for first five floods (I to V) and last five floods (VI to X), derived from Table NS11-72 are shown in Table NS12-73.

t content of Associates Observations on the stomach contents of ssociates show that the frequency of feeding on spawn was more ronounced in Mystus aor, Wallago attu and Ambasis ranga. Among orage fishes, Puntius sophore, Puntius ticto, Rohtee cotio and hela sp., in the order stated, showed predatory leanings on spawn o a marked degree. The other forage fishes which were feeding on pawn less frequently were Barilius spp., Rasbora daniconius, anio rerio, Puntius sarana and Crossocheilus latia.

Table NS11-72

requency of encounter and occurrence in abundance of 10 important species of associates for Floods I to V & IX to X

Species	Floods I to V		Floods VI to X	
	Percentage (En)	Range (Ab)	Percentage (En)	Range (Ab)
1	2	3	4	5
P.ticto	75.0 to 100	9.9 to 51.7	9.1 to 60.0	1.4 to 22.4
Clops sp.	37.5 to 91.6	9.2 to 33.5	27.2 to 50.0	32.8 to 78.2
Chela sp.	28.5 to 70.0	3.2 to 60.2	9.1 to 33.3	2.1 to 34.9
R.cotio	nil to 60.0	nil to 8.7	nil to 8.6	nil to 8.6
A.ranga	nil to 60.0	nil to 3.4	nil to 5.1	nil to 5.1
M. seenghala	nil to 60.0	nil to 1.0	nil to 60.0	nil to 11.2
M. pancalus	8.3 to 71.5	0.5 to 8.5	nil	nil
P. sophore	nil to 71.4	nil to 14.8	nil to 40.0	nil to 5.6
A. mola	8.3 to 37.5	0.2 to 5.7	nil	nil
G. giuris	nil to 30.0	nil to 2.3	nil to 16.6	nil to 1.4

Besides the Associates (predatory and forage fishes), the gut contents of the fry of the major and minor carps viz. Catla catla Labeo calbasu, Cirrhina mrigala, Cirrhina reba, Labeo bata and Barbus (tor) tor, which were encountered with spawn were also examined. Cirrhina reba showed exceedingly high predatory leaning, taking heavy toil of spawn in the 'gamcha'. Catla catla, Labeo calbasu and Barbus (tor) tor were other the three carps which exhibited predatory habits, feeding frequently on spawn in the 'gamcha'.

The guts of Associates and carp fry found to contain spawn in slightly digested condition. This has indicated that the feeding on spawn took place in the 'gamcha' of nets. The frequent of feeding on spawn by Associates and carp fry was not found to be restricted only to the periods of spawn abundance, as the spawn was also encountered in the guts of Associates and carp fry collected from the floods, in which spawn yields were poor. High predatory leanings of carp fry have indicated that the carps are probably highly predacious in their feeding habits at fry stage.

Net selectivity

Net selectivity of spawn

During the investigations at Sisodra, the Midnapore nets of three meshes viz. 1/8", 1/16" and 1/8"-1/16" and the Gujarat net with single mesh were operated, with their position staggered in their day to day operations, to nullify any bais resulting from the relative positions of nets among themselves as well as in relation to river current, turbidity and distance from river bank. The spawn catches (in ounces) from the Midnapore nets of the above mentioned three meshes and the Gujarat nets (denoted M_1, M_2, M_{1-2} and G respectively) for floods II to X are shown in Table NS-12-73.

Table NS12-73

Total spawn catches in ozs by different nets

Flood No.	TOTAL CATCH IN OUNCES IN NETS							
	M1		M2		M1-2		G	
	Catch	No. of nets	Catch	No. of nets	Catch	No. of nets	Catch	No. of nets.
1	2	3	4	5	6	7	8	9
II	2.640	2	30.218	1	39.123	1	0.782	1
III	2.508	1	2.333	1	2.261	1	0.607	1
IV	3.015	1	1.409	1	0.310	1	0.455	2
V (i)	73.860	3	-	-	-	-	30.690	2
(ii)	58.700	1	34.880	1	neg.	1	12.970	1
VI (i)	537.500	4	-	-	-	-	50.650	2
(ii)	0.230	1	139.190	1	nil	1	0.040	1
VII	2.966	1	0.230	1	-	-	neg.	1
VIII	2.966	1	1.276	1	2.230	1	1.730	1
(i)	11.840	3	-	-	-	-	-	-
IX (ii)	9.840	1	-	-	3.256	1	2.742	1
X (i)	-	-	17.530	3	-	-	-	-
(ii)	-	-	17.190	2	-	-	-	-
(iii)	46.075	1	4.343	1	0.546	1	9.736	1

The spawn catch (in number) per net per hour, (derived from the same data as presented in Table NS14-75) split up into catches taken from 10 A.M. to 6 P.M., to 2 A.M. and 2 A.M. to 10 A.M. is shown in Table NS13-74.

The ratio of spawn catches between Gujarat net and Midnapore nets were found to be 1:37.9, 1:1.9, 1:5.4, 1:2.2, 1:3.0 and 1:2.9 in Floods II, V, VI, VIII, IX & X respectively. In the season as a whole Midnapore nets were 8.4 times more efficient than Gujarat nets.

The catching efficiencies of nets were determined by taking Gujarat net(G) as standard (unit = 1) and comparing catch of unit net(G) with catches from three Midnapore nets M_1, M_2 & M_{1-2}. The ratio of spawn catches between G and M_1, M_2 & M_{1-2} in the entire season was found to be:

$$G: M_1: M_2: M_{1-2} = 1:14.1:9.3:1.3$$

The above ratio shows that the Midnapore net with mesh size 1/8" has the highest catching efficiency, the next in order being Midnapore nets with mesh size 1/16" and 1/8"-1/16". The Midnapore net with mesh size 1/8"-1/16" has slightly higher catching efficiency than the Gujarat net. The catching efficiencies of three Midnapore nets with reference to Gujarat net and in relation to one another are shown in Table NS14-75.

Net selectivity of Associates

The catch (in numbers) per net per hour of Associates taken from different nets in Floods I to X is shown in Table NS15-76. The data presented in this table show that the catches of Associates (in number) from Midnapore nets in relation to Gujarat net were approximately 6.5 times. The catching efficiency of Midnapore net M_1 was the highest, next in the order were Midnapore nets M_{1-2}, M_2 and Gujarat net G. The ratio of Associate catches between G and M_1, M_2 & M_{1-2} was found to be as follows:

$$G: M_1: M_2: M_{1-2} = 1:2.9 :1.4 :2 :2.$$

The above observations tend to indicate that the efficiency of nets in catching Associates largely depends on the water filtering capacity of the nets which is evidently in the order M_1, M_{1-2}, and G, the filtering capacity being highest in M_1 and lowest in G.

Table NS13-74

Spawn catch (by number) per net per hour of different nets

Flood No.	CATCH PER NET M1				M2			PER M1-2		HOUR		IN		NUMBER
	18 to 2	2 to 10	10 to 18	18 to 2	2 to 10	10 to 18	18 to 2	2 to 10	10 to 18	18 to 2	2 to 10	10 to 18
1	2	3	4	5	6	7	8	9	10	11	12	13
II	11920	nil	9200	9992	8856	15040	13192	11672	181600	272	96	406
III	1616	3192	512	1528	1960	872	896	2248	664	472	296	72
IV	3608	1368	1512	920	608	520	224	136	736	456	neg	520
V	44296	23752	35600	58128	10056	21472	nil	nil	neg	15408	4344	8792
VI	649456	74064	318184	18400	116000	166760	nil	nil	-	48800	9568	16368
VII	neg	3936	1008	nil	920	nil	-	-	-	nil	nil	nil
VIII	6312	792	856	9840	368	-	9840	nil	-	120	368	4120
IX	11264	10072	9976	-	-	-	11840	368	9840	1832	368	2192
X	7160	17264	12744	26208	22136	9352	-	8368	-	9920	2024	16000
Total	835632	134440	789592	125016	160904	214016	35992	22792	192840	77280	17064	48470
%	92848	14938	87744	15627	20113	26749	5141	2849	38568	8587	1896	6059

Table NS14-75

Catching efficiency of nets

Gujarat net	Midnapore net		
	M_1	M_2	M_{1-2}
0. 78	14.1	9.3	1.3
0.107	10.9	7.3	1
0.107	1.5	1	0.14
0.077	1	0.66	0.09

**Table NS15-76

Associate catch in number per net per hour

Flood No.	CATCH PER NET PET HOUR IN NUMBER							
	M1		M2		M1-2		G	
	Day	Night	Day	Night	Day	Night	Day	Night
I	11	6	*	*	*	*	*	*
II	19	7	2	neg	3	neg	neg	neg
III	13	9	9	6	13	6	2	2
IV	7	9	1	1	4	neg	1	neg
V	6	neg	4	neg	neg	neg	1	neg
VI	11	4	17	6	Nil	Nil	3	4
VII	1	1	nil	3	*	*	neg	neg
VIII	6	2	3	nil	neg	neg	2	2
IX	20	18	*	*	29	70	6	3
X	14	6	24	6	1	1	10	2

* Net not operated

** Excluding major carps

Recommendations for spawn collection in the surveyed stretch of River Narbada.

About 40 km long stretch of the River Narbada from Sisodra to Valugam was covered in the pre-monsoon survey and the sites inspected were sisodra, Indor, Valugam and Narkeshwar. Since only one site was tobe selected on River Narbada, the choice fell upon Sisorda which was easily accessible, and where an existing ditch could be cheaply converted into a nursery for rearing the collected spawn. Besides, Sisorda being geographically located between Moti-Koral and Malsar, two already established spawn collection centres, supervision of the work at the new site under commercial exploitation by the state officer was easier. Indor is also a good site where several small ditches can be converted into nurseries at fairly low cost. Indor as well as Valugam and Narkeshwar may be tried in future years with reasonably high chance of success.

As flood and consequent hydrographical conditions change from year to year such precautions as are stated in 'Discussion and Conclusions' in this report, relevant to spawn collection should, however, be excercised for successful spawn collection.

V H. RANIA ON RIVER MAHI

ABSTRACT

Observations on the availability of spawn were made from July 1 to September 7, 1964 in River Mahi at Rania in Gujarat State. During the course of the investigations, 25.9 ounces of spawn, estimated at over 2 lakh hatchlings, were collected at the centre. Of the six floods, spawn was available in three floods only. 86% of season's catch, comparising mostly minor carps was collected during Flood I. Spawn analysis and rearing of Flood III showed 10.6% and 66.7% major carp content respectively. The catch of Midnapore nets was double that of Gujarat nets. Inadequate floods, poor rainfall, presence of high gradient and rocky bed upstream of Rania appeared to be the factors responsible for poor collection at this centre. Hydrodynamical, chemical, meteorological and hydrobiological features were studied in relation to spawn. Associates and their gut contents were analysed qualitatively. A year of greater flooding of Mahi upstream of Rania may yield more satisfactory results at this centre.

LOCATION AND FACILITIES

The village Rania is situated on the North bank of river Mahi in Kaira District of Gujarat State. It is connected by a metalled road with the town Dakor which is the nearest railway station (Western Railway) at a distance of 16 km. Raina has a post office and is served by the telegraph office at Dakor. About ¾ km of river beg along North bank in the North bank in the vicinity of Rania is sandy with gradual slope. The river beg upstream and 5 km down stream of Rania is rocky and pebbly. 30 km upstream of Rania, there is Wankoori Woir on River Mahi. The general topography of the area near Rania is shown in Figure MR1-34*.

