

to canine Black Tongue. Specific improvement is noticed in such cases when liver extract is administered. It should, therefore, be a very fruitful line of investigation to try and produce pathological conditions in animals similar to pernicious anæmia by controlling the diet and then test the effect of liver preparations on them.

Another promising line of enquiry into the assay of the antianæmic materials would probably lie in estimating one or two of the component amino acids of the potent

polypeptide before and after its hydrolysis. Since the purest preparation of Dakin and West has been shown to contain arginine to the extent of 13.5% and asparatic acid, more than 17%, it should be possible to obtain an idea of the concentration of the active polypeptide by estimating one or both the above constituents. Work in this direction might yield results of great practical utility in the assay of the active principle.

Economic Ornithology in India.

By Sâlim Ali.

(Ornithologist, Dehra Dun.)

A CHARGE that has been preferred against ornithologists in India, perhaps not altogether without reason, is that they have been, and are, far too busy "classification-mongering", *i.e.*, quibbling over morphology and taxonomy, to bother about the *living* bird. Upto a point it may be argued in their defence that before biological studies on any group of animals can be undertaken it is essential that the forms belonging to that group should first be properly classified and made cognisable. But while acknowledging the stirring work done in this direction by ornithologists—wholly European—during the last century and still being carried on by their torch-bearers to-day, there is no doubt that the various other aspects of Indian ornithology have suffered a corresponding neglect.

The Indian Empire encompassing as it does an infinite diversity of climates and physical features—ranging from the eternal snows of the Himalayan peaks to the torrid deserts of Rajputana and Sind—contains an avifauna that for richness and variety can scarcely be rivalled by areas of similar size elsewhere in the world. The total number of species and sub-species so far described is just over 2,350 (including about 350 winter visitors) and more are being added to the list as fresh material from insufficiently worked areas or groups becomes available. Notwithstanding this prodigality of material, our knowledge of the living bird in India is surprisingly meagre. Beyond the barest facts about the nests and eggs of most (but still not all) of them, we know practically nothing concerning their breeding biology. The study of migration—one of the most

engrossing of bird activities and one that has stirred Man's wonderment from the earliest times—is here still in its veriest infancy compared with the researches and the strides being made in Western countries. Bird ecology, despite the vast natural facilities, remains practically an untouched and virgin field, while Economic Ornithology—an aspect of bird study that should have been, if for purely materialistic reasons, one of the foremost to receive attention in an agricultural country like India, has not even been scratched on the surface.

Besides being a source of direct food supply to millions of human beings in this country, it is little realised that wild birds stand in a class by themselves—second only, if at all, to predaceous and parasitic insects—as destroyers of, and natural checks on, harmful insect pests and other vermin, and as agents in the cross-pollination of flowers and the dissemination of seed. Directly or indirectly they exert their influence in practically every branch of human industry.

Economic Ornithology is the science that concerns itself with striking a precise balance between the damage caused by birds to Agriculture, Horticulture, Forestry and other human interests as against the active benefits they confer in less obvious ways. An increasing amount of importance is being attached in recent years to this science in Europe and America with excellent and far-reaching results. In the United States there is a well-organised department carrying on continuous and intensive research work on the life-histories of birds with special reference to their food and feeding habits under the Bureau of Biological Survey, a subsidiary

branch of the U. S. Department of Agriculture.

