JOURNAL OF ECOLOGICAL SOCIETY

Vol. 8, 1995

Editor

Prakash Gole

Foreword

We are back in print. Thanks mainly to the support and goodwill of two industrial houses of Pune city, both headed by Parsee families.

From its inception the Ecological Society has promoted the concept of cooperation rather than confrontation in reaching the national goal in conservation. This has been highlighted by Prakash Gole in his perceptive article on Bird Conservation which speaks convincingly for the cooperative ethos. Let the Governments and the Peoples of this vast land, so variegated in its natural endowments, get together to save the heritage. Let people who post profits by exploiting the natural resources of the country, plough back one paisa in every rupee they make into conservation and regeneration of nature in its mellifluous variety.

What goes for the countryside and for agriculture is even more apparent in our urban locales, the vast megalopolis which has sprouted around the old nineteenth century townships and administrative centres. The water supply to these centres is now severely endangered. The article on water demand for Baroda urban area brings this out so clearly.

On the occasion of the birth centenary year of late Dr. Sálim Ali, we dedicate this volume to his memory. It includes our tribute to him and papers on bird ecology which illustrate the trend of recent ornithological research.

We deeply mourn the sad demise of Mr. Rohington Aga, Chairman of Thermax Ltd. who had supported our society.

Due to increasing costs and lack of adequate support for publishing the Journal, we are now compelled to discontinue the free distribution of the Journal. Members who wish to receive it are requested to send Rs. 40/- by M.O. or demand draft in the name of Ecological Society. If they want it by registered book post, they should send Rs. 50/- per copy.

Vice Admiral M. P. Awati (Retd.)
Chairman

Contents

Water Demand for Baroda Urban Area

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Abstract

Large scale industrialization and urbanisation in Baroda has rendered the present water supply insufficient. This problem has been further compounded by surface and sub-surface water pollution. Water budget studies for the Baroda urban area have shown that the glaring present defecit in demand and supply will be even more acute in the year 2001.

Introduction

Baroda city, at present a large industrial centre, was in the recent past, a small university town. The only water supply was the Ajwa reservoir, built some 100 years ago to cater to the needs of 100,00-200,000 population. With rapid industrialization and urbanization, the synchronous population growth rendered this single water supply insufficient, forcing the authorities to look for alternative sources. Tube wells, bore wells, French wells in the Mahi river bed, were some of the other sources of water for urban as well as industrial consumption.

But all these sources together, are insufficient in the light of large scale surface and sub-surface water pollution. This study includes a calculation of the water budget for the present and future Baroda city. The present available water draft and water demand were calculated. The deficit in demand and supply is even more conspicuous in the year 2001.

Available Water Draft

The calculations of total available water draft for the study area (714 sq. km.) were made based on proven methodology. Since groundwater is the main source of water, discussions about it have been considered in the beginning.

Groundwater

Groundwater is a renewable resource, subjected to periodic replenishment, primarily from precipitation. To have a measure of the quantum of such periodic increment to any groundwater body, it is necessary to obtain precise information on the hydrogeolocial framework of the reservoir, the groundwater conditions and the factors governing the recharge to and discharge from the groundwater system.

The Central Groundwater Board has conducted detailed inter-disciplinary and integrated studies on a large number of selected basins for determining the water balance situation. In view of the large variations in the geologic framework, lithological character of the wide range of rock units, hydrometeorological conditions, etc. the basins selected were typical of that region (Charlu and Dutt, 1982). These major studies were spread over various parts of the country and included, amongst others, the type areas of the peninsular hard rocks, the alluvial sediments of a part of the Sindhu-Ganga basin and the Rajasthan-Gujarat region.

Methodology

For carrying out groundwater development programmes in an effective manner, it is desirable to have an idea of available groundwater potential at any given point of time. Detailed methods are based on

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appreciation of the aquifer parameters, etc. obtained through long duration aquifer tests. However, in the absence of knowledge about these parameters in precise terms, importance is generally given to determine the replenishable component of recharge on an annual basis. The two approaches currently in vogue are (i) the water balance approach, and (ii) the water-table fluctuation / specific yield approach. For the study area, the water table fluctuation / specific yield approach is found most suitable.

Water Table Fluctuation / Specific Yield Approach

Groundwater levels rise due to rainfall or any other source of recharge. The rise during the monsoon period is, by and large, attributable to the increment to the groundwater body due to rainfall. In other words, the magnitude of the rise is in a way a measure of the recharge to the groundwater, which amongst other things is dependent on the specific yield of the formation material comprising the zone of saturation.

From this, periods of recharge and periods of groundwater discharge could be found out. Recharge due to rainfall could be made out from the general relation (after Charlu and Dutt, 1982) :

$R = A \times Sy \times (h1 - h2)$,

where

R = Recharge due to rainfall

A = Area under evaluation (714 sq. km in the case of the study area),

Sy = Specific yield of the aquifer. The specific yield value for different types of geological formations in the zones of fluctuations of water table area as below :

i)	Sandy alluvial areas	:	12-18%
ii)	Silty alluvial areas	:	6-12%
iii)	Granites	:	3-4%
iv)	Basalt	:	2-3%

For the study area (i) is of relevance and hence can be used.

h1 and h2 = Monsoon and pre-monsoon groundwater levels respectively. In the present case, a generalised 1.5 m can be assumed.

Thus, the estimated recharge to groundwater by this method is :

R = A (714 sq. km.) x Sy (18 / 100) x h1 – h2 (1.5 m)
= 192 MCM / Year ..... (1)

In order to supplement the above value (1), the rainfall infiltration method (ARDC III, 1979) has also been used :

Recharge = Total area x 25% of annual rainfall
= 714 sq. km. x 25% of 950 mm
= 170 MCM / Year ..... (2)

Further confirmation has been done by using the Chaturvedi formula (in ORG, 1989) :

$Rp = 2.0 (R - 15)^{2/5} \times$ Area under evaluation

where

Rp = Total recharge

R = Annual rainfall

$Rp = 2.0 (950 - 15)^{2/5} \times 714$

= 2.14 MCM / Year ..... (3)

The mean average of (1), (2) and (3) is

192 + 170 + 214 = 576 / 3 = 192 MCM / Year

This value coincides with the value derived by the water table fluctuation method.

Groundwater Draft

The groundwater draft for all types of structures (tube wells, dug well, dug cum bore wells, etc.) has been calculated for the study area using the report given by the Group on the Estimation of Groundwater Resource and Irrigation Potential from Groundwater in Gujarat State (1986) as the base. The fixed norms of draft for different structures as estimated from their running records are (GWRDC, 1986) :

0.0037 MCM / Year for dug wells.

0.018 MCM / Year for borewells in alluvium.

0.100 MCM / Year for tube wells.

(a) Draft from Dug Wells

Total number of dug wells in the area – 500 (GWRDC, 1988)

Total Draft = 500 x 0.0037 = 1.8 MCM / Year ... (4)

(b) Draft from Bore Wells

Total number of bore wells in the area
= 2000 (VUDA, 1988)

Total Draft = 2000 x 0.018 = 36 MCM / Year .... (5)

(c) Draft from Tube Wells

Total number of tube wells in the area
= 60 (GWRDC, BMC, 1988)

Total Draft = 60 x 0.100 = 6 MCM / Year ..... (6)

Draft from French-wells at Vasad on the Mahi river bed

Total number of French-wells in the area = 8.

Out of these 6 supply water to the industries and the remaining two are used alternatively for supply to Baroda city.

Draft from each French-well is 0.045 MCM / day (B.M.C.)

Total Draft = 131.4 MCM / Year ..... (7)

Surface Water from Ajwa Reservoir

Ajwa supplies 45.7 million litres of water per day to

Baroda city (Baroda Municipal Corporation).

Total Draft = 45.7 x 365 = 16 MCM / Year ..... (8)

Hence, the total calculated water draft for the study area is (4) + (5) + (6) + (7) + (8)

= 1.8 + 36 + 6 + 131.4 + 16

= 191.2 MCM / Year ..... (9)

Considering the groundwater quality and population in the study area, wherein nearly 42% of the wells are polluted (where one or more water quality parameter exceeds the required limit), there has to be a drastic shortfall in the actual available pure drinking water in comparison to the calculated water draft.

From field observations, it has been seen that out of 500 dug wells in the study area, 166 are polluted; out of 2000 bore wells, 600 are polluted; and out of 60 tube wells, 5 tube wells are polluted. Thus the actual and realistic water draft available is as follows :

(a) Draft from Dug Wells

Total number of fit dug wells = 500 – 166 = 334.

Total draft = 334 x 0.0037 = 1.2 MCM / Year .. (10)

(b) Draft from Bore Wells

Total number of fit bore wells = 2000 – 600 = 1400.

Total draft = 1400 x 0.018

= 25.2 MCM / Year ..... (11)

(c) Draft from Tube Wells

Total number of fit tube wells = 60 – 5 = 55.

Total draft = 55 x 0.1 = 5.5 MCM / Year ..... (12)

(d) Draft from French-wells

As only 2 out of the 8 French wells are used to supply water for domestic consumption, the available draft from this source is reduced drastically.

Draft from each French-well is 0.045 MCM / day.

Total draft = 16.00 MCM

(for one well, as the 2 wells are used alternatively and not simultaneously) ..... (13)

Total available pure groundwater draft

= (10) + (11) + (12) + (13)

= 1.2 + 25.2 + 5.5 = 47.9 MCM / Year ..... (14)

Water Demand

The Environmental Hygiene Committee, New Delhi (1987), in the Code of Basic Requirements of Water Supply, Drainage and Sanitation (IS : 1172 - 1971), and the National Building Code (from Manual on Water Supply and Treatment, 2nd Edition, New Delhi, 1984), have recommended basic minimum water requirements for human domestic, non-domestic, industrial, cattle, etc. as per below :

Urban (human)	–	140 L / Head / Day.
Rural (human)	–	055 L / Head / Day.
Cattle	–	015 L / Head / Day.
Industries	–	10% of total urban human, rural human and cattle requirements.

Table 1 shows the overall water demand for the study area for the years 1981, 1988, 1991 and 2001.

Agricultural Water Demand

The net irrigation water requirement for each district and taluka in Gujarat has been worked out by the Gujarat Water Resources Development Corporation. The data pertaining to the net irrigation water requirement in the study area (714 sq. km.) is 0.5 MCM / Year (GWRDC, 1981). This requirement would be reduced drastically with passage of time, as more and more agricultural land would fall prey to urbanisation or industrialization.

The future demand for water poses one of the biggest geo-environmental problems for the study area as :

(i) the Mahi river bed at Fajalpur, which is a potential, futuristic, large-scale water supplier, is affected by tidal ingress and pollution, and

(ii) the number of present tube-wells and dug wells which are currently polluted, do not constitute a future source for water, unless drastic measures are taken to stop pollution, and

(iii) large-scale exploitation of ground-water would greatly reduce the potential in the light of erratic monsoons which are so common nowadays.

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Table 1. Domestic, Industrial and Cattle Water Demand in the Study Area (For 1981, 1988, 1919 and 2001)

Sr. No.	Year	Cattle population	Cattle demand (15 l/ head/ day) in MCM/ year	Rural population	Rural demand (55 l/ head/ day) in MCM/ year	Urban population	Urban demand (140 l/ head/ day) in MCM/ year	Total demand 4+6+8 in MCM/ year	Industrial demand at 10% of a total demand in in MCM/ year	Grand total demand 9+10 in MCM/ year
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
1.	1981	50,000	0.27	2,55,400	5.1	7,65,175	39.0	44.3	4.4	48.80
2.	1988	59,000	0.32	4,34,104	8.7	10,65,934	54.3	63.3	6.3	69.62
3.	1991	60,000	0.32	5,10,692	10.0	11,94,831	61.0	71.3	7.1	78.40
4.	2001	60,000	0.32	79,174	1.6	18,68,464	95.0	96.9	9.6	106.60

Source : Cattle Population : District Statistical Report, 1981, 1988.
Rural and Urban Population : Census of India, Gujarat, Dist. Baroda, 1981.
Population projections have been done on the basis of growth rate as per Census 1971 and 1981.

Environmental Economics

Prakash Gole

By training I am an economist, though my work involves environmental studies. The more I study the environment, the more I am aware of the inadequacy and fallacy of economic theory and practice. It assumes and adapts a wrong view of life processes, arrogates to itself a role that cannot be fulfilled and comes out with prescriptions that are dangerous to man and his surroundings.

The macro-economic theory is based on a vision of a circular flow in which the economy is viewed as a system isolated from its surrounding environment. Some economists conceive the world to be so large compared to human endeavour as to render consequences of economic growth inconsequential. Others believe that human ingenuity and technical efficiency are the ultimate resource that will enable mankind to overcome the constraints of finite resources.

