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This article is reprinted here, with a few minor changes, from The Fourth Annual Report of the Severn Wildfowl Trust, 1950-1951*, with the permission of the author and of the Director of the Trust. In these times when "taxonomy" is often misconstrued by well-intentioned but poorly informed persons, these words of a scientist who has attained singular eminence in the apparently quite different field of animal behavior support and explain progressive systematics very effectively.*—EDS.

All biological science has begun its career with collecting, and it is worthy of psychological consideration that nearly all really successful biologists have, in their own lives, gone through a period in which they repeated, individually, the history of their science.

There are very few of them, indeed, who have not been given to collecting, as a hobby, at an early stage of their scientific development. It is not only legitimate, but absolutely necessary, that the study of animals or plants should begin with simply and modestly collecting knowledge of 'all there is' before proceeding to the more ambitious task of causal analysis. If some modern physiologists show a certain tendency to look down on museum collection, systematics, and comparative anatomy, they forget that these particular branches of biological science have given to all others their common fundamental — the theory of evolution.

For certain reasons, which need not concern us here, the study of animal behavior did not, until a very recent date, introduce the evolutionary viewpoint into its consideration — very much to its own detriment. The fact that all the innate traits of animal behavior can — and therefore must — be studied from the common viewpoint of phyletic descent, remained necessarily hidden from scientists who never studied the behavior of a whole group of species, but confined themselves to just one kind of animal, chosen exclusively for the single reason that it was the easiest to obtain, to keep, and to breed. The basic discovery which has since given rise to a new branch of behavior study — Comparative Ethology — is, in itself, very simple: certain innate behavior patterns are not only common to all the individuals of a species, but very often to much more comprehensive groups of animals as well. In other words, these innate behavior patterns have, among the several species, genera, families, and still larger groups of animals, exactly the same type of distribution and, with decreasing relationship, the same grading of similarity into dissimilarity, as we find in the comparison of bodily characters.

From this the important inference is, obviously, that these behavior patterns are just as old as any structural properties whose systematic distribution is about the same. To people who regard animal behavior as something extremely variable and unrestrictedly modifiable these facts seem very surprising and even unbelievable. Yet, so far from being 'slippery stuff' to use in systematic comparison, innate behavior patterns are, in most cases, extremely conservative characters; indeed, much more so than the specific form of bones and other hard structures. What is hardest and least perishable in the museum, need not necessarily be so in evolution.

Let us look at just one example: since the very beginnings of ornithological systematics, the structure and proportions of the skull and bill have been considered as characters of paramount importance and reliability. A group of Anatidae, the so-called 'Geese,' were lumped together on the strength of just one character: in all of them the lamellae of the bill have been converted into sharp, horny teeth in adaptation to grass-eating, while their skull has assumed, for the same reason, a typical high profile, calculated to heighten the chewing pressure of the mandibles. With the true geese, like the Greylag, Bean, White-front, Pinkfoot, Snow, Bar-headed, Canada, Brent, Barnacle, etc., were included the Andean, Upland, Kelp, etc. (genus *Chloëphaga*), the Abyssinian Blue-winged Goose (*Cyanochen*), the Australian Cape Barren Goose (*Cereopsis*), the Spur-winged Goose (*Plectropterus*), the Maned Goose (*Chenonetta*), and even the tiny Pygmy Geese of the genus *Nettapus*. All were considered as one subfamily. Subsequent close investigations, in which the consideration of innate behavior patterns played an important part, revealed the indubitable fact that these birds, so far from being closely related to each other, really belong to at least three different groups, the true Geese, the Sheldrakes, and the Perching Ducks. The genus *Chloëphaga*, the Abyssinian Blue-winged, and the Cape Barren Goose, have, all of them, evolved from the Sheldrake group, but, in all probability, independently from each other and in very different parts of the world. The Spur-winged

Goose belongs to one group of the Perching Ducks and is allied to the Muscovy Duck, while the Maned Goose and the Pygmy Geese belong to another, and are closely related to the Mandarin and Carolina [=Wood] Ducks. All instinctive behavior patterns of these birds, particularly those of courtship display, are quite typical of the respective groups to which they belong. None of these innate movements is common to all so-called 'Geese.' The fact that the latter do not, by any means, represent a phyletically coherent subfamily is further emphasized by a great number of other morphological characters.

