PRACTICAL ECOLOGY

INTRODUCTION

The central problem in animal ecology is natural control of populations in nature. It is generally believed that natural control is usually dependent upon density-dependent population pressures, either within the same species or between different ones. Therefore, to understand population processes properly we require to know something about the species network in nature. Although there are certain species whose numbers are pre- dominantly regulated by intraspecific relationships alone (though often with strong fluctuations), it is usually necessary to take into account also other kinds of density- dependent pressures resulting from interspecific competition, herbivore-plant, enemy- prey or host-parasite relationships.

The ecological survey at Oxford for which this paper provides a theoretical and practical background, is partly a fact-finding survey on a particular area (Wytham Woods), but equally a research on how to improve the methods of recording and relating ecological events, so as to provide a general basis of knowledge about natural grouping (communities) within the species network. Ecological survey deals with three aspects of the situations found in nature. First, the presence and absence, habits, life histories and tolerance limits of species, from which a more or less qualitative picture of the species network can be established. This can be extended by counting numbers and analyzing population structure, to reach a more exact description. This we call the natural history and statistical stage of survey. Secondly, studies of population processes and balance in particular species can be undertaken. Here we have emphasized the intrinsic properties of the species network as a system of inter- connected populations which give the community a dynamic as well as a statistical meaning. Thirdly, the productivity of the community or the whole ecosystem, or parts of them, can be measured in terms of energy paths and energy flow, adding a physiological and physico-chemical interpretation of the demographic picture, which has so far been little done

As a setting for ecological survey the following practical requirements are needed: <u>taxonomic soundness</u> in the sense that ecologists shall speak a common language when referring to species;

continuity of the survey in one place over a fairly long time; a generally agreed system of classifying and noting habitats; and a system of processing records and specimens, and assembling them into community lists.

In making any such synthesis, even for a limited area, it is necessary to be clear about the limitations inherent in ecological surveys, arising from the degree of indeterminacy that exists in the prediction of population relationships and trends.

Interspecific competition is taken as one example to illustrate that the distribution of species within interspersed community groups is not to be explained only by the set features of the physical environment or vegetation, interacting with set characteristics of the species.

The interaction of animal populations amongst themselves introduces other features, of which fluctuations and temporary replacement of one species by another are especially important.

We need to know not only how many different ecological niches may occur in a community, but within each of them how many species may be in dynamic balance and how this balance may change. One result of the widespread occurrence of fluctuations in populations (probably in a great degree caused by biotic relationships) is that the composition of communities fluctuates also.

The community list for a particular habitat will therefore be a list from which only a particular selection of species will be present in any one year. The proportions will vary, so that the nature of a community can only be understood by following its history as well as by knowing the biological potentialities of each species. The ecological survey in the Wytham Woods area near Oxford is being partly supported by the Nature Conservancy as a pilot project for studying the methods applicable to any nature reserve. This area is fairly representative of calcareous soil ecosystems in the midlands region of England, which means that the conclusions from it should be applicable in general to much of the British fauna. The methods of collecting, indexing and analysing records, to make a series of community lists, will be described elsewhere. One essential feature underlying them is, however, outlined in the present paper: the use of habitat structure as a basis for a simple general classification of habitats. We have chosen habitat subdivisions whose scale is likely to correspond with real centres of dynamic action among populations, while at the same time using descriptive characters capable of being used in the field in a standard way. A rather broad scale of divisions was adopted, for various reasons. These divisions are described in a series of six habitat systems, some of which are further divided into formation-types, and vertical layers, with a few further special distinctions. The classification has been especially designed to be applicable to punch-cards.

We emphasize, however, that any purely mechanical or statistical method of building up community lists of animals must be subordinate to study of the ecology, physiology and behaviour of individual species, of population processes, and of whole sections of the species network treated as dynamic entities.

1. DEVELOPMENT OF IDEAS

Nearly all animal ecologists have some views about the usefulness or otherwise of ecological surveys designed to describe the way in which species are grouped together in different places. The present paper seeks to clarify the position of community surveys in animal ecology, by contrasting as plainly as possible their theoretical aims with the practical limitations that hinder their achievement. At the same time a simplified system of assembling and classifying information about habitats at both a species and a com- munity level is described, that seeks to recognize the limitations of the material without destroying the value of the integrated results. The ideas and methods presented here are partly the result of a good many years of thought and observation by the senior author, and partly of three years spent at Oxford by the junior author, with a background of experience from the western United States. Our conclusions were finally formulated between August 1951 and March 1952, as the outcome of long discussions, based in particular upon field experience of

Wytham Woods. This is an estate close to Oxford, with about a thousand acres of woodland and grassland. It is set on hills ringed below by farm lands that are in turn bounded on two sides by the great bend of the River Thames that gave Wytham its Saxon name. Here the University, which owns most of the land, has encouraged field research and allotted some parts of the hills as scientific nature reserves. The whole area is a representative south midland ecological complex on calcareous soils, with at least several thousand species of animals living on it. During the final period of this study the Nature Conservancy made a grant which enabled Miller to devote his whole time to the work, and also

There are several points about methods which (1) are of general importance in ecological work, e.g.

(2) - the recording of facts with an eye to the use to which they will be put in the future, and

(3) the correct identification of species, which latter depends both

(4, 5) upon a pleasant and comprehending attitude of systematists towards ecological work and

(6) upon the collection of good systematic material by ecologists, who alone can provide the right data with the specimens.

(7) The usual mistake among beginners is to under-estimate the number of animals of each kind.

(8) Information from other people can be of great value if backed up by specimens of the animals concerned.

(9) The carrying out of a biological survey involves various things: first, the listing of the main habitats, then

(10) the collecting of the animals, together with careful habitat- and other notes, and finally

(11) the construction of food-cycle diagrams, which

(12) necessitates exhaustive study of the food habits of animals, a study which can be made in at least ten ways.

(13) The community-relations of animals can be worked out in two ways, either separately or combined together.

(14) ‘The numbers of animals require special methods for their recording: one may use censuses in a given area or

(15) in a given time, while

(16) for recording variations in numbers it is advisable not to refer to ‘‘ the usual ” as a standard, but

(17) to the numbers in the previous year or month, etc.

(18) Finally, in publishing the results of ecological surveys it is desirable to include an index of species or genera, and

(19) to employ certain special methods for recording the facts about food, etc.

1. ALTHOUGH the whole of this note is really concerned with methods of tackling ecological problems, rather than with an inexorable tabulation of all the important facts which are known about ecology, it is advantageous to' draw together all the various lines of thought into one chapter, and to mention a few general ideas which may be of use as a background to ecological work. One of the most striking things about natural history facts is the haphazard way in which they are usually recorded. We are not referring so much to the fact that our knowledge of so many life-histories of animals has to be built up by piecing together fragmentary observations of different people, since it is impossible for any one person to be lucky enough to work out a complete picture of the life and habits of any one animal in all its aspects and phases. The thing which strikes one is rather the way in which the observations are recorded, there being in many cases no principle followed.

After all, it is impossible to describe an occurrence in the most useful way, without having some idea of how the information is going to be used. Adams !* has emphasised the importance of this in a very helpful chapter on ecological methods, and quotes Van Hise, who said: “I have heard a man say: ‘I observe the facts as I find them, unprejudiced by any theory.’ I regard this statement as not only condemning the work of the man, but the position as an impossible one. No man has ever stated more than a small part of the facts with reference to any area. The geologist must select the facts which he regards of sufficient note to record and describe. But such selection implies theories of their importance and significance. In a given case the problem is therefore reduced _ to selecting the facts for record, with a broad and deep comprehension of the principles involved, and a definite understanding of the rules of the game, an appreciation of what is probable and what is not probable.”