The history of the economic evolution of man can be said to be based on the idea of a surplus and its progressive growth. Actually in nature only plants have the ability to produce a surplus by using the energy of the sun without any apparent costs. We have not yet mastered the technique of photosynthesis which is used by the simplest and even the most useless green plant. And suppose if we do master it, the cost of producing even 1 gm. of sugar or food will be enormous.

Man exploits this ability of plants to generate surplus to his own advantage and when the maintenance needs of those engaged in primary production are met, the remaining surplus is appropriated by the strong and the cunning to build what we call the superstructure of human civilization. What is important here is the standard of living of those engaged in primary production. They must always be satisfied with only their maintenance needs fulfilled and allow the extra production to be appropriated by others. If they are not, the superstructure begins to collapse. Witness the fall in share market as soon as the prices of agricultural produce soar or agricultural production fails due to vagaries of weather. Man has refined this system to extract analogous surplus from his fellow beings by running his factories and asking them to work like efficient machines who can very well be run with inputs of matter and energy with no regard to their mental health.

With the growth in technology economists believe and they make others believe that aggregate wants are infinite and technology will enable man to make aggregate production infinite even in a world of finite natural resources. In effect they believe that nature is just one sector of man's economy and not vice versa and can be managed and its growth ensured like any other economic sector. The economy depends on a continuous flow of money, not physical environment and the flow of money can be made infinite and as long as everyone gets a part of the flow it all looks rather fair. What in practice it leads to is growth in intermediate means to satisfy intermediate ends, actually growth in the satisfaction of evermore trivial wants which powerfully add to the externalities i.e. inflict damage to the environment. So the costs are borne either by the environment or by that section of the society which gets only a tiny part of the money flow the so-called trickle down effect. The fund of natural resource goes on decreasing. Witness the growth of consumer goods in the market since the liberalization. They only lead to orgiastic consumption without caring to satisfy the basic needs of a large section of society. Market forces are completely insen-

sitive to the distribution of wealth in society. They are no friends of the poor for the production system they promote is based on savings which are built up only through unequal distribution of wealth.

Why this is so? Simply because the surplus in nature is very small, almost nil. An eco-system in perfect equilibrium, say the rain forest of the Amazon is a biologically closed system. Whatever is produced is consumed or recycled through decomposition. The surplus produced is temporary and small. All the animals living in the forest gear their reproduction activities and consumption to take advantage of this temporary and small surplus. They do not over-reproduce and most of them cannot store the surplus for future use. As long as man was a part of the system, he basically led a life akin to other animals. In an eco-system in perfect balance it is difficult to make any progress. All its cycles are geared to produce a high maintenance efficiency.

Only young eco-systems which have not yet attained an equilibrium have high production efficiency. In order to progress man therefore, needs to disturb this equilibrium so that conditions for a young eco-system are created. All talk by political leaders and the so-called environmentalists to promote natural equilibrium or not to disturb the balance of nature is sham. If nature attains a biological and physical equilibrium, man will not be able to live in its present state. He will have to go back to the state of an animal. The history of man is nothing but a struggle to promote and maintain a disequilibrium in nature to his own advantage.

But now his economic system has grown to such proportions, he has extracted so much physical quantities from nature and given out so much waste into natural reservoirs that the whole matter available to him is likely to pass into a state of high entropy.

After all, all activity on this planet is governed by the laws of thermodynamics which state that matter and energy cannot be created nor can they be destroyed. Matter can be transformed and recycled by using energy. But 100% transformation or recycling is not possible. At every stage some matter and energy are lost, they go into a state of high entropy an unusable state. What is consumed is not energy but its availability for doing useful work, the energy then escaping as heat. Each stage in technological progress involves finding a new source of accessible energy, followed by a great expansion of mineralogical exploitation. But each stage of production involves costs in terms of wasted matter and escaped energy. Therefore, each state in the system of production and distribution leads to increase in costs, so that fewer and fewer people can take advantage of the produce. Furthermore the entropy of the surroundings is increased too — the so-called external costs in economics. This means that if all this entropy is taken into account the cost of production of any product is greater than its value. No human activity can be profitable simply because there is no profit in nature. Profit emerges due to inaqualities simply because part of the cost is borne by someone else, many times by natural surroundings.

In a sense the systems of present production and consumption are both bad. It is extremely hard for economists to digest this fact. Basically because they are more concerned with the flow of money and not with the state of the physical stock.

What is therefore necessary is to improve the nature, extent, quality and complexity of the natural physical stock — the basis of all human activity. But this is only possible if there are limits to production and consumption. Moderate wealth should be the goal. An ideal of Spartan simplicity and Athenian sensitivity and imagination is to be aimed at. Further growth will only increase costs so that the production satisfies the needs of fewer and fewer people, those who get the larger share of the money flow. This accentuates the inequity in society and leads to violence — a state in which most of the developed and less developed nations are today mired. Costs can only be minimised if natural resources are strong enough to satisfy the basic necessities of a majority of the population. This is the state of the Golden Age that every society experienced at sometime in its history. But it ended soon because man became an irresponsible master of his environment and destroyed nature to provide him with luxuries. Production from local resources for the satisfaction of local needs is the most economic and efficient form of production. Dependence on imports and production for export to satisfy the needs of distant people is most uneconomic and unsustainable.

Internalization of costs is not enough. It will only lead to increase in production costs and the price system will then try to spread this increasing burden in such a way as to sink the boat and not float it.

It is best to remember that the earth does not grow but evolves. Human beings can therefore, not continue to grow in terms of numbers or in terms of wants and desires. Birth rates should equal the death rates at low levels. Growth should be in non-physical goods : time intensive activities such as friendship, care of the children and the aged, meditation, arts and service to

others. Good is not contained in more goods. Sustainable development is basically not a technological achievement but a cultural adaptation. Ecological and ethical decisions are price determining and not price determined.

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Dr. Sálim Ali — A Tribute in his Centenary Year

Vice-Adm. M. P. Awati (Retd.)

The poet has always longed to be as free as a bird. Here was a man who did more for those free spirits than any other Indian. Vice-Admiral M. P. Awati, PVSM, Vr.C., pays tribute to a man he knew intimately and admired greatly.

Dr. Sálim Moizuddin Abdul Ali was a blithe spirit, a natural Naturalist. He was as free as the birds he loved and admired and to their study devoted his long life. To me he was a friend and a mentor for longer than I care to remember. In 1941 I had been briefly introduced to him, as a schoolboy of fourteen, when he had come to visit my father to present him a copy of his Book of Indian Birds. Our next meeting was more than a quarter of a century later in the Nilgiris, in Wellington where I was teaching at the Defence Services Staff College. He was our guest and what an engaging, witty and fun-loving guest he was. He was then almost seventy but as active and energetic as someone half his age. He was busy guiding a study of the Nilgiri Black and Orange flycatcher and he flitted about the hills like the bird under his scrutiny. He took the Nilgiris in his lively stride. Of course he was no stranger to the beautiful southern hills, having trudged all over there in Tamil Nadu, Kerala and Karnataka in the process of writing one of his truly beautiful books, Indian Hill Birds. He knew every peak and valley in the Nilgiris, the Sholas, the adjoining Biligiri Rangans, the Shevaroys and the Anamalais, the Travancore High Ranges and the Eastern Ghats in his quest of our avifanna. His knowledge of these wilds was unrivalled.

For the amateur bird watcher he had designed a very simple yet effective method for bird identification based on five or six birds commonly met in the Indian subcontinent ranging from a sparrow upwards through the pigeon and ending with the common kite. All birds were classified as to size accordingly with preponderant and general colouring and plumage. It is an ingenious device which has helped many an amateur ornithologist; marvellously simple yet effec-

tive, the invention of an innovative mind.

Sálim Sahib as he was popularly known was nothing if not innovative in his approach to the study of Indian birds, their habits and their lives in their varied habitats in a country renowned for its geographic and climatalogical diversity. He came upon his avocation, his metier accidentally as he tells us in his autobiography The Fall of a Sparrow, published in November 1985 when he had entered his ninetieth year. I recall reading some of the proofs of the book written in his meticulous hand. When Sálim Sahib presented me with an autographed copy of his book I jokingly chided with him that he had plagiarised the title from one of Wilbur Smith's best selling novels set in South Africa, A Sparrow Falls. The birdman's reposte came by the return of post : 'Wilbur Smith', he wrote, 'writes about a Shakespearian Sparrow. My Sparrow falls in Bombay's Khetwadi! But thank you for alerting me to the plagiarism . . .'. The fall of that yellow breasted sparrow of Bombay heralded the rise of a redoubtable birdman, an ornithologist who was to become a legend in his lifetime.

Sálim Ali had a logical and scientific approach to ornithological problems and mysteries which needed an explanation. He was confirmed in his view that in India the problem of conservation could not be divorced from the problems created by a rapidly increasing population, the human tide which was seemingly sweeping all before it. He held discussions on this intractable question with many eminent Indians. He came away disappointed at the lack of comprehension of the problem at all levels of our society, the absence of leadership in so vital a problem. One religious leader, a saint-politician, was of the view that the only solution he could see to the population problem was in the practice of 'brahmacharya!' Sálim Ali never again broached the subject to any political 'leader', saintly or otherwise. He had no time for flippancy.

Sálim Ali's interest in politics was limited to what politics could do for nature conservation, for the protection of wild life. He was choosy about what he would support. Once he had analysed a problem or a project through and convinced that it deserved his support, he was unstinting in his efforts and would move heaven and earth to see that it was politically accepted.

I am very sure that he would not have been easy on the Sardar Sarovar project or the Narmada. He had frequently expressed his anguish over these large projects which were a drain not only on the country's scarce resources but were environmentally untenable. People in power had to understand that while these projects benefitted a few, improved agricultural yields in the short run, they were a burden on nature in the ultimate analysis. He had lent his support to stopping the Silent Valley project. He was however, sceptical about whether it could be baulked for all times.

Sálim Ali's rapport with children and with the younger generation was legendary — a sign of his true greatness. His childlike innocence, his invariable good cheer and his fabulous sense of humour drew the young to him. I had been a witness to this phenomenon on several occasions.

In early 1976 when Sálim Sahib was our guest at the National Defence Academy he had held the cadets spellbound for over an hour. He had addressed them on the vitality of India's natural endowments and how important it was that they as the future leaders of the Armed Services understood the importance of the continued assurance of this vitality to our existence as a civilised nation and as a civilising society. The day after the address, some cadets got together and formed the first ever Nature Lovers' Club of the Academy. It flourishes. But that was only a beginning. Late that year at the first ever camp for young school boys and girls of Pune, the countrywide Nature Clubs of India of the Worldwide Fund for Nature (India) was launched. 'There has to be a purpose behind every effort' Sálim Ali would urge. 'I have been lucky to find a purpose behind what started as a form of escapism', he had once said with that well-known mischievous twinkle in his eye.

But escapism or not, more than sixty years of unbroken devotion to a cause, to achievement made Dr. Sálim Ali a legend in his lifetime. In Reader's Digest parlance he was, without doubt, the most unforgettable character I had met in my life! From his early success in unravelling the nesting habits of the Baya, the Indian weaver bird, who he said, 'was the unrivalled and unashamedly polygamous biped of the Indian scene', to the monumental magnum opus he wrote in collaboration with Dillon Ripley — The Birds of India, Pakistan, Bangladesh and Sri Lanka — he brought to his work a singular dedication and unremitting zeal. He was never satisfied until he had checked and rechecked a finding because once it went into print it would become permanent evidence. And that evidence had to be backed by observed facts and an empirical test. Half measures, shoddiness would never do where Sálim Ali's name was appended. He was the epitome of thoroughness. In his quest for thoroughness, for method and his fierce devotion to detail, he drove many of his assistants to distraction.

Sálim Ali's achievements, many of them path

breaking, did not have to wait for long for recognition nationally and internationally. Awards and honours came to him with regularity. The Padma Bhushan and then The Padma Vibhushan, the Paul Getty Award and the Orange Order of the Netherlands. The US $50,000 of the Getty Award, he donated to the Bombay Natural History Society of which he was the President. The society had become his first concern. He strove to improve its publications, already recognised in appropriate circles for their valuable and often original contributions to Natural History in the fields Botany and Ornithology.

Today, the BNHS is the principal natural history society in India and perhaps in Asia. Unfortunately, its resources are limited, notwithstanding a membership of about 2,000. Dr. Sálim Ali did much to make it more popular, to spread its word and to bring to it, a galaxy of dedicated workers who are happy to carry on with whatever the society can afford to pay them. With the departure of Sálim Sahib from the scene, the BNHS needs a steadying hand to guide it over the shoals of dissensions and diversions which it will inevitably have to navigate in the future.

I have a personal stake in the continued health of this unique society, which was so carefully and assiduously guided by Dr. Sálim Ali. In 1944, my father, an eminent zoologist of his day, was appointed as a one-man committee by the Bombay University to report on the acceptability of the BNHS as a post-graduate institution able to guide students for a doctorate in Natural Sciences. He had made a positive report!