The only attempt systematically made with the object of evaluating the economic status of birds in this country was an investigation on the food of certain birds by Mason and Lefroy at Pusa. The results, published as a *Memoir of the Department of Agriculture in India* (Vol. III, Entomological Series, 1912), while meagre in extent and circumscribed in scope, demonstrate the vast possibilities and usefulness of this type of research in India. Their weakness lies in the fact that they deal only with adult birds whose diet we know often differs completely from that of juveniles. In Fringilline birds for instance—the tribe to which our common Sparrow belongs—the food of the young consists almost entirely of caterpillars, moths and other soft-bodied insects while that of the adults is almost exclusively seeds and grain. The investigations fail to appraise the *whole* value or status of the birds since they completely overlook this phase of their life-histories. Besides, it is felt that the studies that have been made by an analysis of stomach contents in different months of the year cannot really be appreciated without a knowledge of the density of the bird population on areas of various types and at different seasons. The taking of bird censuses has not been carried out anywhere in India at all. A number of methods for doing this have been employed successfully in Europe and America, none of which could perhaps be applied in their entirety to Indian conditions but which it should not be difficult to adapt. Active co-operation would be necessary from a band of workers, whom it should be possible to find among the biology undergraduates of our various colleges and universities. Tracts of from 40 to 80 acres have been found to be conveniently controlled by one person, but in many areas in India, owing to the density of bird population and other factors, 20 to 25 acres will probably be found to be a more suitable unit. Counts are made at frequent intervals of all birds present in the controlled areas and also of the breeding population of certain selected species over much larger areas by counting their nests.

The study of bird movements is also obviously important from the economic point of view, and it is thought that investigations of methods of catching birds for marking would lead to greater numbers being marked and thus to more rapid progress in our knowledge of their movements. The

method of marking or "banding" birds has been widely employed in Europe and America since the beginning of the present century, but perhaps more systematically and intensively after the War. It consists of fixing on the leg or tarsus of a bird of an aluminium ring of appropriate size on which is stamped a serial number and the address of the ringer. A register is kept by the ringer in which are noted down the species, date of marking, sex, age and other particulars of the ringed bird against the corresponding serial number. The bird is then released, the idea being that if it is subsequently shot or captured the particulars of the date and place of taking and other details would be communicated by the recoverer to the address on the ring. By a recovery of ringed birds in sufficient numbers and a collation of the data it has been possible to build up a great deal of invaluable information concerning the migration and local movements of many species, the age to which they live and other details of their individual life-histories impossible to obtain in any other way.

It will be seen, therefore, that Economic Ornithology does not merely end with the ripping open of the stomachs of birds and listing up their contents, but involves a great complexity of other investigation and study besides. Mason and Lefroy's paper is an attack on but one facet of a many-sided problem, though admittedly the most important contribution that has yet been made to the subject in India. It may be mentioned, however, that the numerical method which C. W. Mason principally employed and the merits of which he so strongly advocates, *i.e.*, of reckoning stomach contents of birds solely by the number of individual insects or seeds, has been well shown by Mr. W. L. McAtee¹ to be vague and often insufficiently illuminating. The principal objection to the numerical method is that it takes no account of the size of the objects eaten and hence conveys no idea to those unacquainted with the groups concerned of the relative importance of the food elements. On the other hand, under the volumetric method which has been in continuous use by the Biological Survey of the U.S. Department of Agriculture since 1895, the proportions the various food elements contribute to the bird's subsistence

¹ W. L. McAtee, "Methods of estimating the contents of Bird Stomachs," *The Auk*, Oct. 1912, 29, No. 4.

are evident at a glance and the bird's capacity for good or harm are clearly indicated. Both methods have their weak points, however, and Mr. McAtee suggests that the ideal technique is one that combines the good points of both the numerical and the volumetric methods.

The following, in general terms, are the harmful and beneficial activities of birds:

Harmful (H):

1. Damage to cereal crops, fruit, vegetables, etc. and destruction of useful insects, fish, etc.
2. Intermediate hosts of parasites which may be dispersed far and wide by their migrational movements and spread diseases among Man and Animals.
3. Dispersal of noxious weeds, etc

Beneficial (B):

1. Destruction of insect pests, refuse, rats, mice and other vermin which are not only destructive to agriculture and other branches of human industry, but carriers of diseases of Man and Animals.
2. As agents of cross-pollination of flowers and dispersal of seed, and hence as regulators of vegetation.
3. As source of supply of meat, feathers, guano and other useful and commercial products.