2. The first point of importance is therefore to have a very clear idea of the use to which your observations will probably be put afterwards, whether by yourself or others. At the same time, of course, facts are constantly assuming an unforeseen importance in the light of later discoveries; we are merely pointing out that it pays to try to look ahead and make records in such a way that they will be as intelligible and valuable as possible. These remarks may sound commonplace and superfluous, but an example will show the great importance of the point raised. When an ornithologist records the food of a particular species of bird, he very seldom troubles to find out the exact species of food-animals concerned. For instance, many food records merely refer to ‘‘ mayflies ” or “‘ worms ” or “‘ Helix.’ Conversely, when an entomologist records the enemies of some caterpillar he will often enough refer to them as “‘ small warblers,” or if a worm-lover were to speak about the enemies of worms upon mud-flats

he would probably talk about ‘‘ wading birds.’”’ Although it is possible to find out a great deal about the food-cycles in animal communities by working in terms of wider groups of animals than species, yet it is essential for a complete understanding of the problem to know the species of eater and eaten—a thing which we very seldom do know. If the ornithologist or entomologist took the small extra trouble of getting the foods accurately identified down to species, their observations would be increased about a hundredfold in value.

3. Although the number of observations about the food and enemies of various animals is prodigious, yet the majority of these data are just too vague to be of much value in making a co-ordinated scheme of the interrelations of animals. In other words, when one animal is seen eating another, it is very desirable to record the exact names of both parties to the transaction. The record of “ green woodpecker eating flies ”’ is of some use, as is the record of ‘‘ Woodpecker eating Borborus equinus,” but the ideal observation is “ green woodpecker eating Borborus equinus.” 'This point leads on to another important one, namely, the necessity for cultivating a proper “‘ species sense.” ‘The extent to which progress in ecology depends upon accurate identification, and upon the existence of a sound systematic groundwork for all groups of animals, cannot be too much impressed upon the beginner in ecology. This is the essential basis of the whole thing ; without it the ecologist is helpless, and the whole of his work may be rendered useless, or at any rate of far less use than it might otherwise have been, by errors such as including several species as one, or using the wrong names for animals. The result of such errors is endless misinterpretation of work, especially by people in other countries. It is possibly

to this danger that we must attribute a certain lack of sympathy for ecological work, politely veiled or otherwise, which is sometimes met with among systematists. They realise that ecological observations are dependent upon correct nomenclature, and are therefore to some extent ephemeral, in cases where the latter is not yet finally settled. Added to this is the feeling that ecologists are rather parasitic in their habits and are to some extent using other people (systematists) to do their work !

4. This feeling is natural enough, and arises from the fact that a systematist has two distinct functions : one is to describe, classify, and name all the species that exist (or have existed) ; the other is to identify specimens for other people, especially when elaborate technique and considerable skilled knowledge are required in the process. Now, it is only recently that the animal kingdom has begun to be completely explored. The systematist is still busy putting his own house in order, or, what is also often the case, putting in order the houses of other people who have died leaving them in a considerable mess. But in a great many groups of animals, we are really in sight of the time when there will be comparatively little purely descriptive work and classifying of species; although, to the study of the exact limits of species and varieties, and what they are, there will never be an end. The point is that the system of classification is rapidly becoming standardised, and we shall, in the near future, be able at least to reach agreement (often arbitrary enough) as to what is meant by any specific name. It follows from what has been said, that the task of the systematist will become more and more that of the

man who identifies specimens for other people, and less and less that of the describer of new species.

5. One of the biggest tasks confronting any one engaged upon ecological survey work is that of getting all the animals identified. Indeed, it is usually impossible to get all groups identified down to species, owing to lag in the systematic study of some of them (e.g. Planarian worms). ‘The material collected may either be worked out by the ecologist himself or he may get the specimens identified by experts. ‘The latter plan is the better of the two, since it is much more sensible to get animals identified properly by a man who knows them well, than to attain a fallacious sense of independence by working them out oneself—wrong. Also, in the majority of cases, there is simply not time for the ecologist to work out all the material himself, and it seems certain that nearly all primary survey work will in the future have to be carried on by co-operation on a large scale between ecologists in the field and experts in museums. At the same time it is useful to know how to name the more obvious species of animals, and to know also where to find out general information about any particular group or species. A list of the works dealing with a number of groups of British animals is given in the bibliography at the end of this book. ‘The list is necessarily incomplete, since in some cases (e.g. fresh-water planarian worms) no comprehensive work has been published ; while in many others, although the systematic work has been thoroughly done, the results are scattered in a number of periodicals, or are in relatively inaccessible foreign works, or else remain locked up inside the heads of experts who have not yet had time or opportunity to write the necessary monographs on their

groups. Furthermore, in the list of works quoted, no complete treatment is attempted of protozoa, parasites, or marine animals.

6. The vital importance of good systematic work and the desirability of making it as far as possible available in a simplified form to working ecologists has been pointed out. We may now turn for a moment to the other side of this matter. It is very important that ecologists should, during the course of whatever work they are doing, pay attention to the collection of material which can be used for systematic studies. Ecologists often have unique opportunities for collecting large series of animals from one place at different times, and such series are often invaluable in helping to decide the limits of variation of different species. It is becoming more and more clearly realised that the habits and habitats of animals may form systematic characters quite as important as structural features, and that unless information of this type is accumulated in the form of good specimens with full data about habitats, etc., attached, there is no proof that one " species "' does not contain a number of species, differing in such ways, but not in obvious structures. A striking example of this kind of thing is Daphnia pulex, whose life-cycle in Europe includes the formation of fertilised winter eggs which enable the species to tide over the winter until the following spring. In SpitsBergen and habitat with the European form, except that it has the unusual power of forming winter eggs parthenogenetically, without the necessity of fertilisation by a male. There are in consequence no male Daphnia in Spitsbergen at all.' Another good example of the importance of field observations for distinguishing species is that

of the British warblers, which are in some cases much more easily distinguished by their songs and nesting habits than by their appearance.

Now, the systematist is not usually a trained field naturalist, or, if he is, he lacks the knowledge of plant and animal associations which is required in order to define accurately the habitat of the specimens he is collecting. ‘The ideal procedure would seem, therefore, to be that as full data as possible should be entered upon labels and handed over to the systematist with the specimens, and that a more detailed account of the environment, and in particular of the animal environment, should be published by the ecologist himself, who can employ, if necessary, some means of referring to the actual specimens collected.

7. We have dwelt at some length on the necessity of getting absolutely reliable identification wherever it is possible, because mistakes in this matter are one of the most fruitful causes of misunderstanding, while vagueness in description of an animal ‘may render the most brilliant observations upon its ecology more or less valueless. ‘The usual mistake made by beginners is in under-estimating the number of species in a genus and so becoming careless about checking all specimens obtained in order to get exact identification in all cases. Thus, suppose I record ‘“‘ Daphnia pulex eaten by sticklebacks”’; there are two quite different species of sticklebacks, the ten-spined (Gasterosteus pungitius) and the three-spined (G. aculeatus), and since I had not distinguished them, you might begin to wonder whether I was aware of the existence of different species of Daphniaalso. "This element of uncertainty makes the value of the observation very small. In practice it often requires only a very small extra amount of

trouble to collect a few specimens of the animal on which the observations have been made, or in the case of animals like birds and fishes, to look up in a book to see how many species there are and which it was. It frequently happens that the person who chances to notice some fact of vital interest to the ecologist working on some problem is not the ecologist himself, but some other kind of biologist, or perhaps some one who is not a scientist at all. If the observations made by such people could be backed up by specimens of the animals, it would be possible to collect a vast amount of very valuable data.

8. It is worth while bearing in mind that the ecologist can frequently get, in this way, facts which he would otherwise never come across at all by himself, and he should make every effort to enlist the help of other people to co-operate. In this connection it is worth while quoting from the rules which were made out by Dr. Levick for the use of non-biological members of the Northern Party of Scott's Antarctic Expedition.!?! They ran as follows: ‘‘ Members are invited to write in this book notes on anything of interest seen by them relating to birds, seals, whales, etc., appending their initials and bearing in mind the following observations : ‘“*(z) Never write down anything as a fact unless you are absolutely certain. If you are not quite sure, say ‘I think I saw’ instead of ‘I saw,’ or ‘I think it was’ instead of ‘ It was’; but make it clear whether you are a little doubtful or very doubtful. ‘

**(2) In observing animals disturb them as little as possible... . “

*(3) Notes on the most trivial incidents are often of great value, but only when written with scrupulous regard to accuracy."