Sálim Ali continued his work almost to his last day. He started to write what turned out to be a most readable autobiography in early 1980. It was published on the day he entered his 90th year on November 12, 1985! It was an instant success. In the same year, he was nominated to the Rajya Sabha. It is a great pity that Sálim Sahib's voice was not heard among the nation's law-makers until so late in his life. But such are the compulsions of our politics and of political existence in India — a pity.

Sálim Moizuddin Abdul Ali was a person from a rare mould. Such people come among us once in a lifetime. They show the way and go their way. Whether we, his legatees, follow the way so unmistakably pointed by Sálim Ali, will depend on us, on our courage, mainly. Sálim Sahib had no enemies. He lived a life of adventure, of wide open spaces, of the leprechauns of the forests and of achievement. He married a lady, Tehmina, who had lived to encourage him during his most difficult days. He won great accolades and still he had no enemies. On 20 June 1987 he went the way of all flesh. But the fragrance and the example of his existence remains. Above all else, Dr. Sálim Ali was the prototype EXEMPLAR.

Foraging Behaviour of Shorebirds

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Abstract

From the studies on the foraging behaviour of three species of shorebirds, it is known that the peck rate is influenced by body size, beak size and its nature, feeding behaviour, nature of feeding ground and preference of dietary items. The peck rate was the highest in the 'Little Stint' and the lowest in the 'Marsh Sandpiper'. The peck rate was intermediate in the 'Curlew Sandpiper'. The peck rate was found to increase with the decreasing body size. Except in the Marsh Sandpiper, in the other two species the peck rate was independent of prey density. The population of predators was influenced by the availability of prey density. Even during the lowest level of prey density the optimum level of peck rate was observed. This supports the optimal foraging theory.

Introduction

Studies of the foraging behaviour of birds in their habitat are lacking in India, especially for our shorebirds (*Charadriiformes*), although their habitat either continues to shrink or gets drastically altered to meet the rising requirements of the expanding human population.

Foraging is the most important activity of migrating birds as they have to recoup energy lost during immigration and store more for emigration and later for breeding when they ultimately land in the breeding areas (Goss Custard, 1985). In this paper the foraging behaviour of three common species of shorebirds, which differ from each other in body-size, bill and tarsus length (Table 1) is examined with respect to the physical characteristics of the bird, nature of its foraging site and food availability therein.

Study Area

The Vedaranyam swamp (10°18'N; 79°51'E) is located on the Bay of Bengal seaboard of Nagai Quaid-e-Milleth district of Tamil Nadu. This swamp which extends over an area of 2400 ha. has vast muddy intertidal flats. 'Table Salt' and 'Industrial Grade Salt' are extracted on a large scale by a few salt industries from the swamp area. (Fig. 1)

Materials and Methods

Foraging behaviour of three species of shorebirds, namely the Little Stint, *Calidris minuta*, the Curlew Sandpiper, *Calidris testacea*, and the Marsh Sandpiper, *Tringa stangnatilis* from different foraging flocks was studied from November 1986 to March 1987 at the Vedaranyam swamp. Each species was observed between 6.00 and 18.00 hrs on alternate days for 5 days in each month. Altogether 327055 observations were made during 148 hrs on the three species. Each observation was made continuously for 10 minutes for every half an hour for each day of observation.

Although focal animal sampling method was followed (Altman, 1974) every attempt was made to confine the observation to the particular specimen selected at the particular time. Observation was made throughout the period of 10 minutes to aovid any

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possible bias. But at times, other birds had to be selected when the bird under observation would become nondistinguishable, if it would get mixed with the flock or flew away from the site.

A spotting scope (35 X) was used and with the help of a stop watch, each activity was observed and the peck rate enumerated. The other behaviour exhibited during foraging were searching, standing, running, preening, bathing, hopping, quivering, wing-flapping, flying, body shaking, chasing and alarm call. Although these also were recorded, only peck rate is discussed here.

Results

Little Stint (*Calidris minuta*)

Of the three species studied *C. minuta* recorded the highest peck rate. This bird did not show any pattern in its peck rate during the study period. The mean peck rate (peck / minute) during the study ranged from 41.03 (February) to 53.65 (November) (Table 2). The hourly mean peck rate for five days between 6.00 and 18.00 hrs varied widely during the study period (Fig. 2).

The variation in the peck rate between 6.00 and 18.00 hrs for five days in each month during the study period was significant at varying levels. (Table 3).

Curlew Sandpiper (*Calidris testacea*)

The peck rate of this species was between that of *C. minuta* and *T. stagnatilis*. No characteristic pattern in the pecking rate could be observed throughout the study period. The mean peck rate (peck / minute) during the study period varied from 32.12 (January) and 42.63 (March) (Table 2). During the study wide variation in the hourwise mean peck rate (between 6.00 and 18.00 hrs) for five days was observed (Fig. 3).

Variation in the peck rate from 6.00 to 18.00 hrs each day was significant for a few days during November, February and March (Table 4).

Marsh Sandpiper (*Tringa stagnatilis*)

The peck rate of *T. stagnatilis* was lower than that of the other two species studied. It would appear to be a visual forager, as it did not show continuity of pecks. No consistent trend in the peck rate was discernible. The mean peck rate (peck / minute) during the study period ranged from 21.22 (December) to 43.20 (November) (Table 2). The number in hourwise mean peck rate for five days in each month during the study period fluctuated widely (Fig. 4).

The variation in peck rate between 6.00 and 18.00 hrs. was significant during 2nd and 4th day only during December and March (Table 5).

In all the three species, variation in the peck rate between months was significant at varying levels (Table 6).

Discussion

It appears that the peck rate is determined by body size, structure of the beak, feeding behaviour, nature of the feeding ground and food preferences shown by the particular species.

Body Size : Among the three species studied *C. minuta* recorded the highest peck rate and *T. stagnatilis* the lowest; the former has the smallest body size and the latter the biggest. The peck rate and body size of *C. testacea* were intermediate between those of *C. minuta* and *T. stagnatilis*. It is evident from this study that the peck rate increased with decreasing body size.

It has been argued that the energy requirements of a bird increase with decreasing body size (Pienkowski and Evans, 1984 and Goudie and Ankey, 1986). Samller-sized birds would take more time in meeting their food requirements than their larger-sized counterparts (Goss-Custard *et al.*, 1977; Pienkowski and Evans, 1984; Vijayan, 1984 and Goudie and Ankey, 1986). The present study lends further support to this finding.

Size and Nature of the Beak : In *C. minuta* the beak is small and pointed whereas in *C. testacea* it is comparatively long and slightly decurved. *T. stagnatilis* has the longest and pointed beak. It could be inferred from this study that "Smaller the beak size higher the peck rate".

It also appears that the nature of the beak would affect the rate of pecking. In *C. minuta* with comparatively stouter and shorter beak, the peck rate was the highest, whereas in *T. stagnatilis* with a slender and long beak the peck rate was the lowest. For *C. testacea* with medium-sized and slightly decurved beak, the peck rate would lie between *C. minuta* and *T. stagnatilis*.

Feeding Behaviour : The peck rate could be related to the feeding norms of the species. *C. minuta*, a tactile feeder, showed the highest peck rate, while *C. testacea*, a tactile deep-feeder (Puttick, 1979) had a lower rate of pecking. The prey of the bird, polychaete worms, *Ceratonereis costae*, upon which *C. testacea* feeds more, is found relatively in the deep layers of the soil and so are less active. Therefore, greater time was taken to detect and seize them. Accordingly the peck rate would also be low.

T. stagnatilis prefers to remain a visual feeder. How-

ever, the rate of feeding of this bird was the lowest, as it would require more time to search and discriminate between its food items. Goss-Custard (1980) has stated that the visually hunting Redshank *Tringa totanus* feeds very slowly.

Nature of Habitats and Availability of Food : The nature of the substratum also plays an important role in determining the peck rate. In *C. minuta* the peck rate was high when they feed on loose mud, as reported in the Pied Avocet *Recurvirostra avosetta* and also in the Redshank *Tringa totanus* (Goss-Custard, 1970). Myers *et al.* (1981) noted sizeable changes in the foraging rate at varying degrees of "Penetrability" of substratum.

Monthly Fluctuation in the Peck Rate : Monthly fluctuation in the mean peck rate of *C. minuta* and *C. testacea* was not statistically significant (G=2.098, P>0.1 and G=2.08, P>0.1 respectively), in spite of a drastic change in the density of their prey species (November 41,000 organisms/m^2 to March 4500 organisms/m^2). This shows that the feeding rates of *C. minuta* and *C. testacea* were independent of the density of prey species. This corroborates with the observation of Goss-Custard (1981) for Redshank *Tringa totanus*. The peck rate even at the lowest level of prey density was equally high. This shows that the lowest level of prey density was adequate enough to maintain an optimum level of intake of food (Pulliam, 1974, Krebs et al., 1983 and Goss-Custard, 1977). In the present case a decline in bird population was observed, resulting in the availability of food in about the same quantum to the remaining population of birds. This finding of a decline of bird population simultaneously with the decline of the prey density appears to lend further support to the optimal foraging theory (Pyke *et al.*, 1977).

In *T. stagnatilis* monthly fluctuation in the peck rate was significant (G=11.28, P<0.05). It was mainly caused because of the large variation in peck rate between November and other four months (Table 2). In November, density of amphipod, the principal food item of *T. stagnatilis* was very high (2500 organisms/m^2), whereas during the subsequent months, the density gradually showed a declining trend. It appears that in this species the peck rate was facultative and so dependent on prey density. When the prey density was very high as in November, the peck rate also was high, thus conforming to the findings of Goss-Custard (1981 and 1983) and Myers (1984). They have also reported that the ingestion rate increased with increase in prey density. Pierce (1986) reported the same phenomenon in the stilt (*Himantopus* spp.). An interesting observation in *T. stagnatilis* has been made. As the prey declined to a certain limit, the peck rate also declined as reported by Evans (1976) in various shorebird species. Beyond a limit, the peck rate did not show any significant fluctuation. It remained stable irrespective of prey density (Evans, 1976). It only reveals that when the prey density reaches a certain level, the peck rate becomes independent of it as observed in *C. minuta* and *C. testacea*. The population of *T. stagnatilis* closely follwed that of prey. But the peck rate at the lowest level of prey density was also high (Goss-Custard, 1985).

Acknowledgements : We thank the Director, Centre of Advanced Study in Marine Biology and the authorities of the Annamalai University for the facilities provided. Also thanks are due to Dr. (Mrs.) Lalitha Vijayan, Principal Scientist at the Sálim Ali Centre for Ornithology and Natural History, Coimbatore for her help in statistical analysis. One of us (K. S.) is grateful to the University Grants Commission for the award of a Research Fellowship.

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Table 1. Variation in the morphological features of three species of shorebirds. (after Sálim Ali and Dillon Ripley, 1983).

Bird Species	Weight (Average in gm)	Bill Length (in mm)	Tarsus Length (in mm)
C. minuta	20.6	17 to 20	19 to 22
C. testacea	45.5	37 to 45	28 to 32
T. stagnatilis	60.7	37 to 50	47 to 52

Table 2. Monthly mean peck rate (6.00 to 18.00 hrs) of three species of shorebirds from November 1986 to March 1987.

Months	*C. minuta*	*C. testacea*	*T. stagnatilis*
November	53.65	33.06	43.20
December	47.27	38.11	21.22
January	50.14	32.12	26.41
February	41.03	33.75	24.23
March	43.95	42.63	21.05

Table 3. Chi-Square test (X^2) for the variation in the values of peck rate of *C. minuta* between 6.00 and 18.00 hrs during five days in each month from November 1986 to March 1987.

Observation days	November	December	January	February	March
1 Day	11.51	8.23	37.69***	2.08	1.36
2 Day	15.25	82.20***	17.40	17.05	5.64
3 Day	22.31*	18.86	23.78**	37.37***	3.20
4 Day	23.32**	32.11***	25.32**	4.55	8.52
5 Day	12.16	9.59	23.21**	10.26	12.59

Table 4. Chi-Square test (X^2) for the variation in the values of peck rate of *C. testacea* between 6.00 and 18.00 hrs during five days in each month from November 1986 to March 1987.

Observation days	November	December	January	February	March
1 Day	89.48***	1.68	13.73	23.75*	3.89
2 Day	8.47	2.91	7.53	6.15	3.01
3 Day	4.76	3.44	12.77	24.06	3.74
4 Day	10.81	1.07	5.89	13.14	20.96*
5 Day	7.09	3.49	7.54	5.90	10.48

* Significant at 10% Level
** Significant at 1% Level
*** Significant at 0.1% Level

Table 5. Chi-Square test (X^2) for the variation in the values of peck rate of *T. stagnatilis* between 6.00 and 18.00 hrs during five days in each month from November 1986 to March 1987.

