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Some Insects found associated with the Bitter-Gourd,[1] *Momordica charantia* Linn. (Cucurbitaceæ), in Calcutta.

By S. RIBEIRO.

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The insects which are reported in this paper were collected in the months of April to June, 1933, from plants of bitter-gourd which were growing in the compound of a house in Calcutta. In view of the bitter taste of the fruit and of the sap of this plant it was thought desirable to ascertain what insects were associated with this plant. The material collected belongs to 16 species, representing 12 genera, 8 families, and 5 orders. Of the species of insects dealt with in this paper the fruit-fly, *Chaetodacus cucurbitae* Coq., is the only species referred to in literature as having been reared from *Momordica charantia* Linn.

The insect fauna is of special value as it includes families that are of great economic importance; and it is interesting to note the predominance of the injurious over the non-injurious forms. These are here classified according to their infestation of the plant, i.e. (1) those found on the foliage, (2) those found in the flowers, and (3) those found in the fruit.

My thanks are due to Dr. Hem Singh Pruthi for his valuable suggestions.

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1. *On Foliage.*

Order COLEOPTERA.

Fam. COCCINELLIDÆ.

Epilachna pubescens Hope.—The species is a prolific breeder, being found abundantly in all stages feeding voraciously on the epidermis of the leaves and devouring the buds of the flowers. Male and female specimens of this beetle that I had caught copulated in captivity. Copulation lasted for about ten minutes, after which the females attempted to fly away. The females started laying eggs two days later. It is noteworthy that on both occasions copulation took place in the evening at about dusk. The Epilachninæ are herbivorous, their food being

[1] The variety with small globose fruit locally known as *uchhé*.

chiefly the plants belonging to the Orders Cucurbitaceæ and Solanaceæ. Subramaniam[1] remarks that both *E. dodecastigma* Muls. and *E. vigintioctopunctata* Fabr. are known to feed on the bitter-gourd, *Momordica*, etc. Takahashi[2] gives a full account of the life-history and bionomics of the latter species.

Fam. CHRYSOMELIDÆ.

Aulacophora abdominalis Fabr.—Many adults were noticed eating the leaves. This species is a well-known pest of young Cucurbitaceæ. Husain and Shah[3] consider this species to be of the greatest economic importance in the Punjab. These authors have given a list of the 'Plants refused by *A. abdominalis* in captivity' in which *M. charantia* is included.

Aulacophora atripennis Fabr.—Several individuals were seen feeding on the leaves. This beetle[4] is reported to be 'common on all cucurbitaceous plants, although it is usually a less serious pest than *A. abdominalis*'.

Order RHYNCHOTA.

Fam. JASSIDÆ.

Eutettix phycitis Dist.—Numerous adults and some nymphs were found infesting the leaves and stems, particularly the former. They lie concealed in the dense foliage, usually at the petioles of the leaves. The nymphs always eluded observation. This Jassid apparently undergoes its full life-cycle on the plants, as both nymphs and imagines were collected simultaneously. Moreover, very few nymphs were seen after May, though the adults still prevailed. Dr. Annandale[5] found this species feeding on the leguminous shrub, *Crotolaria striata* D.C., in Barkuda Island, Chilka Lake.

Numerous adults of a Typhlocybid were also seen on the leaves of this plant at the end of June. Nymphs were fewer.

Order LEPIDOPTERA (HETEROCERA).

Fam. PYRALIDÆ.

Glyphodes indica Saund.—Two larvæ were found eating the leaves. One of these pupated almost immediately, the

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[1] Subramaniam, T. V., Some Coccinellids of South India, *Rep. Proc. 5th Ent. Meeting, Pusa*, p. 117, 1923.

[2] Takahashi, S., Studies on *Epilachna* lady beetles in Japan, *Journ. Tokyo Agric. Col.*, III, pp. 5 and 115, pls. 7, 1932.

[3] Husain, M. A. and Shah, S. A., The Red Pumpkin Beetle, *Aulacophora abdominalis*, Fb. and its control; with a short note on *A. atripennis* Fb., *Mem. Dept. Agric. Ind.*, IX, pp. 45-46, 1926.

[4] Cf. *Rep. Proc. 2nd Ent. Meeting, Pusa*, p. 303, 1917.

[5] Annandale, N., Ecological Notes, in Paiva, C. A., Rhynchota from Barkuda Island, *Rec. Ind. Mus.*, XV, p. 15, 1918.

other I lost sight of. The pupal period lasted for 8 days. Two adults were also collected. This species is regarded as 'a minor pest of pumpkins and cucurbits generally'.[1]

Order DIPTERA.

Fam. STRATIOMYIDÆ.

Sargus metallinus Fabr.—Several specimens were observed flying swiftly about the plants and suddenly alighting on the leaves, where they remained quite motionless. This fly is known to frequent grass and low herbage. Brunetti[2] records it as 'being common and widely distributed in India in May and July to October'.

2. *In Flowers.*

Order COLEOPTERA.

Fam. COCCINELLIDÆ.

Epilachna pubescens Hope.—Already enumerated as destroying the buds of flowers.

Order HYMENOPTERA.

Fam. APIDÆ.

Halictus albescens Smith.—Several specimens were seen frequenting the flowers. Three more specimens of Apidæ were collected, one of which may be referred to the genus *Halictus*. All these belong to the group of 'flower-visiting' bees, whose habits are still not fully known. In this connection it may be remarked that *H. albescens* Smith shows a distinct fondness for the flowers of *Momordica charantia* Linn.

Fam. FORMICIDÆ.

The following species of ants, possibly attracted by the honey, have been collected in the flowers :—

Solenopsis geminata Fabr.—Only a few workers were collected. This ant is regarded both as a harvester and scavenger.

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[1] Cf. *Rep. Proc. 2nd Ent. Meeting, Pusa*, p. 303, 1917.
[2] Brunetti, E., *Faun. Brit. Ind., Dipt. Brachycera*, I, p. 83, 1920.

Fletcher[1] and Misra[2] record it as being harmful to *Cajanus indicus* in Mandalay, brinjal seedlings in Calcutta and coconut stems in Ratnagiri.

Monomorium latinode Mayr.—Numerous workers were collected.

Tapinoma melanocephalum Fabr.—Numerous workers were taken. Lefroy[3] records the species as doing damage to young 'tur' plants, *Cajanus indicus*.

Prenolepis longicornis Latr.—Numerous workers were collected. This species was more abundant than the preceding.

3. *In Fruit.*

Order DIPTERA.

Fam. TRYPETIDÆ (TRYPANEIDÆ).

Chaetodacus cucurbitae Coq.—A few female specimens were noticed only in the evening time hovering about the fruit and inspecting them probably with a view to oviposition. Quite a number of the fruit were collected. Of these twenty per cent. were found to have been attacked; a few being infested with the living larvæ while the majority showed signs of their ravages. The larvæ equally relished both the ripe and unripe fruit. A few of the contaminated fruit were kept in the laboratory. The observations made are as follows:—

1st Lot—	16. v. 33 ..	Larvae (evidently well-advanced).
	22. v. 33 ..	Pupae.
	27. v. 33 ..	Adults emerged.
2nd Lot—	31. v. 33 ..	Pupae.
	8. vi. 33 ..	Adults emerged.
3rd Lot—	6. vi. 33 ..	Larvae (evidently well-advanced).
	13. vi. 33 ..	Pupae (all perished).

This fruit-fly[4] has always been regarded as a serious pest of the Cucurbitaceæ and is reported to have been reared from the fruit of *Momordica charantia* Linn. Shiraki[5] in recording this fly mentions *M. charantia* among the plant-hosts of the species. Lefroy[6] has observed its complete life-cycle, which is said to occupy about 15 days; the larval period being between $3\frac{3}{4}$ to 11 days and the pupal period between 10–14 days.