OBSERVATIONS

Observations were made for a period of 68 days from July 1 to September 7. Midnapore type of nets with 3 meshes (1/8", 1/16" &

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* 'M' - stands for River Mahi. 'R' - stands for Rania.

The first number in the Tables and Figures depicts the number in the chapter and the second in the report as a whole.

Table MR1-78

Daily averages of Flood level, turbidity, air and water temp., pH, D.O. and total spawn catch in the River Mahi at Rania.

Date year 1964	Flood level in meters	Turbidity in ppm.	Air Temp./ water Temp. in °C	pH	D.O. in ppm.	Total catch of spawn in ozs.	Floodwise spawn in ozs and percentage in total
1	2	3	4	5	6	7	8
July							
1	-	1,250	29.5/29.2	7.8	7.48	0.04	
2	0.40	1,250	26.9/29.0	7.8		nil	
3	1.45	1,400	26.6/27.1	7.8		2.11	)
4	1.94	2,500	28.2/28.6	7.6	6.60	9.62	)
5	1.76	2,500	28.5/28.5	7.6		5.55	) I
6	1.40	2,500	27.3/28.2	7.8		2.01	)
7	1.18	2,500	26.6/27.5	7.3	7.04	1.57	) 22.3 ozs
8	0.96	2,500	29.3/29.0	7.5		1.08	) (86.0%)
9	0.93	2,500	28.6/28.6	7.5		0.20	)
10	0.80	2,500	26.3/28.5	7.6	6.60	0.04	)
11	0.42	5,000	28.4/28.6	7.6		0.12	)
12	0.05	5,000	28.5/29.5	7.6		nil	)
13	0.12	5,000	28.5/29.2	7.5	6.16	nil	
14	-0.17	5,000	29.0/29.4	7.5		nil	
15	-0.34	5,000	30.3/29.9	7.9		nil	
16	-0.47	1,500	29.6/29.5	8.2	5.5	nil	
17	-0.59	1,200	29.8/29.8	7.9		nil	
18	-0.73	1,500	30.2/30.1	7.6		nil	
19	-0.79	1,070	29.5/30.3	7.5	7.04	nil	
20	-0.80	1,160	28.8/29.2	7.5		nil	
21	-0.49	1,030	28.3/30.2	7.3		nil	)
22	0.23	3,930	28.6/29.8	7.5	5.3	nil	) II
23	0.85	3,930	28.6/29.7	7.5		nil	) nil
24	0.41	1,428	27.3/29.5	7.3		nil	)
25	2.22	875	26.5/29.4	7.3	6.6	nil	)
26	0.91	5,000	27.1/29.3	7.3		nil	)
27	0.18	5,000	27.3/28.5	7.3		0.70	) III
28	-0.17	5,000	26.3/29.3	7.8	6.38	0.43	)
29	-0.44	3,600	27.6/29.3	7.5		0.22	) 3.26 ozs
30	-0.47	2,500	28.0/29.3	7.5		1.15	) (12.5%)
31	-0.64	2,500	28.8/29.7	7.5	6.6	0.38	)

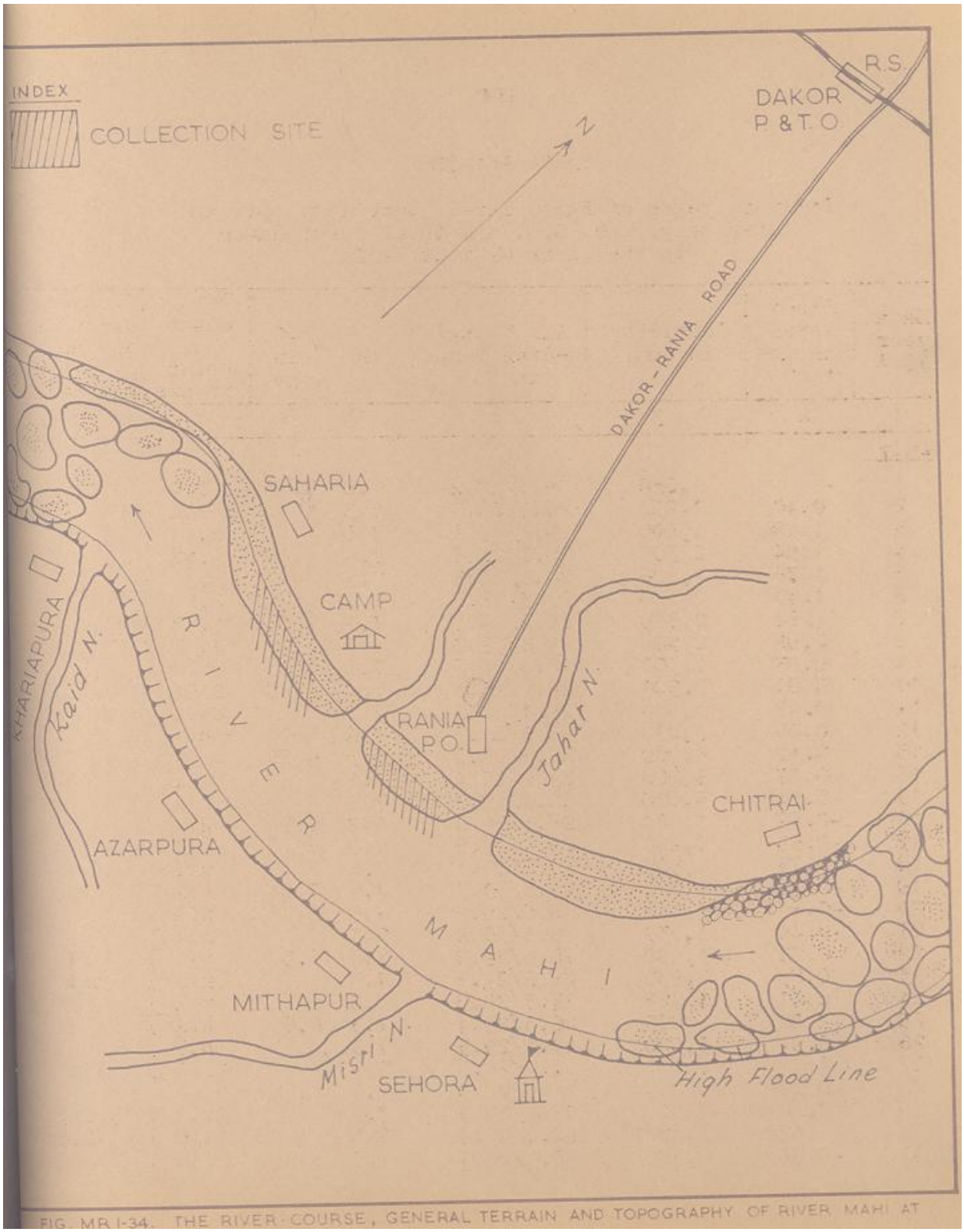

FIG. MR I-34. THE RIVER COURSE, GENERAL TERRAIN AND TOPOGRAPHY OF RIVER MAHI AT

1	2	3	4	5	6	7	8
August							
1	-0.90	1,500	30.1/30.6	7.3		0.25)	
2	-1.09	1,500	30.0/30.5	7.3		0.06)	
3	-1.05	1,500	29.0/30.5	7.3	6.38	nil	
4	-1.27	630	28.5/29.8	7.3		nil	
5	-1.34	247	28.5/29.8	7.3		nil	
6	-1.43	250	29.0/32.0	7.5	6.94	nil	
7	-1.47	200	28.0/31.4	7.3		nil	
8	-1.41	161	28.1/30.5	7.5		nil	
9	0.71	184	28.0/29.5	7.3	6.38	nil)	IV
10	0.10	910	27.3/29.7	7.3		nil)	nil
11	-0.09	258	26.9/29.0	7.3		nil)	
12	0.76	728	26.6/28.8	7.3	7.04	nil)	V
13	1.58	1,157	27.0/28.5	7.3		nil)	
14	1.11	5,000	27.3/28.6	7.3		nil)	
15	0.50	4,640	26.1/26.2	7.2	6.6	nil)	nil
16	-0.04	4,500	25.8/27.3	7.3		nil)	
17	0.27	3,600	25.3/26.4	7.3		nil)	
18	1.10	1,114	27.0/27.4	7.3	7.04	nil)	
19	0.95	1,156	26.8/27.4	7.3		nil)	
20	1.56	678	26.1/27.6	7.3		nil)	VI
21	1.56	521	26.5/27.4	7.5	7.04	nil)	
22	1.31	2,078	26.0/27.5	7.5		nil)	0.36 ozs.
23	1.65	584	26.8/27.9	7.3		0.18)	(1.5%)
24	1.08	420	26.9/26.3	7.3	7.04	0.08)	
25	0.71	820	27.0/27.9	7.3		nil)	
26	0.22	750	26.8/28.0	7.6		nil)	
27	-0.09	500	27.2/28.1	7.6	6.60	0.10)	
28	-0.26	255	26.6/28.4	7.5		nil	
29	-0.37	355	26.7/28.2	7.5		nil	
30	-0.59	221	26.0/28.4	7.3	7.26	nil	
31	-0.71	164	26.7/28.8	7.5		nil	
Sept.							
1	-0.85	107	27.9/29.1	7.6		nil	
2	-0.92	270	27.6/29.9	7.3	7.26	nil	
3	-0.66	107	27.6/29.0	7.6		nil	
4	-0.84	107	26.8/29.0	7.6	7.04	nil	
5	-0.95	107	27.4/29.9	7.9		nil	
6	-1.06	107	27.5/28.6	8.1		nil	
7	-1.16	107	27.8/29.3	7.8	7.48	nil	