Observation days	November	December	January	February	March
1 Day	13.00	12.67	8.24	9.92	2.18
2 Day	6.31	13.63	11.24	11.59	7.34
3 Day	13.32	34.67***	11.29	16.19	9.62
4 Day	13.07	28.06**	12.25	8.83	18.12*
5 Day	–	5.20	8.08	7.64	12.14

* Significant at 10% Level
** Significant at 1% Level
*** Significant at 0.1% Level

Table 6. Values (Kolmogoro-Smirnov Test) of variation in peck rate between months for three species of shorebirds from November 1986 to March 1987.

Species	N-D	N-J	N-F	N-M	D-J	D-F	D-M	J-F	J-M	F-M
C.minuta	8*	6*	12*	11*	3	8*	5	8*	6*	4
C testacea	12*	4	9*	12*	10*	9*	11*	2	11*	10*
T.stagnatilis	12*	12*	12*	12*	8*	6*	2	6*	9*	5

* Significant at 5% Level

N-November; D-December; J-January; F-February; M-March

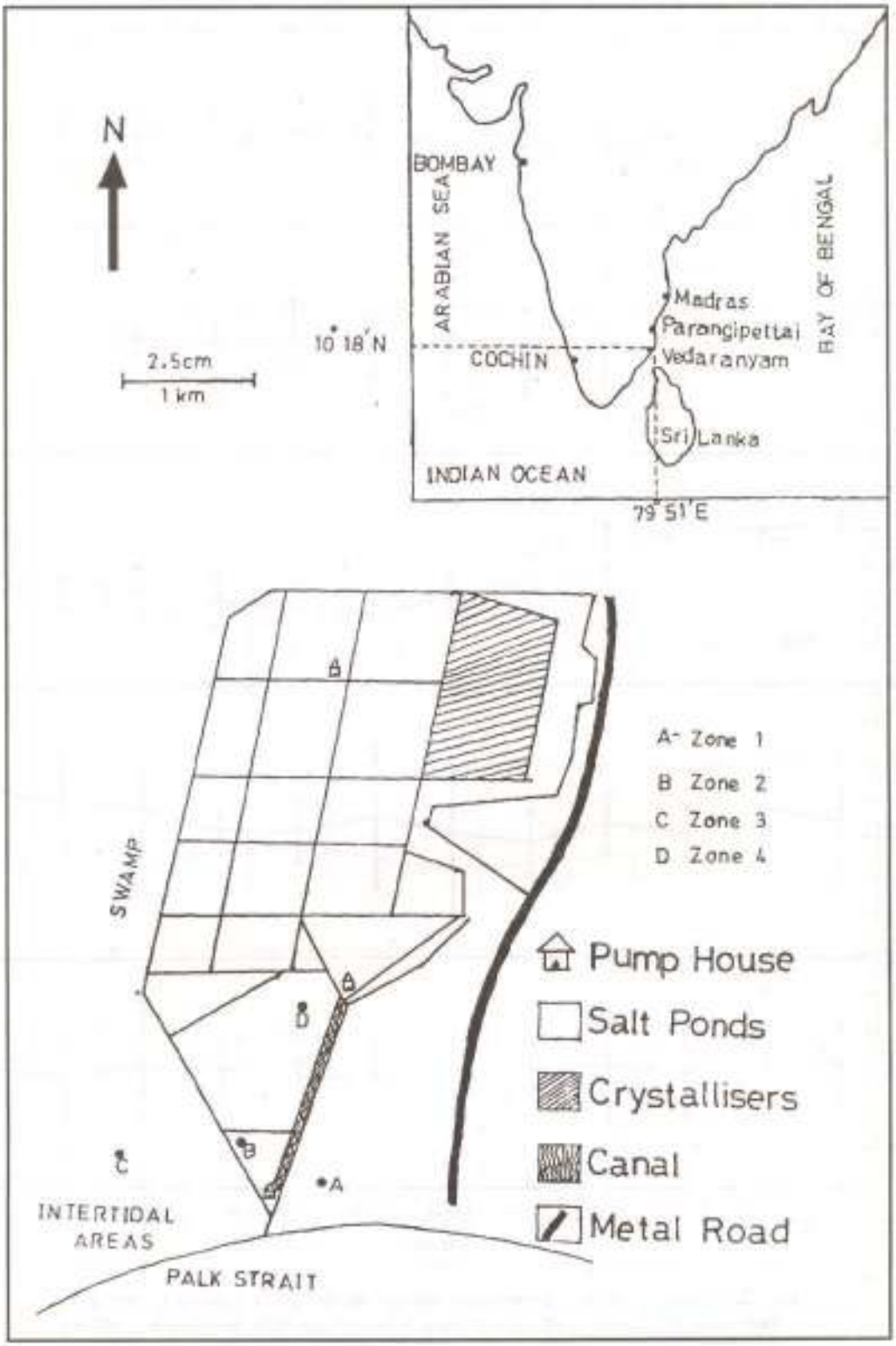

Fig. 1. Map of the Vedaranyam Swamp

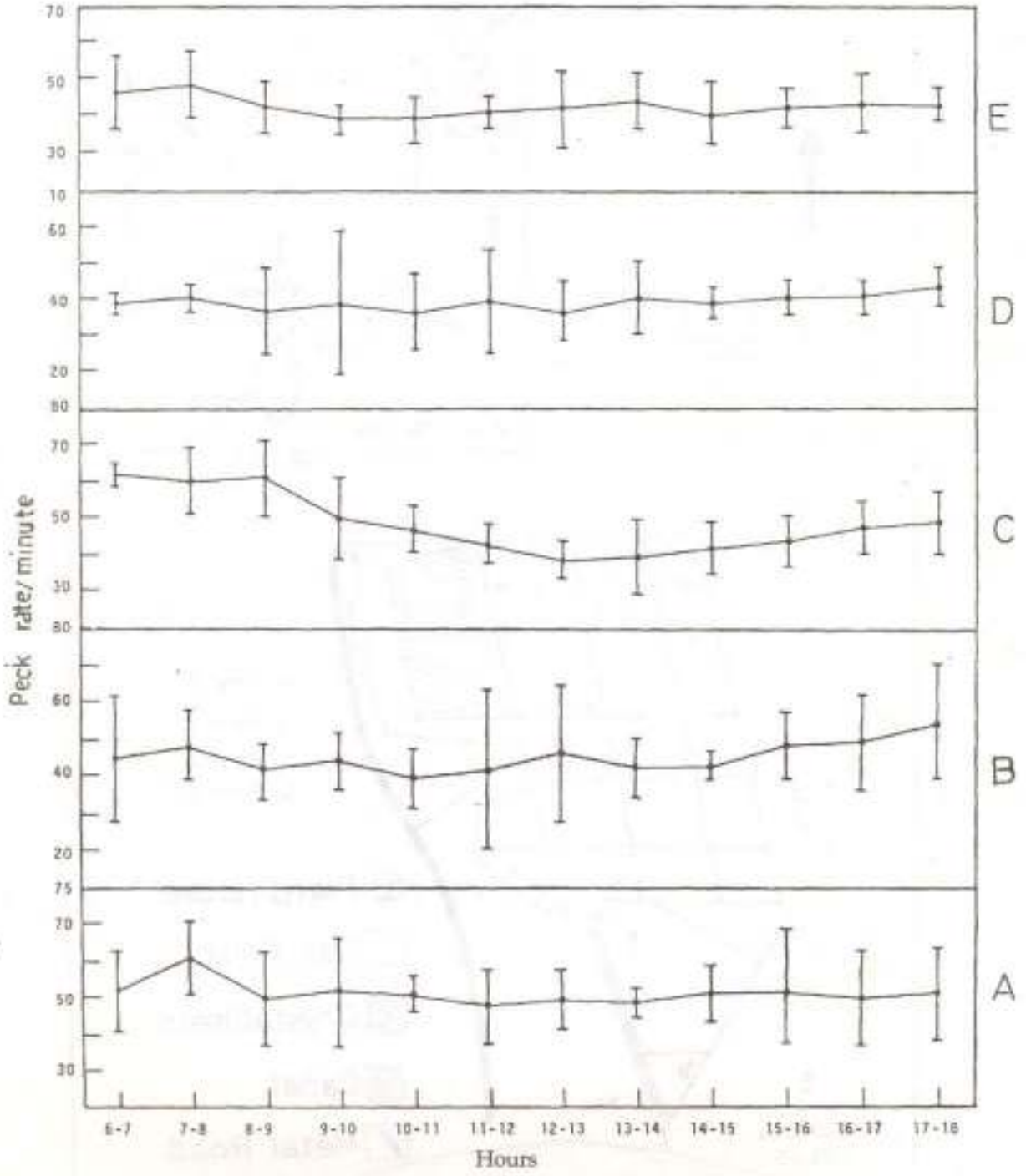

Fig. 2. Showing hourly mean and ranges in the peck rate of *C. minuta* between 6.00 and 18.00 hrs during November 1986 to March 1987

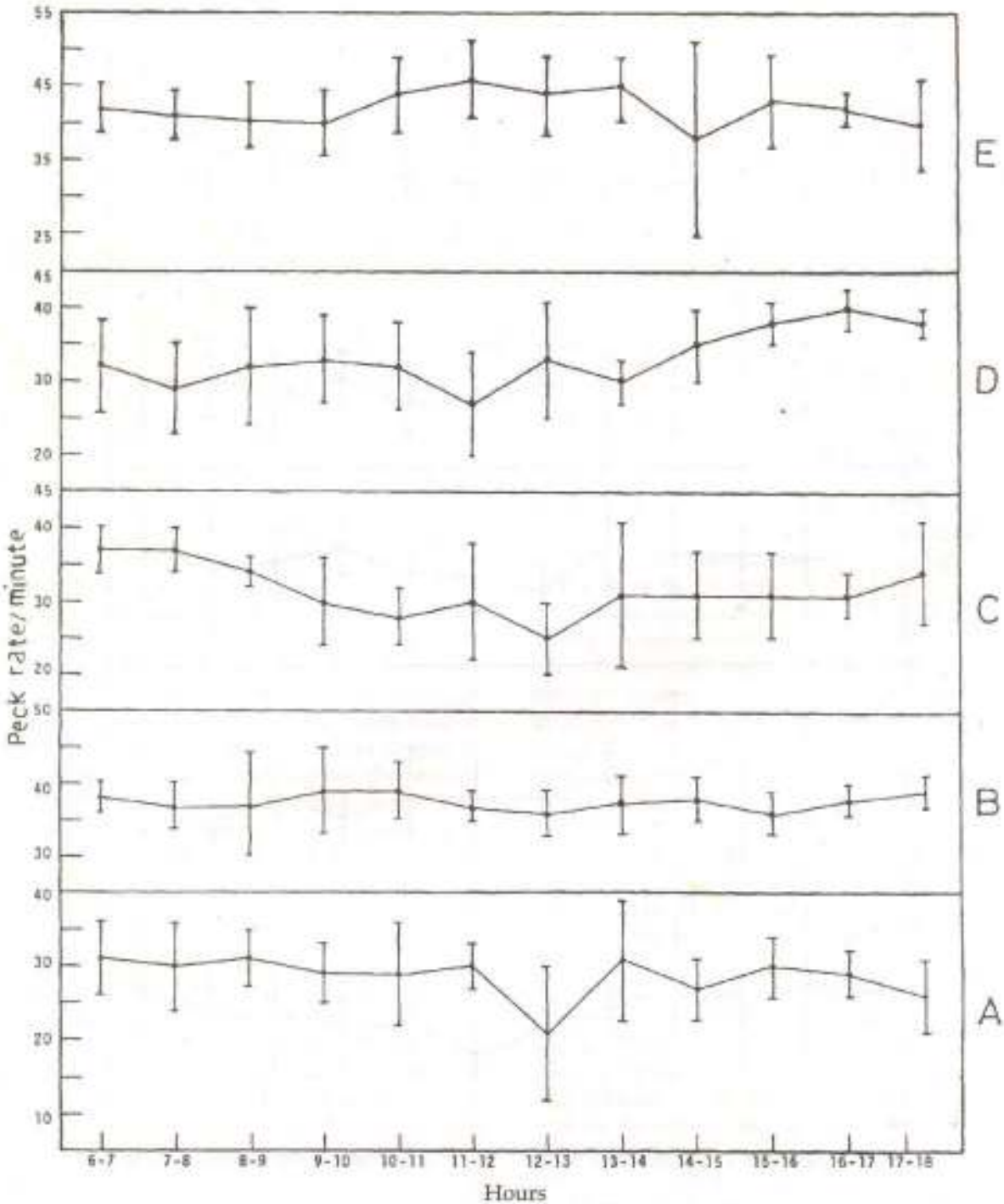

Fig. 3. Showing hourly mean and ranges in the peck rate of *C. testacea* between 6.00 and 18.00 hrs during November 1986 to March 1987