To take these various activities in some detail:—

(H) 1.—Crows, Mynahs, Parakeets, the Fringilline birds and others cause damage to ripening crops of Maize, Jowari, Bajri, Wheat, Paddy, etc., which is occasionally considerable in extent. Migratory ducks, coots, geese and cranes do extensive damage in certain areas to rice, gram, wheat and other crops. From a scrutiny of the stomach contents and feeding habits of Rosy Pastors in the Nander District of Hyderabad recently, it was estimated² that a flock of 400 birds would account for 25 lbs. of Jowari in one day, equivalent to the food of an average villager for 10 to 12 days! As there are thousands of these birds continuously at work all through the ripening period of Jowari, it is not difficult to realise the magnitude of the damage they cause. Mr. K. V. Joshi, Deputy Director of Agriculture, Bombay Presidency, roughly estimates that the damage done by these birds to cereals

in some talukas of S.-E. Khandesh is about 15 per cent. of the total crop.

Crows, Mynahs, Starlings, Parakeets, Bulbuls and Barbets are some of the principal despoilers of orchards and vegetable gardens. Mangoes, apples, pears, plums, peaches, cherries, litchies, guavas, tomatoes, green peas, etc., are some of the more important sufferers.

Bee-eaters occasionally do some damage by destroying honey bees, but this is on the whole negligible. Aquatic birds have important relations with the fishing industry. Grebes, Cormorants, Herons, Gulls and Kingfishers have often been accused and convicted for causing serious reduction of food fishes, but a careful study of their food habits by the Biological Survey of the U. S. Department of Agriculture has demonstrated that only a small proportion of their diet consists of such fishes, their staple food being crawfish, crustaceans and insects some of which are more injurious to the fry of food fishes than the birds themselves. Trout fry studies by the Biological Survey reveal that the greatest amount of disappearance, which less careful observers are inclined to attribute to birds, is caused by enemy or competitor fishes. Few realise what serious destroyers of spawn there are among the fish themselves, which have frequently well-developed cannibalistic tendencies. Larvæ of water beetles, nymphs of dragonflies, water-bugs and crayfish are some of the worst offenders. Birds eat all these and on the whole probably more than compensate for any direct loss they may cause to the fry. Moreover, most edible fishes of any value live in deeper water and are, therefore, immune as a rule from depredations by Herons, Egrets, etc., who keep close to the shore and devour whatever can be most easily procured. In this way they sometimes eat numbers of catfish which are indeed notorious spawn eaters. Fish-eating birds do most damage about hatcheries as has been the experience during the introduction of trout into the Nilgiris and Kashmir, and here their numbers need to be controlled.

(H) 2.—Very little work has so far been done even in Europe and America—and practically none in India—on the subject of the dispersal by birds of diseases of Man and Animals. It is an investigation pregnant with possibilities and obviously of the greatest importance to health and sanitation as well as to animal husbandry and agriculture, especially as birds are well

² Sâlim Ali, "The Hyderabad State Ornithological Survey," *Jour. Bom. Nat. Hist. Soc.*, 1933, 36, 365.

known to be the hosts of a large variety of both ecto- and endo-parasites which their far-flung wanderings may help to disperse. Thus Sparrows introduced into North America are responsible—or at least blamed—for spreading among poultry certain diseases such as "Blackhead" due to parasitic Coccidia. Some of the worms found almost exclusively in birds belong to the following classes: Trematoda, Cestoda, Nematoda, Acanthocephalidæ and Pentastomidæ. Among the Arthropoda several forms of Acari are known to be ecto-parasites of birds, and among insects numerous forms of Aphaniptera, Rhynchota, Diptera and Mallophaga are prominent.

