Proc. Indian natn. Sci. Acad. B 46 No. 1 pp 27-32 (1980)

The Satpura Hypothesis

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Dr S L Hora enunciated the Satpura Hypothesis to explain the presence of Malayan element in the fauna and flora of Peninsular India. The geological evidences especially the Age of the Garo-Rajmahal Gap remained the major obstacle in accepting the hypothesis. The intensive field studies carried out by the various workers have been reviewed and the Satpura Hypothesis reoriented on the basis of the Pleistocene glaciation. During the glacial period, the aeustatic drop in the sea level had actually bridged the Garo-Rajmahal Gap topographically and climatically enabling the fauna especially the hill stream forms to cross over from the north to the Peninsula.

Introduction

Satpura Hypothesis was proposed and developed chiefly to account for the anomalies in the distribution of hill-streams or torrential fishes of India. Enunciating his hypothesis of the distribution of the Malayan fauna and flora to Peninsular India, the late Dr S L Hora had stated that the migration of the Malayan element in the fish fauna of India was checked along the Himalayas through certain orogenic movements and became deflected along the Satpura trend of mountains (Hora 1937). The typical Malayan element in the fish-fauna of the Himalayas does not extend westwards beyond the Tista drainage system on the southern face though along the northern face the fish-fauna is uniformly spread from Yunan (South China) in the east to Seistan in the west. Since the Malayan forms are well represented in all the hills of the Assam, Hora thought that by bridging the Garo-Rajmahal Gap the hill-stream fishes could easily find their way to the Vindhya-Satpura ranges and thence to the Western Ghats. His hypothesis was based on the following fundamental conceptions:

(*i*) Continuity of the Vindhya-Satpura trend of mountains with the Assam Himalayas in the east and Western Ghats in the west.

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(*ii*) 1500 to 2000 m elevation of the Vindhya-Satpura ranges and the northern section of the Western Ghats.

(*iii*) Continuity of the ecological belt of mountains with rainfall about 250 cm or above and consequently tropical evergreen forests between Assam Himalayas and the mountains of Ceylon via Vindhya-Satpura trend.

(*iv*) The Garo-Rajmahal Gap is a very recent feature in the physiography of India

Ecology of Hill-stream Fishes

In the case of hill-stream fishes or other aquatic animals, swift currents, similar to those of the Khasi Hills in the east and Travancore High Ranges in the west, are essential for their existence, as the structural modifications undergone by the majority of them fit them only to this type of habitat.

In the case of terrestrial animals, warmth and dampness seem to be the most essential factors of their environment. For example, the most characteristic feature of the climate of Assam Hills is the dampness during all seasons with the moderately high and comparatively equable temperature. There is copious rain in Assam, the higher ranges getting over 250 cm and the plains from anything between 200 and 250 cm. The mean temperature in the plains of Assam is 95°F (temp. rarely exceeds 100°F). To satisfy the migration of both terrestrial and aquatic fauna, Hora considered it necessary that the Satpura trend of mountains must have had at least once over 250 cm of annual rainfall so that the ecological conditions for the hill-stream fishes and other aquatic animals must have been analogous to those prevailing now in the hills of Assam or the hills of the Peninsula. For such a precipitation, according to Hora, the Vindhya-Satpuras should be of a height of 1500 to 2000 m higher and continuous with the Assam Himalayas on the one hand and the northern section of the Western Ghats on the other. The southern section of the Western Ghats was at that time connected with the hills of Ceylon so that there were no gaps around which the monsoon winds could flow. Such a topography could ensure continuity of evergreen and moist deciduous forests for the migration of terrestrial forms and torrential perennial streams for the migration of hill-stream fishes from Assam up to hills of Ceylon.

Geological Obstacles against Satpura Hypothesis

The geological evidences (Auden 1949), are however, against the existence of a former elevated Satpura-Vindhya range of mountains extending with the Assam Himalayas in the east, and the Western Ghats in the west. According to the geologists the Garo-Rajmahal Gap is an old feature of the physiography of India. The Satpura Hypothesis, thus, lacked the support of the geologists (Auden *op. cit.*, Mayr 1950, Beaufort 1951, Dilger 1952).