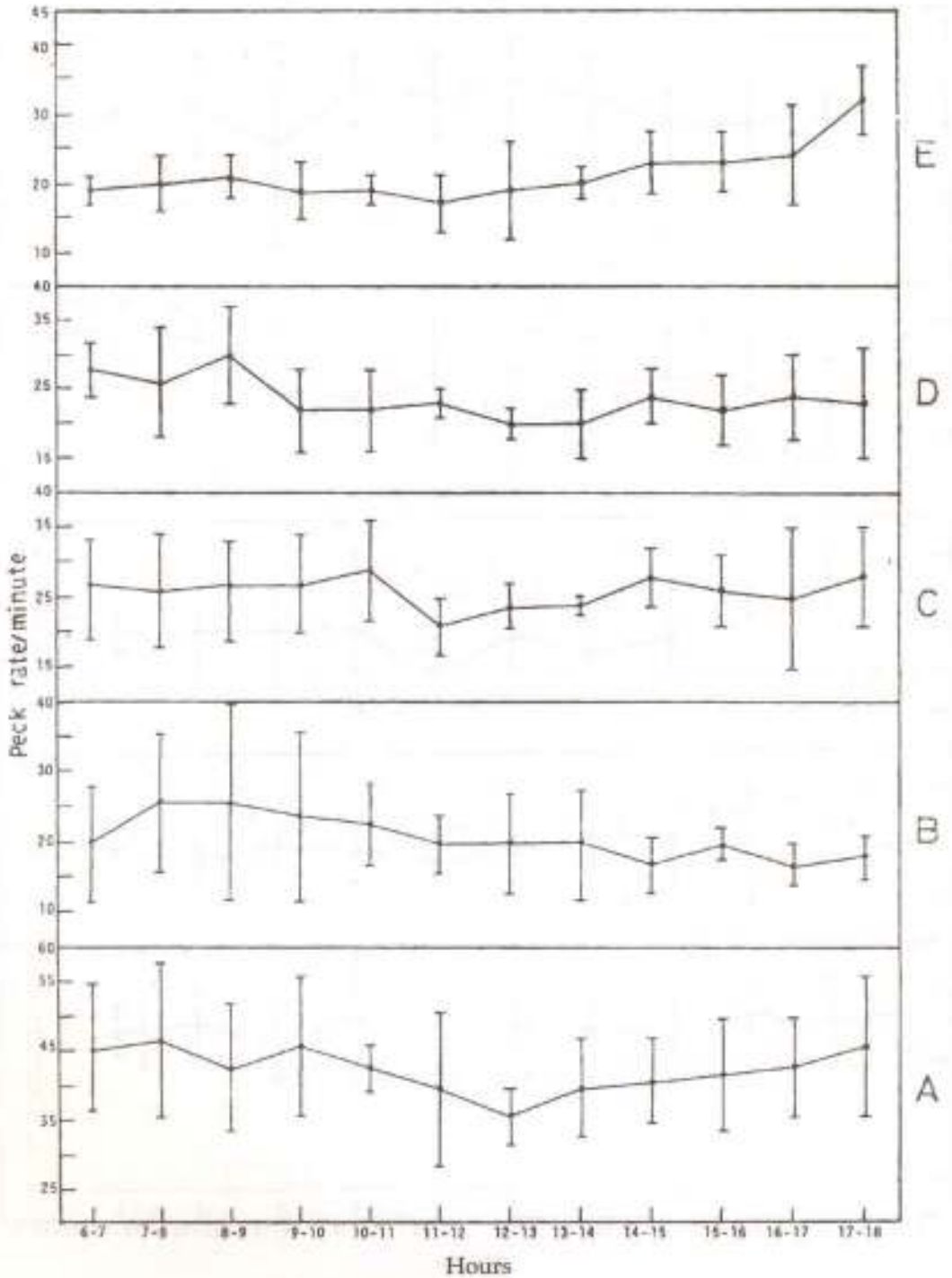

Fig. 4. Showing hourly mean and ranges in the peck rate of *T. stagnatilis* between 6.00 and 18.00 hrs during November 1986 to March 1987
A - November, B - December, C - January, D - February, E - March

The Food of Malabar Pied Hornbill

*M. S. Reddy and S. Basalingappa**

Abstract

Food of Hornbills

Visual observations were made to find out the types of food of Malabar pied hornbill *Anthracoceros coronatus*. Lipids, proteins and carbohydrates were determined for different fruits. The hornbills were observed feeding on the fruits of 17 different food plants and eight animal food items. The food consumption was understood on the basis of the food consumed per feeding bout. Hornbills are very fond of *Ficus* and *Strychnos* fruits. These birds preferred to feed on the succulent fruits which obviate the need of water. Consumption of fruits is related to the size, weight and its nutritional value. All the types of fruits are found equally effective in contributing the essential nutrients.

Introduction

Hornbills (*Aves : Bucerotidae*) are inhabitants of the tropics and distributed in Ethiopian, Oriental and Australasian region of the World. According to Kemp (1976) 11 out of 14 genera of hornbills (28 of the 45 species) are mainly frugivorous and the remaining three are mainly insectivorous. These birds inhabit all types of the tropical forest. Population of hornbills is fast dwindling due to indiscriminate deforestation which leads to the scarcity of food and suitable nesting trees and roosting places. According to Kemp (1973) the food supply is one of the main proximate factors to trigger breeding in hornbills. After making detailed studies, Kemp (1976) emphasised the importance of food particularly during the breeding period of hornbills and came to the conclusion that the food supply determines clutch size, duration and timing of egg laying. The reports of Stonor (1937), Moreau and Moreau (1941), Kilham (1956) in *Bycanistes* hornbills regarding the inadequate food supply are so alarming in the sense that it affects the breeding so much that the females come out of the nest without laying eggs.

The literature on hornbills lists the food items of about 20 out of 45 species. Detailed information on the food of very few species of hornbills is available. Some information is available from the field studies on the Casqued hornbill *Bycanistes subcylindricus* (Kilham, 1956), Monteiro's hornbill *Tockus monteiri* (Kemp and Kemp, 1972), eight species of the hornbills of Sarawak (Kemp and Kemp, 1974), three species of *Tockus* hornbills of Africa (Kemp, 1976), Ground hornbills *Bucorvus* and *Sagittarius* (Kemp and Kemp, 1978), Great pied hornbills *Buceros bicornis*, Indian pied hornbill *Anthracoceros albirostris*, Wreathed hornbill *Rhyticeros undulatus*, Brown hornbill *Ptilolaemus tickelli* of Thailand (Poonswad et al., 1983) and Malabar grey hornbill *Tockus griseus griseus* (Basalingappa *et al.*, unpublished). Records are available for a very few feeding incidences of Ground hornbill *Bucorvus* species (Pitman, 1928), Common grey hornbill *Tockus birostris* (Lowther, 1942) and most of the hornbills of the Indian sub-continent (Ali and Ripley, 1983). Primrose (1921) for Indo-Burmese pied hornbill *Anthracoceros albirostris*, Abdulali (1951) for Malabar grey hornbill *Tockus griseus griseus* and Hutchins (1976) for *Anthracoceros malabaricus malabaricus* have reported the food of the different species of hornbills

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maintained under captivity. Very few feeding incidences are reported by Ali and Ripley (1983). Except Basalingappa *et al.* (unpublished) on *Tockus griseus griseus* no detailed study has been made on the hornbills of the Indian sub-continent.

In the present investigation attempts are made to enumerate food, food preference and the consumption of different food items. The nutrients such as lipids, proteins and carbohydrates of different food items have also been analysed.

Materials and Methods

The observations were made on the food and food consumption of hornbills *A. coronatus* at Dandeli (15° 18' N, 74° 37' E) forest in North Kanara District of Western Ghats in Karnataka (India). The hornbills *A. coronatus* during their forage were closely followed to manifest the different food plants on which they regularly feed. Consumption of different food items including the animal food per feeding bout was understood by observing through 7 x 50 field binoculars.

We collected ripe fruits from different fruit plants on which the hornbills regularly feed, brought them to the laboratory, weighed and determined their average weight and diameter. We estimated the food consumption of hornbills on the basis of the fruits consumed per feeding bout.

The percentage of water was determined by drying the fruits in hot air oven to constant weight at 90°C. Total lipids, proteins and carbohydrates of different fruits which formed the food of hornbills were estimated and recorded. Total lipid from a known quantity of dried fruit sample was extracted with the mixture of chloroform methanol in a ratio of 2 : 1 (v/v) following the method of Folch *et al.* (1957). Further, the extract was estimated by semi-micro method of Pande et al. (1963). Total protein was estimated on wet weight basis according to the Folin-Ciocalteu method of Lowry *et al.* (1951). Total carbohydrates were estimated on wet weight basis following the Phenol-Sulphuric acid reaction method of Dubois *et al.* (1956). The above estimations were repeated twice with three sets and calculated the percentage of total lipid, protein and carbohydrate using the average values.

For analysing the data and the food values, two-way analysis of variance with one missing value followed by the Student-Newman-Keuls multiple comparison test was conducted. The significance test at 5% level is chosen for the analyses.

Results and Discussion

Malabar pied hornbills *A. coronatus* feed mainly on fruits. The hornbills were also found taking to animal food whenever there was the seasonal paucity of plant food. The list of the fruits on which the hornbills feed is presented in Table 1. It is interesting that the hornbills were found feeding on a variety of fruits belonging to 17 different plant species and eight types of animal food. The hornbills were also found feeding on the leaves of *Melia composita*.

Regarding the animal food, hornbills were found feeding more on smaller insects such as termites than larger prey like lizards. The larger hornbills of Africa-*Bucorvus* and *Sagittarius* even feed on large prey such as mongoose, polecat and hares (Kemp and Kemp, 1978); and most of the large hornbills of Oriental region feed on fishes, lizards, snakes, tree frogs, nestling birds and cave swifts (Kemp and Kemp, 1974; Ali and Ripley, 1983; Tikadar, 1983). The hornbills were also observed meticulously pecking the covered runways of termites and feeding on them with the tip of their huge beak. Thus, the diet of hornbills *A. coronatus* includes 68% plant food (fruits) and 32% animal food. Of the plant food, fig fruits contribute 20% and the remaining 48% includes non-fig fruits. These birds are very fond of *Ficus* (Ali and Ripley, 1983) and *Strychnos* fruits (Gamble, 1972). The present observations also revealed that *Ficus* and *Strychnos* fruits are eaten commonly. The pulp of the Strychnos fruit though poisonous is eaten by these hornbills (Gamble, 1972). The fruits of *Strychnos* contained two major alkaloids Strychnine and Brucine (Chakravarti, 1976). It was observed that the hornbills fed on such poisonous fruits voraciously and with much liking. How exactly the alkaloids are detoxified by these hornbills is a matter to be investigated. According to the forest officials of Kanara Circle, these hornbills were visiting the agricultural fields in the plains of Malannad adjacent to the forest and found feeding on ripe chillies.

Thus, the hornbills *A. coronatus* appear to be more frugivorous than carnivorous. Poonswad *et al.* (1983) while studying the other hornbills of the Oriental region held a similar opinion. During three years of study, the Malabar pied hornbills were never observed drinking water. There are no reports on record regarding any of the hornbill species drinking water.

The wet weight of the fruits, number of fruits consumed and food consumption per feeding bout are given in Table 2. It was not possible to record food consumption for different fruits except *Machilus macrantha*, because of the mixing up of the birds in a flock during their forage. It was, however, possible to observe and record the food consumption of a female hornbill which was recognised by its broken casque in

a flock. During two days of observation, the birds confined their feeding mainly to the fruits of *Machilus macrantha* tree situated at the Experimental Plot, at Dandeli Timber Depot. A female hornbill consumed an average of 165.5 fruits of *Machilus macrantha* and 4.5 items of animal food per day (Table 3).

Table 2 illustrates average wet weight, maximum fruits consumed and food consumption per feeding bout of the hornbills. These birds consumed a minimum of five fruits of larger size (*Strychnos nux-vomica*) and maximum of 79 fruits of smaller size (*Grewia tiliifolia*). Consumption of fruits was dependent on the size, weight and the nutritional value. The weight of the fruits consumed by these hornbills varied from 5.74 g to 117.72 g per bout. Among the fruits consumed, the maximum quantity of 117.71 g per bout was of *Ficus glomerata* followed by *Strychnos nux-vomica* (102.12 g per bout) and *Machilus macrantha* (98.28 g per bout). The birds were very fond of *Ficus* fruits which they ate voraciously. The fruits of *Melia composita, Polyalthia longifolia, Caryota urens* and *Mallotus philippensis* were consumed in lesser quantities than those of Ficus, may be for they had larger seeds. Most of the fruits contain high percent of water. Hence the hornbills were not found to drink water. The hornbills were also found feeding on the placenta from the fruits of *Swietenia mahogoni*. Feeding on such a dry placenta of fruits though with meager content of lipid and protein might be for supplementing their food with high content of carbohydrate as the fruits of *Swietenia mahogoni* contain higher carbohydrate (9.38%). Thus the hornbills feed on a variety of fruits. But the analysis of variance test for the food items revealed insignificance for differential preference, implying all the food items are equally effective in contributing the nutrients.