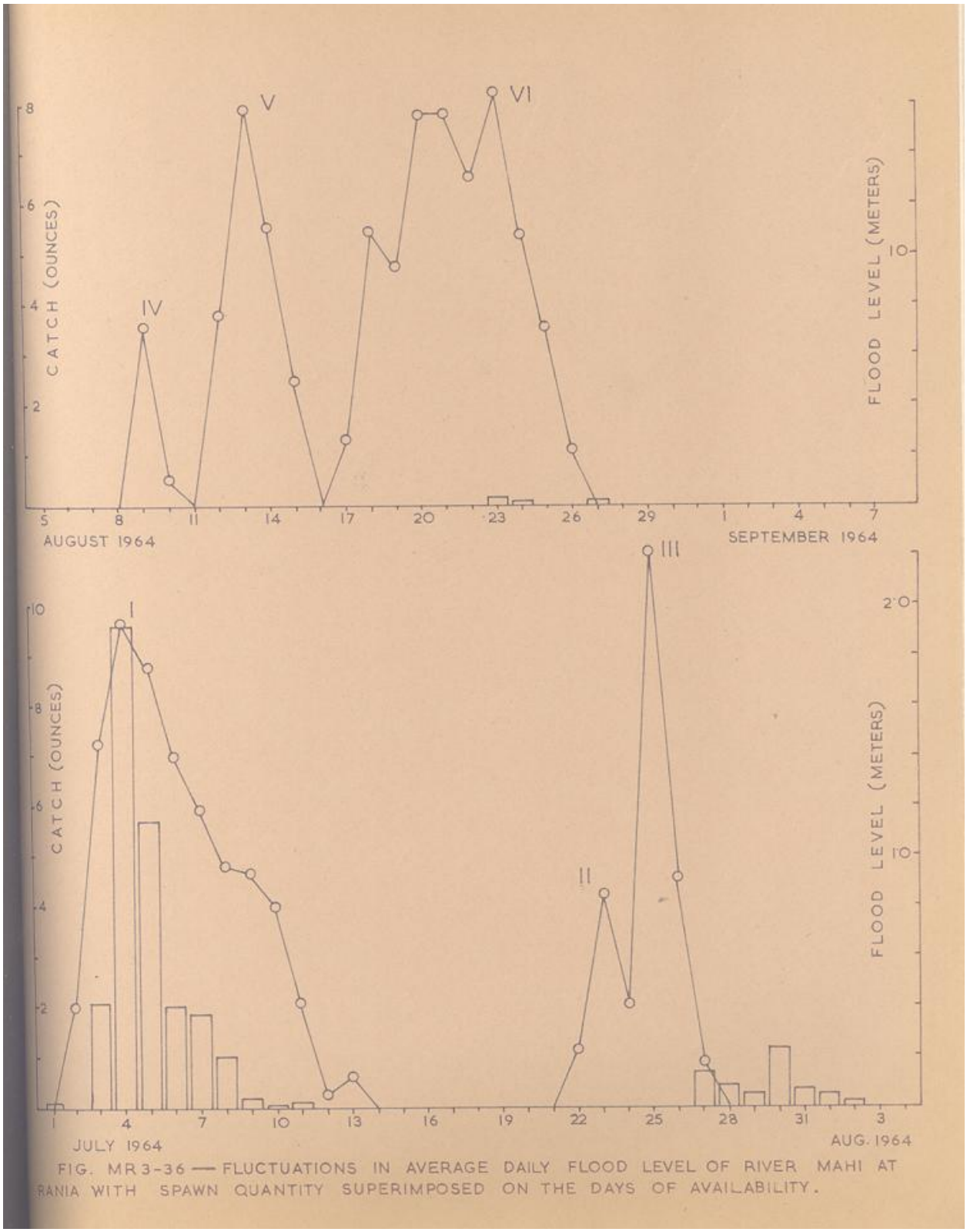

FIG. MR 3-36 — FLUCTUATIONS IN AVERAGE DAILY FLOOD LEVEL OF RIVER MAHI AT RANIA WITH SPAWN QUANTITY SUPERIMPOSED ON THE DAYS OF AVAILABILITY.

Table MR2-79

Details of spawn collection in relation to different floods in Mahi at Rania

Flood No.	Duration of flood in 1964		Flood peak			Commencement of spawn availability			Days of peak collection				Total catch of spawn in ozs			
										Quantity in ozs						
	Rising Phase	Receding Phase	Date in 1964	Hour	Flood level in me-tres	Date in 1964	Hour	Flood level in me-tres	Date in 1964	Day 6 A.M. to 6 P.M.	Night 6 P.M. to 6 A.M.	Total	Rising phase	Receding phase: Day 6 A.M. to 6 P.M.	Receding phase: Night 6 P.M. to 6 A.M.	Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
I	3/7 to 4/7	5/7 to 12/7	4/7	12	1.94	3/7	22	1.45	4/7	0.5	9.1	9.6	11.7	1.6	9.0	10.6
II	21/7 to 23/7	24/7	23/7	2	0.85	-	-	-	-	Nil	Nil	Nil	Nil	Nil	Nil	Nil
III	25/7	26/7 to 2/8	25/7	2	2.22	27/7	6	0.18	30/7	Nil	1.2	1.2	Nil	0.06	3.20	3.26
IV	8/8 to 9/8	10/8 to 11/8	9/8	4	0.71	-	-	-	-	Nil	Nil	Nil	Nil	Nil	Nil	Nil
V	12/8 to 13/8	14/8 to 16/8	13/8	10	1.58	-	-	-	-	Nil	Nil	Nil	Nil	Nil	Nil	Nil
VI	17/8 to 23/8	24/8 to 27/8	23/8	10	1.65	23/8	0	1.65	23/8	0.04	0.14	0.18	Nil	Nil	0.18	0.18

Duration Flood I, the first appearance of spawn was 14 hours before the flood attained its peak. In Flood III, the spawn appeared after 28 hours of the attainment of flood peak associated with a fall in water level of 204 cm, while in Flood VI, the first appearance of spawn coincided with the peak hour of flood.

None of these six floods registered at Rania were of high magnitude. Flood I, with which 86% of total spawn yield was associated, rose to 1.94 meters from summer water level, while Floods III & IV touched their respective peaks at 2.2 and 1.65 meters. None of the remaining 3 floods exceeded 1.6 meters. The low magnitude of these floods was probably due to in adequate rains in the upper reaches of Rania.

Current velocity: The determination of water velocity by means of a cork float was consistently handicapped by high intensity of wind which, as stated above, was more prevalent in day time hours at Rania. Current velocity observations at Rania are, therefore, no trustworthy.

Chemical characters

Turbidity: No direct positive or negative correlation was found between turbidity and spawn availability, both of which are correlated with flood. In Flood I, when spawn was collected in relatively greater quantity, turbidity values ranged from 1,400 to 2,500 ppm but subsequently there was no spawn when turbidity value reached 5,000 ppm. From July 27 to August 2, less quantity of spawn was collected when average turbidity was over 3,000 ppm. Again spawn was not available on August 14, when turbidity value was 5,000 ppm.

Hydrogen ion concentration: The pH value in the entire period of observations is shown date-wise in Table MR1-88. This table shows that pH value ranged mostly from 7.2 to 7.9 during the course of observations, except on two days when it rose to 8.1 and 8.2. In Flood I, when more spawn was collected than in others, pH value ranged from 7.3 to 7.8 and the same range peristed during subsequent floods also when little or no spawn was available. Thus, there does not appear to be any correlation between the availability of spawn and pH.

Dissolved oxygen: The value of dissolved oxygen determined every third day is shown in Table MR1-78, which varied from 5.3 to 7.5 ppm during the entire period of observations. The dissolved oxygen content was estimated to be 6.6 ppm on the peak collection day

(July 4) as well as on days of non-availability of spawn. Dissolved oxygen, therefore, has no direct correlation with spawn availability.

Meteorological characters

No striking correlation was observed between air/water temperature and spawn availability. The average air and water temperatures ranged from 26.0°C to 30.1°C and 26.7°C to 30.6°C respectively during the period of observations. As stated earlier, the intensity of wind adversely affected the availability of spawn. At Rania most of the collections were made during night time when intensity of wind was gentle as compared to high intensity in day time. Even during nights with high intensity of wind the collection appeared to be either very poor or nil. Thus, gentle wind was found to be favourable for good collection of spawn. The wind was mostly in South to North direction (180°) and the water current direction ranged between 90° and 130°.

Hydrobiological characters

The average plankton density per litre and average catch per day of Associates in each of the six floods are shown in Table MR3-80 separately for days of spawn availability and otherwise. The number of plankters per litre ranged from 0.1 to 6.1 and showed no correlation with spawn availability. The occurrence of Associates in appreciable number in first 4 floods and their low catch in last 2 floods evidently show that the abundance of Associates was more in the beginning of the season than towards the end.

Table MR3-80

Flood-wise quantitative abundance of plankton and spawn associates split up into days of spawn availability and otherwise

Flood No.	Dates in 1964	Average plankton density in number per litre		Average catch per day of spawn associates in numbers	
		On days of spawn availability	Otherwise	On days of spawn availability	Otherwise
I	3.7.64 to 12.7.64	0.12	0.18	106	96
II	21.7.64 to 24.7.64	-	nil	-	140
III	25.7.64 to 2.8.64	0.2	nil	126	619
IV	8.8.64 to 11.8.64	-	6.1	-	148
V	12.8.64 to 16.8.64	-	nil	-	26
VI	17.8.64 to 27.8.64	nil	nil	13	nil

SPAWN QUALITY AT RANIA

Spawn quality derived from spawn analysis

The two hourly floodwise percentage distribution of major and minor carps and 'Others', beased on spawn analysis, is shown in Table MR4-81 with their daily average in column 17.

Flood I: As stated earlier this flood yielded 22.3 ozs of spawn in its rising phase making 86% of the season's catch but the spawn of this flood was of an extremely poor quality. Spawn was available in five spurts from July 3 to 8, with percentage of minor carps ranging between 92.2 to 100%. Clupeid and Perch larvae figured rather prominently among 'Others' which ranged for 1-4.3%. Major carps were represented in percentages ranging from 1-9.8% in the individual two-hourly collections.

Flood II: This was a minor flood and yielded no spawn.

Flood III: This flood yielded only 3.3 ozs of spawn constituting 12.5% of the total seasonal collection. Six spawn spurts were witnessed in this flood of which only the first spurt comprised appreciable percentage of major carps while the remaining five largely contained minor carps. The first spurt commenced at 6 hours on July 27 and continued intermitently upto 12 hours on July 28. This collection comprised 79%, 66% and 61% major carps at 22, 0 and 2 hours on July 27 respectively. The occurrence of major carp spawn, however, dwindled from 4 hours on July 27 (30%) to 12 hours on July 28 (7%).

Flood IV & V: While Flood IV was minor and Flood V major no spawn was available in these floods.

Flood VI: This was the last flood observed in River Mahi at Rania in 1964. During this flood only 0.4 ozs of spawn were collected in three minor spurts. The first spurt commenced at 0 hour on August 23 and concluded at 4 hours on August 23. It comprised low percentage of major carps ranging from 7% to 23% while spawn of minor carps was predominant. The spawn of two subsequent spurts contained cent per-cent minor carps.