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[1] Fletcher, T. B., Annotated List of Indian Crop-Pests, *Rep. Proc. 3rd Ent. Meeting, Pusa*, p. 34, 1919.

[2] Misra, C. S., Index to Indian Fruit-Pests, *op. cit.*, p. 576, 1919.

[3] Lefroy, H. M., *Indian Insect Life*, pp. 229-230, Calcutta, 1909.

[4] Cf. *Rep. Proc. 2nd Ent. Meeting, Pusa*, p. 304, 1917.

[5] Shiraki, T., A Systematic Study of Trypetidae in the Japanese Empire, *Mem. Taihoku Imp. Univ.*, VIII, Entomology No. 2, p. 76, 1933.

[6] Lefroy, H. M., *Manual of Entomology*, pp. 444–445, London, 1923.

Order HYMENOPTERA.

Fam. FORMICIDÆ.

Monomorium latinode Mayr.—Many workers were seen feeding on the substance of the ripe fruit. This species, as already stated, was observed on flowers also.

Rains of Fishes in India.[1]

By SUNDER LAL HORA.

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CONTENTS.

INTRODUCTION.

The vagaries and ravages of the south-west monsoon of 1933 will be remembered for a long time in this country. Calcutta had a long rainy season and received over 20 inches more rain than usual. In several provinces torrential downpours and cloud bursts devastated vast areas. In Orissa, Central India, Delhi and the Punjab, the heavy floods absolutely disorganized, all communications and caused considerable loss of life and property. With these reports, it has also to be mentioned that Assam and several other parts of the country recorded a heavy deficit in rainfall for the monsoon period. These abnormal conditions of weather have been responsible for several phenomena of interest and one of these has been the reports of fish falling from above with rains.

In the *Statesman* of September 14, Kim reported three rains of fishes as follows :—'It rained fish in the Muzaffarpur district on July 11 and again on September 1. . . . my informant says :

"I have known this to happen once before in 1912, and on that occasion my tennis lawn and all the surrounding ground over a large area was literally white with small fish and maunds of them were picked up by coolies."

The recent falls were not so big, but plenty of fish were to be had for the picking up. What is the explanation ? My correspondent suggests that the fish were sucked up out of a river by a water-spout and then discharged again during a heavy thunderstorm. The objection to this theory is best put by means of a

[1] A note on the Meteorological Aspects of the Rains of Fishes in India is given by Dr. S. N. Sen in a separate article immediately following this paper.

question. Where are the fish in the interval between the breaking up of the water-spout and the thunder-storm ? What keeps them suspended in the air ? '

After reading this note, I wrote to Kim requesting him to put me in touch with his correspondent. At the same time, I informed him that several cases of 'rains of fishes' have been recorded from different parts of the world and that the generally accepted theory is that the fishes after being taken up in water-spouts, are transported some distance by the heavy winds and come down with the rain. Kim made a reference to my letter in the *Statesman* of September 21, and remarked 'I can quite understand fishes being sucked up by a water-spout. What I can't understand is how the fishes are transported some distance without their weight bringing them to the ground immediately the forces which created the water-spout have dispersed. It seems to be a case for the physicist as well as for the zoologist. And what about falls of frogs, and that surprising thing the army experienced in Salonika, when the sky rained small turtles, so thick that it was impossible to move about without crushing two or three of them at every step ? '

In the *Statesman* of the 26th September, Kim recorded another fall of fishes based on information supplied by a centurion, who saw fish fall from heaven in Jhansi in 1905. The rifle ranges, a long way from the water, had small fish rained on them:

> 'I had my company on the range that morning and a lot of men were rather shaken by it; at least I think that must have been the cause of the bad shooting that day.'

On September 21, I wrote to Kim about the action of thunder-storms, whirlwinds, water-spouts, etc., and requested him to throw further light on the fall of turtles in Salonika.

In the *Statesman* of the 29th September, Kim remarked that 'both[1] my correspondents say that fishes picked up by a water-spout are carried long distances by strong, vertical currents. It is not surprising at all they should be sustained in the air. Have I never heard of tornadoes lifting from the ground and transporting to a considerable distance trees, animals, human beings, houses and even railway trains ? Dr. Hora mentions that in one case of a rain of fishes, the fishes were found in a comparatively straight path, only a few inches wide, but extending over a considerable stretch of country'.

In the *Statesman* of September 30, Kim published a vivid account of the ferocity of a tornado as observed by a scientist

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[1] Kim's other correspondent was Officer-in-Charge, Meteorological Office, No. 1 (Indian) Group Headquarters, Royal Air Force, Peshawar (N.W.F.).

and referred to the fall of turtles as follows :—' It is quite possible that the turtles did not drop from the skies. The sudden terrific blizzard which was immediately succeeded by brilliant sunshine might have created the moist, heated atmosphere suitable to hatch multitudes of eggs buried just below the soil. This suggestion leads to the thought that perhaps these fish that appear miraculously after heavy rain belong to the type which, when rivers and pools have dried up, bury themselves in the earth, there to wait till the rivers and pools have water in them again. A heavy shower might induce them to think that the time had come for them to dig their way out. But before we go further with this theory it is necessary to find out whether the fishes that are supposed to have dropped from the sky belong to the same species that are accustomed to dig themselves in during a dry season. After all, fish is a big word. Are the fishes picked up after rain all of the same size and species ? If so, what species ? '

I informed Kim that the explanation based on vivification of æstivating species, though plausible, did not fit in with all the known facts. Moreover, the species that rained at Muzaffarpur represented both the æstivating and non-æstivating kinds. From the weather charts of the Muzaffarpur area for the days on which the fishes rained, it was clear that the meteorological conditions were responsible for the falls. But later Kim received another explanation of the phenomenon from one of his correspondents and published the following note in the *Statesman* of November 9 :—

' A Mozufferpore (*sic*) reader is rather sceptical about fish falling from the air. He thinks that the fish appear after heavy rain when roads and fields are under several inches of water. They merely swim out of tanks and streams, which have overflowed. When the waters recede, the fish are left stranded. We saw how easily fish are stranded several times in Mesopotamia. When high winds blow over the marshes, they drive the waters over the flat land exactly after the manner of tides. When the winds cease the waters recede leaving behind them multitudes of fish generally lying along the furthest point they reached. These fish, very white in colour, show up like a gigantic semi-circle drawn in chalk. . . . This letter, of course, does not entirely dispose of the theory that fishes can be sucked up by water-spouts and later discharged from the sky. Still, I would like to have a statement from somebody who has actually seen fishes fall or can affirm that he has found them after a heavy shower in places which were not actually flooded and which they could not reach from flooded tanks or streams.'

In response to his enquiry, Kim received replies from three persons and these he referred to in his notes published in the *Statesman* of November 22, as follows : ' One letter refers me

to another man who has seen two falls of fish and the other man is a trustworthy and reliable witness. A second correspondent can speak of being an actual witness of three falls, and all in the same district, Muzaffarpur. On one occasion, during the visit of a well-known and previously sceptical scientist, several small live fishes fell on the raised *chabutra* of the old planters' club and were bottled by him and sent to South Kensington. On the second occasion fishes were found on the roof in an open iron reservoir the base of which was corroded through and could not hold water. On the third occasion two small fish were found in a galvanized bath-tub put under the eaves of the roof to collect rain water. And what about the following experience ? '

'When a boy, and in Dum Dum, I was caught in the rain not far from home, when suddenly I felt I was being struck on the topee as if by hail-stones, but to my surprise found them to be fishes. I remember it too well and I also took a topeeful to my mother, more because of the surprise than as a proof of my story. The largest fish I think was about three inches long.'