These rules are useful for zoologists also. g. Having given these general suggestions about ecological work, we will now consider the best methods of carrying out a general primary ecological survey of animal communities. Many valuable hints are contained in Tansley's book," since to a large extent the methods of primary survey are essentially the same for plants and animals. 'The process of making such a survey is as follows :

First of all, have a general look round the area to be studied, and get an idea of the main habitats that exist, and in particular of the main plant associations. Don't bother about details yet, but simply try and get a grasp of the big habitats and habitat gradients. When you have made a list of the important habitats, come down more to details and subdivide these into smaller areas or zones, in the manner indicated in. Thus, at this point your notes would be in the following form: "The country can be divided roughly into the lowerlying parts which are cultivated, and the upper hilly parts which are not. The uncultivated area can be divided into three very distinct main zones : "

1. Grassland. "

2. Bracken, with scattered trees, forming a sort of bracken savannah. "

3, Woodland. '' and 2 are more or less abruptly separated, but 2 and 3 grade into one another at their margins owing to the complicated distribution of shrubs, such as bramble, and small trees, such as hawthorn."' Supposing we then took the woodland, the notes would go on something like this : "There are several fairly distinct types of woodland. "zy. Ash, with some sycamore. "2. Oak woods (which species ?), with hazel undergrowth. "3, Oak and sweet chestnut woods. "These again vary much in undergrowth owing to the effects of fires, and felling, and age. N.B. This summer 1s dry enough to have caused grass fires, but the woods have not caught seriously." If, then, we considered the oak-hazel wood, we might write : ""'The oak wood can be divided into vertical strata : "yz. 'Tree-tops— "" (a) Leaves. "*(b) 'Twigs and branches. "(c) Under bark and rotten wood of branches. "2. Trunks— '"

(a) Upper part with lichens (drier).

(b) Lower part with mosses and liverworts (damper than last owing to run-off from the trunk, and height often only a foot, but varying according to the aspect). "

3. Hazel undergrowth, with some other shrubs. ""

4. Herbaceous undergrowth. "

5. Litter of dead leaves, etc.; or

6. Moss carpet. "

7, Soil, underground."

10. This listing of habitats does not take very long to carry out, and is absolutely essential. Wherever possible the co-operation of a plant ecologist should be enlisted, in order

that the plant associations may be accurately determined. But often it is sufficient to make lists of plants yourself from each of the habitat divisions (perhaps with the aid of some field botanist who knows the species well). Druce's Botanist's Pocket-book®® is extremely useful for accurate identification of British plants. When this has been done, the next thing is to start collecting the animals from these different habitats, and in doing this there are several points to be borne in mind. First, it is vitally important to make as full notes as possible on the animals, and to record full details of the exact habitat, e.g. the species of plant on which they are found, whether they were on the upper or on the lower sides of the leaves, and any other observations made at the time, such as the reaction to light or rain, or food-habits, or numbers. The last is especially important. The data can either be written on a label with the specimen or, what is usually more convenient, a number can be placed in the tube or box containing the specimen and a corresponding number entered against the notes upon it in your notebook. A rather convenient method of making notes is to carry a few record cards such as are used for a card index, instead of the usual notebook. On the other hand, if a notebook is used, it is possible to take a carbon copy at the time, which may often be useful. Usually, however, it is impossible to make anything but very brief and rough notes in the field, and they have to be written up carefully at home afterwards. It is customary to warn students that they must make notes on the spot, and not afterwards. A trained ecologist can, however, quite safely carry a lot of the details in his head and put them on paper at the end of the day. This is a matter of practice, and is a habit worth cultivating, as it saves much time and also makes it possible to do better work in wet weather, when note-taking is awkward. The chief time when it is best to take notes on the spot is when one is trying to prove something definite, since at such times it 1s very easy to forget the facts that do not agree with one's theories. It usually happens that a certain number of animals are found in odd places which do not fit in with any of the habitats originally listed, and these will necessitate some revision of the habitat-divisions you started with. Again, a number of animals are always occurring accidentally in the wrong habitat, and although they should be recorded carefully, the amount of detail as to their habitat need not be great. Discretion has to be used in this matter. 11. When a general idea of the distribution of the fauna has been gained, it is advisable to attempt the construction of a rough food-cycle diagram showing the relationships of the species. 'Io do this accurately it is necessary to get the specimens identified, but a rough preliminary idea can be formed without knowing the exact species, although it is useless to publish such a diagram unless backed up by lists of the ~ actual species concerned. It will be found necessary to organise a sort of ring of consulting systematists who are willing to work out material from the various groups of animals. Itisa good plan, when sending large numbers of specimens (most of which will probably be quite common ones) to include, if possible, some which seem unusually interesting or rare, since in this way the expert who is working out the material for you will find it more interesting, and will be the more willing to help in the future. For details of methods of collecting and preserving animals the reader may be referred to the British Museum Handbook for Collectors,!2 which covers a number of animals, to Ward and

Whipple,®*? who give excellent directions for most fresh-water animals, and to the various books given in the bibliography of special groups of animals.

It is very important that specimens should be killed and preserved in the appropriate way, as otherwise they may be useless for purposes of identification, or, at any rate, cause a lot of unnecessary trouble. 12. For constructing food-cycles there is only one method— the patient collecting of all kinds of information about the food and enemies of the species that are being studied. Direct observation in the particular place in which you are working is the best, since the food habits of animals are often very variable at different times and in different places. It may be convenient to summarise the various ways in which evidence about animals' food may be obtained. (1) Watch the animal eating and, if necessary, take a specimen of its food (and of the animal itself). 'This is the type of evidence that is most difficult to obtain. (2) Examine the contents of the crop or stomach or intestine. 'This may give good positive evidence but is useless for proving a negative, e.g. remains of butterflies disappear very quickly under the influence of the digestive juices of birds. (3) Finding stores of food, etc. (4) From a study of the animals and plants associated with it, deduce the animal's probable food. 'This enables the field of observation to be narrowed down. For instance, the writer saw a ptarmigan rise from a hillside, and on going to the spot where it had been, found that a number of seeds and flowers had been eaten from various plants. Since this bird was the only large herbivorous animal in the region, it was certain that the bird had eaten them itself. (5) Experiments may be made to confirm such probabilities. (6) Examine excretory products, e.g. castings of owls containing remains of small mammals, or droppings of terns containing limbs of crustacea. (7) The structure of the animal will help to narrow down the field to a particular size of food. (8) Note any food preferences, with reference both to quality and quantity.

(9) The amounts eaten per day are of great interest, e.g. counts of the number of animals brought to its nest by a bird in a given time. (10) Finally, the numbers of two species will often give a clue to the fact that one is feeding on the other, e.g. birds attracted by an unusual abundance of caterpillars on oaks. 13. There are two ways of tackling the problem of foodcycles and community-organisation of animals. One way is to start with one particular species and radiate outwards along its various connections with other animals and follow the train of associations wherever it leads. ‘This was the method described in Chapter V. It is a very fascinating form of ecological work, owing to the variety of interesting facts and ideas which are encountered, and it also has the advantage that it can be carried out without any very elaborate previous survey or listing of all the species of animal in the district. On the other hand, one may list all the animals and then subdivide them according to their place in the community—herbivores and carnivores, key-industries, terminal species, large and small,andsoon. ‘The separate food-chains can then be worked out, and in this way one gets a better perspective of the whole community. Perhaps a combination of the two methods — would be the best procedure. 14. Another important subject about itieh something may be said here is that of numbers. The study of numbers is a very new subject, and perfect methods of recording the numbers and changes in the numbers of animals have yet to be evolved. In

practice, we have to deal with two main aspects of this matter. The first question is as to the best way of taking censuses of the animal population at any one time, and the second is the question of recording changes in-the numbers from one period to another. With regard to the first, a certain amount of work has been devoted to the methods of estimating the absolute numbers of various animals. Quantitative work on plankton has reached a very high degree of efficiency ; the usual method consists in doing counts of small samples from the whole collection and then multiplying by a factor to get the total(9) The amounts eaten per day are of great interest, e.g. counts of the number of animals brought to its nest by a bird in a given time. (10) Finally, the numbers of two species will often give a clue to the fact that one is feeding on the other, e.g. birds attracted by an unusual abundance of caterpillars on oaks. 13. There are two ways of tackling the problem of foodcycles and community-organisation of animals. One way is to start with one particular species and radiate outwards along its various connections with other animals and follow the train of associations wherever it leads. ‘This was the method described in Chapter V. It is a very fascinating form of ecological work, owing to the variety of interesting facts and ideas which are encountered, and it also has the advantage that it can be carried out without any very elaborate previous survey or listing of all the species of animal in the district. On the other hand, one may list all the animals and then subdivide them according to their place in the community—herbivores and carnivores, key-industries, terminal species, large and small,andsoon. ‘The separate food-chains can then be worked out, and in this way one gets a better perspective of the whole community. Perhaps a combination of the two methods —

