graph. The constant r is defined as the factor by which the true hourly rate of meteors of any magnitude increases for a unit increase in the apparent visual magnitude. The value of Q_0 and r derived from Fig. 2 are 1·3 and

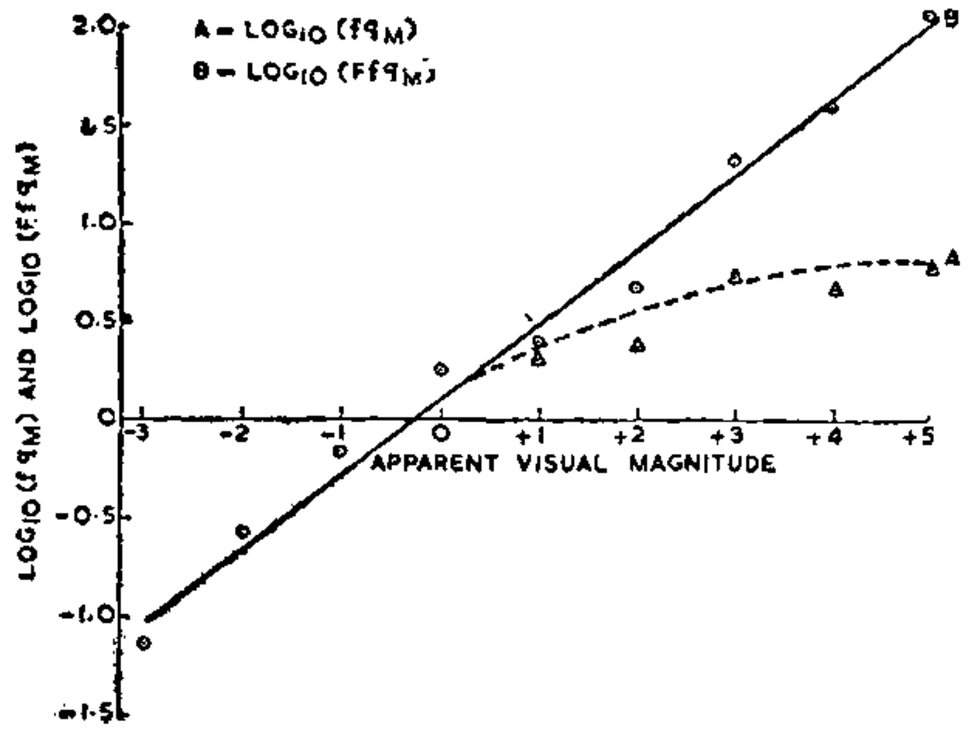

FIG. 2

2·4 respectively. The corresponding mean hourly rates for a single observer, say n_M, may then be obtained by dividing the six observer rates by 3·3 (*see* Mc Kinley[3]). The value of n_0, for the present observations, is thus found to be 0·4.

The value of r is an important index, which indicates the relative abundance of meteors of different magnitudes. Mc Kinley[3] indicated that the value of r lies between 2·5 and 4·0. The present value of 2·4 lies at the lower limit of this range. An attempt is also made to derive the value of r for some important major shower meteors observed during this period of observation. These results are presented in Table I. It may be seen from this table that the values of r for the Taurids and the Geminids are in close agreement with that of all the meteors observed. The value of r for the Leonids is, however, relatively low as has already been indicated by Lovell[4] from Millman's observations. This indicates relative abundance of brighter meteors in the Leonid stream.

TABLE I

Values of r *for shower meteors*

Shower meteors	Duration of activity	Number of meteors observed	Value of r
Taurids	November 1–30	1,447	2·5
Leonids	November 15–20	1,046	1·8
Geminids	December 6–19	1,714	2·4

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1. Lokanadham, B. and Rao, M. S., 1967, **5**, 537.
2. Rao, M. S., Rao, P. V. S., Venkataramayya, Y. and Rao, C. V. R., 1968, **6**, 377.
3. Mc Kinley, D. W. R., *Meteor Science and Engineering*, McGraw-Hill Book Co., U.S.A., 1961.
4. Lovell, A. C. B., *Meteor Astronomy*, Oxford at the Clarendon Press, 1954.

SUCCESSFUL ARTIFICIAL PROPAGATION OF *HILSA ILISHA* (HAMILTON) NEAR ALLAHABAD

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IN view of the commercial importance of the Indian Shad, *Hilsa ilisha* (Hamilton), and the reported dwindling of its fishery due to physical barriers across rivers,[1] various attempts were made to artificially propagate hilsa at several places in this country,[2-8] but none succeeded in rearing the resultant hatchlings beyond three days. However, Karamchandani[9] was able to hatch fertilised hilsa eggs collected from the Narmada and rear the hatchlings upto fourteen days. An attempt was, therefore, made at artificial propagation of hilsa through stripping and hypophysation at Sirsa on the Ganga, about 50 km. downstream of Allahabad.