Mr. G. T. Gill, to whom we are indebted for an account of the two recent falls of fishes in the Muzaffarpur District, has also written to Kim (*Statesman*, Nov. 24, 1933) to say that 'The theory as to the presence of fish swimming on to the roads and lawns from overflowing tanks is quite untenable, and in my case there were no such tanks anywhere near my garden, and every single coolie I asked said to me, " *Upar sé aya* " ' (came from above).

Another correspondent of Kim records (*Statesman*, 1st December, 1933) that 'while a boy at school, between 1870 to 1879, at St. Mary's Institution, Byculla (Bombay), he on several occasions picked up small silvery fish in the centre of the playground after heavy showers of rain. Several of the other boys stated they actually saw fish falling'. Much more interesting is the account that appeared in the *Statesman* of Dec. 3, 1933. In 1905, one of Kim's correspondent was walking between Khargpur and an estate on the Maurbhanj side. 'All of a sudden a downpour of heavy rain came on and on looking down I found the fields all alive with small fish. . . I took a palki-bearer's umbrella, opened it, and turned upside down, and, lo and behold, it filled up with these same fish. A few minutes afterwards a shower of frogs descended into this handy piece of furniture, and the fields, too, were alive with both frogs and fish. Such are the facts.'

I have quoted from Kim's notes in the *Statesman* at some length, firstly, because they show the scepticism with which this phenomenon is regarded by the general public and, secondly, because they show how attempts are usually made to explain the falls of fishes and other animals by such processes as may eliminate the possibilities of animals having fallen from above.

The various explanations of the rains of fishes put forward in Kim's notes are discussed below (pp. 105–109).

Particulars of the Rains of Fishes hitherto recorded from India.

It is undoubtedly true that every fall of fishes that occurs is not recorded, but the phenomenon is sufficiently unusual and striking to have attracted the attention of a number of scholars, who have recorded their observations. Gudger[1] has brought together all references, so far as possible, to rains of fishes up to 1929 in two illuminating articles. He concludes that 'The seventy-one[2] records here quoted of rains of fishes from fifteen countries (counting England, Scotland, and Wales as one country—Great Britain) encircling the globe, their time-limits covering the two thousand years from Athenæus (circa 200 B.C.) to McIlhenuy (1921 A.D.) leave no ground for doubts as to their occurrence, or for belief that one writer was influenced by another. And for these "rains" the explanation uniformly given (and the only one tenable) is that of the whirl-wind or water-spout.' Early Greeks were aware of the universally spread belief of the fall of fishes in India and later Hamilton,[3] Grant[4] and Day[5] recorded this belief in their writings without making any reference to a definite fall of fishes observed by them. Gudger, in 1921, gave an account of 10 records of rains of fishes from India, and these may be tabulated as on the following page.

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[1] E. W. Gudger, Rains of Fishes, *Natural History*, XXI, pp. 607–619 (1921); More Rains of Fishes, *Ann. Mag. Nat. Hist.*, (10), III, pp. 1–26, pl. 1, 2 text-figs. (1929).

[2] Norman in his *History of Fishes*, p. 430 (London: 1931) gives more records of the rains of fishes.

[3] F. Hamilton (formerly Buchanan), '*Gangetic Fishes*', pp. 68, 99 (Edinburgh: 1822).

[4] C. W. Grant, On the Fact of Small Fish Falling during Rain in India. *Papers Corps Royal Engineers of Great Britain, London*, II, pp. 209–213, fig. (1838).

[5] F. Day, *Fishes of India*, p. 363 (London: 1876). Day makes reference to the fishes descending with downpours of rain in several of his earlier works, especially in his reports on the Freshwater Fish and Fisheries of India and Burma.

For still more recent literature see Vinton, A Rain of Fishes, *Nat. Hist.*, XXXIII, pp. 555-556 (1933), Gudger, Do Fishes Fall from the Sky with Rain?, *Scientific Monthly*, XXIX, pp. 523–527, 5 figs. (1929), and Deraniyagala, A rain of fishes, *Ceylon Journ. Sci.*, XVII, pp. 43-44 (1932). Deraniyagala's paper contains references to other rains of fishes in Ceylon.

The table given below shows that the last rain of fishes recorded in scientific literature from India is that which occurred at Poona in 1852. Several rains of fishes[1] have been

Date or year	Locality	Type of fish	Observer or recorder
1809 ..	'Kattywar'	?	Hariott (Sykes, *Rep. Brit. Ass. Adv. Sci.*, 10th meeting, p. 40, 1840).
1824 ..	Meerut ..	?	Buist (*Bombay Times* for 1856; Littell's *Living* Age, 1857).
20th July(?), 1829.	Moradabad	'A small species of *Cyprinus*, two inches and a quarter in length, green above, silvery white below, with a broad lateral band of bright red.'	Mrs. Smith (*Trans. Linn. Soc. London*, XVI, p. 764, 1833).
19th February, 1830.	Nokulhatty Factory, Jelalpur, Zilla Dacca.	*Bodulis*, *Saul*, *Sale*, *Guzal* and *Nouchi*.	Cameron (Prinsep, *Journ. As. Soc. Bengal*, II, pp. 650–652, 1833).
1833 ..	Benares ..	?	Prinsep (*op. cit.*).
16th or 17th May, 1834.	Fattehpur	Chelwa (*Clupea cultrata*).	'S' (*Journ. As. Soc. Bengal*, III, p. 367, 1834).
1835 ..	Allahabad	?	Buist (*op. cit.*).
20th September, 1839.	Sundarbans	?	Thompson (*Introduction to Meteorology*, pp. 162–164, 1849; Buist, *op. cit.*).
25th July, 1850.	'Kattywar'	?	Buist (*op. cit.*).
1852 ..	Poona ..	?	Buist (*op. cit.*).

[1] A correspondent from Patna writes that at about 1 P.M. on the 9th November, 1933, a bright and sunny day, when travelling about a mile south of the Gandak Bridge, he noticed a flock of 20 to 30 kites circling over his head. At the same time he noticed silvery objects in the sky which the kites picked up with a sweep as they dropped down. This lasted for 2 to 3 minutes and my correspondent thinks that the silvery objects must have been fishes raining from above.

A gathering of hundreds of kites higher up in the sky is not an unusual occurrence in any part of India, but the falling of silvery objects is certainly uncommon. It is very difficult to say what these objects were, but they could not be fish. As is explained later (p. 107), the fish are carried up and transported by water-spouts and fall from the sky with torrential rain when the water-spout dissipates. In the circumstances it seems difficult to believe that fish were raining on November 9,

referred to in Kim's notes quoted above, but the three rains of fishes recorded in the first note deserve further consideration as I have been able to obtain full particulars from Kim's correspondent.

RECENT RAINS OF FISHES IN THE MUZAFFARPUR DISTRICT.

(i) Mr. G. T. Gill observed a rain of fishes at Bunhar Factory, District Muzaffarpur, in 1912. Bunhar Factory, I am informed, no longer exists, but it was situated on the bank of the Baghmati River midway between Darbhanga and the large village of Rusera. Mr. Gill writes that the date has completely escaped his memory, except that it was some time during the monsoon, and in the middle of the day. With reference to the 1933 falls, he writes: 'These falls were, however, nothing as compared with the one which occurred at Bunhar Factory in 1912, where I then was, I actually observed this with my own eyes, that is to say that when the rain was actually falling I did not notice fish coming down with it, but the rain, which was very heavy, ceased very suddenly, just like the rain on the 10th July last, and when it did, my tennis lawn and the road in front of the bungalow were simply white with maunds of fish, so much so that at first, before I went outside to investigate the matter, I thought it must be hail lying on the ground. To my amazement I saw it was fish. They were also all over the indigo factory which was one-third of a mile from the bungalow. None of the fish were of any size, none of them being more than two inches long.'