On the basis of limited number of days of spawn availability and that too with meagre collections no specific inference can be drawn about the pattern of availability of spawn quality. It may, however, be stated that spawn during the first flood was of extremely

Table MR4-81

Flood-wise percentage distribution of Major and Minor carps and others in two hourly spawn samples from Mahi at Rania

Flood No.	Phase	Dates in 1964	Percentage of	HOURS OF OBSERVATION 6	8	10	12	14	16	18	20	22	0	2	4	Average % age for the day
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	Rising	Jul.5	Major	-	-	-	-	-	-	-	-	Nil	-	-	-	Nil
			Minor	-	-	-	-	-	-	-	-	97.6	-	-	-	96.6
			Others	-	-	-	-	-	-	-	-	2.4	-	-	-	2.4
	Rising	Jul.4	Major	-	-	-	-	-	-	-	4.9	Nil	9.8	Nil	Nil	2.9
			Minor	-	-	-	-	-	-	-	93.6	98.8	88.4	98.0	100.0	95.8
			Others	-	-	-	-	-	-	-	1.5	1.2	1.8	2.0	Nil	1.3
	Receding	Jul.5	Major	4.5	-	-	-	-	-	2.9	3.8	2.9	Nil	5.9	1.9	3.1
			Minor	93.6	-	-	-	-	-	95.1	92.2	96.1	95.7	91.6	97.1	94.5
			Others	1.9	-	-	-	-	-	2.0	4.0	1.0	4.3	2.5	1.0	2.4
	Receding	Jul.6	Major	1.0	1.9	Nil	-	-	-	-	-	-	-	Nil	-	0.7
			Minor	99.0	95.6	100.0	-	-	-	-	-	-	-	98.4	-	98.3
			Others	Nil	2.5	Nil	-	-	-	-	-	-	-	1.6	-	1.0
I	Receding	Jul.7	Major	Nil	-	-	-	-	-	-	-	-	0.9	Nil	Nil	0.2
			Minor	98.2	-	-	-	-	-	-	-	-	97.4	100.0	100.0	98.9
			Others	1.8	-	-	-	-	-	-	-	-	1.7	Nil	Nil	0.9
	Receding	Jul.8	Major	Nil	1.0	-	-	-	-	-	-	-	-	-	-	0.1
			Minor	100.0	99.0	-	-	-	-	-	-	-	-	-	-	99.9
			Others	Nil	Nil	-	-	-	-	-	-	-	-	-	-	Nil
	Receding	Jul.9	Major	-	-	-	-	-	-	-	1.0	-	-	-	-	1.0
			Minor	-	-	-	-	-	-	-	99.0	-	-	-	-	99.0
			Others	-	-	-	-	-	-	-	Nil	-	-	-	-	Nil
	Receding	Jul.10	Major	Nil	-	-	-	-	-	-	-	-	-	-	-	Nil
			Minor	100.0	-	-	-	-	-	-	-	-	-	-	-	100.0
			Others	Nil	-	-	-	-	-	-	-	-	-	-	-	Nil
	Receding	Jul.11	Major		Nil	-	-	-	-	-	-	-	-	-	-	Nil
			Minor		99.4	-	-	-	-	-	-	-	-	-	-	99.4
			Others	-	0.6	-	-	-	-	-	-	-	-	-	-	0.6

Pooled sample of 157 specimens

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	Receding	Jul.27	Major	30.3	-	-	-	-	-	-	-	79.8	66.0	61.0	30.0	53.4
			Minor	67.5	-	-	-	-	-	-	-	19.9	34.0	39.0	70.0	46.1
			Others	2.2	-	-	-	-	-	-	-	0.3	Nil	Nil	Nil	0.5
		Jul.28	Major	32.0	31.0	15.0	7.0	-	-	-	-	Nil	-	-	-	18.0
			Minor	58.0	69.0	85.0	93.0	-	-	-	-	100.0	-	-	-	81.0
			Others	Nil	Nil	Nil	Nil	-	-	-	-	Nil	-	-	-	Nil
		Jul.29	Major	-	-	-	-	-	-	-	-	Nil	Nil	Nil	Nil	Nil
			Minor	-	-	-	-	-	-	-	-	100.0	100.0	100.0	100.0	100.0
			Others	-	-	-	-	-	-	-	-	Nil	Nil	Nil	Nil	Nil
III		Jul.30	Major	Nil	-	-	-	-	-	-	-	Nil	Nil	-	Nil	Nil
			Minor	100.0	-	-	-	-	-	-	-	100.0	100.0	-	100.0	100.0
			Others	Nil	-	-	-	-	-	-	-	Nil	Nil	-	Nil	Nil
		Jul.31	Major	4.0	-	-	-	-	-	-	-	-	-	Nil	-	2.0
			Minor	96.0	-	-	-	-	-	-	-	-	-	100.0	-	98.0
			Others	Nil	-	-	-	-	-	-	-	-	-	Nil	-	Nil
	Receding	Aug.1	Major	Nil	-	-	-	-	-	-	-	-	-	Nil	Nil	Nil
			Minor	100.0	-	-	-	-	-	-	-	-	-	100.0	100.0	100.0
			Others	Nil	-	-	-	-	-	-	-	-	-	Nil	Nil	Nil
		Aug.2	Major	-	Nil	-	-	-	-	-	-	-	-	-	-	Nil
			Minor	-	100.0	-	-	-	-	-	-	-	-	-	-	100.0
			Others	-	Nil	-	-	-	-	-	-	-	-	-	-	Nil
	Rising	Aug.23	Major	-	-	-	-	-	-	-	-	-	30.0	7.0	23.0	13.3
			Minor	-	-	-	-	-	-	-	-	-	90.0	93.0	77.0	86.7
			Others	-	-	-	-	-	-	-	-	-	Nil	Nil	Nil	Nil
VI	Receding	Aug.24	Major	2.0	-	-	-	-	-	-	-	-	-	-	-	2.0
			Minor	98.0	-	-	-	-	-	-	-	-	-	-	-	98.0
			Others	Nil	-	-	-	-	-	-	-	-	-	-	-	Nil
		Aug.27	Major	1.0	-	-	-	-	-	-	-	-	-	-	-	1.0
			Minor	98.0	-	-	-	-	-	-	-	-	-	-	-	98.0
			Others	Nil	-	-	-	-	-	-	-	-	-	-	-	Nil

poor quality and contained only 0.8% of major carps. The quality slightly improved in Flood III when 10.6% of major carps were recorded. In this flood, particularly on 27.7.64, the percentage of major carp seed was high (53.4%). The quality of seed in regard to major carp dwindled thereafter. The spawn of minor carps dominated in all the collections of the three spawn bearing floods. The abundance of 'Others' appeared to be restricted to only earlier phase of monsoon. They were particularly more in the first flood. The flood-wise percentage distribution of spawn quality determined from spawn samples is shown in Table MR5-82.

Table MR5-82

Flood-wise percentage of Major carps, Minor carps and others

Flood No.	Major carps	Minor carps	Others
I	0.8	98.2	1.0
II	nil	nil	nil
III	10.6	89.3	0.1
IV	nil	nil	nil
V	nil	nil	nil
VI	5.4	94.6	nil

Spawn quality derived from rearing

The species composition arrived at after rearing spawn samples of different floods is shown in Table MR6-83. The spawn collected during first flood could not be reared due to lack of rearing facilities at that time. At a later stage, rearing was possible in two pits in which the spawn of Floods III & VI was released. A reared sample of 25 specimens pertaining to spawn of July 27 to August 1 (Flood III) comprised 66.7% major carps and 23.3% minor carps. The major carps consisted of Labeo rohita (33.3%), Barbus (tor) (25.0%) and Catla catla (8.4%). In case of rearing of Flood VI spawn (released on July 23, 24 and 27) over a month old reared sample of 157 specimens showed major carps (32.2%), minor carps (54.6%) and 'Others' (13.2%). The major carps consisted of Barbus (tor) tor (28.5%) and Labeo calbasu (3.7%).

Filtered off Associates at Rania

Two-hourly qualitative and quantitative data on filtered off associates was collected and analysed for Rania also, as at other centres. In view, however, of the poor results in spawn catches no useful purpose will be served in presenting the results of the analysis of the data on Associates which yielded nothing of importance. These are, therefore, being omitted from this report.

Net selectivity at Rania

Net selectivity of spawn

Table MR6-83

Total spawn catch in ozs by different nets

Flood No.	TOTAL CATCH IN OUNCES IN NETS							
	MIDNAPORE NETS						GUJARAT NETS	
	M1		M2		M1-2		D	
	Catch	No. of nets	Catch	No. of nets	Catch	No. of nets	Catch	No. of nets
I	14.96	10	nil	1	-	-	7.34	8
II	nil	2	nil	1	-	-	nil	3
III	1.40	3	1.19	1	0.08	1	0.59	3
IV	nil	1	nil	1	nil	1	nil	3
V	nil	1	nil	1	nil	1	nil	4
VI	0.15	1	0.15	1	nil	1	0.06	1

Table MR6-83 presents the data on total catch in ounces and number of nets operated in respect of each type of net from six floods. The three Midnapore nets of mesh sizes 1/8", 1/16" & 1/8"-1/16" and the Gujarat net are mentioned as M_1, M_2, M_{1-2} and D respectively in this table.

Table MR7-84 shows flood-wise catch per net per hour (in number) in respect of different types of nets further divided into day (6 A.M. to 6 P.M.) and night (6 P.M. to 6 A.M.). The Midnapore nets were found to be more effective than Gujarat nets and the catch per net per hour of Midnapore net was double that of Gujarat net. It has been stated earlier that spawn catches during night were

Table MR7-84

Spawn catch (by number) per net per hour of different nets

Flood No.	CATCH PER NET PER HOUR IN NUMBERS							
	MIDNAPORE NETS						GUJARAT NETS	
	M1		M2		M1-2		D	
	Day	Night	Day	Night	Day	Night	Day	Night
I	27	304	nil	nil	Not operated		12	152
II	nil	nil	nil	nil	Not operated		nil	nil
III	neg.	43	neg.	37	nil	3	neg.	22
IV	nil	nil	nil	nil	nil	nil	nil	nil
V	nil	nil	nil	nil	nil	nil	nil	nil
VI	nil	6	4	18	nil	nil	nil	2

consistently high than those of day. Table MR7-84 shows that night catch was 10-12 times that of day.

The ratio of spawn catches between D, M_1 and M_2 was found to be: D: M_1: M_2 = 1:2.3:1.8

Table MR8-85

Catching efficiency of nets

Departmental net	Midnapore nets	
	M1	M2
1	2.34	1.68
0.44	1	0.86
0.59	1.16	1

The catching efficiencies of the nets are tabulated in Table MR8-85 which shows that Midnapore nets are on the average 2 times more efficient than the departmental nets.

REMARKS

Contrary to expectations Rania on River Mahi yielded poor results, the seasonal index of spawn quantity of the centre being only 3 ozs. The index of spawn quality was, however, 37.4% major

carps (including Tor tor), 51.1% minor carps and 11.5% 'Others' as revealed by rearing of Floods III and IV spawn. Spawn analysis showed first flood content to be 92.2 to 100% minor carps in different spurts. The causative factors of the failure of the centre were sought after and the river upto Wanakbori weir from Rania surveyed as to type of terrain. The following appear to have contributed to the failure of Rania centre as a spawn resource.

1. There was inadequate flooding which, as is well known, is the primary factor inducing carps to breed in rivers. Paucity of rainfall in the upper reaches coupled with interference with normal flooding of the river at least for some distance below the Wanakbori weir probably had a great deal to do in preventing flooding of the Mahi at and above Rania.

2. The riparian terrain upstream of Rania is largely rocky where suitable breeding grounds of major carps would perhaps be not be easily available to the fish. Judging from the fact that some major carps spawn was available (33.3% Rohu and 8.4% Catla) through the limited quantity it is felt that with adequate flooding quality spawn in greater bulk would have been available.

3. Whether or not there would be flooding of the river in future years and what the effect of weir would be is a matter of conjecture.

4. It would be worthwhile trying spawn collecting at Rania in a year of greater flooding of the river.

5. Tor tor fry and fingerlings can be collected in Mahi at and above Rania and probably further below as well.

Recommendations for spawn collection in the surveyed stretch of River Mahi

About 24 km long stretch of the River Mahi from Vasad to Rania were covered in the pre-monsoon survey and the sites inspected were Rania, Vasad and Kharda. Here again since only one site was to be selected on River Mahi the choice fell upon Rania where the State Fisheries Department was planning to construct a few nursery tanks which might help in rearing the collected spawn. The State Department itself was to take up the centre at Vasad for spawn prospecting in 1964.