Table 4 illustrates the values of total lipid, protein and carbohydrate of some of the fruits which formed the food of *A. coronatus*. Though the hornbills feed voraciously on the fruits of *Ficus* spp, *Strychnos nux-vomica, Caryota urens, Grewia tiliifolia, Polyalthia fragrans*, the multiple comparison test showed that all the food items have the same mean effect and they equally contribute the nutrients in the diet of hornbills.

Summary

Hornbills inhabit mainly tropical forests of Ethiopian, Oriental and Australasian regions of the world. Most of the hornbills live on plant food. Their population is fast dwindling due to indiscriminate cutting of forest which leads to scarcity of food, suitable nesting trees and roosting places and even affecting their breeding success. Information on the food of hornbills is meager except the record of very few feeding incidences. Visual observations were made to enumerate the food of hornbills. The food preference and consumption of different food items were observed. The percentage of water, lipids, proteins and carbohydrates from the fruits on which hornbills regularly feed was determined. The hornbills are mainly frugivorous and less carnivorous. These birds were found feeding on the fruits of 17 different plant species and 8 types of animal food. Hornbills are very fond of *Ficus* and *Strychnos* fruits. During three years of study, the hornbills were never observed to drink water. These hornbills consume a minimum of five fruits of larger size and a maximum of 79 fruits of smaller size. Their consumption of fruits depends upon the size, weight and nutritional value but, all food items have a high percentage of water. Results of the nutritional value tests show that all food items have the same mean effect and they contribute the nutrients equally in the diet of hornbills.

Acknowledgements

We thank Dr. Alan Kemp, Transvaal Museum, Pretoria for his help in providing the complete bibliography on hornbills and also for his suggestions. This research was financially supported by The Department of Environment and Forests, Government of India, New Delhi.

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Table 1. List of the food items (fruits and animals) recorded as the diet of the hornbill *Anthracoceros coronatus* during the field study.

A. PLANT FOOD (FRUITS)	B. ANIMAL FOOD
Grewia tiliifolia	Terrestrial Snails
Mallotus philippensis	Beetles
Ficus infectoria	Lepidopteran larvae
F. glomerata	Grass-hoppers
F. religiosa	Cicadas
F. bengalensis	*Mobuya sp.*
F. rumphii	*Calotes versicolor*
Strychnos nux-vomica	Termites
Polyalthia fragrans	
P. longifolia	
Schleichera oleosa	
Machilus macrantha	
Caryota urens	
Melia composita (fruits and leaves)	
Swietenia mahagoni (plancenta of fruits)	
Syzygium cuminii	
Buchnania sp.	

Table 2. Average wet weight of food items (fruits), maximum number of fruits consumed and food consumption per feeding bout of the hornbill *A. coronatus*.

Food items	Average diameter (cm)	Average wet weight gm	Maximum fruits consumed per bout	Maximum food consumption g/bout
Grewia tiliifolia	0.87	0.50	79	39.50
Mallotus philippensis	0.96	0.33	22	7.26
Ficus infectoria	2.65	8.98	9	80.73
F. glomerata	2.89	9.81	12	117.72
F. religiosa	1.19	0.63	71	44.73
F. bengalensis	1.97	3.00	12	36.00
Strychnos nux-vomica	5.15	47.48 (20.43)*	5	102.12
Polyalthia fragrans	2.17	9.88	7	69.16
P. longifolia	1.85	4.44	13	57.72
Schleichera oleosa	1.83	3.45	11	37.95
Machilus macrantha	1.75	2.52	39	98.28
Caryota urens	1.96	3.54	8	28.32
Melia composita	2.43	Part of the fruit was eaten		
Swietenia mahagoni (Placenta only)	–	11.48	1/2	5.74
Syzygium cuminii	1.98	4.62	9	41.58

* Wet weight of only pulp and seeds.

Table 3. Food consumption of a female hornbill *A. coronatus*.

Date of Observations	Total hours of Observations	Number of food items consumed	
		Plant food	Animal food
12.2.1985	11	153	5
13.2.1995	11	178	4
Average	11	165.5	4.5

Table 4. Nutritional composition of the fruits which formed the food items of hornbill *A. coronatus*.

Food items (fruits)	Percent water	Percent lipid (Dry wt)	Percent protein (Wet wt)	Percent carbohydrate (Wet wt)
Grewia tiliifolia	65.88*a	3.05b	1.74b	6.82b
Mallotus philippensis	22.26	8.75	6.53	3.38
Ficus infectoria	82.20	4.17	4.15	5.77
F. glomerata	86.20	3.28	2.60	6.00
F. religiosa	74.33	3.89	2.90	9.50
F. bengalensis	72.90	3.08	4.10	5.50
Strychnos nux-vomica	79.86	7.58	2.82	25.44
Polyalthia fragrans	78.93	19.61	2.86	8.75
P. longifolia	78.85	9.20	3.26	6.94
Schlichera oleosa	81.76	3.13	5.38	1.43
Machilus macrantha	73.53	30.07	2.23	2.08
Caryota urens	70.06	2.70	3.80	11.82
Melia composita	69.73	4.99	3.32	21.43
Swietenia mahagoni	7.00	0.98	1.92	9.38
Syzygium cuminii	83.70	0.30	0.70	14.00

* Calculated missing value.

Analysis of variance : Food contents $F_{3,41}=91.59$, $P<0.05$
Food items $F_{14,41}=1.04$, $P>0.05$

S.N.K. test for food contents : The columns followed by the same letter are not significantly different from each other at $P<0.05$ level.

Demoiselle Cranes Wintering near Khichan, Rajasthan

Jules Philippona

A small number of Demoiselle Cranes (*Anthropoides virgo*) has wintered near Khichan in West Rajasthan of old (27°5' N, 72°26' E) (near Phalodi). The area is part of the Thar or Indian Desert. Inhabitants of the village traditionally fed birds since long times. I visited Khichan in the period 11-18 January 1995 and stayed at the home of Mr. Prakash Jain and his daughter Surekha. Mr. Prakash Jain, who lives in Khichan is very interested in nature. He had built a small fenced feeding station for the cranes. This place has been called "Birds feeding home". Since then the feeding with grain has been increased. As a consequence the number of Demoiselle Cranes has risen since 5 or 6 years to several hundreds and even some thousands.

The Society for Cranes Protection and Care was founded in 1992. Mr. Prakash is the secretary of this society.

The cranes are fed two times a day. The first feeding is late in the evening when it is dark. The cranes arrive the next morning shortly after sunrise. Afterwards they leave the feeding home and spread over the fields with a sparse steppe vegetation around Khichan. It was seen that several birds tried to find their food. At the end of the morning most of the cranes fly to the small lakes near Khichan, where they can drink.

In the late afternoon a second feeding takes place and soon afterwards the birds move to the feeding station. During or after sunset the Domoiselles return to the lakes and to some other sites further from the village. At these places they will spend the night.

Arriving flocks were counted on 17th January at the feeding home. The number totalled 3700. Age-ratio counts of cranes near the lakes and in the feeding station gave the following results : among 1000 Ex. 121 Juveniles were counted. The percentages of first year birds (born in 1994) was 12:1.

The feeding project is costly, especially in a country like India. In the period of high numbers (more than 2000, possibly even 4000 or 5000) hundreds of kilograms of grains are fed every day. The price of one kg. is about 40 cent. Total costs a day may vary between 15 and 65 dollars.

Many thanks are due to Mr. Prakash Jain and Surekha for the hospitality I received.

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Bird Conservation : Some Aspects

Prakash Gole

Bird conservation, to say the least, is a neglected subject in India. I am saying this inspite of our efforts to save such endangered species as the Great Indian Bustard and the Siberian Crane. In bird conservation, I believe, or for that matter any conservation effort, much more is involved in thinking, planning and execution than mere protection to an endangered species. In this ancient land it essentially involves relations between man and wildlife, their interactions : symbiotic as well as in conflict. I wonder in our research and conservation effort if we have paid enough attention to this aspect.

Recently I attended a workshop whose aim was to prepare a Red Data Book for India's birds. Besides the endangered species, 98 bird species were listed as threatened and a slightly higher number (108) was under the near-threatened category. Some 21 species were considered near threatened for India by various investigators but were rejected in the overall regional context. These lists show that almost one-fifth of India's bird fauna are not secure in their home.

Actually the situation, I am afraid, is far more complex and serious than these lists project. When I looked at these species lists more closely, I found that most of these insecure birds belong to two major groups : forest and wetland. The remaining occupy more open areas such as agriculture and fallow, grasslands and uncultivable waste. But these broad categories conceal more than they reveal. In this land of great bio-geographical diversity, local variations in climate, landscape and the degree of human interference count a great deal and expose birds to varied impacts. The same species may be abundant in one place but in an adjacent state may be severely depleted. It is good that forest and wildlife are state subjects. Each state can therefore, prepare its own list of insecure birds; and I believe this effort alone will give us a truer picture of the status of various bird species. If suppose each state does prepare such lists under the three categories : endangered, threatened and near threatened, many more species than those listed already, I believe, will be covered. It is better to have some relation between the number of birds and the extent of its typical breeding and feeding habitat, to arrive at some judgement of its status. The statewise assessment may provide a more accurate picture of both, the number of birds in a particular state plus the area available to a species for feeding and reproduction.

Unfortunately we have not prepared distributional maps for our birds; neither do we have a correct assessment of the numbers of our birds. It is far more difficult than these two things, to prepare an assessment of the extent of feeding and breeding habitats for birds. But if and when we do have some indication of these three things, the real gravity of the situation of the status of our birds and need for their conservation will be revealed to us.

My apprehensions naturally are based on my own investigations. In 1988-90 when I carried out an extensive survey for judging the status of the Sarus crane, I found that over vast areas of north and central India, you do not see, while travelling, on 1 to 2 kilometre width on both sides of the road, a single bird, not even common species such as house sparrows and crows. I found Little Brown Dove the most often seen bird over this vast region. During this survey I visited more than 500 wetlands, many of them exhibiting impressive numbers of birds. But these numbers belie actual conditions when you come to think of the extent of feeding and breeding habitat available for our water-

fowl. I find that for most of our waterfowl, suitable breeding areas, especially suitable nesting trees, are becoming extremely scarce all over the countryside. A time is fast approaching when there are more large trees in our cities than in the countryside.

I am now investigating the birds of Western Ghats forests in my own state, Maharashtra. As you know forest exists only in patches in our hills and that too, in widely scattered, small patches. I now find that in a forest the percentage of canopy cover has a direct bearing on the occurrence of certain bird species, especially flycatchers and thrushes. These birds occur only where there is dense canopy. Such areas are being narrowed down everyday restricting the habitat of these birds. Even if a forest looks luxuriant from a distance, it is the canopy which gives it a true forest character; and it is there only, I believe, that the true forest birds are to be found. I feel the investigation of the canopy cover should be given primary importance whenever we consider the status and hence the conservation of forest birds. The whole question of the availability of habitat for our forest birds should be examined on this basis : the extent and percentage of canopy.

The list of protected areas available to me shows 30 odd reserves where especially birds are protected. There must be some additions to this list in recent years. 22 of these 30 are wetland reserves, the rest being forest and grassland. Besides these our large animal sanctuaries and national parks also protect birds, manily of the forest and to a lesser extent of open areas. Now I want to ask what do we know about the status of birds in these protected areas? With one or two exceptions practically nothing in scientific terms. What do we know about the management of these reserves in terms of bird protection? Again practically nothing, barring a few exceptions.

My own observation suggests that much of the time of our reserve managers is spent in settling peoples' claim or looking after important visitors and visitor amenities. There are no arrangements for continuous collection of data relevant to management. No ornithologist serves on the reserve staff. Indeed even the famous Keoladeo Ghana National Park in Bharatpur lacks the services of a trained ornithologist to support the manager. Where a lot of data are collected, these lack proper organization to elicit management options and practices. This is indeed a sad state of affairs and prompts the comment that bird protection exists only on paper!

Some may argue that least management is the best management. But least management is not no management. The least a manager may be called upon to do is to control such weeds as water hyacinth and *Ipomoea carnea*, control fires, poaching and other destructive activities. The question is whether he should go beyond these basics. What should be the goal of management? For certain reserves like Karera, protection of a single species may be the primary goal. But what should be the management goal of a place like Keoladeo Ghana? We need a serious debate on this point, probably each reserve to be taken up separately and discussed in detail. My feeling is only continuous collection of data regarding numbers, movements and feeding and breeding activities of birds will clarify management goals. Such data collection need to be started immediately in different protected areas, at least in one area from each of the biogeographical segments to begin with. But the proper organization of the mass of data so as to make it management-oriented, should be stressed once again.