(ii) Mr. G. T. Gill observed a rain of fishes at Bhicanpur Factory, due four miles north of the small Gundak River on the main road to Sitamarhi, in the Muzaffarpur District. He writes: 'I had tremendous rain here at that time, my falls that I registered being as follows:—9th July, 0·68; 10th July, 4·18; 11th July, 6·78. The rain I have written down as having fallen on the 11th, really all fell on the 10th, and the reason for that is that I always measure the rainfall for the 24 hours ending on the morning of the day I write it down. Actually this fall of 6·78 inches ended on the 10th about 2-30 P.M. I was waiting for the rain to moderate, and when it did I heard *lathi* and stick blows all over the garden, so, being curious, I went out in the rain before it had ceased to investigate the matter, and the cause was that all my garden coolies and syces, and many other coolies were killing the fish as they swam all over the garden paths and the road down to the

near Patna on a bright, sunny day. Dr. S. N. Sen informs me that the weather conditions over Bihar were not favourable for the formation of water-spouts on that day. However, the observation is recorded here to elicit further information on the point raised by my correspondent.

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stable. The fish must all have come down during the final shower which was tremendously heavy. Every single coolie whom I asked how he accounted for the fact of fish being over the garden said, *oopar se aya* (came from above), and there is no doubt whatever that they had '. On getting this information I requested Mr. Gill to send me the local names of the fishes that came down with the rain and, if possible, specimens of the various species. I also enquired about the principal stretches of water in the vicinity of the factory. To these questions I received the following replies :—

' I have asked my chowkidar (watchman) what were the names of the various kinds of fish which fell here on the 10th July at 2-30 P.M., and he at once told me as follows, and I am quite sure he was telling me the truth, as he himself was one of those who benefitted by the fall, and I saw him pick up a large quantity. The vernacular names of the varieties are : (1) *Gainchi*, a thin fish, 3 inches in length. Grows to one span in length ; (2) *Potia*, a broad fish which grows to about two inches ; (3) *Garaye*, a fish with a large mouth, growing up to 3 inches in length ; (4) *Darwa*, a small fish hardly exceeding 2 inches ; and (5) *Chelwa*, a table delicacy for Europeans and Indians alike. When fried they taste exactly like white-bait which they greatly resemble in appearance. A very well-known species. All the above kinds of fish are obtainable locally in the Bazar on any market day here.' The scientific names of the species were determined from a small collection sent by Mr. Gill and are given below on the following page.

As regards stretches of water, Mr. Gill wrote that ' the occurrence took place on the top of a very rapidly rising flood, and practically the whole countryside was under water at the time, though, after the heavy rain ceased, which it did with the fall which precipitated the fish, the flood rose a good deal higher. In addition the small Gandak River is close by, also the Baghmati is only 5 or 6 miles away in a northernly direction, and there is a large jheel (lake) 4 miles north of this bungalow which is always full of water, even in the hot weather. My chowkidar assures me that the fish fell over a large area, which I have calculated, as far as my knowledge goes of the extent of the fall, as being 60 square miles, but it may have been much more, and I was told by a lady that fish fell in her garden on the same day in Muzaffarpur itself.'

(iii) On the 30th of August, 1933, Mr. Gill observed coolies getting fish out of a small and shallow drain by the roadside close to his house, immediately after a shower of rain, and when he asked them how they expected to catch any fish in such a small quantity of water they all replied again ' *oopar se aya* ' (came from above).

Among the menial staff employed in the Indian Museum there are several people who come from the Muzaffarpur District.

They heard from their friends and relatives about the falls of fishes, but treated the matter as a mere joke. On my making enquiries from some of these people, who were on leave during the monsoon period in their villages, I have been able to collect corroborative data. One man named Ram Avatar Singh of Khalilpur village has informed me that he reached his village on the 11th of July and heard that on the day previous there was heavy rainfall accompanied by a fall of fishes from the sky. During his stay in the village he witnessed two falls of fishes, one in the middle of the Hindu month *Śravan* (16th July to 15th August) and the other in *Bhadon* (16th August to 15th September). On both these occasions, an exceptionally heavy rainfall was preceded by storm, whirlwinds, etc. and the rain fell from 10 A.M. to about 7 P.M. and water accumulated in the streets knee-deep. When the rain stopped, he found the courtyard of his house full of fish and on coming out he saw silvery objects on the thatched roof, which on close inspection turned out to be *Chelwa* fishes. Among the fishes collected, he mentioned the names of all the kinds stated above in Mr. Gill's account, but he added the name of a small loach known as *Natua*. Reports of the rains of fishes have been received from the inhabitants of the following other villages in the Muzaffarpur District :—Karja, Dwarkapur, Anantkarja, Bhadawna, Bhopalpur and Mohatpur. A man of the Parsagarh village in the Chapra District of Bihar and not very far from Muzaffarpur has also told me of a rain of fishes in his village. I am informed that *Potia* and *Darwa* rained in great abundance. Some of the villages, where the fish rained, have no ponds, lakes or rivers in their neighbourhood, and the phenomenon, therefore, excited great interest among the villagers. They attributed the falls to the miracle performed by the all-pervading and powerful god Indra. I shall have occasion to refer to the beliefs of these simple people later (p. 108).

Species of Fish known to have fallen with Rains in India.

It has been mentioned above that Mr. G. T. Gill sent me specimens of five species of fish that he found in the compound of his bungalow after a heavy fall of rain. These have been identified as follows :—

Local Name.	Scientific Name.
1. *Gainchi*	.. *Mastacembelus pancalus* (H.B.).
2. *Potia*	.. *Barbus* (*Puntius*) *sophore* (H.B.).
3. *Garaye*	.. *Ophicephalus gachua* (H.B.).
4. *Darwa*	.. *Esomus danricus* (H.B.).
5. *Chelwa*	.. *Chela bacaila* (H.B.).

Ecologically, these species can be grouped under two main categories. *Mastacembelus* and *Ophicephalus* live in mud, are capable of living out of water for a considerable time and are known to æstivate during the hot and dry months. The other three kinds, *Barbus*, *Esomus* and *Chela*, are essentially surface fishes, though *Barbus sophore* may be found at the bottom. I enquired from Mr. Gill the proportion of the various species in the rains of fishes witnessed by him. He writes, 'As far as my personal observation went (which was not very much as it involved paddling about and getting my feet very wet which I soon tired of) I should have said that the greatest number of fish were *Garaye*, but my bungalow chowkidar, whom I just asked, says that by far the largest proportion was *Potia*, and no doubt he is right. The *Garaye*, however, were specially noticeable owing to their large size and reddish colour in the water. I should say, therefore, that the largest number were the *Potia*, then possibly I should put the *Garaye*, though I may be wrong, and the *Gainchi*, *Darwa* and *Chelwa* third'. From the accounts of my other informants, I gather that the greatest proportion of the fish that rained were of the *Potia*, *Darwa* and *Chelwa* types. *Natua*, a fish that is said to have fallen with rains in the Muzaffarpur District, is the dirty loach, *Lepidocephalichthys guntea* (H.B.), which is similar in habits to *Mastacembelus* and *Ophicephalus*.