Dr Ernest Mayr suggested that the hypothesis be tackled from the following three other aspects (*vide* Hora 1951, p. 437):

(*i*) The possibility of dispersal of torrential fauna in spite of the existence of the Garo-Rajmahal Gap

(*ii*) The possibility of the Eastern-Ghats acting as an alternative route

(*iii*) A taxonomic assessment of fishes with the so-called Malayan affinities in Peninsular India* and their different levels of evolutionary divergence

*Peninsular India is the triangular plateau lying south of the Indo-Gangetic alluvium extending to the north-east as far as the Rajmahal Hills. Shillong plateau in Assam is the severed portion of the Peninsula which has been isolated by the alluvium of the lower Ganges and the Brahmaputra.

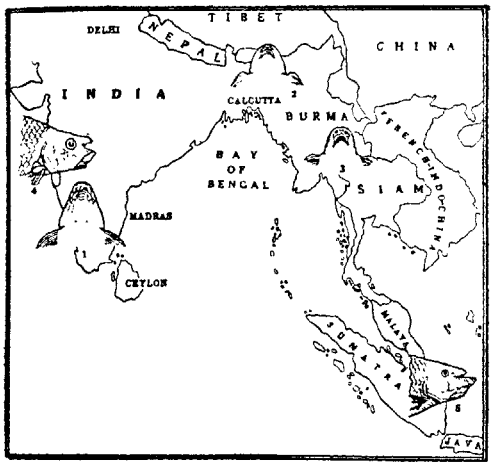

Figure 1 The Satpura Hypothesis: discontinuous distribution in some tropical torrential fishes (*Balitora* and *Schismatorhynchus*) *1, Balitora mysorensis; 2, Balitora brucei; 3, Balitora melanosoma; 4, Schismatorynchus nukta; 5, Schismatorhynchus heterorhynchus*

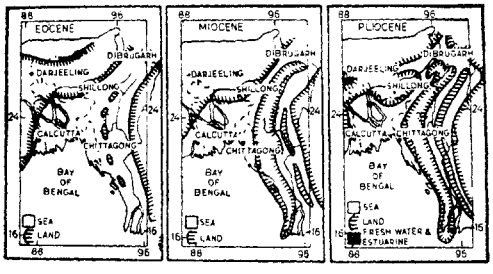

Figure 2 Map of the north-eastern India showing the northward transgression of the Bay of Bengal during the Eocene, Miocene and Pliocene periods

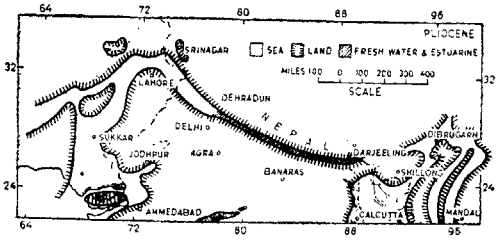

Figure 3 The Siwalik foredeep of the Pleistocene period

Garo-Rajmahal Gap

The flat strip between the Garo and Rajmahal Hills, known as the Garo-Rajmahal gap has been an obstacle to accepting Satpura Hypothesis by the geologists. The geological evidence on its age remains ambiguous, but seems on the whole to indicate a great antiquity. Basing his studies on correlating climatic fluctuations during the Pleistocene with the eustic movements of the sea, Hora (1951), has shown that during each successive glacial period of the Pleistocene the gap area became a few hundred feet higher relative to the sea level (figure 4). The colder climate also favoured increased precipitation, less evaporation and greater run-off, thus producing ideal conditions for the spread of torrential fishes across the gap. Every glacial period favoured the migration of torrential fishes, and every interglacial period isolated stocks, with evident effects on speciation, in different geographical areas.