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"These methods are fully dealt with by Whipple,%* and by Birge and Juday. One of the more important recent inventions, not described in these books, is the apparatus designed by Hardy,!°3 which enables marine plankton to be collected continuously on a band of silk as the ship moves along at sea. 'This apparatus has already shown good results on the Discovery whaling expedition, and will provide information of great ecological interest. For by means of it, a belt-transect of the plankton can be made along any desired line, and variations in the fauna which are clearly shown can be used for correlation with the physical and chemical gradients in the sea, or with changes in the distribution of larger animals such as whales . and fish. Similar methods can be employed for soil-animals, and in fact for any animals which are sufficiently small and numerous to be susceptible to mechanical sampling and counting. 'The problem becomes much more difficult in the case of the higher animals like birds and mammals, which are more mobile, are constantly shifting their place of abode, and are, relatively speaking, so scarce as to make it impracticable to kill large samples and count them. However, it is comparatively easy to make accurate censuses of nests during the breeding season, and a good deal of work along these lines has been done in the United States. The reader may be referred to a recent book by Nicholson,'*' who gives an account of the methods of bird census successfully employed by him in England. 15. Grinnell and Storer 4° have successfully employed a different method of recording the numbers of birds. 'They say: "' Instead of using a unit of area, we used a unit of time. Birds were listed, as to species and individuals, per hour of observation. In a general way this record involved area too. Our censuses were practically all made on foot, and the distance to the right or left at which the observer could see or hear birds did not differ, materially, in different regions. 'The rate of the observer's travel did, of course, vary some . . . also, in some places, the greater density of the vegetational cover acted to limit the range of sight. But for each of these adverse features of the method there were certain compensations." One of the advantages of this method is that it gives a good idea of the relative numbers of animals in any association, and this is one of the most important types of fact about which we require information. It seems probable that the method will give information of great value, so long as a sufficient number of censuses are obtained by different people, in order to eliminate the effects of factors like the weather, time of day, rate of travel, etc. 16. In addition to censuses giving the average numbers of animals in different habitats, we require methods of recording the changes in numbers from month to month or year to year. Of course, a series of censuses of the kind described will provide this information, but in many cases there is not the time, staff, or opportunity for carrying out censuses of sufficient accuracy, in which the methods will remain the same as time goes on, so that the results are comparable. The chief difficulty of recording changes in the numbers of any animal which undergoes violent fluctuations in numbers is in finding a standard to which the abundance in different years can be referred. Such statements as "wasps are more abundant than usual'' cannot be safely used, for two reasons. The first is that we do not know what " usual '' means ; the second is that its meaning varies from year to year, and in the minds of different people. 'The latter is due to the fact that most people do not remember with any accuracy for more than about five years ; and also that more significance is attached to recent years than to earlier ones. The result of all this is that the word " usual" when applied to numbers may mean practically anything, according to the particular emotions, powers of observation, and strength of memory of the observer. The records of butterfly abundance in England given in the Phenological Reports of the Royal Meteorological Society, prove conclusively and surprisingly that butterflies are ‘‘ scarcer than usual ”’ in about one year out of every five! It comes to this, that records referring to the " usual " are only of value when they refer to years of very great scarcity or very great abundance. In intermediate years they are almost, if not quite, valueless. 17. The best method of recording the relative changes in numbers of fluctuating animals appears to be as follows: the numbers in any one year are referred to the abundance of the previous year. Thus we might say “small tortoiseshell butterflies more abundant this year than last year.” If a continuous series of such records be made, we can then get a very clear idea of the relative abundance from year to year, and if there is any regular periodicity in the numbers, the maxima and minima will be quite easily distinguished. ‘The advantage of this method is that it avoids the errors which arise when a fictitious average (‘‘ usual’’) is used as a standard. Furthermore, most people can remember pretty clearly what the numbers were in the previous year, and so there is no danger of introducing a great error in this way. It is advisable to keep at least two separate records, one referring to the breeding season, and the other to the non-breeding season. Then the numbers in the breeding season of one year can be compared with those both of the breeding and non-breeding seasons of the previous years. The method is, of course, equally applicable to monthly or other variations in numbers ; its limitation is that it can only be used on fairly conspicuous animals. ‘This method of recording changes in the numbers of animals requires if possible to be backed up by actual census figures in some years at least. In this way it would be possible to give the curve of fluctuating numbers an absolute value. 18. In conclusion, it is desirable to say something about publication of the results of ecological work and the best methods of presenting the facts so as to be of the greatest use to other people. We have already dealt with some of the more important errors into which it is possible to fall—insufficient description of the habitat and inadequate or inaccurate identification of species. ‘There are one or two other points which are worth mentioning also. The first is that primary survey work and other ecological work dealing with large numbers of animals belonging to different taxonomic groups has ultimately as its main use the elucidation of particular problems about individual species, by providing a picture of the biological surroundings of the animals. ‘The result of this is that writers of ecological papers should aim at making their results as accessible as possible to the man who is working on one group or one species (e.g. some animal of economic importance). Now, it is usually impossible for such a man to pick out what he wants from amongst the great mass of facts contained in an ecological survey paper, with its huge lists of species. If, however, a short index to species or genera, or even families, is included at the end of the paper, it immediately increases its practical value to other biologists about a thousand-fold. Wherever possible, therefore, an index giving page references should be included, thus enabling the information about any one animal to be picked out with the greatest ease and saving of time. 1g. Another method of presenting the results of ecological surveys, which has advantages, is that used by Richards,!8 and consists in tabulating the lists of species in the following way The best way of describing and recording food-cycles is another important problem to be faced in the publication of ecological work. Simple diagrams like those on pp. 58, 66, can be employed; these are all right for showing general results, but when we wish to include a large number of species something more is required. Perhaps the most effective method would be to put in on the general diagram the group names, e.g. ‘‘ aphids,” together with a number referring to a list of the actual species in question—a list which would be too

HABITATS OF EGYPT

Egypt occupies a more or less central position in the great palearctic desert belt which extends from the Atlas Mountains in the west to the Gobi Desert in the east. It covers an area of one million square kilometer of some of the driest deserts of the world, only interrupted by the narrow Nile Valley and the few, tiny oases scattered throughout a great expanse of desert. The Nile River divides Egypt into two geomorphologically distinct deserts; the flat expanse known as the Western Desert to the west, and the dissected plateau forming the Eastern and Sinai Deserts to the east. Each of these two main regions encompasses a number of geographical and geomorphological sub-regions, featuring a great variety of habitats and microhabitats (Kassas 1993).

The arid climate of Egypt, as we know it today is relatively recent in geological . terms. Climatic changes leading to the present day arid conditions of North Africa, in general, appear to have begun during the Upper Pliocene some 2.5 millions years BP (Williams, 1982). The Sahara began to take shape soon thereafter. Since the beginning of the desiccation of the Sahara, however, considerable climatic fluctuations took place and brief episodes of pluvial climate occurred at more or less regular intervals of about 100,000 years (Williams, 1984). During the last pluvial period which extended from 12,000 to 6,000 years ago, the Sahara was a land of lakes and flowing rivers (Williams, 1984). Following that period aridity began to be re-established and the present conditions of the Sahara were reached between 2000 to 2500 years ago (Butzer, 1971, Williams, 1984)). These climatic fluctuations invariably resulted in the re-distribution of plant and animal life in the region. The nature and distribution patterns of the present day herpetofauna of Egypt reflect this climatic history.