It is thus seen that half of the species associated with the recent falls of fishes are surface-living, small forms, which could be easily sucked up with water-spouts. The presence of three æstivating mud-fishes in the falls does not show that they had been awakened from their summer sleep by the heavy downpour. Æstivating fishes of India become active after the first few monsoon showers which commence about the second half of June, so at the time when the falls of fishes are stated to have occurred they must have been fully revived. To me, the presence of mud-fishes in the falls seems to provide evidence of the great force of suction produced at the time of water-spout formation—so much so that the bottom mud of ponds, lakes or rivers is also sucked up along with the entire volume of water at the particular place. Recently a rain of small Gobioid fishes has been reported[1] from Christobal Canal Zone (America). These fishes possess powerful ventral suckers with which they adhere to rocks in swift currents of small streams in oceanic islands.[2] It should be clear from these instances, that the presence of mud-fishes in the falls can be accounted for only by the water-spout and whirlwind theory of the rains of fishes.

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[1] Vinton, Rains of Fishes, *Nat. Hist.*, XXXIII, pp. 555-556 (1933).

[2] Hora, Gobioid Fishes of Torrential Streams, *Acharya Ray Commemoration Volume*, pp. 92–99 (1932).

In 1829, ' A small species of *Cyprinus*, two inches and a quarter in length, green above, silvery white below, with a broad lateral band of bright red ' is stated to have rained at Moradabad. The description is applicable to a number of Cyprinid fishes, but it is likely that the fish belonged to the genus *Rasbora*, which comprises surface-feeding species. In 1834, *Chelwa* rained at Fattehpur and this appears to be the same fish as *Chela baicala* referred to in the account of the Muzaffarpur fishes. In the Dacca District, in 1830, a number of species are recorded to have fallen with rains and it has been possible to identify all the species from their vernacular names. The following note regarding them may be useful:—

1. *Boduli* or *Bodulis*:—These names probably refer to *Vadāla* (वदाल), ' a kind of Silurus or sheat-fish '.[1] As is indicated in the note from the Collector of the Dacca District (*vide infra*), this name is no longer in use. It is a word given in native lexicon and not yet met with in any published text.

2. *Mirgal*:—This is the common *Cirrhina mrigala* (Ham. Buch.) which is esteemed as food and is used for stocking ponds in Bengal.

3. *Saul* and *Sale*:—These two names probably refer to the same species—*Ophicephalus striatus* Bloch. It is known in Eastern Bengal as *Shol*, *Sal* or *Shaul*.

4. *Guzal*:—This is probably the same as *Gajal*, *Gajar* or *Shal*. These vernacular names refer to *Ophicephalus marulius*.

5. *Nouchi*:—I have not been able to trace this name, but if N is a misprint for M, then we have a fish known as *Mouchi* in Eastern Bengal. It is *Amblypharyngodon mola* (H.B.) which is not much esteemed as food.

It seems that the 10 witnesses, whose statements were recorded about the rain of fishes in the Dacca District, paid attention only to larger specimens for all the species mentioned above, with the exception of the last, grow to a fairly big size. The smaller species seem to have been overlooked altogether. There must have been a very strong water-spout to have sucked up fishes of the size, one cubit in length and 6 lbs. in weight, stated to have been collected by these witnesses. Moreover, not one of these species is a surface-feeding form. In fact, *Wallago* and *Ophicephalus* are bottom-dwelling species, whereas the other two generally live among vegetation near the bottom and occasionally come to the surface.

Enquiries were made from the Collector of Dacca regarding the local names *Boduli* and *Nouchi*. In reply he has written to say that ' the fishes *Boduli* and *Nouchi* cannot be identified. The local names of fishes vary to a great extent, the same fish being called by different names in different parts of the same district. As far as I have been able to ascertain on enquiry

[1] Monier-Williams, *A Sanskrit-English Dictionary* (Oxford : 1899).

the names *Boduli* and *Nouchi* resemble the names of *Boali* and *Baichi* or *Baicha* which are well-known fishes. It is possible that these well-known names may have been corrupted into *Boduli* and *Nouchi*.'

Boali (*boal* of Eastern Bengal ; *boil* and *boala* of Chittagong ; *barali* of Assam ; etc.) is the well-known cat-fish popularly known as the freshwater shark. It grows to an enormous size, up to at least six feet in length. I am inclined to agree with the District Collector of Dacca that *Boali* is the same fish as *Boduli*. The fish is known among ichthyologists as *Wallago attu* (Bl. and Schn.). *Pseudeutropius atherinoides* (Bloch) is a small species which is known as *Bodua* in Eastern Bengal. The reference in the Dacca fall of fishes cannot be to this species as specimens of *Boduli* about one cubit in length and 6 lbs. in weight were picked up by the local people.

Baichi or *Baicha* (*bacha* of Eastern Bengal) refers to *Eutropiichthys vacha* (H.B.) which is a common fish at Dacca, but I do not see any similarity between these names and *Nouchi*. I am inclined to regard *Nouchi* a misprint for *Mouchi* as indicated above.

Explanation of the Rains of Fishes.

Gudger (*op. cit.*, 1921 and 1929) has already discussed the various explanations that have hitherto been advanced to account for the rains of fishes and has come to the conclusion that ' for these " rains " the explanation uniformly given (and the only one tenable) is that of the whirlwind or water-spout '. The analysis of the meteorological data concerning the recent rains of fishes at Muzaffarpur has led Dr. S. N. Sen to the same conclusion (*vide infra*, pp. 111–116), but in view of the matter that has appeared in Kim's notes, it seems desirable to review in somewhat greater detail the popular explanations of the phenomenon.

Leaving out of consideration the explanation sometimes given of the dormant eggs hatching out after a heavy rainfall as highly untenable, attention may be directed to four other explanations that have found currency in literature.

I. *The fishes supposed to have fallen with rain might have been migrating overland from one stream or pond to another.*

Of the species of fish that are known to have fallen with rains in India, *Ophicephalus* is the only kind that migrates overland. The other fishes such as *Wallagu*, *Barbus*, *Esomus*, *Chela*, *Cirrhina*, *Amblypharyngodon*, *Barilius*, *Lepidocephalichthys* and *Mastacembelus* are not known to leave water and wander about. The last two kinds are amphibious in their mode of respiration, whereas the others are purely aquatic-breathers. Gudger (1921) has remarked that ' many of the falls have taken place in northern countries, where there are no migratory fish,

and finally many of the fish rained down are marine forms '. In view of the above, this explanation is ruled out of further consideration.

II. *The fishes might have been left behind by overflows* in the manner indicated by Kim's correspondent or as alleged by Eglini long ago (*Wittenbergischen Wochenblatt zum Aufnehmen der Naturkunde*, pp. 329-330, 370, 1771).

I am fully aware of the fact that after heavy floods fishes are left stranded on the banks of rivers. This often happens in the high lands of Central Asia, and I have received collections of such stranded fishes from Tibet and Chitral. The details that are available in connection with the rains of fishes do not lead one to the conclusion that the fishes had been left behind by overflows. The rains of marine fishes many miles inland from the sea, the falls on high lands or roofs of houses far out of the reach of floods, the falls of fishes in places with no stream, lake or pond in their neighbourhood, the localized occurrence of these falls, especially the falls in the Sundarbans and Burdwan where fishes were found in a comparatively straight path only a few inches wide, extending over a considerable stretch of the country and the occurrence of the bottom, mud-dwelling or stone-sucking (Gobiidæ) species in the falls clearly show that the above explanation cannot apply to such occurrences. Reference may also be made to the account of the three witnesses mentioned by Kim.

III. *The fishes may have been æstivating and have been awakened by the coming of the rain.*

Gudger has already given reasons to show that this explanation cannot apply to the reported rains of fishes from countries all over the world. The recent rains of fishes in Muzaffarpur occurred during July and August when even the æstivating species are active, for it is well known that these fishes become vivified after a first few monsoon showers which occur usually in the second half of June. Moreover, the majority of the fishes known to have rained in India belong to the non-æstivating type.