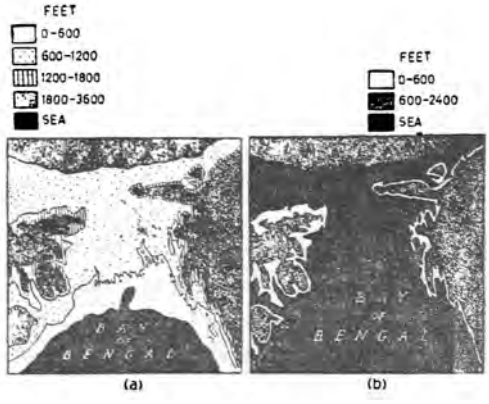

Figure 4 Orographic features of the Garo-Rajmahal gap *a*, Condition during the glacial period; *b*, Condition during the interglacial period (*After Hora 1951*)

The Role of the Orissa Hills and the Eastern Ghats

Menon (1951), following the suggestion of Mayr, carried out extensive surveys along the Eastern Ghats and Orissa Hills but found no Malayan elements in the fishes studied. Ninety-three species of fishes were collected and critically analysed as a result of which he concluded that the Eastern Ghats derived their fish fauna from the Satpura-Vindhya mountains and northern portion of the Western Ghats during the Pleistocene earth movements that affected the Peninsula and that the migratory route of the torrential fishes from the Himalayas did not lie along these hills, especially as collections made along the Satpura trend of mountains revealed several relict forms.

The Peninsular Isolates

The third point stressed by Mayr, namely, the taxonomic assessment and the levels of evolutionary divergence of fishes with the so-called Malayan affinities in Peninsular India has been carried out by Silas (1952). Forty-nine fish isolates known at present from Peninsular India were critically studied as a result of which he found the following types of divergences among them:

I. Generic Divergence

1. *Bhavania* Hora
2. *Travancoria* Hora
3. *Lepidopygopsis* Raj
4. *Neotropius* Kulkarni

II. Subgeneric Divergence

1. *Osteiochilus (Kantaka) brevidorsalis* (Day)
2. *Rohtee (Rohtee) ogilbii* Sykes
3. *Schismatorhynchus (Nukta) nukta* (Sykes)
4. *Tetraodon (Monotretius) travancorcius* Hora & Nair

III. Specific Divergence

1. *Osteiocheilus thomassi* (Day)
2. *Osteocheilus nashi* (Day)
3. *Tor khudree* (Sykes)
4. *Thynnichthys sandkhol* (Sykes)
5. *Balitora mysorensis* Hora
6. *Homaloptera montana* Herre
7. *Silonia childreni* (Sykes)
8. *Eutropiichthys goongwaree* (Sykes)
9. *Batasio travancoria* Hora & Law
10. *Pseudobagrus brachysoma* Gunther
11. *Gagata itchkeea* (Sykes)
12. *Silurus goae* Haig
13. *Amphipnous fossorius* Nair

IV. Subspecific Divergence

1. *Tor morsal* (a new var.)
2. *Erithistoides montana pipri* Hora
3. *Silurus berdmoeri wynaadensis* (Day)
4. *Clarias dussumieri dussumieri* C. V.
5. *Clarias dussumieri dayi* (Hora)
6. *Pristolepis marginatus marginatus* Jerdon
7. *Pristolepis marginatus malabaricus* (Gunther)
8. *Puntius sarana pinnauratus* (Day)
9. *Osteobrama cotio peninsularis* Silas
10. *Puntius ticto punctatus* (Day)

V. No Divergence

1. *Labeo dero* (Ham.)
2. *L. dyocheilus* (Mc Clell.)
3. *L. prox. chrysophekodion* Bleeker
4. *Crossocheilus latius* (Ham.)
5. *Gãrra gohyla* (Gray)
6. *Psilorhynchus sucatio* var.
7. *Silonia silondia* (Ham.)
8. *Pangasius pangasius* (Ham.)
9. *Gagata cenia* (Ham.)
10. *G. gagata* (Ham.)
11. *Glypothorax horai* Shaw & Shebbeare

12. *G. annandalei* Hora
13. *Laguvia ribeiroi* Hora
14. *Amblyceps mangois* (Ham.)
15. *Silurus cochinchinensis* Valenciennes
16. *Pristolepis fasciatus* (Bleeker)
17. *Batasio tengara* (Ham.)