During each of the pluvial periods, the extent of the Sahara diminished, and desert species, being unable to cope with wetter conditions, became locally extinct. Savanna species moved in from south occupying the new habitats and becoming more numerous and widespread. Some species from Eurasia also gained access to the African continent during these wet episodes. With the end of each of the brief wet periods, arid conditions were reestablished and the Sahara with its desert forms regained its lost ground, expanding a • great deal both north and south. Species which favored drier conditions extended their geographical ranges, and those of the arid zones of the Middle East were able to recolonize North Africa. During the present interpluvial period the advancing desert has left isolated habitat patches where local topographic or climatic peculiarities have allowed somewhat near-mesic conditions to continue and hence relict biota of the receding, wetter episode to survive. Isolated populations of species representative of the temperate Eurasian fauna or those of the Afrotropics are found in a number of such reIict habi tats scattered throughout the desert of Egypt.

A major corridor connecting arid North Africa to the Afrotropical region is the ile Valley. This corridor has allowed several Afrotropical species to be established in the riverain habitats in the hyperarid Egypt and to spread along the Mediterranean sea front. The Mediterranean coastal belt which enjoys higher rainfall than the rest of Egypt, forms a second corridor connecting the Levant to Africa. This corridor has continued to function for thousands of years allowing faunal exchange between Africa and the Palearctic region. However, this corridor is now interrupted by the intensified arid conditions of Mediterranean coastal belt of Sinai, the Suez Canal and the Nile Valley and Delta.

Today, the prevailing hyperarid conditions of most of the Egyptian desert have resulted in patchy distribution of vegetation and fauna. In most parts of the Egyptian desert, where rain is extremely rare and unpredictable, animal life occurs only in areas of perennial vegetation based on ground water, namely oases and depressions, or in the drainage channels. In some cases, these patches of life are separated from one another by vast tracts of totally barren desert. Upon the very rare event when rain occurs and . continuous ephemeral vegetation briefly covers the normally barren desert, can faunal exchange between these isolated islands of life take place.

The following is a brief description of habitats of amphibians and reptiles in Egypt. Extensive review of the habitat diversity of Egypt has been published in the first volume of this series (Kassas *et al., 1993).*

The Western Desert

The Western or Libyan Desert extends from the narrow Nile Valley to the Libyan borders, and from the Mediterranean sea to the Sudanese frontiers, occupying more than two thirds of the total land area of Egypt. This vast area is mostly a flat, and featureless rocky plateau only interrupted with the mountain mass of Gabal El Uweinat (1907 m) and the plateau of EI Gilf EI Kebeir (1000 m) at the extreme southwest, and a . number closed-in depressions. The northern part of the Western Desert which extends 30 to 50 km inland from the Mediterranean coast (Plate 1) is known as the Western Mediterranean Coastal Desert. Coastal dunes of white oolitic sand and limestone ridges running parallel to the coastline are the dominant geomorphologic feature of this area. Inland of this lies a relatively flat strip of sand and clay soil interspersed with exposed rocky surfaces *(hamada).* A few short wadis drain the run-off of the adjacent desert into the sea. This coastal belt receives an average annual precipitation ranging from 100 to 150 mm and supports the most diverse flora of any other region in Egypt. Vegetation forms a sparse, yet more or less continuous cover. The Western Mediterranean Coastal Desert possesses the richest herpetofauna of all surveyed regions of similar area in Egypt (Saleh, 1993).

Going south of the littoral belt, rainfall becomes progressively low and in some places virtually non-existing. Vegetation becomes rare and generally restricted to depressions where ground water is sufficiently close to the surface, or the few wadis of the extreme southwestern highlands (Saleh, 1993). Several oases, all dependent on groundwater sources, and to a much lesser extent on local precipitation or occasional run-off from adjacent areas are scattered throughout the Western Desert. Most of these oases are found in depressions of varying sizes. Larger oases have been settled by man for thousands of years, and are usually made of clusters of settlements formed around water sources. Inhabited oases clusters are the Bahariya, Farafra, Dakhla, Kharge Baris, and Siwa. The highly isolated, tiny oasis of Qaret Urn AI Saghir at the Northwestern edge of the Qattara depression (Plate 2). with its small human population of some 150 persons is a unique example of an isolated oasis of a single settlement. The oases, with their cultivated fields and palm groves represent a special kind of a largely man-made ecosystem. Numerous uninhabited oasis, commonly referred to as *Hattiya* are also common in the Western Desert. A *Hattiya*, generally has ample grazing for camels and is traditionally used as a stop-over or resting area for desert travelers. Some of these uninhabited oases may have springs or wells of brackish water. A few of these wild oases have been little disturbed by human activities and remain more or less pristine.

Many of these, however, are currently targeted for agricultural land reclamation projects which will certainly result in the total destruction of their fragile and unique ecosystems. Important uninhabited or occasionally utilized oases with surface water sources include Hatiyat Urn EI Ghozlan, EI Megharba, Gigah, Sitra, Nuewmisa, EI Bahrain, EI Arag, Tabaghbagh, Abd EI Nabi, Ras El Qattara, EI Maghra, Wadi EI Raiyan, Wadi Muwellih, Karawein, Kurkur, Dunqul and several others (Plates 3 and 4). Numerous uninhabited oases with superficial groundwater but no surface water are scattered throughout the Western Desert.

Deeper depressions where most of the oases of the Western Desert are found, are characterized by their salt lakes, *sabakhas* and salt marshes. Saline lakes are formed from subterranean water seeping to the surface or from outflow of artesian wells. Continuous evaporation of water from these shallow lakes results in the concentration of dissolved salts leading to hypersaline conditions. These lakes generally undergo a great deal of seasonal size fluctuations due to changes in the evaporation rate. Largest saline lakes occur in EI Malfa, EI Megharba, Gigah, Siwa, Timera, Sitra, EI Bahrain, Farafra, Dakhla, EI Maghra and several areas within the Qattara Depression (Plates 5). Fresh, or slightly brackish water springs are found beneath some of these hypersaline lakes. Water from these springs float on the surface of the more dense

THE HERPETOFAUNA OF EGYPT

Composition:

The herpetofauna of Egypt as described in this book consists of 98 reptiles and seven amphibians. Reptiles consist of 51 lizards, 37 snakes, eight turtles, and the Nile Crocodile. Amphibians include four toads, two frogs and one tree frog. Snakes of family Colubridae which is represented by 21 species is the most diverse reptilian family in Egypt. Families Gekkonidae, Lacertidae, and Agamidae are also important. contributing, 15, 13 and ll species respectively. Table 1 shows the families of amphibians and reptiles represented in Egypt, and the number of genera, species and subspecies each contributes to the Egyptian herpetofauna.

The herpetofauuna of Egypt is not evenly distributed among different geographical regions and habitat types (Saleh, 1993). Among the four main geographical regions of Egypt, Sinai, with its 51 recorded species of amphibians and reptiles, has the highest number of species (Table 2; Figure 1). The Western Desert (44 species), the Eastern Desert (41 species) and the Nile Valley and Delta (37) follow.