Protected areas are not isolated units. They exist in a socio-economic milieu. As such biological data need to be supplemented by socio-economic research. We need not only to know the demands made by non-human beings on the habitat, but also demands made by human beings. Indeed in the Indian situation the latter may have to be given greater weightage than the former. When the manager can gauge both, he will be in a position to reconcile these sometimes conflicting demands.

I started my wetland research with a socio-economic survey of villages surrounding a wetland reserve. I found that our process of economic development is such that the present-day markets are increasingly unable to satisfy the biomass needs of people. People are forced more and more to fall back on whatever nature remains around them. Now if a manager can manage a reserve so that a part of the biomass needs of the people is satisfied while protecting birds, a reconciliation is achieved. Now in my study I found that the satisfaction of man's needs does not always conflict with the satisfaction of the needs of birds. Indeed many of them complement each other. How did I find out this?

Looking at birds of this wetland, I found that they can be divided into groups according to their feeding habits : groups such as divers, surface feeders, marsh and mud-flat feeders, etc. I also found out that the extent of their feeding habitat varied with the fluctuations in the water level. When we correlated bird numbers of various groups with the extent of feeding habitat available over a year, we were able to find out when optimum conditions for the existing bird groups

prevailed in the wetland. It became plain to us that the composition of birds at a particular time and at a particular place is adjusted to the optimum conditions in a wetland governed mainly by the availability of water. Because over this wetland water level fluctuations were very large, leaving wide areas dry for a considerable period of time, various birds had adapted to these conditions. The prevailing bird communities there, had a larger proportion of birds feeding in dry and semi-dry conditions than birds feeding in more wet areas. In other words surface feeders, marsh and mudflat feeders were under-represented in the prevailing composition of birds on this wetland.

Now comes the need or the necessity for management. The question is should we try to alter conditions on the wetland so that we get a better representation of surface, marsh and mudflat feeders? This involved extending the feeding habitat for these groups, i.e. not only extending the area where shallow water would prevail but also extending the period of shallow water prevalance, i.e. extending the hydro-period. Obviously we opted for management, carried out certain measures extending the wet conditions over that part which habitually remained dry due to high water-level fluctuations.

Our decision to opt for management measures instead of adopting laissez faire or no management is the best management attitude, was reinforced when we found out that these management measures were going to benefit not only birds but people also. We built low earthen bunds to impound water over a hectare of an area. When the water level went down this one-ha. pond was seen to be teeming with riverine fish which people had a field day catching. We planted waterside vegetation including Indian willow trees whose roots tolerate total submergence. Once fully grown these Salix trees provide shelter for birds, shade over water, keeping down water temperature, and providing detritus which promote aquatic life including fish. Moreover they provide good quality wood for people.

The area surrounding wetlands is also very important for the health of the wetland. If well managed it acts as a filter through which nutrients are released into the wetland. Over this we tried to create wet and dry meadows with a background of selected drought-resistant indigenous trees : *neem, ficus* and *acacia*. This again was done with a dual purpose, to help birds as well as people.

The lessons I learnt from this research on this particular wetland were several. The most important being a correct blend of management and ornithology will go a long way in reconciling peoples' interests with wildlife. It is here that the cooperation between government agencies and NGOs becomes most fruitful. The inputs from NGOs can not only be management-oriented ornithological research but also correct relations with local land-owners. Only NGOs can persuade them to become partners in this process. An atmosphere of trust and mutual accommodation is a prerequisite for successful conservation : between government agencies and NGOs and between both these and local landowners. At present the Government has little faith in its own citizens and citizens do not trust their own government. Actually the government should encourage NGOs to organize their own sanctuaries and reserves like the Royal Society for the Protection of Birds in England. NGOs can be given grants and awards for exemplary management of reserves. The law which says that a sanctuary can only be legalized when the government wholly owns the designated land, is wrong in intent and bad in practice. Indeed in some cases government takeover may be inimical to the interests of wildlife.

I found this at Sangti valley in Arunachal Pradesh. This is now the only valley where Blacknecked Crane winters in India. When I studied Sangti cranes, I found that they are dependent on the traditional rice-growing practices of the people in which after the harvest, the land is kept fallow in winter. In this fallow land, the crane finds food : fallen grain, insects and small fish in wetlands. Crane and people complement each other. If a sactuary is to be declared, government may have to take over the land, the rice cultivation will be hampered, and there will be no winter food for the crane. The best solution is to encourage local people to follow their traditional practices and protect the crane which task, a Buddhist resident population is only too willing to perform! Sangti valley is in effect a peoples' sanctuary. Government's task of protecting the small wintering population of an endangered species is made easier by the people. The government should recognize peoples' help, reward them, help them in various ways and give this example wide publicity so that it is emulated elsewhere.

Conservation is cooperation. Neither the government alone nor the people alone will be able to achieve it. Let everyone come together to fulfill this noble duty!

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Turtles Recorded in Dibru-Saikhowa Wildlife Sanctuary, Assam

Anwaruddin Choudhury[1]

Abstract

The paper lists the turtles recorded during a survey in Dibru-Saikhowa Sanctuary of Assam. Some significant range extensions and new locality records are among the major finds. *Chitra indica* has been recorded for the first time in Assam.

Introduction

The Dibru-Saikhowa Wildlife Sanctuary is located in eastern Assam, India (27°35' - 27°50'N and 95°10' - 95°40'E). Established in 1986, the sanctuary covers about 640 sq. km. of floodplains of the Brahmaputra and the Lohit rivers. The sanctuary falls in Tinsukia and Dibrugarh districts with a small portion of riverine area in Dhemaji district (Fig. 1).

The average elevation of the sanctuary is 118 m. (range : 110-126 m) above sea level. A large number of sluggish channels and wetlands in the form of seasonal *beels* (ox-bow lakes, depressions, etc.) and perennial marshes are in the sanctuary besides a large stretch of the Brahmaputra and Lohit rivers. Dibru-Saikhowa sanctuary has a tropical monsoon climate with a hot wet summer and a cool and usually dry winter. The average annual rainfall is around 2900 mm.

The original natural vegetation of the sanctuary was tropical wet evergreen 'rain' forest with grassland and reedbeds in the chapories (islets and riverine tracts) and depressions. However, during the great earthquake of 1950, the bulk of the sanctuary sank by a few metres resulting in regular flooding of the area. This has been followed by a succession of new vegetation. *Salix* swamps and deciduous forests now dominate the sanctuary with only patches of evergreen forest (Choudhury, 1995).

Between July, 1992, and May, 1994, a wildlife survey was carried out in the area. During the survey, any evidence / sign /specimen of turtles found had been meticulously recorded. Whenever specimens were found, measurements were taken. All live specimens were released into the wild after examination.

This paper discusses the observations on chelonians recorded during the survey. My collections of preserved specimens are referred to as AUC. The local names of different species and groups are listed in table 1.

Results

Bataguridae

***Cuora amboinensis* (Daudin) Malayan Box Turtle**

In July, 1993, six turtles of this species were caught in fishing traps near Baluchar. A local brought three of these to me for examination. After measurement and photography, I released them in the wild. During the survey, three carapaces were also collected. The localities were : Amarpur (May, 1993; AUC 16); Guijan village (August, 1993; AUC 22) and near Santipur, Sadiya (February, 1994; AUC 21). The last named locality is about 12 km away from the sanctuary boundary. The specimen from Guijan was originally caught somewhere in the sanctuary. The habitat of these specimens is wet grassland with pools near rivers. Habitat in Santipur was a small *beel* not far

1. Rhino Foundation for nature in North-East India, c/o The Assam Tea Company Ltd., Bamunimaidam, Guwahati 781021, Assam, India.

from human habitation. Table 2 lists measurements of the specimens.

Cyclemys dentata **(Gray) Asian Leaf Turtle**

No live turtles were seen. A carapace with a detached plastron was collected from Guijan village (August, 1993; AUC 18). It was originally collected by locals from inside the sanctuary. One more carapace was collected from Rohmoria village, in the extreme western part of the sanctuary (June-July, 1994; AUC 30). Table 3 lists measurements.

Geoclemys hamiltonii **(Gray) Spotted Pond Turtle**

No specimens were recorded during the survey. In January, 1990, while on a field trip to Jamjing Reserved Forest of Dhemaji district, I collected a carapace from a cattle camp (AUC 05). Jamjing RF is only about 10 km from the sanctuary boundary. The habitat in the area consisted of wet savannah grassland with *beel* and sluggish channels.

Kachuga smithii **(Gray) Brown Roofed Turtle**

One live specimen and a carapace were examined during the survey. The plastron of the live turtle was patterned and hence, it was of the nominate subspecies *K. smithii smithii*. The live turtle was caught somewhere near Saikhowaghat from the Lohit river (March, 1994) and later released near Guijan. The carapace was also collected from the Lohit river somewhere north-east of Saikhowaghat (April, 1994; AUC 24). No spines could be seen on the carapaces; however, blackish vertebral stripes were conspicuously present.

Kachuga sylhetensis **(Jerdon) Assam Roofed Turtle or Khasi Hills Terrapin**

A short report on the occurrence of this species in Dibru-Saikhowa has already been published, including records of three live specimens from Banko *beel* (Choudhury, 1993). Two more specimens have been recorded subsequently from the vicinity of the sanctuary. A live turtle was caught near Saikhowaghat, in all probability from the Lohit river in May, 1994 (reportedly several were caught, but I could obtain only one). After examination I released it near Guijan. A carapace (part) of a juvenile was also collected from near Saikhowaghat in April, 1994 (AUC 23). A narrow reddish wavy stripe was present posterior to the eyes. The neck was marked with alternate greenish and yellowish stripes. The carapace of a live immature (sl No. 4 of Table 4) had a narrow yellowish margin. Habitat in all the cases was floodplains, with rivers, *beels* and marshes. Its measurements are listed in Table 4.

Kachuga tentoria **(Gray) Indian Tent Turtle**

The most abundant *bataguridae* in the region, with ten specimens (eight live) having been recorded and examined by me. In May, 1993, a specimen from Guijan was released in the Tingrai river after being measured and photographed. On 26 September, 1993, I collected a live specimen from a fishing camp at Baluchar on the banks of the Brahmaputra river. Then on 10 October, 1994, I examined an immature in the Guijan Range Office. Five live turtles were purchased by me in March, 1994, which were captured from the Lohit river somewhere near Saikhowaghat (a few more were reportedly there). After measuring all were released near Guijan.

Two preserved specimens collected included a large plastron (AUC 20) from Baluchar in September, 1993, and a carapace (AUC 31) from Rohmoria in June-July, 1994. Measurements are listed in table 5.

All the specimens resembled *Kachuga tentoria tentoria*, however, a few individuals showed interesting variation and a new subspecies may come into light with further study. The average carapace length of seven specimens (excluding those below 10 cm) was 16.37 cm. Elsewhere, I examined six more carapaces ranging between 13 and 17 cm. This subspecies grows upto 23.0 cm (Das, 1991). The amber or hazel stripe of the first three vertebrals of the nominate race was replaced here by a blackish stripe extending to the 4th and 5th vertebrals also. Some individual variations observed included pink blotches behind the eye besides the reddish patch (No. 5 of table 5) in one specimen and in another (No. 7 of the table 5), the shell was conspicuously compressed at the 6th marginal (Fig. 2).

Trionychidae

Aspideretes gangeticus **(Cuvier) Indian Softshell Turtle or Gangetic Softshell Turtle**

A fairly common species, it is frequently caught / killed and sold in the local markets. On 1 November, 1992, a local Mising tribal was seen carrying a big specimen along with an equally big *Chitra indica* from Laika to Guijan. Both had reportedly been caught the previous night from the Brahmaputra-Lohit rivers. Both were tied to a bamboo pole, one at each end and carried for sale at Guijan or Tinsukia markets. Although I did not take measurements, it was more than 50 cm long.

A locally collected young specimen (less than 10 cm long) was examined in an aquarium at Tinsukia town. A small turtle belonging to Genus *Kachuga* was also there in the aquarium. One morning a few days later, only the bony portions of the *Kachuga* sp were seen which suggested that the young *Aspideretes* had consumed it during the span of one night (the owner of the aquarium had observed both the previous night). Of course, it is not known whether the latter had killed it or it died of other reasons. I observed them in the aquarium on a few earlier occasions also during which *Aspideretes* sp used to chase *Kachuga* sp and was never friendly. Cannibalism by *Aspideretes gangeticus* had been reported earlier also (Rao, 1986).

Chitra indica (Gray) Narrow-headed Softshell Turtle

Only seen once. A big specimen seen carried by a local Mising tribal of Laika to Guijan on 1 November, 1992. It was reportedly caught from the Brahmaputra-Lohit rivers along with a big *Aspideretes gangeticus*. Although I did not take measurement, it was more than 50 cm long.