The Origin of Torrential Fish Fauna of South-East Asia

The original stock of the present-day Ostariophysi and other freshwater fishes of India seems to have invaded south-east Asia during the Eocene period, about 60 million years ago, but India began to get the Malayan forms only during the Pliocene Siwalik period (Menon 1973). The highly specialised torrential fauna developed much later, probably in the Pleistocene. There are 89 genera of primary freshwater fishes, of which excepting 23 endemic genera, 66 can be traced to centres of dispersal in south-west China or Yunan region. Only with the major upheaval of the Himalayas during the Pliocene and the establishment of land connections between India and further east, migration of fish along the base of the Himalayas took place (Menon 1954). The Garo-Rajmahal Gap was still under the sea and did not permit the Pliocene fish fauna to migrate to the Peninsula (Menon, *op cit*).

Pleistocene Ice Age and Climatic Conditions

Geologists have used the faunal and floral evidence and the presence of the Malayan element in the Peninsula as collateral evidence of the cold period having affected India in the late Tertiary or Post-Tertiary times. In India the glaciers of the Kashmir valley descended to the present elevation of 1700 m during the first and second glaciations. In the central and eastern Himalayas there are definite signs of glaciation down to present-day elevations of 2000 to 2500 metres. But these elevations were clearly not those that obtained during the Ice Age, because the Himalayas are known to have risen very considerably in late Pleistocene and recent times. The tilting of the Kerewas in Kashmir is probably only 20,000 years ago showing vividly how strong and recent these elevations have been.

It is likely that the land in Northern India may have been from 300 to 900 m lower in the early Pleistocene than it now is, and that the glaciers might have descended to levels which were then much nearer the sea-level. While the present glaciers of Karakoram and Himalaya have little effect on the climate of the Peninsula, it is almost certain that with a snow line and glacial line probably 1800 to 2500 m lower than what now obtains (allowing for glacier recession and isostatic rise) the temperature and humidity in northern India would have been markedly different. It is these climatic factors which had probably facilitated the migration of the Himalayan fauna and flora to Peninsular India.

Distribution of Terrestrial Fauna

During the Pleistocene when the glaciers had come down to some 1800 to 2500 m lower than at the present time, conditions in the montane and bordering zones of northern India must have resulted in a diminution of the temperature in the Peninsular India which had undoubtedly facilitated the spread of the terrestrial fauna southwards as far as the western ghats and further south to the hills of Ceylon. But the glacial theory does not explain the distribution of the hill-stream or torrential fishes of India whose distribution is influenced by certain dynamic ecological conditions. The factors affecting the distribution of freshwater fishes are quite different from those governing the distribution of terrestrial plants and animals. The former are generally

restricted, according to their mode of life, to specific water channels or drainage systems and they remain restricted unless their habitats are disturbed by orogenic movements or stream captures. The latter are relatively so easily spread that the whole of India must have become ecologically fit, under pluvial conditions to support their uniform distribution and after the retreat of the glaciers they had colonised the hill tops of the Peninsula where favourable ecological conditions prevail uptil today.

Distribution of Torrential Fish Fauna

The Satpura Hypothesis was propounded and developed primarily to account for the anomalies of distribution observed among the hill-stream or torrential fishes of India.

In the modern conceptions of the Satpura Hypothesis there is no need to assign the Garo-Rajmahal gap a recent age against the geological evidences contrary to it. During the glacial epochs of the Pleistocene the aeustatic drop in the sea level by 180 m had actually bridged up the gap topographically and climatically enabling the freshwater fishes, especially the hill-stream forms, to cross over from the north to the Peninsula (Hora 1951). The colder climate favoured increased precipitation, less evaporation and greater runoff, thus producing ideal conditions for the spread of torrential fishes across the gap. Every glacial period favoured the migration of terrestrial fishes and every interglacial period isolated stocks, with evident efforts on speciation, in different geographical areas. This concept of the glacial theory has been considered as the chief cause of the presence of Malayan element in the fish fauna of the Peninsula and it is quite possible that the route of migration of torrential and other aquatic animals lay along the Narbada-Tapti drainage of Vindhya-Satpura trend of mountains (Menon 1951).

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