Within each of these main geographical regions, habitat types differ considerably in the number of species they support (Figures 2, 3 & 4). The cultivated lands, cities and villages of the Nile Valley and Delta collectively support the largest number of reptiles and amphibians of all habitats of Egypt. In the Western Desert, the Mediterranean Coastal Desert and the oases support the largest number of species. In the Eastern Desert, the largest number of species is recorded from the inland desert. For Sinai, the southern mountains produced the largest number of species. Subcaudal scales and whether divided or entire is also important. In lizards the presence of femoral pores, the structure and relative sizes of toes and fingers, and the relative length of limbs are additional diagnostic features. Although color pattern is often useful for identification, color itself is seldom used, as many species show considerable color variations among individuals. Typical head shields of a lizard *(Acanthodactylus boskianusi* and a snake *(Splareosophis diadema)* and their nomenclature are shown in drawings

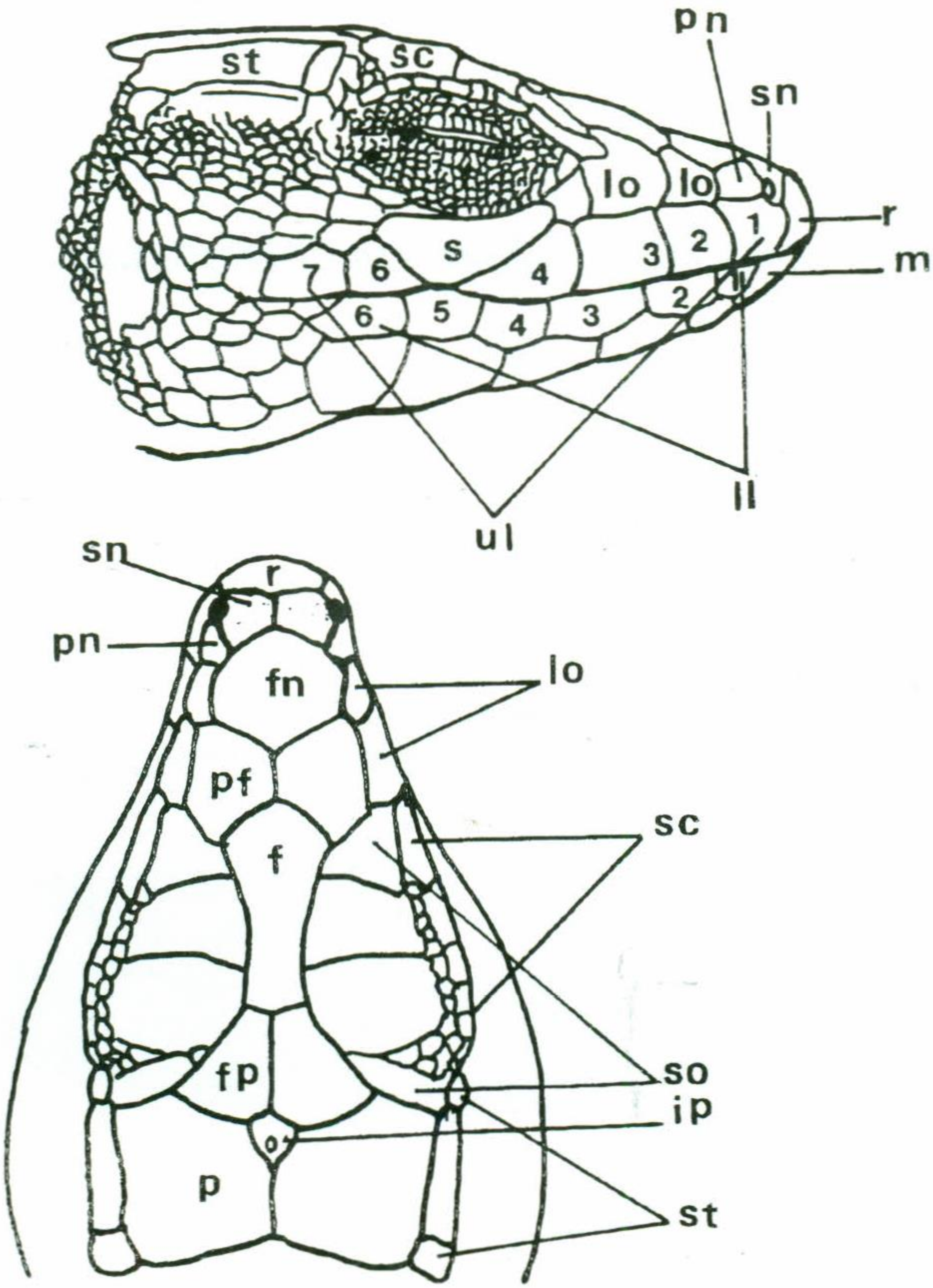

Figure: Pholidosis of the lizard *Acanthodactylus boskianus.* r = rostral; sn = supranasal; pn = postanasal; fn = frontonasal; pf = prefrontal; f = frontal; ip = interparietal; p = parietal; so = supraocular; s = subocular; sc = supraciliaries; st = supratemporals; 10 = loreal; ul = upper labials; 11= lower labials.

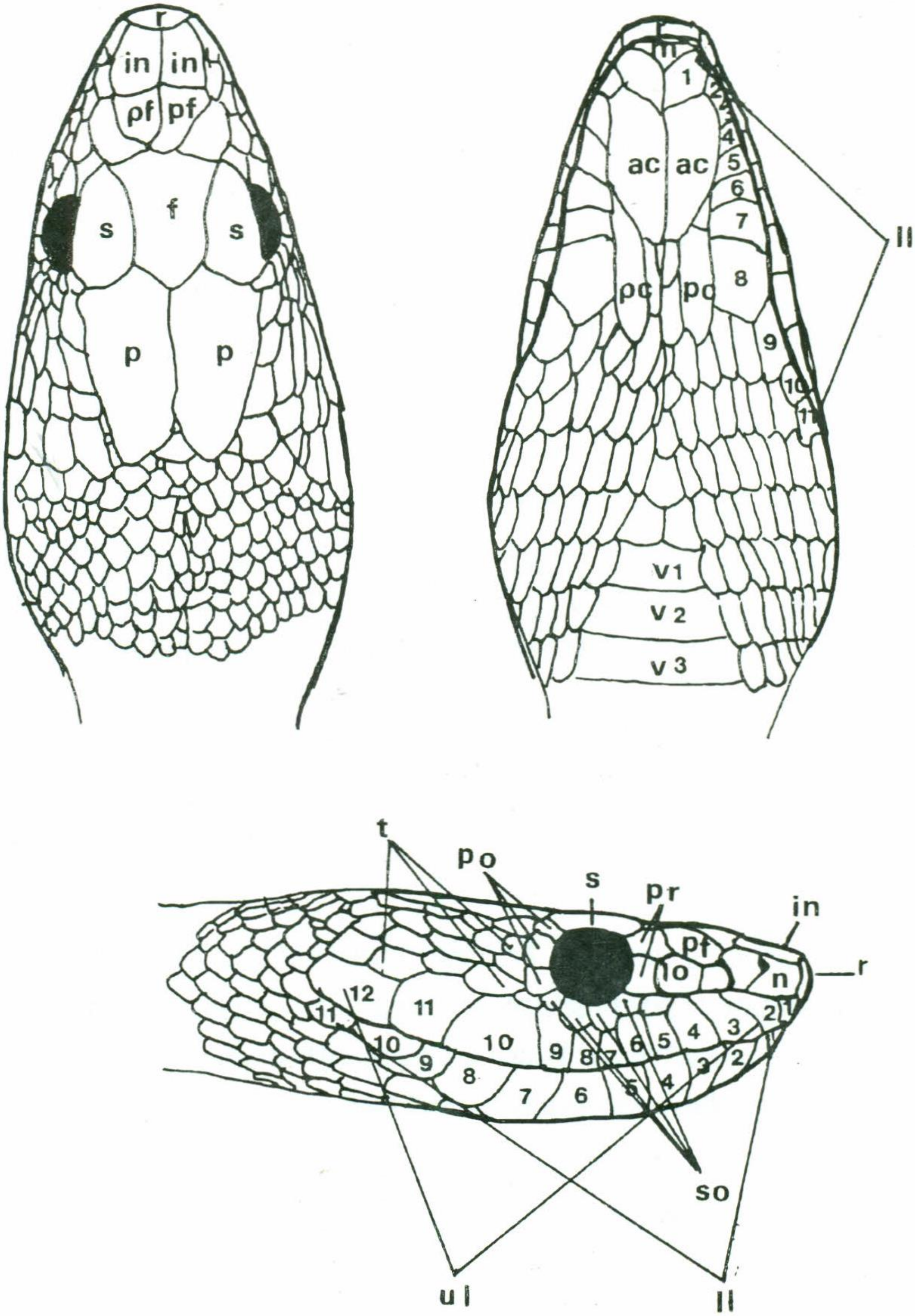
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Figure: Pholidosis of the snake *Spalerosophis diadema*. r = rostoral; in = internasal; f = frontal; n = nasal; pf = prefrontal; s = supraocular; p = parietal; 1= loreal; pr = preocular; so = subocular; po = postocular; t = temporals; ul = upper labials; 11= lower labials; m= mental; ac = anerior sublinguals; pc = posterior sublinguals; v = ventral scales .