Of the Trematodes and Acanthocephalidæ many need two intermediate hosts, the last of which forms the principal food of the birds. For example, one common Trematode of the gut of *Hirundinidæ* (Swallows) and *Micropodidæ* (Swifts)—*Plagiorchis maculosus* Rudolphi—has in the larval or miracidium stage to enter a fresh-water snail (*Limnæa*) where it multiplies parthenogenetically. The cercaræ leave the host by hundreds and find their way into the larvæ of mosquitoes (*Chironomis*, etc.), survive the insects' metamorphosis and are swallowed along with the host by swallows and swifts. They develop and reach sexual maturity in the small intestine of these birds, the eggs being passed out with the fæces of the hosts and requiring to reach the water for their development.³

(H) 3.—No better instance of the harm done by birds in the dispersal of noxious weeds can be cited than the phenomenal spread in India of that pernicious exotic weed *Lantana camara*. This plant, of Mexican domicile, first imported into Ceylon for ornamental purposes just over a hundred years ago, has since overrun thousands of square miles of the peninsula and become the despair alike of agriculturist and forester. Its widespread dispersal within such a comparatively short period would have been impossible without the agency of birds, numerous species of which extensively devour its berries which the plant everywhere produces in overwhelming profusion. I have observed an Oriole (*Oriolus kundoo*) swallowing 77 berries in the course of 3 minutes! The seeds pass through the birds' intestines unaffected (negatively at least) by the gastric

secretions and out with the fæces, germinate rapidly under favourable conditions and establish themselves.

Another plant that does considerable damage to trees of many kinds both in forest and orchard, causing financial loss to the mango-grower which, were it possible of assessment, would run into lakhs of rupees annually, is the *Loranthus* tree-parasite. It belongs to a family, well represented in India, almost all of whose members are more or less wholly symbiotic with Sunbirds (*Nectarinidæ*) and Flowerpeckers (*Dicaeidae*) and other species which both fertilise its flowers and disperse its seeds.⁴

Having dealt briefly with some of the actual as well as hypothetical or alleged harm from which man suffers or may suffer at the hands of birds, it is fitting to discuss some of their activities which are decidedly beneficial to his interests.

(B) 1.—It has been observed by the French writer Michelet that the Birds could exist without Man, but that Man would perish without the Birds, and Buckland⁵ observes that "But for the trees the insects would perish, but for the insects the birds would perish, and but for the birds the trees would perish; and so follow the inexorable laws of nature to the conclusion of their awful vengeance, but for the trees the world would perish." An impartial analysis of the evidence, both direct and circumstantial, shows that there is, indeed, little extravagance in either of these statements. The number, fecundity and voracity of insects are unbelievable. Over 300,000 forms have been described and it is considered not improbable that twice that number still remain to be described. In the Indian Empire alone more than 30,000 forms are known. Practically all living animals as well as most plants furnish food for these incomputable hordes. Many estimates have been made of what a single pair of insects would increase to if allowed unchecked multiplication, and astounding figures have been reached, rivalling in their stupendousness those which we associate with astronomical calculations. A Canadian entomologist estimated that a single pair of

³ Stresemann, E., *Handbuch der Zoologie-Aves.*, Berlin, 1933, p. 712.

⁴ Salim Ali, "The Role of Sunbirds and Flowerpeckers in the Propagation and Distribution of the Tree-parasite *Loranthus longiflorus* Desr. in the Konkan," *Jour. Bom. Nat. Hist. Soc.*, 35, 145-49.

⁵ Buckland, James, "The Value of Birds to Man," *Ann. Rep. Smithsonian Inst.*, Washington, 1913, 429-53.

Colorado Beetles or Potato Bugs *Leptotarsa decemlineata* (belonging to the prolific family *Chrysomelidae* of which over 20,000 species have been described and which is well represented in India) would, without check, increase in one season to sixty millions. Riley computed that the Hop Aphis or Chinch Bug *Blissus leucopterus* (Order *Hemiptera*, Fam. *Lygaeidae*), very destructive to grasses and cereals in America, which develops 13 generations in a single year, would, if unchecked, reach ten sextillion individuals at the end of the 12th generation. Forbush calculates that if this brood were marshalled in line end to end at the rate of 10 per inch, the procession would be so long that light travelling at the rate of 184,000 miles per second would take 2,500 years to reach from one end to the other!