In view of the suspision of climatological factor being associated with poor spawn yield at Rania in 1964 it appears worth while to once again try spawn prospecting at Rania in a year of greater flooding of the river.

VI. DISCUSSION AND CONCLUSIONS

Each of the eight sites investigated in Uttar Pradesh and Gujarat in 1964 had its own characteristic features which have been described in detail in the foregoing chapters. The sites can, however be grouped into centain types on the basis of quantitative and qualitative spawn yields and features of physical geography and zoo-geography of their location. The sites Kishanpur and Mahewa on Jamuna are situated in a major carp abundant zoo-geographical zone, in the heared of the Gangetic plain on alluvial soil characterised by gradually rising and receding floods of which there are usually 4 or 5 in a season. Such sites have been prodigal in the yield of excellent quality spawn. The sites at Tajpur (Moradabad) and Sardarnagar (Bareilly) on River Ramganga are located in a poor major carp zoo-geographical zone just below Siwalik Foot Hills at places where alluvial deposites just commence their formation in the North, with frequent and abruptly rising and falling pattern of floods. Such sites have yielded spawn in reasonably high quantity but poor in quality. The site on River Ken at Gonribaba (Banda) is, in some ways, similar to sites on Ramganga being close to hills but lies in a zone where the major carps are reported to be negligible. The floods in Ken at Gonribaba resemble in their abruptness those of Ramganga, especially at Tajpur which is still closer to Siwaliks. No spawn was collected at Gonribaba.

Baluha on River Tons had, as assessed at the beginning of these investigations, some major qualities of a good spawn resource but actual work there showed that apparently the cause of poor results was hydrodynamical in character rather than biological. The main reason for non-availability of spawn was that due to the proximity of the site to the confluence of Tons with River Ganga, the current velocity in Tons depended on the relative water levels of the two rivers. The water level of the Ganga was consistently higher than that of Tons in the 1964 monsoons and consequently there was little current in Tons.

In general, it was noticed that turbidity were rather high at Jamuna Centres (Average of the season being 651 ppm at Kishanpur and 671.4 ppm at Mahewa), lower at Tajpur (Seasonal average 471.6 ppm) and still lower in Tons and Ken (Seasonal average at Baluha on Tons: 330.1 ppm and at Gonribaba on Ken:311.6 ppm). Sardarnagar on Ramganga, located further South of Tajpur, more in the interior of the alluvial zone, showed seasonal average turbidity of 786.1 ppm.

The Gujarat sites are situated on different river systems but still some of the characteristics of the sites were common with those of the Ganga system. Although flood level data at Sisodra on River Marbada was resolved into ten floods, the major ones were actually only five and Floods V & VI yielded 81% of the season's total spawn which compares favourably with Kishanpur on Jamuna where two floods, viz. II & IV, yielded 93% of the sessonal catch of the centre. The floods at Sisodra are likewise gradual in rise and fall. The species composition of major carp spawn at Kishanpur and Sisodra, however differ, Sisodra showing 68.2% Catla, 0.1% Rohu, 1.6% Mrigal and 0.7% Calbasu and Kishanpur (Flood II) 55.2% Mrigal, 30.2% Catla, 11.2% Rohu and nil Calbasu. Sisodra therefore also lies in major carp abundant zoogeographical zone* with, however, the dominant species differing from Jamuna. The average turbidity at Sisodra in 1964 was 1189.4 ppm against 651 ppm at Kishanpur.

Rania, on River Mahi in Gujarat, is on a different river joining the Arabian Sea independently. Rania is, however, located on a rocky river terrain and could be considered akin to Gonribaba site on River Ken in U.P. The average seasonal turbidity at Rania was 1813.3 ppm. Perhaps the black cotton soil and Gujarat centres is responsible for the high turbidity at both Sisodra and Rania centres.

A wide variety of hydrodynamical, chemical, meteorological and hydrobiological characters were studied in these investigations. A brief appraisal of the significance of each factor, based on spawn prospecting observations is 1964, is presented below.

Hydrodynamical Characters

Flood level:

Flood level is the most significant character showing a strong positive correlation with spawn as found at all centres. Sisodra site gave a clue to a particular flood level (18.5 to 21 m above river bottom) at least upto which water level must rise or below which it must recede having risen higher, before a copious yield of

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* Commercial catches of Narbada do not show a dominance of Catla because the prevalent commercial gear are not effective.

spawn is available suggesting a 'table land' at or above which elevation important breeding grounds of major carps are probably located. The alluvial based Gangetic centres showed no such flood level specificity for spawn availability. The more gradual the rise and fall of flood, the better the prospects for collection of spawn in abundance. Receding phases of floods yielded most of the spawn at all centres. Spawn availability commenced in day or night. Night collections were, however, found to have an edge over the day time collections at all centres.

Current Velocity

Within the limitations of current velocity determination in these investigations it may be stated that slow and gentle current, probably of the order 1-3 km/hour, is condicive to spawn catches. Faster currents of the midstream carry little spawn, it being probably cast aside as if by centrifugal force to areas of gentler currents towards and river banks.

There are indicatinns that current velocity, even within its optimum range limits, in conjunction with turbidity, determines the mesh of the spawn collection net for effective collection, 1/8" meshed net being relatively more effective in slower currents. These trends, however, need further investigations.

Current Direction

The spawn is carried in the direction of the current and shooting net operation is solely dependent upon the generation of current in the river and tis direction. Lack of current is attributed to be the cause of failure of Baluha centre. As a large number of nets have to be installed for commercial exploitation they are fixed with advantage at slightly varying degrees off the exact current direction.

Chemical characters

Turbidity

Floods are, in general, associated with higher turbidity when spawn is also available. Unattended by floods, turbidity by itself has no correlation with spawn. There are indications that turbidity in conjunction with current velocity determines the efficiency of spawn collection nets. Turbidity probably reduces the

mesh size and fast currents negate its mesh reducing capacity. These observations, however, need further corroboration.

pH and D.O.

None of these features of a river have any bearing on spawn appearance or its abundance in the river. These characters, in conjunction with others, are probably important in inducing fish to breed in their natural breeding grounds, which are the primary sources of riverine spawn.

Meteorological Characters

Temperature

Periods, prior to spawn appearance show lower air and water temperatures than post-spawn available periods. The temperatures during the span of spawn availability show similar or slightly higher trend than in the pre-spawn available periods. This temperature gradient is caused by wide-spread spells of rain in monsoon when fish breed, with temperature rising after the spell of rain. The gradient of temperatures is, however, very slight and not easily perceptible (about 1°C at Kishanpur).

Weather

Rainfall over the catchment area of a river is of vital importance since it is this factor which causes floods and generates the temperatures gradient mentioned above. It is, however, not feasible to procure rainfall data in respect of catchments since meteorological field units are not located according to catchment area of river basins. If, however, it were possible to collect rainfall data river basin-catchment-wise, it would be useful for interpretation of the spawn data, as well as for understanding of the phenomenon of riverine fish breeding and probably prediction of the appearance of spawn. Wind though, having little to do with spawn, except for its causing the monsoon itself (e.g. S.W.monsoon Winds, N.E.monsoon Winds etc.) is of vital importance in shooting net fixation and operation. Windy days yield poor, and at times nil, spawn because the wind interferes with the net remaining fixed and stationary. High winds deshoppe the spawn nets and gamchas. At Rania windy days throughout the season made day time operation of nets and spawn collection difficult. Wind also adversely affects the correct recording of current velocity and direction by the float method.

Hydrobiological Characters

Associates

Associates are unavoidable accompaniments of spawn in riverine collection. It has not been possible to throw light on any breeding sequence of species which can/generalised. It is, however, an /be important study in as much as Associates' qualitative sequence, if any, can possible be of diagnostic significance of spawn quality. Gut contents study of Associates is not of much consequence since predation on spawn occurs, in all probability, within the confines of tail piece, and even if it takes place in the river, there is little that can be done to control it.

Plankton

The occurrence of plankton was found to have no connection with spawn availability or its abundance in the main river or stream.

Spawn purity and its admixture with other biota

The contaminats of major carp spawn are (i) hatchlings and larvae of minor carps, (ii) those of other fishes called 'Others' (forage fish, mullets, murrels etc.) in this report and (iii) Associates. The relative abundance of major carp spawn and each of its above-stated contaminants, in respect of each site investigated, has been described in detail under relevant centres. In Jamuna centres purer major carp spawn was obtained in Floods II-IV in the middle and later part of the season rather than at its commencement or the terminal phase. Minor carps tended to dominate towards the beginning and end of the season. The spawn of 'Others' as well as the Associates appeared to be abundant in the early part of the season only. The above-stated sequence shows that if the spawn collection activity is concentrated in the mid-season alone it can result in the collection of superior quality spawn not much mixed with miror carps, 'Others' and Associates. This pattern is depicted in Figure 37 for the centres on Jamuna as well as on Narbada.

At Ramganga Centres, the first heavy flood tended to release relatively good quality spawn, whereas spawn of minor carps was

profuse throughout the season. The spawn of 'Others' and Associates followed the same positively skewed distribution as at Jamuna centres.

Net Selectivity

The seasonal catch ratios between Departmental and Midnapore nets (D : M) at different centres have been mentioned under respective centres. They were found to be 1:6 at Kishanpur and Mahewa, 1:3.1 at Rajpur; 1:1½ at Sardarnagar, 1:8 at Sisodra and 1:2 at Rania.

The catch ratios between different Midnapore nets with reference to Departmental nets, for days when proper statistical comparison was justified, at different centres, were recorded as under:

	D	M_1	M_2	M_{1-2}
Kishanpur*[1]	1	10.34		7.15
Mahewa-Jamunapur	1	7.3	5.4	6.1
Tajpur (Moradabad)*[2]	1	3.1	1.89	
Sardarnagar (Bareilly)*[3]	1	1.58		
Sisodra	1	14.1	9.3	1.3
Rania*[4]	1	2.3	1.8	-

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*[1] Nets M_1 and M_2 were found to be statistically similar at Kishanpur.

*[2] Nets M_2 and M_{1-2} were found to be statistically similar at Tajpur.

*[3] Only 1/8" meshed nets of Midnapore were used at Sardarnagar.

*[4] Data on M_{1-2} were inadequate at Rania.