Live male and female specimens, which were procured from commercial catches of 'Kamel' (clap net), were simultaneously stripped on to enamel trays containing 22 mm. deep river-water. The trays were then gently tilted from side to side for about five minutes. All the fertilised eggs turned transparent in about fifteen minutes.

In all, eight strippings were attempted, all of which proved successful. They were invariably undertaken late in the evening, since initial examination revealed that fish in oozing condition were available only in the afternoon catches. The length of the females employed ranged from 380 to 480 mm., while that of the males varied from 316 to 448 mm. It was observed that one male was more than sufficient to fertilise the eggs stripped

from a single female. In one experiment, the live female was partly stripped and the eggs were got fertilised successfully with the milt of a male which had died about 30 minutes earlier. In another experiment with the same female 30 minutes after its death, all of its remaining eggs were stripped and mixed with the milt of two males, one partly spent and the other oozing. It was again successful. In both these cases, about 90% of the eggs were found to have been fertilised.

To start with, enamel trays containing 50 mm. deep river-water were employed for hatching the fertilised eggs; but they proved of little use, as 98% of the eggs died after about eight hours of development, possibly due to the steep fall in temperature of the tray water from 28° C. to 16° C. For all the subsequent hatchings, double-walled hapas, usually employed for hatching carp eggs, were employed. They were fixed in the river-bed close to the bank at a place where the depth was about 1·0 m. and a mild current was available all the time. The inner hapa of round meshed mosquito netting, employed to segregate dead eggs and egg shells from the hatchlings, proved of no value, as all the hilsa eggs invariably passed through the 2 mm. mesh of the inner hapa. An inner hapa made from 1/16" meshed cloth was tried experimentally, but with no better results. Thereafter, single-walled hapas of markin cloth were put into commission and the hatchlings segregated mechanically, taking advantage of the direction of the flow.

The resultant hatchlings were successfully reared in the river in markin cloth hapas, fixed adjacent to the hatching hapas, for periods ranging from 7 to 20 days, and thereafter two samples, one of 50,000 hatchlings and the other of 75,000 hatchlings, were transferred to two freshwater nursery ponds (90′ × 70′ each) for further rearing. The remaining hatchlings were released in the river. In 20 days of river rearing, the first batch of 2·5 to 3·0 mm. long hatchlings grew to 10 mm. size, while the second batch attained a size of 7·5 to 8·0 mm. in seven days. In nursery ponds, the post-larvæ of the first batch attained a size of 22 mm. in 45 days, while those of the second batch grew to 20 mm. in 30 days. Sudden intense cold killed all these early fry after the above periods of rearing. In all, the first batch of hatchlings could be reared for a total duration of 65 days and the second batch for 37 days. Successful rearing of hilsa larvæ after artificial fecundation over such long durations was thus achieved for the first time.

Preliminary experiments, conducted to adjudge the possibilities of transporting hilsa spawn under oxygen in sealed containers, indicated that yolked larvæ could be successfully transported under oxygen packing with relatively little mortality.

Experiments were also conducted to induce breed hilsa through hypophysation, employing pituitary glands of *Hilsa ilisha*, *Cirrhina mrigala*, and *Wallago attu*, preserved in absolute alcohol or acetone, at temperatures ranging from 7° C. to 8° C. Double distilled water was employed to prepare the extract. As the injected fish could not be kept alive beyond 4½ hours under captivity, no tangible results could be achieved by this method.

To keep hilsa alive under captivity, an essential prerequisite to breed it through hypophysation, and to circumvent certain situations in stripping experiments, such as the availability of individuals of only one sex at a time, hapas of different materials and dimensions were tried. It was possible to keep the fish alive for only about 4½ hours, and the hapa found most useful was the one made from bamboo splits and measured 185 cm. in length, 105 cm. in width and 135 cm. in height. It was fixed in river-bed close to the bank at a spot where the water depth was about 100 cm. and a mild current was available all the time.

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1. Day, F., *Report on Freshwater Fish and Fisheries of India and Burma*, London, 1873.
2. Wilson, H. C., *Govt. of Madras, Revenue Dept.*, G. O. 1219, 1909.
3. Raj, B. S., *Journ. and Proc. Asiatic Soc. Bengal*, 1917, **13**, 188.
4. —, *Madras Fish. Bull.*, 1928, **22**, 1.
5. —, *Administrative Report of the Madras Fisheries Department for the Year 1934–35*, 1936, p. 74.
6. Southwell, T. and Prasad, B., *Bull. Dept. Fish. Bengal, Bihar and Orissa*, 1918, p. 11.
7. Kulkarni, C. V., *Proc. nat. Inst. Sci. India*, 1950, **16** (3), 169.
8. Dixitulu, J. V. H. and Chacko, P. I., *Fisheries Station Report and Year-Book*, Madras, 1962.
9. Karamchandani, S. J., *Curr. Sci.*, 1961, **30** (10), 373.