It is, on principle, impossible to attribute a fixed and constant systematic value to any single character, because one and the same structure may, in different groups, undergo evolutionary change at quite different speeds. What is an exceeding conservative, slow-changing property in one family or order, may be very plastic in another. In the Anatidae, for example, the color markings of the downy young are evidently most resistant to evolutionary change, while the form of head and bill is extremely plastic; in the family of Rails (Rallidae) the very opposite is true. The 'relative conservativity' of every single property must, therefore, be gauged in every single instance by a thorough comparison with as many other characters as possible. If, in a group of animals represented by a considerable number of forms, we amass as many comparable characters as possible, our conclusions become more reliable in geometrical proportion to the number of characters considered. The historical correctness of our conclusions increases not only with the number of agreeing 'documents' which point in one direction, but the significance of each document is increased with the number of others with which we are able to compare it, in order to ascertain its particular age and value.

This is precisely why the phylogeneticist is forever on the lookout for new, comparable characters; and also why he prefers to work on groups which are rich in species. A group consisting exclusively of one or two isolated species with nothing but 'missing links' to join it together, and on to other groups, is obviously not a favorable object for evolutionary studies. On the other hand, in a group with many species, every taxonomic character can be studied in many different forms and stages of differentiation. Charles Otis Whitman and Oskar Heinroth, the pioneers of Comparative Ethology, both chose for investigation a group which fulfilled these requirements: the former worked on the pigeons, the latter on the ducks and geese. It is an interesting historical fact that both these scientists were primarily phyleticists rather than behavior students and that it was their assiduous search for comparable characters that induced them to bring innate behavior patterns into consideration. Thus, Comparative Ethology originated in the service of the study of evolution.

Thus we may infer that the studies of evolution in general and of comparative ethology in particular are dependent on a suitable object of study which possesses certain essential qualities. The discovery of a law of nature has always been dependent upon the selection or discovery of a favorable object of study. If we review these essential qualities we find ourselves simultaneously expounding the scientific value of collecting and keeping live animals belonging to one systematic group. For the purpose of the studies in question it is necessary to keep live animals in perfect condition, in order to investigate their innate behavior patterns. It would be absolutely impossible to acquire an extensive comparative knowledge of these patterns by field observation alone, even if one genus were not, as it so often is, distributed all over the globe. The group chosen for an object of a study ought, therefore, to be technically easy to keep and to breed; only if the animals display the whole inventory of their instinctive activities are we furnished with a solid basis for our comparison of behavior. The group must also be rich in innate behavior patterns and,

last but not least, it must contain an abundance of sub-orders, families, genera, and species, and there must be enough gradations and transitions which link up the under-groups.

There can be hardly any doubt that, among all the groups of animals which are available in captivity at present, the family Anatidae is the one which fulfills all these requirements in the most ideal manner. Though C. O. Whitman worked on pigeons and though valuable work has been done on Cichlid fishes, the Anatidae still rank first as an object of evolutionary and ethological study. A number of prominent phylogeneticists such as Heinroth, Mayr, Delacour, von Boetticher, and others have given special attention to this family. The writer of these lines, as a comparative ethologist, has found the unique collection of Anatidae at the New Grounds a wonderful subject for his investigations. The word 'unique' is not used here in the complimentary but in the literal sense. There is not, in all the world, another collection of Anatidae as complete, and what is more, there is no other collection of any group of live animals which could, for the type of evolutionary investigations sketched in this article, be exploited to such advantage as that of the Severn Wildfowl Trust.

Systematics and taxonomy are regarded by many people as tedious subjects. Some biologists even think that phylogenetic investigations performed by the method of systematic comparison are something rather antiquated, something that was all right in the days of Darwin and Wallace, but rather out of date at the present time. So far from having shot its bolt, however, phylogenetics is only beginning to get, from other branches of biological science, the consideration which it merits. The current modern physiology of the central nervous system, to cite only one instance, would do well to give more thought to phylogenetic considerations. The 'simple' reflex-arc, still regarded by many physiologists as the basic element of all central nervous structures and functions, is, in reality, a phyletically extremely 'young' acquisition which does not occur at a lower stage of evolution than birds and mammals. But apart from their everlasting scientific value, phylogenetic studies done by the good old method of comparison of homologous characters are a superlatively alluring occupation. The attempt to disentangle the course which evolution has taken ages ago, by the simple means of comparing the similarities and dissimilarities of living animals, and thus delving into times a thousandfold more remote than the earliest dawn of human history, is among the most fascinating enterprises that the human mind can undertake. To me, at least, it always causes a truly reverential thrill, whenever comparative study leads to some real insight into the blood relationship of different species and allows us, to a certain extent, to reconstruct their latest common ancestor!