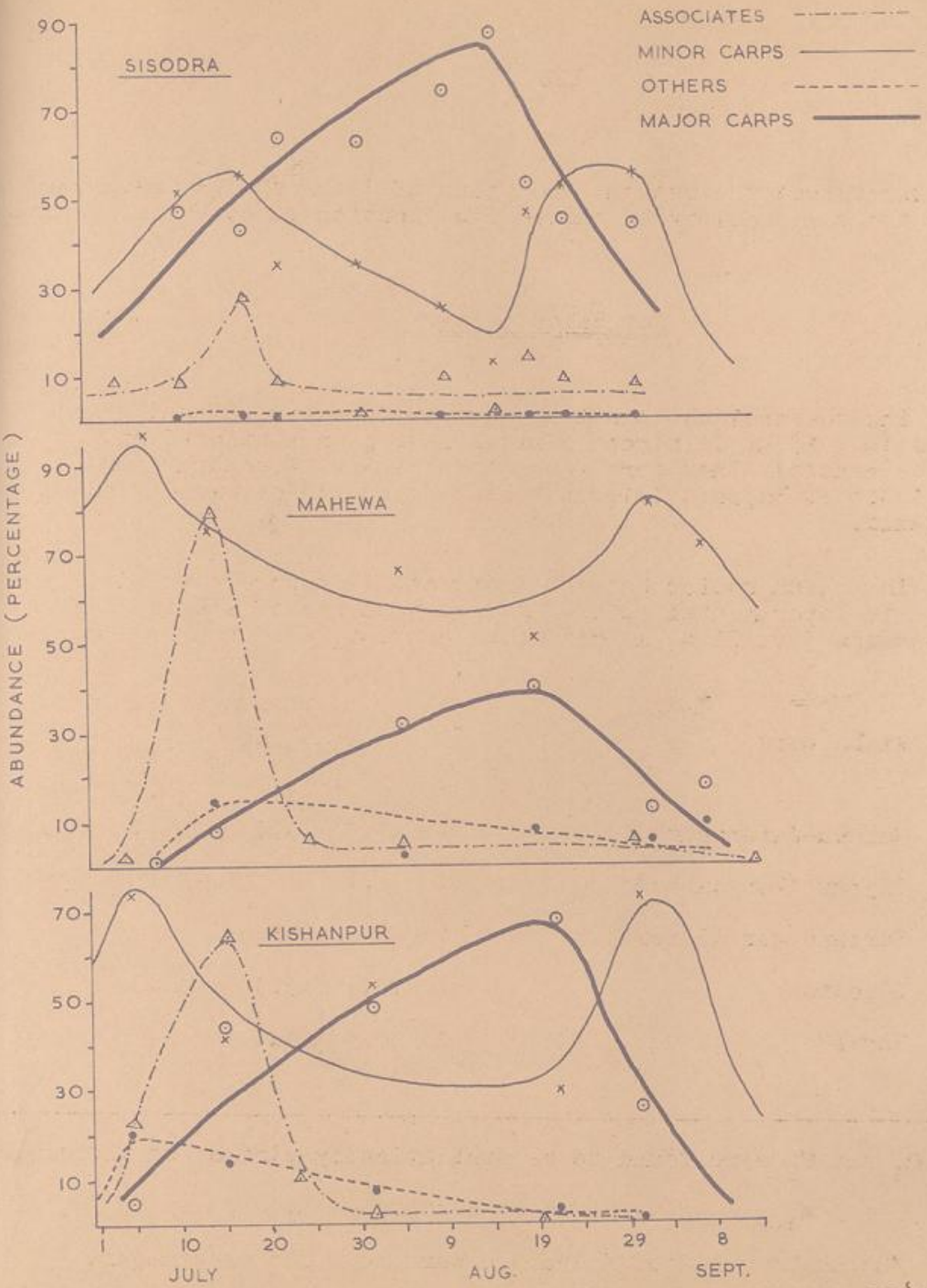

FIG. 37 A GENERALISED PATTERN OF INTRA-SEASONAL DISTRIBUTION OF 'MAJOR CARPS' 'MINOR CARPS', 'OTHERS' AND ASSOCIATES REVEALED AT JAMUNA AND NARBADA CENTRES.

These figures clearly show the overall superiority of 1/8" meshed Midnapore nets over others. It is also indicated that centres where the current velocity is known to be fast (Recorded as high as 9.1 km/hour at Tajpur and 6.5 km/hour at Sardarnagar), such as at Ramganga centres situated below the Himalayan foot hills, the catch-ratio between Departmental and the 1/8" Midnapore net is not so divergent. This suggests that in faster currents spawn probably escapes through the meshes of 1/8" meshed Midnapore net. There is, however, no documented proof to this effect. All nets, as stated earlier, were staggered to nullify their positional effect to bring out the most efficient net among those operated. It was however observed, especially at Sisodra, that when 1/8" Midnapore net was placed away from the river bank in fast current its catches were poorer. In such situations 1/16" meshed Midnapore net yielded better catches. Turbidity is believed to be another factor to recton with, which, depending upon current velocity affects not meshes. Turbidity in low current chokes the fine meshes of 1/16" meshed net making it finer still resulting in vomiting out spawn. In faster current choking is perhaps not possible and the net proves to be more efficient. Similarly 1/8" meshed net is more effective in low current and high turbidity and less effective in faster current. These points need scrutiny in specially devised double walled and trouser type of nets in future investigations. Nevertheless, the fact remains that 1/8" meshed Midnapore type is the most efficient net and till such time as specific environmental factors notably, current velocity and turbidity to suit nets to different meshes can be elaborated upon, it is proposed to treat this type of net as standard for spawn collection operations by central and state Governments in future.

The U.P. State Department nets (panel B of Figures 2 a and 2b) showed no uniformity of design and shape in as much as cut pieces of diverse shapes and sizes of netting were found tailored at different points of the net. These nets were not streamlined in shape and water struck with great force at the sides within the nets. The long tapering funnel part of the nets leading to tail piece often collapsed in the middle while in iperation resulting in vomiting of spawn. The tail piece was not deep and long enough. It swayed in wind and at its extreme and there was an acute angled pouch from where scooping presented difficulties resulting in death of spawn in appreciable numbers. The net ring was made of a material which did not retain its shape and was not durable.

In the case of Gujarat State nets used at Sisodra the netting cloth, being of square type mosquito netting material, (Panel C of Figures 2a and 2b) had no uniform meshes. The tail piece suffered from the same drawbacks as in the case of U.P. nets.

Notwithstanding the structural defects in the main body of the net, as in the case of U.P. nets, when the Midnapore type of gamcha was fixed to some of the State Department nets, both in U.P. and Gujarat Centres, the catches by them showed improvement. This show that in the nets of the State, one of the main defects lay in the gamcha. The same remarks are applicble to Gujarat State nets used at Rania although the net size at the two Gujarat centres differed appreciably.

Measure of spawn abundance

Standardisation of shooting net is a sine qua non as in other catch/unit/effort investigations in fishery biology to develop a measure of spawn abundance. Since 1/8" meshed Midnapore type of net proved most efficient at all centres and the shape and design of these nets and position of pieces and seams produced a streamlined net, it is recommended that this type of net should be adopted as a standard gear for spawn collection operations till conclusive studies on its efficiency in different riverine habitats are made. The total spawn catch taken by one standard net in course of the whole season, best based on average of several identical nets, is a satisfactory index of spawn yield of a centre. The seasonal spawn quantity indices of Kishanpur, Sisodra, Mahewa, Tajpur, Sardarnagar, Rania and Baluha were 259, 251, 155, 118, 34, 3 & 1 ounces respectively. It is easy to compute possible spawn yield from a centre by operating appropriate number of nets, if the net holding capacity of a site is known.

Index of spawn quantity alone, however, does not convey the entire spawn picture of a centre. The quantitative spawn index must be associated with an index of spawn quality. On account of considerations mentioned earlier, the index of spawn quality should be based on nursery rearings rather than spawn analysis. It is appropriate to categorise spawn only into three groups namely (i) major carps (ii) minor carps and (iii) 'Others' and to express their percentage ratio in the above stated sequence immediately following the spawn quality index. The indices of spawn quantity and quality, adopting the above system of expressing them, will be read as under, in respect of the centres prospected in 1964.

Name of centres	Index of spawn			
	Quantity in ozs	Q U A L I T Y		
		Major carps	Minor carps	'Others'
Kishanpur	259	85.3	14.6	0.1
Mahewa-Jamunapur	155	72.3	27.4	0.3
Tajpur (Moradabad)	118	2.8	96.7	0.5
Sardarnagar (Bareilly)	34	5.9	94.0	0.1
Sisodra	251	70.6	29.3	0.1
Rania	3	37.4	51.1	11.5
Baluha	1	-	-	-

The first number in these indices represents quantitative index of spawn as defined above, and the following three numbers are the percentages of major carps, minor carps and 'Others' expressing the pooled average of all floods in the whole season as revealed by nursery rearing and not by spawn analysis. This expression in capable of expansion in respect of different floods as well as in specific exposition within each of the groups, major carps, minor carps and 'Others'. For example, major carps could be further resolved into C.R.M. & Cb indicating the percentages of Catla, Rohu, Mrigal and Calbasu respectively.

In the following paragraphs are mentioned the various operations and observations which are necessary in future spawn prospecting investigations both by Centre and States.

(1) A thorough pre-monsoon survey, aimed at ascertaining the fish fauna in general and major carps in particular, if not already known, should be initially conducted. The results will indicate whether good quality spawn can be expected or not. The possibility of local breeding migration of major carps from outside the surveyed zone should not be lost sight of in anticipating results. A proforma showing the items on which information should be collected in the pre-monsoon survey on administrative and technical aspects of sites is attached as appendix 2. Information on the local of confluences with other rivers; dams, anicuts, weirs etc. positions of fixed fishing engines if any, highest recorded water level; average rain fall etc. would be highly beneficial in field operations.

(2) The choice of general location of centre should be essentially guided by proximity of all weather roads and/or rail or

feasibility of organising water transport. Subject to satisfying the transport needs, river bank configuration should be considered before choosing the exact sites for prospecting. River meanderings in plains results in a serpentine course outting off oxbow lakes. The bends and curves of various shapes in the river course often show a precipitous fast eroding bank on one side, called here 'erosion zone' and a flat gently sloping bank exactly opposite, called here 'shadow zone'. Both these banks (erosin and shadow zones) are unsuitable for spawn collection. The best collection sites were found to lie in these investigations on the gentle sloping bank but at a spot where the current just diverges, casting spawn to the sides, as if by centrifugal force. Figure 38 depicts the above-described position diagrammatically. During the present investigations, the collection sites had to be shifted in course of the season to suit the current and spawn concentration requirements at practically all the centres.

(3) 1/8" meshed Midnapore type net and tail piece should be adopted as a standard gear for some time to come and in order not to miss any spawn spurt at least one trial net (preferably 3), should be operated round the clock at the most likely point, judging from criteria laid in item (2) above. When spawn is available in appreciable quantity in the trial net, then following the procedure laid under item (4) below (viz, ascertaining area of maximum availability in each flood) the full battery of nets should be operated continuously day and night at the spot of maximum concentration. Blanket and trouser type experimental nets should be devised to study net efficiency under varying hydrodynamical conditions.

(4) In order to ascertain the spot of maximum availability of spawn within a specified stretch of the river concerned three trial nets each should be simultaneously operated at four or five sites in the first flood and, if necessary, in subsequent floods as well, and that site quickly selected for operation of full battery of nets in each flood where the catches are the maximum. If a boat is available then trial netting to ascertain area of maximum concentration of spawn should also be done on the islands in the river, if any, and on the opposite bank as well. Spawn prospecting and collection is a dynamic activity requiring vigilance and it is often necessary to shift the collection site, as stated under paragraph (2) above, to cope up with changing pattern of river current. During the 1964 investigations the Kishanpur site had to be shifted to Ashat Bank and Mahewa site to Jamunapur in floods II & III respectively. The same had to be done in the case of the Sisodra Centre on River Narbada after Flood. I in which some spawn was missed by the collection party.