Status:

No studies of the population status of any of the Egyptian amphibians and reptiles have ever been published. consequently, changes in these populations are very difficult to assess. **In** some cases, however, distributional changes appear to have occurred indicating range extension or contraction and possibly significant population changes. An approximate assessment of the status of some species can also be elucidated from comparing past and present collection efforts required to obtain the species.

Several factors appear to have had significant impacts on the populations of reptiles and amphibians of Egypt. These include commercial exploitation, habitat destruction, and environmental pollution. By far, the most significant threat facing reptiles and amphibians in Egypt is the uncontrolled, commercial exploitation which affects practically all species. This activity has reached a considerable level in recent years and is posing a real threat to the survival of several species.

Habitat destruction is another factor that appears to be affecting some of the reptiles and amphibians of Egypt. Agricultural land reclamation as well as widespread urbanization has transformed desert habitats into agricultural fields or urban centers not suitable for their original reptilian or amphibian inhabitants. This is most true in the Mediterranean coastal desert west of Alexandria. where habitat loss must have contributed to the great decline in the population of the critically endangered Egyptian tortoise *Testudo kleinmonni*.

Environmental pollution, particularly that caused by pesticides is probably affecting aquatic or semi-aquatic forms. The causal relationship between pollution and the decline of species such as *Trionyx triunguis* and *Varanus niloticus* is not clear and needs to investigated. Amphibians are also most likely to be affected by water pollution
but no data are available neither on population changes in these animals, nor on how they are affected by the widespread water pollution in Egypt.

Based on the available information, the status of each of the species listed in this book is estimated according to the IVCN Red List Categories defmed as follows (IVCN, 1994):

EXTINCT (EX)

A taxon is Extinct when there is no reasonable doubt that the last individual is dead.

EXTINCT IN THE WILD (EW)

A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed extinct in the wild when exhaustive surveys in known and/or expected habitat, at appropriate

times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to
the taxon's life cycle and life form.

CRITICALLY ENDAGERED (CR)

A taxon is Critically Endangered when it is facing an extremely high risk of extinction in the wild in the immediate future as defined by any of the criteria given in the IUCN Red List Categories (1994).

EN DANGERED

A taxon is Endangered when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future, as defined by any of the criteria given in the IUCN Red List Categories (1994). '

VULNERABLE (VU)

A taxon is Vulnerable when it is not Critically Endangered or Endangered but is facing a high risk of Extinction in the wild in the medium-term future, as defined by any of the criteria given by the IUCN Red List Categories (1994).

LOWER RISK (LR)

A taxon is Lower Risk when it has been evaluated, does not satisfy the criteria for any of the categories Critically Endangered, Endangered or Vulnerable. Taxa included in the Lower Risk Category can be separated into three subcategories:

1. Conservation Dependent (cd). Taxa which are the focus of a continuing taxonspecific or habitat-specific conservation program targeted towards the taxon in question, the cessation of which would result in the taxon qualifying for one of the threatened categories above within a period of five years.
2. Near Threatened (nt). Taxa which do not qualify for Conservation Dependent, but . which are close to qualifying for Vulnerable.
3. Least Concern (c). Taxa which do not qualify for Conservation Dependent or Near Threatened.

DATA DEFICIENT (DD)

A taxon is Data Deficient when there is inadequate information to make a direct or . indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution is laking. Data Deficient is therefore not a category of threat or Lower Risk. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate. It is important to make positive use of whatever data are available. In many cases great care should be exercised in choosing between DD and threatened status. If the range of a taxon is suspected to be relatively circumscribed, if a considerable period of time has elapsed since the last record of the taxon, threatened status may well be justified.

NOT EVALUATED (NE)

A taxon is Not Evaluated when it has not been assessed against the criteria. Venomous Snakes of Egypt:

Of 36 species of snakes in Egypt, nine are highly venomous and their bits are known to have resulted in human mortality. Those are the Palestinian Mole Viper *Atractaspis engaddensis*, the Egyptian Cobra *Naja haje haje,* the Spitting Cobra *Naja nigricollis,* the Black Desert Cobra *Walterinnesia aegyptia,* the Lesser Cerastes Viper *Cerastes vip era,* the Horned Viper *Cerastes cerastes,* the Saw-scaled Viper *Echis carinatus,* Burton's Carpet Viper *Echis coloratus,* and Field's Horned Viper *Pseudocerastes persicus.*

It is important to note, however, that a poisonous snake only bites to secure its . intended prey or in self defense against imminent danger. How dangerous a snake species is considered, depends on a number of factors. Obviously, the potency of the venom is an important factor. However, the quantity of the venom which is normally injected when the snake bits can very much affect the extent of the resulting envenomation. Some snakes can be very aggressive, attacking vigorously and even attempting to chase its adversary. Both the Egyptian Cobra *Naja haje* and the Spitting Cobra *Naja nigricollis* are known to be that aggressive. Other venomous species are more docile and rarely bit even when cornered, an example of these is the Black Desert Cobra *Walterinnesia aegyptia.* How abundant a poisonous snake species is in an areas frequented by humans, is another important factor that determine the significance of species as a public health hazard .

Symptoms of envenomation resulting from bites by these dangerous snakes vary considerably according to the snake species and its severity depends on quantity of . injected venom and the bitten part of the body (Reid, 1988). Bites by the Palestinian Mole Viper *Atractaspis engaddensis* almost always show but a single fang puncture because the snake's peculiar manner of biting. Pain and swelling develop rapidly usually accompanied by nausea, vomiting, and diarrhea, respiratory distress and cyanosis. Local necrosis may be severe enough to require amputation of digits (Leviton *et al., 1992).* Fatalities as a result of bites by this snake have been reported (Weiser *et al., 1984).* Bites by elapid snakes are generally painful and show some swelling. Eurotoxic symptoms (Warrell, *et al.,* 1976) such as drooping of the eyelids, blurred vision, difficulty in speaking and swallowing, and dilated pupils may begin within 30 minutes.Flaccid paralysis with loss of tendon reflexes, drowsiness, and mental confusion often follow. Breathing becomes shallow and difficult; convulsions and coma may precede death (Leviton *et al.. 1992).*

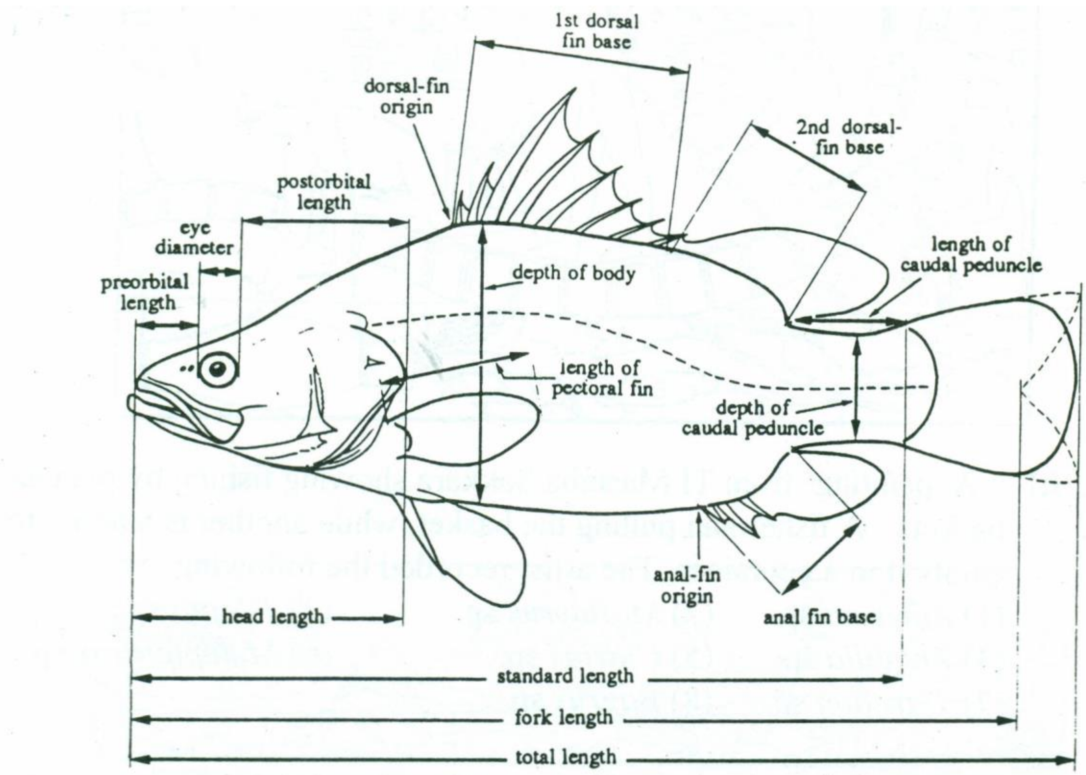
Typical cases of bites by the Saw-scaled Vipers *(Echis sp.)* are characterized by pain, which may be often delayed 15 minutes or so after the bite, followed by sweating, thirst, vomiting and often diarrhea. Swelling spreads from the site of the bite. Within 6 hours,