IV. *The rains of fishes are due to the action of heavy winds, whirlwinds and water-spouts.*

In the accompanying diagram (fig. 1), I have indicated the places in India whence the rains of fishes have been recorded so far including those given in this paper. It will be seen that the part of the country below Nepal, from Muzaffarpur in the east and Meerut on the west with Jhansi, Allahabad and Benares forming the southern boundary, is the most suitable area for the occurrence of these rains. Dr. Sen shows that over this area the heavy winds of the south-west monsoon come in contact with the cold north-easterly winds of the Himalayas, and it so happens that portions of the Bay winds are sometimes enclosed between the cold winds and these in trying to escape

upwards in the form of strong, vertical currents cause whirlwinds and water-spouts. Water-spout formation is a fairly frequent occurrence in Northern Bihar, and has been responsible for the popular belief [1] that Airāvata, one of Indra's elephants, sucks up water from the earth by means of its trunk. The similarity in the funnel-like form of a water-spout and that of the trunk of an elephant is very suggestive to the minds of the simple village folks.

The Kathiawar area and the region of the Gangetic Delta also seem suitable localities for the falls of animals, and Dr. Sen shows how sometimes the meteorological conditions over these areas induce the formation of water-spouts. The falls at Poona and Byculla have to be regarded meteorologically as exceptional occurrences. In other parts of India where the north-easterly Himalayan winds have no access, the chances of the water-spout formation, and the consequent falls of animals, are very remote. Most of the rains of fishes have occurred during the monsoon months—July, August, and September—but an exceptionally big fall of fishes has been reported from Dacca (*vide* table on p. 100) in February and from Fattehpur in May. Both these months fall within the nor'wester period, during which water-spout formation may occur wherever and whenever light air gets enclosed between cold and heavy winds.

There are two other facts concerning the falls of fishes which may be mentioned. So far as it has been possible to ascertain, the falls are said to have occurred about the middle of the day and the fish precipitated with a final, heavy shower. Dr. Sen shows from a study of the meteorological conditions that this is what it should be. It is thus seen that all the problems associated with the falls of fishes in India are capable of simple meteorological explanations. I am greatly indebted to Dr. Sen for his kind help and valuable suggestions, and above all, for his contribution on the meteorology of the recent rains of fishes at Muzaffarpur.

In connection with the action of whirlwinds and water-spouts, Mr. Johan van Manen has directed my attention to two interesting passages in Peddington's 'The Sailor's Horn-book'. For instance, it is stated that 'The mischievous kinds of these whirlwinds seem to be nothing more than those just

[1] It may be worth while to say a few words here to explain this mythological belief among the Hindus. A reference to Hopkin's *Epic Mythology* (Strassburg: 1915) will show that Indra is worshipped as a great benefactor and rain-god of the Hindus. The clouds are believed to be Indra's elephants on which he rides about in his tours of the world. One of these elephants, Airāvata by name, rose at the churning of the ocean and was seized by Indra. This animal, sometimes known as Airāvaṇa, draws up water from the under-world and Indra seated on his elephant pours down the rain. The chief gift of Indra is the rain he gives to all. The elephants are also believed to blow the wind out of their trunks.

described, but of force enough to destroy houses and men, uproot trees and even to tear, break and throw down buildings, and they may be traced, in accounts from various parts of the world as well as in India, of all sizes ; from a few feet up to some hundred yards in diameter, and as occurring in all kinds of weather, and by night as well as by day. *Many of these also in passing brooks or ponds, have been known to assume the appearance of water-spouts for the time, and to raise up the water and even the fish with it* ' (1st ed., p. 264 ; 2nd ed., p. 240. The italics are mine). The sucking up of fishes by the action of whirlwinds is again referred to as follows : " We have seen that whirlwinds on shore, certainly so far resemble water-spouts, that they lift water and fish. There is equally no doubt, that when sea water-spouts reach the shore, they become whirlwinds..... " (1st ed., p. 270 ; 2nd ed., p. 245).

The late *Jamadar* of the Asiatic Society of Bengal, an inhabitant of the Ballia District, U.P., informed me that whirlwinds are a common feature in his part of the country and that he had himself witnessed the water of a tank in his village being sucked up by one of Lord Indra's elephants. No water or fish were left in the tank afterwards. In this district, people are fully aware that sometimes fishes fall from the sky with rains. Ballia is to the south-west of Muzaffarpur, but not very far from it. Thus it is within the area of special weather conditions which induce the formation of water-spouts.

Dr. J. N. Mookherjee, Professor of Chemistry in the University of Calcutta, informs me that some years ago there was a rain of fishes near his village in the Burdwan District. The fish did not fall all over the country but were found in a long, narrow and fairly straight row over a considerable stretch of the country. The nature of this rain is comparable to that which fell at the Sundarbans on September 20, 1839.[1] As has been indicated by Gudger[2] ' These fishes must have fallen from the whirling lower end of a funnel-shaped spout after the pillar had broken in two, as is often the case '.

Addendum.

Since the above was sent to press, Kim has reported two further falls of fishes in the columns of the *Statesman*. Mr. James Dewar, at one time Manager of the Patrakala Tea Co. in Sylhet, informed Kim that one late afternoon during the late Spring of 1913, just when the chota barsat was breaking. ' The coolie women were plucking leaf about a hundred yards from the edge of a dried up bheel and the nearest stream was about half a mile away. The ground was generally hard and dry as usual at

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[1] Buist, Rains of Fishes, *Bombay Times* for 1856.

[2] Gudger, Rains of Fishes, *Natural History*, XXI, p. 619 (1921).

the end of the cold weather. In looking over the quality of the leaf in the baskets of the pluckers, Mr. Dewar noticed two or three small fish in the basket of one woman. She explained that she had found them on the ground and added that quite a number had been found by other pluckers. Mr. Dewar was not

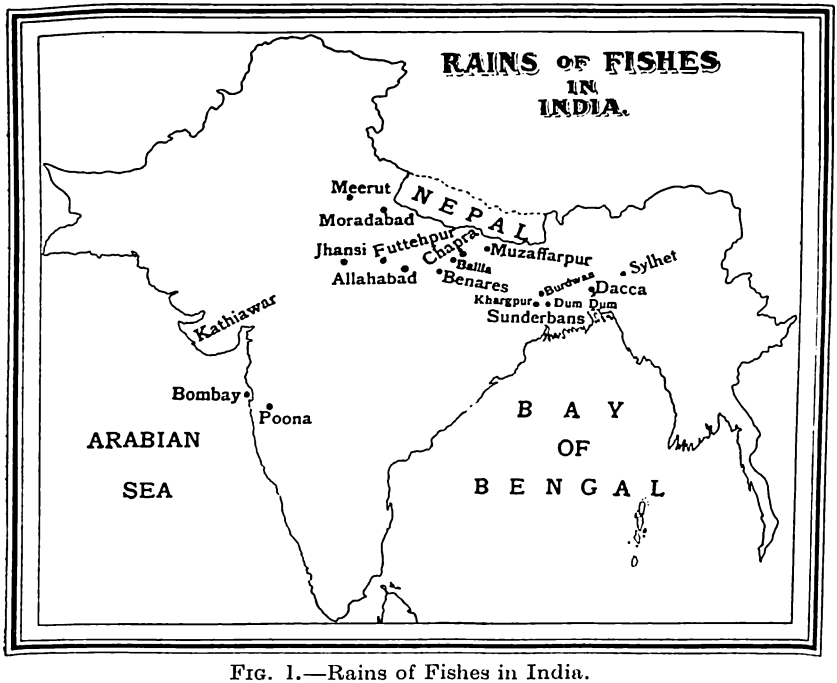

FIG. 1.—Rains of Fishes in India.

quite convinced and himself made a search for fish and actually found a number under the bushes over a line of about 200 yards.'