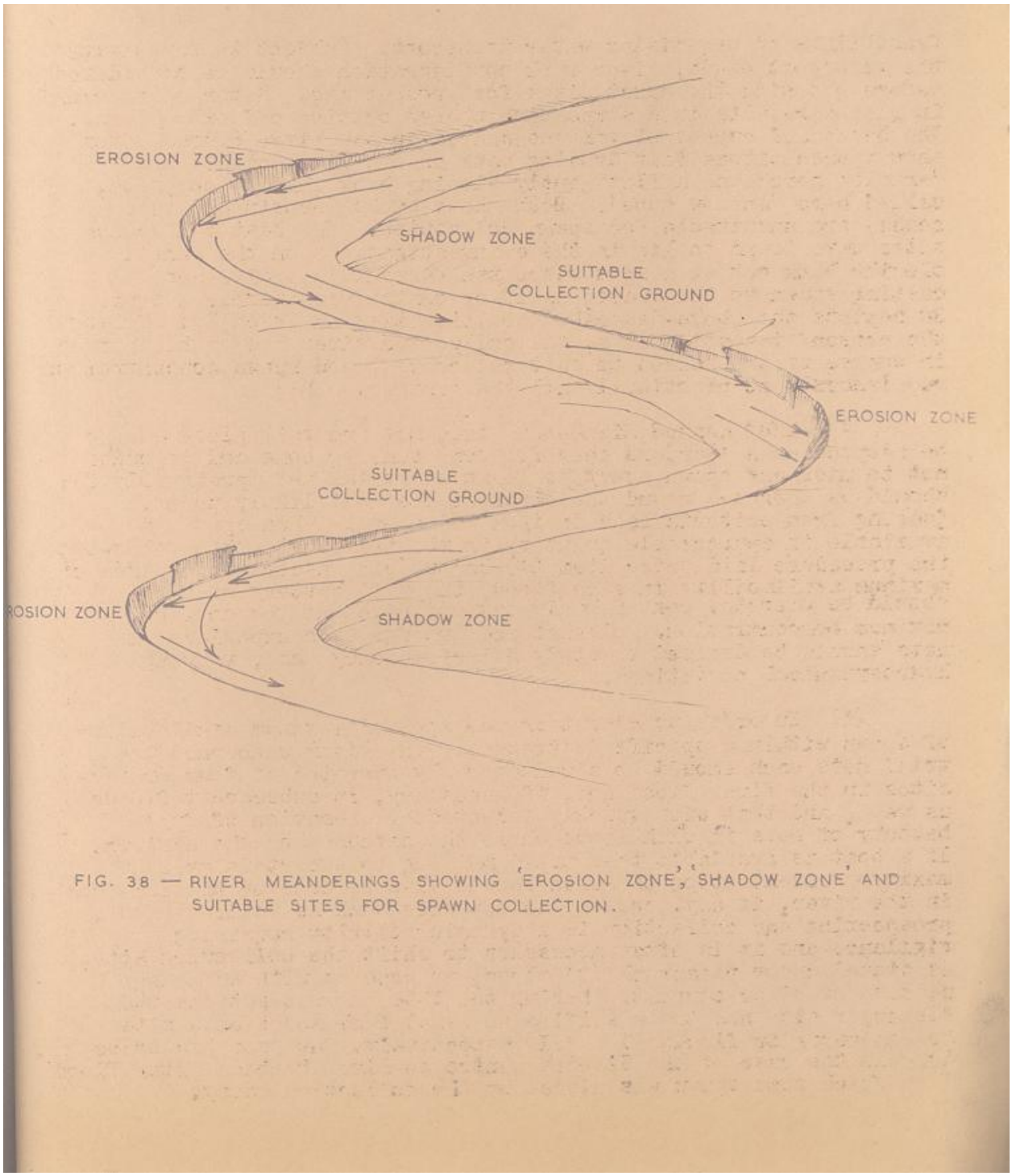

FIG. 38 — RIVER MEANDERINGS SHOWING 'EROSION ZONE', 'SHADOW ZONE' AND SUITABLE SITES FOR SPAWN COLLECTION.

(5) The collections should be frequently scooped, their exact frequency depending upon the intensity of collection; the Associates filtered off by sieving through cotton netting and the spawn either stored in hapa or directly oxygen-packed from tail piece keeping a record of net-wise collections.

(6) Measuring cups may be standardised in metric system at 200, 100, 50, 30, 20, 10 and 5 kl capacity and on the basis of present work, they may be accepted to hold spawn at the rate of 3500 per 10 ml at about 6 mm in length. No further counting of the spawn appears necessary.

(7) Flood level, weather conditions, air and water temperatures should be recorded every two hours. Turbidity and current velocity should be accurately determined by proper instruments with the same frequency as flood level etc. Associates and spawn samples should be analysed every two hours. pH, D.O. determination and plankton collection should be omitted altogether as they have no bearing on spawn appearance or abundance in the main river or stream.

(8) Information on the aforesaid items, shown in proformae attached as appendices 2-4, should be collected and recorded in bound log books for subsequent processing which would help in building up the basic nation-wide estimates of spawn catches. This data would furnish much needed primary statistics for more elaborate investigations on riverine spawn.

(9) Attemps should be made to locate and chart breeding grounds of carps, since study of success of spawning and survival is the only method whereby yearclass strength (and thereby abundance of fish) can be predicted. Location of breeding grounds can, in due course, provide means of improving spawning and/or survival rates and bridge the gulf between capture and culture fisheries. Besides, location of spawn sources would furnish a direct approach to the study of spawn behaviour and concentration in the river.

(10) The extent to which the aims and objects of the present investigations have been achieved in 1964 may be stated as under:

Aims	Achievements
1. To prospect for new sources of fish seed in the rivers and streams of the country to provide a fillip to fish culture.	1. Three excellent sources of quality fish seed, Kishanpur and Mahewa/ Jamunapur on Jamuna in U.P. and Sisodra on Narbada in Gujarat, and two sources of relatively lesser importance on Ramganga, viz. Tajpur

	(Moradabad) and Sardarnagar (Bareilly) in U.P., have been discovered, out of eight sites on six rivers prospected in 1964. Even from these experimental investigations appreciable quantity of spawn was utilised for fishery development by the State Departments concerned.
2. To train local fishermen and other personnel in riverine spawn collection technique.	2. At each of the eight centres investigated, several State Department personnel and local fishermen were trained in riverine spawn collection technique.
	3. Expert spawn collectors, from Midnapore who were specially recruited, imparted invaluable empirical field knowledge of spawn collection at each centre.
3. To elucidate factors responsible for fluctuations in abundance of quality fish seed and to predict its availability in time and space.	4. Flooding of rivers in Monsoon has emerged as a major factor in determining the availability of quality fish seed in time and space. Major floods, in their receding phases, have been found to yield bulk of the quality spawn. The role of numerous hydrographical characters has been critically appraised.
4. To evolve and standardise spawn collection nets and the technique of collecting, and measuring fish seed on all-India basis suitable to different current, depth and hydrographical conditions, a process essential for building up country-wide estimates of spawn yield, and its fluctuations from year to year which have an obvious	5. 1/8" meshed Midnapore type net has emerged as the most efficient net taking overall conditions of the environment into account. However, current velocity and turbidity appear to be the factors directly involved in determining the net efficiency. 1/8" meshed net has been found to be more effective in slow current and high turbidity and 1/16" in faster current and low turbidity. These trends have to be further investigated.

advantage in piloting a planned development of the fisheries of the country.

6. It is proposed to treat 1/8" meshed Midnapore type of net as a standard for the present for nationwide operations till details of environmental factors under which effectiveness of nets of different dimensions and meshes is elucidated.

7. A uniform pattern of investigation in future spawn collection work has been laid. Indices of spawn quantity and quality have been developed for comparison of centres located on different rivers of the country.

VII. SUMMARY

1. Spawn prospecting investigations were conducted in Uttar Pradesh at (1) Kishanpur and (2) Mahewa-Jamunapur on River Jamuna; (3) Tajpur (Moradabad) and (4) Sardarnagar (Bareilly) on River Ramganga, a tributary of Ganga; (5) Baluha on River Tons, a tributary of Ganga; (6) Gonribaba on River Ken, a tributary of Jamuna and in Gujarat at (7) Sisodra on River Narbada and (8) Rania on River Mahi. Investigations at Gonribaba were discontinued from July 28 onwards.

2. The duration of observations was from July 1 to Mid-September. Round the clock two-hourly observations were recorded on (1) Spawn and (2) Associate catches in 3 types of Midnapore nets viz. 1/8", 1/16" and 1/8"-1/16" meshes and a single type of State department net; (3) flood level; (4) air temperature; (5) water temperature and (6) weather conditions (wind and sky). Two-hourly day time (6 A.M. to 6 P.M.) observations were made on (7) turbidity; (8) current direction and (9) current velocity. Twice a day observations were made on (10) pH at 6 A.M. and 6 P.M. Once a day observations were made on (11) plankton at 6 A.M. and once every three days' observations were made on (12) dissolved oxygen at 6 A.M.

3. Spawn quality was determined by microscopic examination of hatchlings at spawn stage and by rearings in earthen gamlas and/or rearing pits and/or nurseries upto the stage hatchlings could be identified visually. Except at Sisodra on River Narbada, where Catla is the overwhelmingly dominant major carp, the rearings furnished somewhat higher estimates of major carps than those revealed by analysis at hatchling stage. This is attributable to the numerical underestimation of major carp at below 6 mm size due to lacunae in knowledge on spawn identification and also due to differential mortalities of different species of fish in nursery rearings.

4. In absolute terms the spawn yields in experimental investigations in 3-5 Midnapore and 3-5 departmental nets were 1385 ozs at Kishanpur, 819 ozs at Mahewa-Jamunapur; 744 ozs at Tajpur (Moradabad); 287 ozs at Sardarnagar (Bareilly); 4½ ozs at Baluha; 1158 ozs at Sisodra and 26 ozs at Rania. New measures of spawn abundance and indices of spawn quantity and quality have been developed to render spawn catches taken by a standard net, at centres located even on different rivers, mutually comparable, and to enable assessment of spawn yielding potentiality of centres being made. Catch per

net-hour is the unit of effort derived. Whole season's catch of spawn, taken by a standard net represents the index of spawn quantity available at a centre. The index of spawn quality is the expression of seasonal percentages of major and minor carps and 'Others'. In this manner the indices of spawn quantity and quality at different centres investigated work out to be as shown below:

Name of centres	Index of spawn quantity	Index of spawn quality		
		Mj	Mi	O
Kishanpur	259 czs	85.3	14.6	0.1
Mahewa-Jamunapur	155 "	72.3	27.4	0.3
Tajpur (Moradabad)	118 "	2.8	96.7	0.5
Sardarnagar (Bareilly)	34 "	5.9	94.0	0.1
Sisodra	251 "	70.6	29.3	0.1
Rania	3 "	37.4	51.1	11.1
Baluha	1 oz	-	-	-

Mj: Major carps M1: Minor carps and O:'Others'

The index of spawn quality is capable of being resolved into different floods of the season as well as expanded into different species falling under all the 3 above-stated categories of spawn.