A caterpillar is said to eat twice its own weight in leaves per day. According to Forbush certain flesh-feeding larvæ will consume within 24 hours, 200 times their original weight. Trouvelot who made a special study of the subject, affirms that the food taken by a single silkworm in 56 days equals in weight 86,000 times its original weight at hatching.

The fecundity and voracity of locusts are well known. Their swarms are at times so thick as to obscure the sun and where an extensive swarm alights, green and prosperous areas are frequently converted into a desolate tract with bare stems in the course of a few hours. The female locust lays its eggs in capsules underground, each capsule containing about 100 eggs and several of these capsules are laid by each individual. On a farm in South Africa measuring 3,300 acres no less than 14 tons of eggs have been dug up at one time, estimated to have produced 1.250 million locusts. Birds not only take heavy toll of the marauding hordes, but also scratch up and devour the eggs in vast quantities as well as the different stages of the insects' metamorphosis. The White Stork (*Ciconia ciconia*) is a great destroyer of locusts, and many birds such as the Rosy Pastor (*Pastor roseus*) live and feed their young exclusively on these insects in their common breeding grounds.⁶

A large proportion of the normal food of numerous birds consists of insects including many that are in the highest degree injurious

to Man and his concerns. Many young birds in the first few days of their lives consume more than their own weight of food in 24 hours. A pair of starlings have been observed to bring food to their nest-young (caterpillars, grasshoppers, locusts etc.) 370 times in a day, and according to Dr. W. E. Collinge, the well-known British authority, House Sparrows bring food (caterpillars, soft-bodied insects, etc.) from 220 to 260 times per day. A German ornithologist has estimated that a single pair of Tits with their progeny destroy annually at least 120 million insect eggs or 150 thousand caterpillars and larvæ. This warfare is waged not only when insects are at the peak of their periodical abundance but incessantly, relentlessly and in all stages of the insects' lives. Therefore, where birds have not been unwisely interfered with they constitute one of the most effective natural checks upon insect numbers.

Vultures, Kites and Crows are invaluable as scavengers. They speedily and effectively dispose of carcasses of cattle and other refuse lying in the precincts of Indian villages—notoriously lacking in any system of sanitation—that would otherwise putrify and befoul the air and become veritable culture-beds of disease. Their services are of particular importance during epidemics of cattle diseases when large numbers of animals perish and even when buried as compelled by Regulations, are no more than covered over with a flimsy layer of earth to be exhumed by the first prowling jackal that happens to come upon the spot. The swiftness with which a party of vultures will dispose of carrion is amazing. I once timed them on the carcasses of 2 sloth bears which, after being skinned, could not have weighed less than 250 lbs. between them. Within a space of 40 minutes nothing but picked bones remained, this being the work of 50 to 70 vultures.

Owls, Kestrels, Hawks and the birds of prey generally—so often stigmatised as destructive to poultry and game and slaughtered out of hand—are amongst the most important of nature's checks upon rats and mice, some of the most fecund and destructive pests from which Man and his works suffer. They do enormous damage to crops and agricultural produce, and are besides the carriers directly or indirectly of diseases often fatal to Man. Any one acquainted with the ravages of the Sind Mole Rat (*Gunomys sindicus*) in the rice-growing tracts of the

⁶ Serebrennikov, M. K., "Der Rosenstar (*Pastor roseus* L.), seine Lebensweise und ökonomische Bedeutung in Uzbekistan (Turkestan)," *Jour. für Orn.*, 1931, 79, 29-56.

Indus Delta in Lower Sind—varying from 10 to over 50 per cent. of the paddy crop⁷—will readily appreciate the truth of this.