'The fish were from six to seven inches in length, wriggling, glistening, and very much alive and looked very edible. The "happening" took place just after a slight drizzle of rain. It intrigued me greatly and I have no hesitation in saying that the fish were not placed where they were found by any human agency' (*Statesman*, January 26th, 1934.).

The second record is furnished by Mr. A. Barbour of Titaghur who wrote to Kim as follows:—

'At Uttar-Tirhut, 10 miles east of Muzaffarpur, in 1906, along with another man, I saw a dry road (an inch above the level of the country round about) become covered by a shoal of tiny fish which arrived in a sudden rain-storm' (*Statesman*, February 20th, 1934.).

Mr. Dewar's observation is probably the first on record which shows that a fall of fishes was not accompanied by a heavy shower.

The Meteorological Aspects of the Recent 'Rains of Fishes' in the Muzaffarpur District.

By S. N. SEN.

In connection with the rains of fishes observed on the 10th July and 30th August, 1933, in the Muzaffarpur District, Bihar, Dr. Hora of the Zoological Survey of India asked me to explore the possibility of a meteorological explanation. I have looked up the weather charts of the dates mentioned and find that typical nor'wester conditions (*vide* p. 83 of the *Proceedings of the Indian Science Congress, Nagpur*, 1931) were established over Bihar on both the days. As a matter of fact widespread thunderstorms were successfully forecasted by the Alipore Observatory on both the occasions.

The Monsoon Front.—Before proceeding to a meteorological explanation of the particular instances cited by Dr. Hora it may be an advantage to discuss Fig. 2 which shows the normal distribution of the various air currents over India at the height of the monsoon season.

So far as the monsoon air trajectories are concerned the diagram is essentially the same as that given by Hann. The only modification that has been introduced is the identification and distribution of the various air masses over the Indian continent in the monsoon season. These are the easterly air current at the foot of the Eastern Himalayas and the hot air over the Punjab and the N.-W.F. Province. The mode of representation of the various air currents is the same in Figs. 2, 3 and 4. The boundary line between the two branches of the Indian monsoon current and the Eastern Himalayan current is shown by a toothed line. This line will be referred to later as the line of discontinuity or the monsoon front. Even in the absence of pure monsoon air the same type of front may be established over Northern India in other seasons also but the details need not be discussed here. Provisionally the diagrams in this paper may be taken to represent the average conditions from the ground up to 0·5 km. level.

Occlusion of the Bay air.—The Himalayan current usually comes down as an easterly or north-easterly current mainly along the Brahmaputra Valley and travels westwards along the foot of the Himalayas. It is cooler and therefore heavier than the southerly Bay current. Consequently there may start separate streams from the parent Himalayan current and flow down approximately southwards mainly under the action of gravity along river beds or at right angles to the prevailing horizontal temperature gradient. In the circumstances when two Himalayan air streams coalesce a portion of the warm and

moist Bay air is likely to become isolated within the Himalayan air mass. When this type of isolation or 'occlusion' of the Bay air occurs, whirls in the atmosphere are likely to be formed (*vide Nature*, January 1931, p. 128). In favourable circumstances these whirls may give rise to water-spouts. In the nor'wester season, *i.e.*, from February to June, these whirls often develop into tornadoes. As a matter of fact, descriptions of corrugated iron roofs being lifted and carried many miles away, appear in the newspapers almost every year

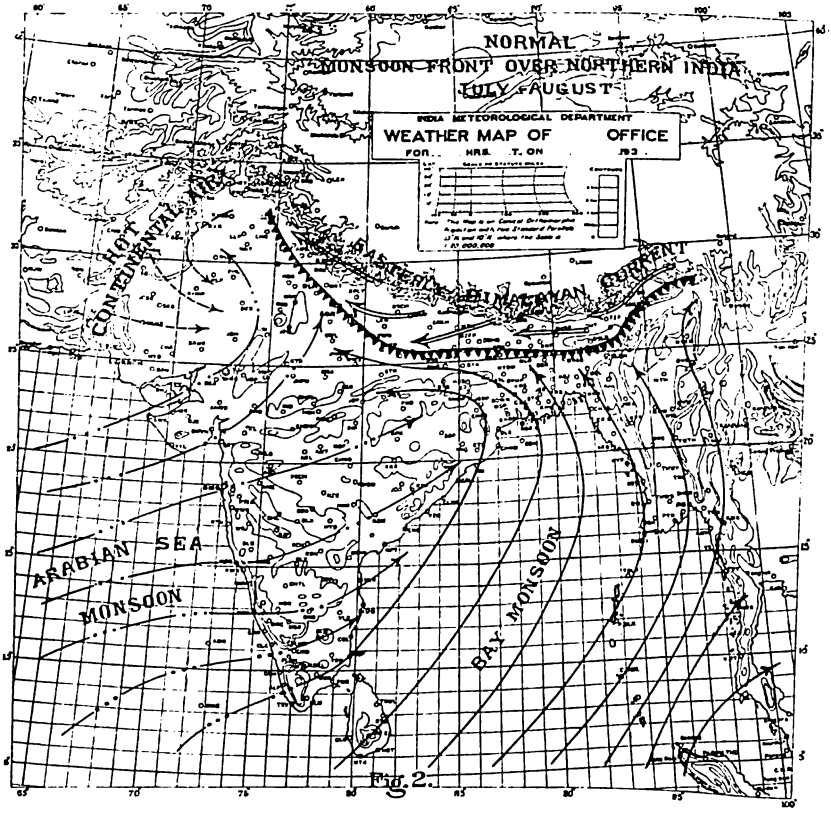

Fig. 2.

especially in the nor'wester season. This fact gives an idea of the magnitude of the tremendous lifting forces inside a strong whirl. It seems, therefore, probable that if a whirl forms over a pond or river then the fishes may be easily lifted and carried away and thrown down when the whirl begins to dissipate.

The Daily Weather Charts suggest that at the height of the monsoon season, wide scale subsidence of the Eastern Himalayan air often takes place over Bihar through the valleys

of Nepal, possibly mainly along the course of the river *Kosi*. Whatever the details of the process may be, it is a fact that the Eastern Himalayan air generally accumulates over Bihar and the United Provinces north of the toothed line in Fig. 2 and then again subsides towards the Central Provinces. It is during this subsidence that the occlusion of the Bay air very often occurs giving rise to locally heavy rainsqualls. The frequency of the whirls should naturally be large near about the normal line of discontinuity as shown in Fig. 2. A remarkable confirmation of this view is provided by Dr. Hora's chart

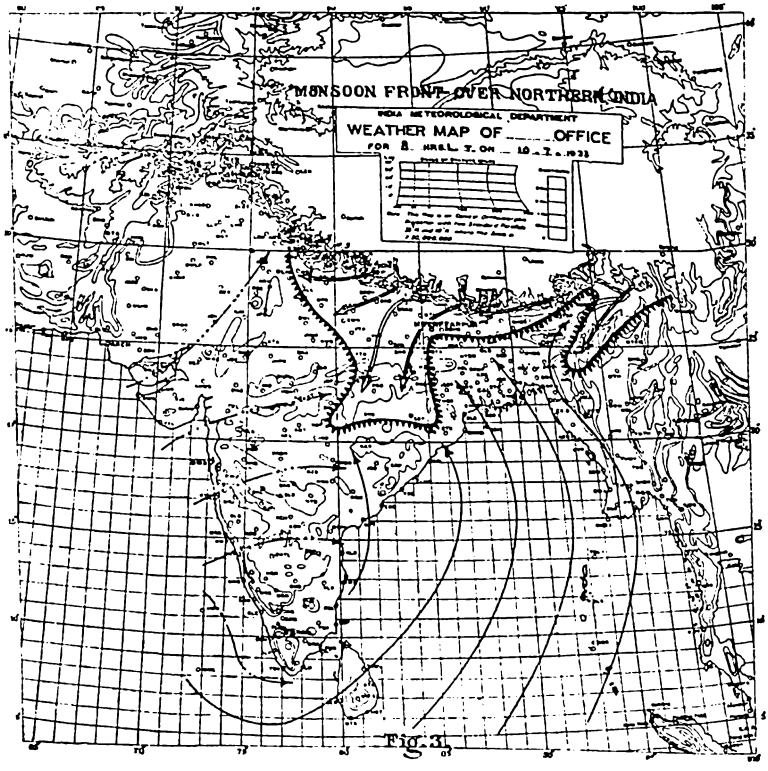

Fig. 3.