Discussion

This is the firstever survey carried out in Dibru-Saikhowa sanctuary. Only a few references are available for areas near the sanctuary (Das, 1991; Bhupathy and Choudhury, 1992). However, more work is necessary to have a clearer picture of the status and ecology of the turtles of the area.

The present study revealed some significant range extensions and new locality records.

Cuora amboinensis was earlier recorded in Assam from Kaziranga, Manas, Mazbat (Darrang district) and Gelabil of Jorhat (Das, 1991). This study has extended its range farther east and provided at least three new locality records. In Arunachal Pradesh, it has been recorded from D'Ering Sanctuary (Bhupathy and Choudhury, 1992) which is not far from Dibru-Saikhowa. Santipur in Sadiya, Tinsukia district (95°45'E) is now the known easternmost locality record for the species in the Indian Sub-continent. Moreover, the specimen from Santipur (AUC 21) appears to be the longest known specimen with 23.3 cm. SCL. The longest recorded earlier was 21.6 cm (Das, 1991).

The occurrence of *Cyclemys dentata* in Dibru-Saikhowa is quite significant as it was thought to be a hill-forest-dwelling species (Das, 1991). In Assam, it was known only from Sibsagar and North Cachar Hills districts. Hence, this is a new locality and also more easterly (not the easternmost).

The record of *Geoclemys hamiltonii* in Jamjing RF has extended its range by about 180 km towards east. The previous easternmost record was from Kaziranga (Das, 1991; Bhupathy and Choudhury, 1992).

Kachuga smithii was known only from a few localities, the easternmost being Kaziranga National Park (Das, 1991). The records from near Saikhowaghat have extended its range by about 250 km. A carapace collected by me at Disangmukh, Sibsagar district (AUC 01) was also tentatively identified as *K. Smithii* but it was very unusual with a vertebral spine (Choudhury, 1990). Elsewhere, I observed *K. smithii* in Dhakuakhana area of Lakhimpur district in 1990.

For *Kachuga sylhetensis*, the vicinity of Dhola-Saikhowaghat is a new locality record. However, occurrence of this species in Dibru-Saikhowa has already been reported earlier (Choudhury, 1993). The new records further establish that the species also occurs in the floodplains as well as outside fast-flowing streams of evergreen forests.

Of the total of 32 specimen observed / examined during the survey, 10 (31%) belonged to *Kachuga tentoria* suggesting its relative abundance. The known easternmost locality for the species was Pani-Dihing, Sibsagar district (Choudhury, 1990). These new locality records place Sikhowaghat as the easternmost (95°40'E).

Although *Aspideretes gangeticus* is a common turtle of Assam, it has not been mentioned by Das (1985, 1991). In 1987, I recorded a few live as well as preserved shells in Disangmukh, Sibsagar district. Thereafter, between 1989 and 1991, I came across the species on a number of occasions in Dhakuakhana sub-division of Lakhimpur district. Hence, the record of Disangmukh of 1987 appears to be the first record of the species from Assam as well as north-eastern India.

Chitra indica appears to be rare in the area as only one specimen was seen by me. However, this is the first authentic record of the species from the north-eastern India. The previous easternmost locality was Jalpaiguri district of West Bengal (Das, 1991). This new locality extends its range by about 630 km.*

Exploitation of turtles in Dibru-Saikhowa and adjacent areas is done mainly for human consumption. However, all the catches are not intentional, some are

* This record needs greater authentication, as the author was not a witness to the actual catch. Ed.

trapped in fishing nets while a few small ones are caught in various types of crude fishing-traps. All such unintentional catches also end up in the kitchens or markets. However, since 1993, the local wildlife authorities have taken a keen interest in putting a halt to such capture, with great success. Open sale at Guijan market has practically stopped, and many fishermen release their accidental catches in the wild. However, in the Brahmaputra-Lohit rivers, turtles are still caught as enforcement is difficult due to lack of man-power and continuation of 'fishery mahal' (leased for commercial fishing). A secondary use of turtle-shells is for its supposed medicinal value. People of all communities believe that by keeping a shell in the cow-sheds, the cattle remain disease-free.

Regarding market surveys in Assam, one must be cautious as some turtles are also imported from other states, notably, Andhra Pradesh, for sale in the major towns. These are called *Challani* turtles.

Acknowledgements

For assistance during field survey, I wish to thank R. C. Bhattachrjee (DFO), T. Das (ACF), N. Sharma (Range Officer), Nur Husain, Ranjit Doley, Dilip Handique, Babul Debnath, Munin Hazarika (JE), Sonowal and Buragohain (both JEs of Sadiya Block). Special thanks are due to Paniram Das of Garamjan for accompanying me in most of the trips and also for collection of specimens.

I also thank the Oriental Bird Club for a small grant (sponsored by NAUTURETREK) for a bird survey of the area which also helped me greatly during this survey.

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Abbreviations used in the text are : SCL = Straight carapace length; CCL = Curved carapace length; SCW = Straight carapace width; CCW = Curved carapace width; CH/SH = Carapace height/Shell height; PL = Plastron length. All PL are from notch to notch and SCL from cervical to the posterior edge of 12/13th marginal in all the tables.

Table 1. Local names used in the vicinity of Dibru-Saikhowa Sanctuary.

	Assamese	Bengali	Mising
All turtles	Kaso	Kochhop, Kathua	Rankob
All small turtles, may be youngs of larger sp.	Kasim	Kasim	
Larger softshells	Bor kaso (=Big turtle)		
All Bataguridae	Kath kaso (=Wood turtle; i.e. basks on log), Dura kaso		
All Testudinidae	Bam kaso (=Land turtle)		Kop-kadera
Malayan box turtle	Jap dura, Dura kaso		Kop-kadera
Spotted pond turtle	Nal dura		Kop-kadera

Table 2. Measurements (cm) of *Cuora amboinensis*.

No.	Locality	SCL	CCL	SCW	CCW	SH/CH	Remarks
1.	Baluchar	18.0	–	12.5	–	7.0/	Live specimen
2.	"	16.0	–	10.5	–	6.5/	"
3.	"	13.0	–	9.5	–	–	"
AUC 16	Amarpur	18.8	23.4	12.8	21.2	/7.5	Preserved carapace
AUC 21	Santipur	23.3	26.4	15.3	26.0	/8.8	"
AUC 22	Guijan	21.9	27.8	15.4	23.7	/7.7	"

Table 3. Measurements (cm) of *Kachuga sylhetensis*.

No.	Locality	SCL	SCW	SH/CH	Remarks
2*	Banko beel	9.6	6.8	5.0/	Live specimen
3*	"	9.8	7.2	5.2/	"
4*	"	6.4	5.7	3.6/	"
5	Saikhowaghat	16.6	13.2	8.0/	" (PL=16.0)
AUC 23	North-east of Saikhowaghat	–	–	–/3.4	Part carapace

* Serial number of Table 1 of Choudhury (1993) retained for convenience of future reference.

Table 4. Measurements (cm) of *Cyclemys dentata*, *Geoclemys hamiltonii* and *Kachuga smithii*.

No.	Locality	SCL	CCL	SCW	CCW	SH/CH	Remarks
C. dentata							
AUC 18	Guijan	20.1	23.0	15.0	20.0	/5.8	Preserved sp. (PL=17.8)
AUC 30	Rohmoria	19.5	21.6	14.2	18.7	/5.3	Preserved sp.
G. hamiltonii							
AUC 05	Jamjing RF	32.6	37.1	20.6	30.8	/10.0	"
K. smithii							
AUC 24	North-east of Saikhowaghat	17.3	18.9	12.25	15.8	/4.9	"
1	Sajkhowaghat	15.0	–	11.0	–	5.9/	Live specimen (PL=14.4)

Table 5. Measurements (cm) of *Kachuga tentoria*.

No.	Locality	SCL	SCW	SH/CH	PL	Remarks
1	Guijan	17.0	12.0	–	–	Live specimen
2	Baluchar	8.8	6.6	3.8/	–	"
3	Guijan (Range Office)	7.0	5.5	3.8/	–	"
4	Saikhowaghat	17.9	12.7	8.4/	16.4	"
5	"	16.8	12.1	7.87/	15.8	"
6	"	15.3	11.3	7.3/	14.54	"
7	"	16.5	12.13	7.45/	15.1	"
8	"	15.6	11.6	7.64/	15.4	"
AUC 20	Baluchar	–	–	–	20.7*	Only Plastron
AUC 31	Rohmoria	15.5 (CCL= 17.5)	11.8 (CCW= 15.5)	/6.6	–	Preserved carapace

* Greatest Length : 21.4

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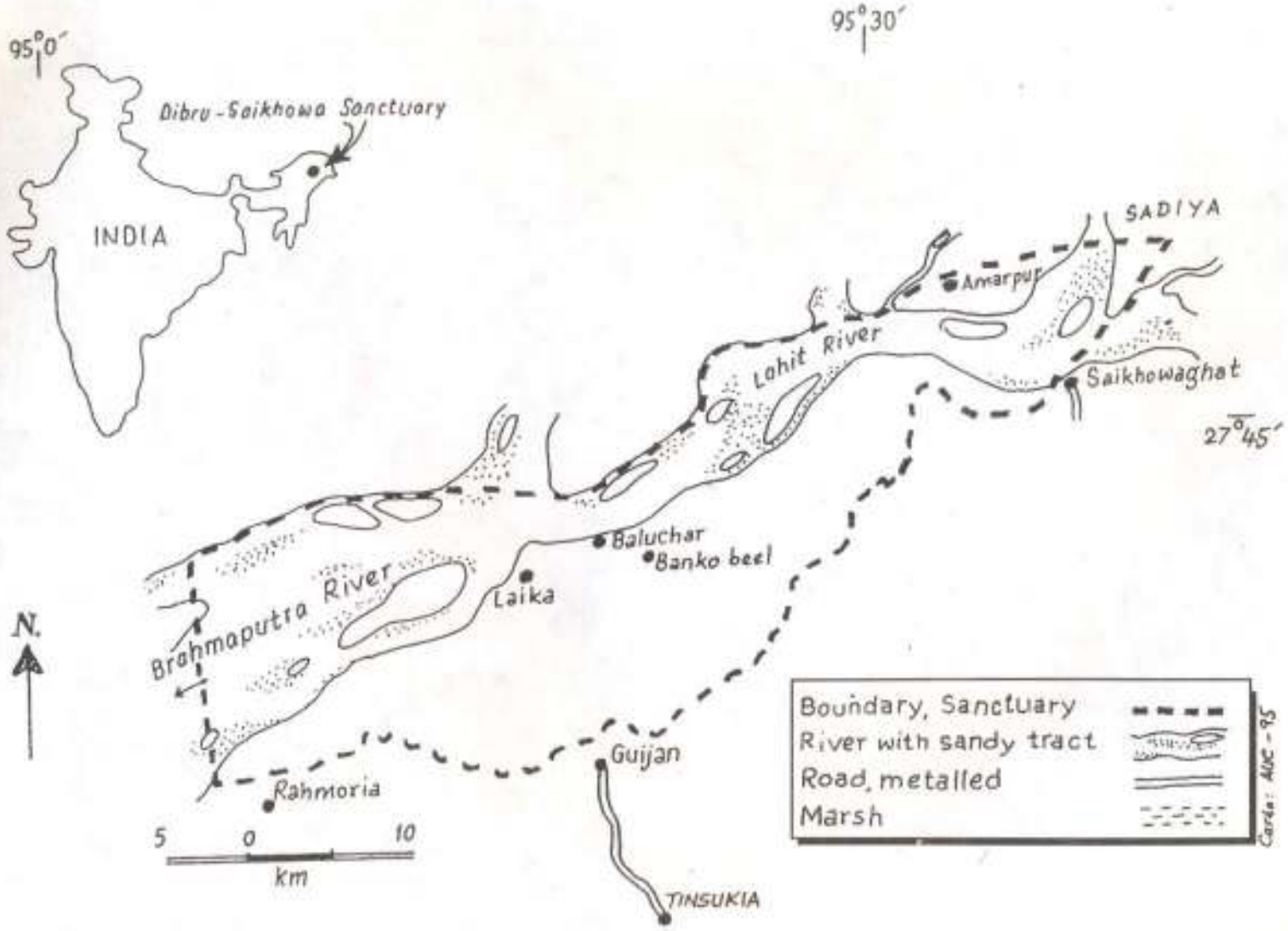

Fig. 1 : Map of Dibru-Saikhowa Sanctuary

Cover transparency, courtesy :
International Crane Foundation, USA

Published by :
Prakash Gole, Director, Ecological Society, 1B Abhimanshree Society, Pune 411008

Printed at :
Aksharchhaya, 2035 Sadashiv Peth, Tilak Road, Pune 411030

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