It has been calculated that one pair of rats having six litters of 8 young annually and breeding when $3\frac{1}{2}$ months old, with equal sexes and no deaths, would increase at the end of the year to 880 rats. The unchecked increase of a pair in 5 years has been computed at 940,369,969,152 rats.⁸ The Sind Mole Rat also breeds throughout the year. The number of young born in a litter is 5 to 10, but in October and November the litters are very large varying from 14 to 18 young each. Mice are equally fecund. The sex season of the female is a very long one and the period of gestation as short as from 12 to 21 days. The usual litter is 5 to 6 young, and the female is ready to breed again soon after parturition.

Calculations such as the above, however, are purely theoretical and their results will never be approached in Nature, but it is pointed out that they are not extravagant *qua* the power to reproduce and are based upon moderate and conservative estimates. It will be seen that every pair of rats destroyed by birds means the annual suppression of a potential increase of 880 rats. Most of the birds named above feed largely on rats and mice, and some of the owls more or less exclusively on them. In the stomachs of Horned Owls (*Bubo bengalensis*) I have frequently found the remains of 2 or 3 rats or mice, and as digestion in birds is a continuous and rapid process, it is conceivable that a larger number may be destroyed in the course of 24 hours. Since these birds are engaged in the good work from year's end to year's end, some idea of their beneficial qualities may be obtained.

(B) 2.—While the importance of bees, butterflies and a host of other insects in the cross-fertilisation of flowers is well known, the significance of birds in the same capacity has not been adequately recognised. A large number of birds of divers families and species are responsible for the cross-fertilisation of flowers, many of them possessing special adaptations in the structure and mechanism of their tongue and bill for the purpose of extracting honey from the base of the

flower-tubes. Flower-nectar is rich in carbohydrates and provides excellent nutriment, so much so that many of the most highly organised flower-birds subsist more or less exclusively on this diet. In trying to reach the nectar, the forehead or throat of the bird comes into contact with the anthers. The ripe pollen adheres to the feathers and is transported to the mature stigma of the next flower which it thus fertilises. It is little realised how largely responsible birds are for the success of the present-day match industry in India. Of all the indigenous woods that have been tried for the manufacture of matches, that of the Silk Cotton tree (*Bombax malabaricum*) has been found to be the most satisfactory both as regards quality and abundance. The large crimson flowers of this species contain a plentiful supply of nectar and are mainly cross-pollinated by birds who thus contribute to the production of fertile seed and thereby to the continuance of healthy generations of the tree.⁹ Practically no research on these lines has been carried out in India and it will probably be found that we are ultimately dependent upon birds in this House-that-Jack-built sort of way for many of our everyday requirements.

(B) 3.—No one who has visited the larger *dhands* or *jheels* in Sind and other places in Northern India during the cold weather can have failed to remark upon the magnitude of the netting operations that go on throughout this season for supplying the markets of the larger towns, both near and distant, with wildfowl of every description for the table. The inhabitants of the neighbourhood subsist during these months more or less exclusively on the flesh of these birds or on the trade in them. Round every village near a *dhand* of any size in Sind may be seen little mounds of coot feathers which furnish some indication of the esteem the birds enjoy as an article of diet. The wildfowl netting on the Manchar Lake alone must involve a turnover of several thousand rupees annually, besides providing countless inhabitants of the neighbourhood with free or almost free sustenance for several months in the year. Wild ducks, geese, coots, etc., were debited further up in the course of this account with damage to paddy and other crops. The netting operations against them and the profits accruing therefrom, now

⁷ Wagle, P. V., "The Rice Rats of Lower Sind and their Control," *Jour. Bom. Nat. Hist. Soc.*, 1927, 32, 330.

⁸ Hinton, M. A. C., "Rats and Mice as Enemies of Mankind," British Museum (Natural History), Economic Series No. 8, London, 1920.