(Fig. 1)[1] in which the regions of frequent occurrence of the rains of fishes are shewn to be the United Provinces and Bihar. The places of occurrence are just to the south of the toothed line in Fig. 2 which is based on purely meteorological considerations and drawn independently of Dr. Hora's diagram.

It may be interesting to note here that the Eastern Himalayan current has an uncanny power of giving rise to weather wherever it meets another air mass. The Daily

[1] *JPASB*, (N.S.), XXIX, 1933, p. 110 (1934).

Weather Charts shew that the Eastern Himalayan air frequently travels long distances over the Indian continent and the Bay of Bengal. Under the influence of the Bay depressions it often penetrates South India and with the westward travel of the depressions this air mass finds its way into Gujrat. The isolated occurrences of rains of fishes in other parts of India as shewn in Dr. Hora's chart may, therefore, be explained on the same basis as has already been indicated.

Meteorological Conditions over Bihar on the 10th July, 1933.—With the introductory remarks in the preceding paragraphs it is now proposed to consider in detail one of the two cases, *viz.*, the rain of fishes which occurred at Bhicanpur in the Muzaffarpur District at 2-30 P.M. on the 10th July, 1933.

Figs. 3 and 4 represent the distribution of the Bay, the Arabian Sea and the Himalayan current at 8 hrs. and 17 hrs. respectively on that date. The figures, though idealized for the sake of easy explanation, have nevertheless been derived from an analysis of the actual weather charts of the Alipore Observatory. The changes in the upper winds at Allahabad were significant. The wind at 0·5 km. in the morning was southerly, force 6, and in the afternoon it changed to northerly, force 4. This reversal and other evidence suggest large scale subsidence of the Himalayan air. It will be seen from Fig. 3 that Muzaffarpur was very near to the monsoon front in the morning. The position of the front in the afternoon of the same day as seen from Fig. 4 suggests that there was a general tendency for the occlusion of the monsoon air over south Bihar. It is, therefore, apparent that conditions were favourable for the formation of whirls on the monsoon front especially over Bihar. In the following table rainfalls of 2″ and over at the various rain-recording stations in Bihar and Orissa are given.

AMOUNT OF RAINFALL.

RECORDED BETWEEN 8 HRS. OF 10TH AND 8 HRS. OF 11TH JULY, 1933.

District.	Station.	Rain, inches.	District.	Station.	Rain, inches.
Patna ..	Bihar ..	4·75	Darbhanga	Darbhanga	2·23
	Asthanwan	2·50		Mahiuddin-nagar.	3·34
	Bakhtiarpur	2·30		Jalay	2·75
Muzaffarpur	Sitamarhi ..	3·93		Pusa	3·53
	Muzaffarpur	1·80			
	Minapur ..	2·00			
	Katra ..	14·80	Monghyr ..	Sagrampur	2·40
	Belsand ..	1·97			

District.	Station.	Rain inches	District.	Station.	Rain inches.
Purnea ..	Purnea ..	2·60	Feudatory States of Orissa and Chota Nagpur.	Bolongir ..	2·41
	Gondwara	3·20		Baramba ..	3·15
	Barsoi ..	2·06		Athgarh ..	5·93
	Manihari ..	3·45			
			Sambalpur	Ambabhona	2·80
Santal Parganas.	Madhupur..	3·89	Palamau ..	Garhwa ..	2·45
				Ranka ..	2·27
Angul ..	Balandapara	2·00	Singhbhum	Majhgaon ..	1·78

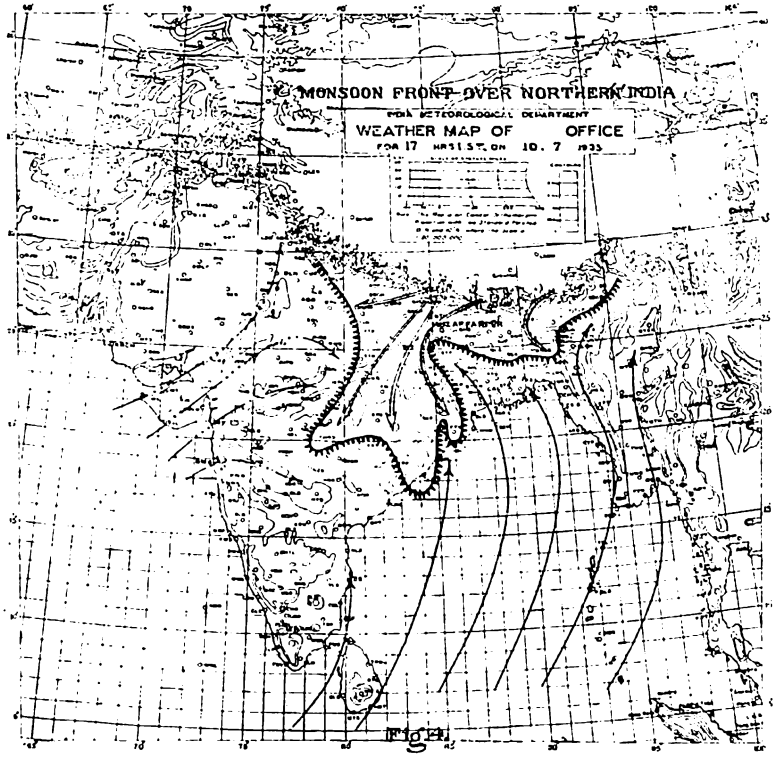

Fig. 1.

Incidentally it may be noted that the rainfall figures in the above table illustrate the importance of the path of subsidence of the Eastern Himalayan air from the point of view of flood warnings.

The afternoon Daily Weather Chart of the 10th July shews that most of the rain in the Muzaffarpur District at any rate occurred before 5 P.M. The Bhicanpur Factory where the rain of fishes occurred on that day is about 4 miles to the north of the small river *Gundak* and about 6 miles north of the Muzaffarpur town. The factory recorded 7″ of rain by the afternoon of the 10th. The rainfall of 15″ at Katra which is about 18 miles north-east of the Muzaffarpur town and about 3 miles on the east bank of the river *Baghmati* is also significant. The rainfall distribution in the neighbourhood of Katra-Bhicanpur-Muzaffarpur region suggests the formation, travel and dissipation of a water-spout or spouts. These probably formed and sucked up fishes to be deposited later. The details of the mechanism of the formation of water-spouts, which are very local in character, are questions of micro-meteorology, and cannot, therefore, be discussed here.

As regards the frequency of the rains of fishes being greatest in the afternoon it may be noted that the greatest frequency of the nor'westers is also in the afternoons. The reasons have been discussed in another paper which will be published shortly. It may be briefly noted here that in the afternoons there is usually an accentuation of the horizontal temperature gradient to the south of the Eastern Himalayan air mass thus giving rise to conditions favourable for its subsidence.


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