5. Trends of intra-seasonal distribution in abundance of major carps, minor carps, 'Others' and Associates, the latter three being unavoidable accompaniments of major carps spawn, revealed in the investigations were, that at centres on Rivers Jamuna and Narbada purer quality seed was obtained in the middle and later part of the season (Floods II and IV in Jamuna and V and VI in Narbada) rather than at its commencement or end, following a rather negatively skewed distribution. Minor carps tended to dominate towards the beginning and terminal phases of the season, following a bimodal distribution of occurrence. The spawn of 'Others' as well as the Associates were found to be abundant in the early part of the season only showing a somewhat positive skewness in distribution. At Ramganga centre the first heavy flood released relatively good quality spawn, whereas spawn of 'Others' and Associates followed positively skewed distribution as at Jamuna centres.

6. The role of each of the eleven hydrodynamical, chemical, meteorological and hydrobiological characters listed under (2) above

in the "Summary" was critically assessed on the availability and fluctuations in abundance of riverine spawn. Flood level and meteorological conditions are the factors governing appearance of riverine spawn in time and space. Current velocity and turbidity appear to affect mesh selectivity of the spawn collection net. pH, D.O. and plankton are unimportant factors in riverine spawn collection though they may be important at breeding grounds. Associates are unavoidable accompaniments of spawn and no sequence of their appearance by species, capable of generalisation, was discovered.

7. 1/8" meshed Midnapore type net has emerged as the most efficient net taking overall conditions of the environment into account. There were indications that this net was more effective in slow current and high turbidity and 1/16" meshed net in faster current and low turbidity. These trends need further investigation. The ratio of spawn catches between Departmental and Midnapore nets of 3 meshes at different centres were as shon below:

Name of centre	D	M 1/8"	M 1/16"	M 1/8-1/16"
Kishanpur*[1]	1	10.34		7.15
Mahewa (Jamunapur)	1	7.3	5.4	6.1
Tajpur (Moradabad)*[2]	1	3.1	.89	
Sardarnagar (Bareilly)*[3]	1	1.54		
Sisodra	1	14.1	9.3	1.3
Rania*[4]	1	2.3	1.8	-

8. It is proposed to treat 1/8" meshed Midnapore type net as a standard net for the present, till details of environmental factors under which effectiveness of nets of different dimensions and meshes is elucidate. Midnapore as well as Departmental nets are sketched to scale to sow their exact size, shape and design and the dimensions of the formr given. The deficiencies of departmental nets are pointed out.

1 Nets M 1/8" and M 1/16" were found to be statistically similar at Kishanpur.

*2 Nets M 1/16" and M 1/8"-1/16" were found toe statistically similar at Tajpur.

*3 Only 1/8" meshed Midnapore nets were used aSardarnagar.

*4 Data on M 1/8"-1/16" were inadequate at Ran.

9. The spawn yielding potentiality of each site investigated and developmental measures needed for their commercial exploitation have been stated. Three excellent sources of quality fish seed, Kishanpur and Mahewa-Jamunapur on River Jamuna in Uttar Pradesh and Sisodra on River Narbada in Gujarat and two sources of relatively less importance on Ramganga viz. Tajpur (Moradabad) and Sardarnagar (Bareilly) in U.P., have been discovered. Even from the experimental investigations, appreciable quantity of spawn was utilised for fishery development by the State Departments concerned.

10. While each site investigated showed its own characteristic features, they have been classified into certain types on the basis of features of physical geography and zoogeography.

11. A uniform pattern of investigation in spawn collection work has been laid. Factors to reckon with in choosing exact sites are enumerated. Proformae to be used for recording data are given. Successful spawn collection is a dynamic activity requiring whole-time vigilance. At least one standard trial net should be operated round the clock throughout the entire season so as not to miss any spawn spurt. When spawn is available as many nets as possible should be operated day and night after determining the spot of maximum concentration of spawn by simultaneous trial of nets at several points. It is often necessary to shift the collection site in the mid-season to cope up with changing pattern of river current in different floods.

12. It is recommended that attempts should be made to locate and chart breeding grounds of carps since study of success of spawning and survival is the only method whereby year class strength (and thereby abundance of fish) can be forecasted. Location of breeding grounds can, in due course, provide means of improving spawning and/or survival and bridge the gulf between culture and capture fisheries. Besides, location of spawn source would furnish a direct approach to the study of spawn behaviour and concentration in the river.

- = -_- = -_- _

DKB: 11/1965.

Appendix 1

Centre-wise record of enumeration of hatchlings or early fry in one ounce spawn samples and their length ranges or average length

River	Centre	Sample No.	Total count	Length range or Average length
Jamuna	Kishanpur	1	10,208	5.9
		2	9,939	6.0
		3	9 566	6.0
		4	10 103	6.9
		5	9 201	6.9
		6	8 963	6.0
		7	9 103	6.0
	Mahewa/Jamunapur	8	10 518	5.3-6.5
		9	9 502	5.8-7.5
Ramganga	Tajpur (Moradabad)	10	8 889	5.6-7.5
		11	10 743	4.0-6.5
		12	10 412	5.5-6.8
	Sardarnagar (Bareilly)	13	10 550	4.0-6.6
		14	10 882	4.0-6.5
		15	10 371	4.0-6.5
Narbada	Sisodra	16	9 486	5.95
		17	11 399	5.99
		18	10 367	5.93
		19	10 417	5.93
Mahi	Rania	20	11 520	6.73
		21	8 819	6.90

Average Number of hatchlings per ounce of spawn = 10048

APPENDIX 2

SPAWN PROSPECTING INVESTIGATIONS

Proforma for Pre-Monsoon Survey*

A: ADMINISTRATIVE

1a. Name of the River _____ b. Drainage _____

2. Name of the village _____ 3. District _____

4. Tehsil/Taluka _____ 5. Police Station _____

6. C.D.Block _____ H.Q. _____ Distance _____ km.

	Name	Distance	Frequency of delivery or Hour of operation.
7. Nearest Post Office	_____	_____ km.	_____
" Telegraph Office	_____	_____ km.	_____
" Telephone Office	_____	_____ km.	_____

8. Nearest (i) Railway station _____ on _____ Rly. Distance _____ km.
(ii) All-weather road at _____ Distance _____ km.
(iii) Fairweather road at _____ Distance _____ km.

9. Camping space available at (1) _____ Distance _____ km.
Field Lab.accommodation at _____ Distance _____ km.

10.**Likely minimum rent p.m. for (i) Field laboratory accommodation _____
(ii) Camping space _____

11. Availability of general amenities (i) Drinking water _____
(ii) Market _____
(iii) Medical _____

---

* All distances are to be given from the proposed or likely sites of operation.

** This should be assessed or enquired indirectly rather than openly. An open enquiry raises monetary hopes amongst villagers which should be avoided.

B: TECHNICAL

12. Confluences of Rivers, upstream, and downstream.

River	Confluence at	Distance	Up/Down

13. Location of Dams/Weirs/Anicuts on the River.

Name	Location	Distance	Upstream	Downstream

14. Position and distance of fixed engines, if any _____

15. Kind of terrain (Rocky/sandy/clay)
(i) Locally_____ (ii) Catchment area_____

16. Highest flood level known in the area (i) Weight_____ (ii)Year_____

17. (i) Average annual Rainfall in the locality _____
(ii) Usual time of onset of monsoons _____

18. Species-wise quantitative analysis of fish catches either from areas near the site or from the river in general _____

19. Location of major carps' congregation centres in areas inundated during Monsoon 1 _____ 2 _____ 3 _____
4 _____ 5 _____ 6 _____

20. Nature of the river bank near collection site _____

21. Location and distances of deep pools _____

22. Extent of area available for operation of nets in relation to flood

Flood rise from summer level.	Approximate week of flood.	Area available at site for Operation of nets with number.	Camping	Approachability by land.

23. Availability of pits/ditches/ponds for experimental rearing near si

Sl. No.	Location	size	Distance	Whether Freehold or lease	Ready for use	Chances of flooding/ overflowin

24. Whether fishermen will be available locally for casual employment during monsoon period _____

25. A diagram showing the general topography of the river 8 km up and down streams of the site, location of Nallahs, rivulets with their names (and important land maps) should be prepared separately on a foolscap size paper and attached to this proforma. The locations of sites entered under items 20, 22, 23 and 24 should also be shown in this diagram.

Surveyor _____

Date of survey _____

APPENDIX 3

Proforma No. 1 (65)

Name of River _____

SPAWN PROSPECTING SURVEY

Name of Centre _____

Positional Identity of Nets

Date _____1965

Hour of Observation	Net No.1 (N1)			Net No.2 (N2)			Net No.3 (N3)			Net No.4 (N4)			Net No.5 (N5)			Remarks if any.
	Distance from bank in m	Operational depth in m	Relative position (coded)	Distance from bank in m	Operational depth in m	Relative position (coded)	Distance from bank in m	Operational depth in m	Relative position (coded)	Distance from bank in m	Operational depth in m	Relative position (Coded)	Distance from bank in m	Operational depth in m	Relative position (coded)	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
6																
8																
10																
12																
14																
16																
18																
20																
22																
0																
2																
4																
Total																

APPENDIX 4

SPAWN PROSPECTING SURVEY

Proforma No. 2 (65)

Name of River_____ Date _____

Name of Centre_____

Observations on Spawn catch and related characters

Hour of observation	SPAWN: Spawn catch in ml in different nets							HYDROBIOLOGICAL: Associate catch in different nets							HYDRODYNAMICAL			METEOROLOGICAL					CHEMI
	N_1	N_2	N_3	N_4	N_5	Total	Sample No.	N_1	N_2	N_3	N_4	N_5	Total	Sample No.	Flood level in m	Current Vel. in km/hour	Current Direction in degrees	Rain fall in mm	Temperature in °C Air	Temperature in °C Water	Weather Sky condition	Wind Direction	Wind Speed	Turb dit in ppm
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
6																								
8																								
10																								
12																								
14																								
16																								
18																								
20																								
22																								
0																								
2																								
4																								
Total or Average																								

Appendix 5

Instructions for filling proformas of spawn prospecting survey

Proforma No.1/65 (Positional Identity of Nets)

(a) Distance of different nets (N_1 - N_5) from bank (col.Nos.2,5, 8,11 and 14) :- Shortest distance between the water mark on the bank and the farthest pole of the net to be recorded in matric measure for each net.

(b) Operational depth of different nets (N_1-N_5) (col.Nos.3,6, 9,12 and 15) :- Water depth at the farthest pole of each net i.e. from the water mark on the pole to river bed to be recorded in matric measure for each net.

(c) Relative position of different nets (N_1-N_5) (col.Nos.4,7, 10,13 and 16) :- Nets may be operated in rows, and each row may have one or more than one net. First identify the rows; i.e. the first row facing the current may be called row 'A', the one behind as row 'B', the one behind row 'B' as row 'C' and so on. Thereafter, different nets of the rows are to be identified. The net closest to the bank may be called net '1' and the next net in the same row, when fixed abreast, as net '2' and so on for each row. Thus, the net closest to the bank in the first row facing the current will be termed as net 'A_1' and the next abreast to 'A_1' in the same row as 'A_2'. The net close to the bank in the second row would have the identity number as 'B_1' and the one next to it in the same row as 'B_2' where all the five nets are fixed one behind the other, the first net facing the current would be termed as 'A_1', the one behind it as 'B_1' and so on, and the last one will be net 'E'.