⁹ Sâlim Ali, "Flower-Birds and Bird-Flowers in India," *Jour. Bom. Nat. Hist. Soc.*, 1932, 35, 573.

provide an item to their credit which probably far outbalances the harm they do. Rosy Pastors are also greatly relished as an item of food and thousands upon thousands are netted or slaughtered every year in North-west India and elsewhere during the autumn and spring migrations, especially the latter as the birds are then very fat.

The working of the Wild Birds and Animals Protection Act and similar measures has put a check upon the exploitation of birds for the plumage trade. Feathers are largely used in the millinery business and although modern trend in women's fashions has for the time being made them less popular than they were some years ago, there is still a vast and lucrative demand from abroad, both the Eastern countries and Europe. With a scientific determination of the economic status of various species of our commoner birds and a regulated system of controlling the numbers of the more or less undoubtedly harmful ones, such as the parakeets apparently are, there is no reason why the plumage trade should not be legitimised and even encouraged to become a fruitful source of revenue, which could be earmarked for the furtherance of research in Economic Ornithology and for measures of conservation. Apart from revenue considerations, the legalisation of the plumage trade under an officially regulated and controlled system would give fillip to the farming of certain birds such as egrets for the sake of their valuable plumes. Egret-farming is a potentially profitable cottage industry extensively practised at one time by the lacustrine section of the population in Sind. It is now dwindling in importance owing to the complete ban on exports of feathers to foreign countries and the consequent narrowing down of the market to local demand chiefly in Calcutta.

A few years ago certain suggestions were put before the local government by the Bombay Natural History Society for the permitting of export under officially certified and sealed packages of egret feathers produced in these farms in order to revitalise the industry, but as far as is known the suggestions have not been given effect to.

There are other minor products of birds which, if properly husbanded, could be made to yield considerable revenue in India. The saliva nests of the Edible Swifts (*Collocalia*) which breed in vast colonies in caves on islands off the Burma

coast are even now the source of a considerable income to the Government. They are collected and exported to China as a table delicacy and the better qualities fetch from 10 to 20 dollars (= approximately Rs. 8-4-0 to Rs. 16-8-0) per catty ($1\frac{1}{4}$ to $1\frac{1}{2}$ lb.). The value of nests imported into China during 1923, 1924 and 1925 exceeded a million tael (Rs. 25,00,000). More than half this amount came from the port of Shanghai, mostly from Singapore, Java and Hongkong but also from India and French Indo-China.¹⁰

Guano, which is really the excrement of sea birds such as gannets, cormorants and pelicans, is another product of great commercial value. The fertilising properties of the phosphoric acid and nitrogen contained in fish was not recognised until guano became a stimulus to intensive agriculture. The real guano is found in vast stratified accumulations on islands off the Peruvian coast, and although no deposits of anything like the magnitude or value of those on Chincha Island exist within our limits, still the sources and possibilities of the "guano" of colonial nesting birds have not been sufficiently explored in India.

CONCLUSION.

Sufficient examples have been given to show that a scientific investigation of the life-histories of birds generally is worthwhile from the economic point of view. The potentialities of research in Economic Ornithology in an agricultural country like India are unbounded. In its bearings and ramifications the subject is in no wise less important than Economic Botany or Economic Entomology which, under official recognition, have already made such good progress in this country. It is suggested that research in Economic Ornithology should also be similarly encouraged. It should be taken up in earnest by the Imperial Council of Agricultural Research under whose ægis it should become an All-India—or under the impending reforms, a Federal—function as it is in the U.S.A. The migrations of birds, in addition to their ordinary free movements, carry them to all parts of the country, and therefore the only adequate survey of their economic relations can be the one that takes in their entire range regardless of provincial boundaries.

¹⁰ Sowerby, Arthur De C., "The Edible Birds' Nest Swift," *China Journal*, March 1931, 14, 135-137.