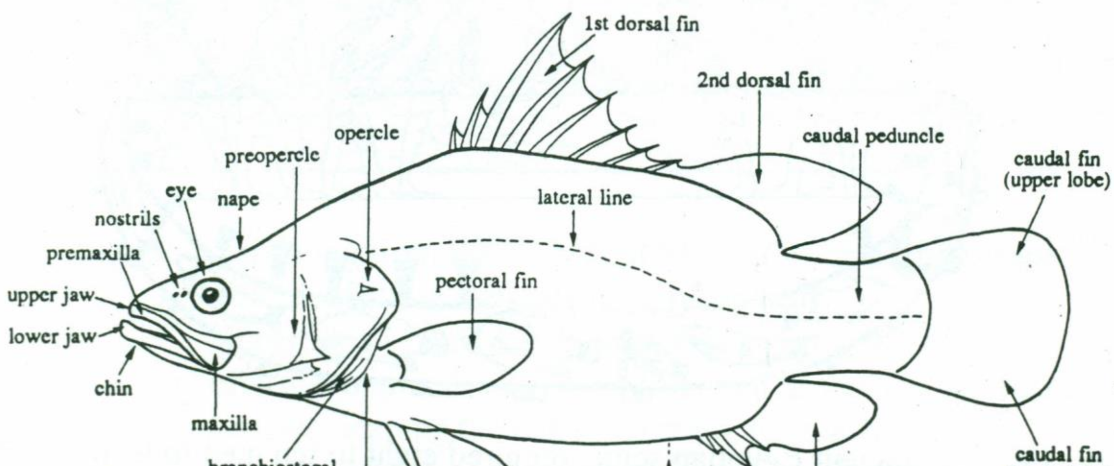
however, a profound consumption coagulopathy develops and the patient's blood fails to clot (Warrell and Arnett, 1976). Spontaneous bleeding is minor in patients bitten by *E. coloratus* and may be restricted to bleeding from the gum. In victims bitten by *Echis carinatus* spontaneous bleeding from many sites occur. The patient may cough up blood, have nosebleeds, and have blood in urine and stool. Death from internal bleeding may occur as long as three weeks after the bite (Leviton *et al.. 1992).*Bites by *Cerastes cerastes* and *Cerastes vipera* are known to result in local pain, swelling and blistering. Generalized symptoms are not common. There are a few reports of fetal bites (Leviton *et al.,* 1992). *Pseudocerastes persicus* has an extremely toxic venom and should be considered highly dangerous (Leviton *et al., 1992).* A number of snakes of family Colubridae have enlarged teeth in the rear of the upper jaw, and, in many, these teeth are grooved and can be considered fangs. These rear-fanged snakes are often described as semi-poisonous. They can produce envenoming that is not life threatening, but can be painful (Minton, 1990). Rear-fanged species found in Egypt are the Montpellier Snake Malpolon monspessulanus, Moila Snake Malpolon moilensis, the Coin-marked Snake Coluber nummifer, the Cliff Racer Coluber rhodorhachis, the Sand Snake Psammophis schokari, the African Beauty Snake
Psammophis sibilans, Clifford's Snake Spalerosophis diadema, the Egyptian Cat Snake Telescopus dhara, Hoogstraal's Cat Snake TeJescopus fallax hoogstraali Bites by rear-fanged colubrid snakes rarely result in envenoming. When it occurs, it is usually manifested as pain, swelling, and echymosis around the bitten area. Soreness and enlargement of regional lymph nodes and numbness and involuntary muscle twitching may occasionally occur. These symptoms are most marked following bites by large individuals of these snakes (e.g. *Spalerosophis sp.* and *Malpolon sp.).* Relatively sever
envenomation symptoms, such as drooping of the eyelids, difficulty in swallowing, and slight difficulty rarely occur (Minton, 1990; Leviton *et al., 1992).*

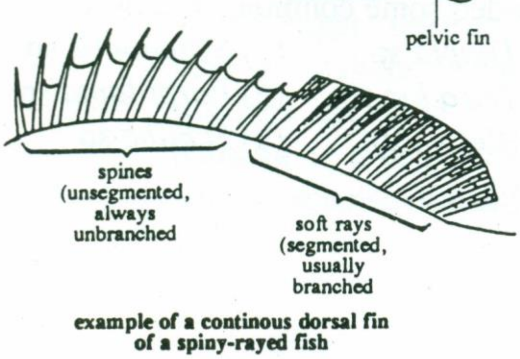
PART I

FRESHWATER FISHES OF EGYPT

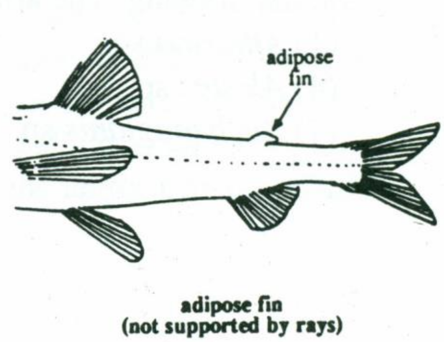
TECHNICAL TERMS AND MEASUREMENTS



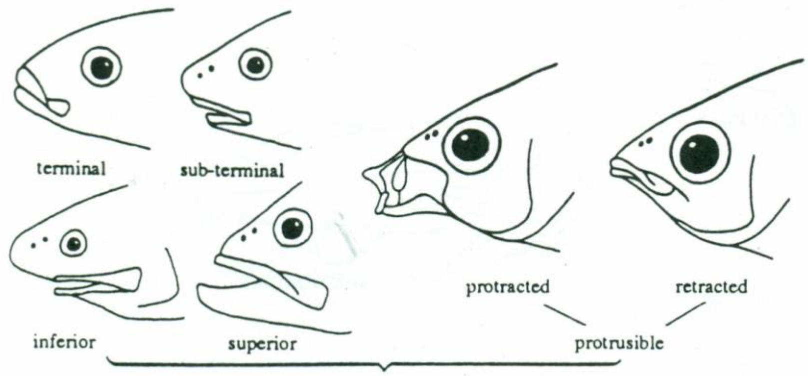




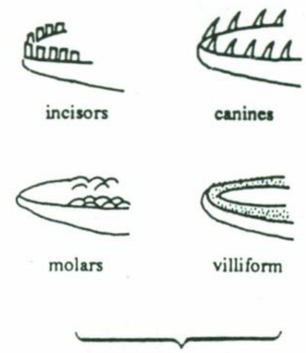
example of a continous dorsal fin of a spiny-rayed fish



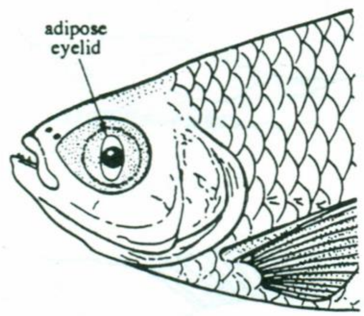
adipose fin (not supported by rays)



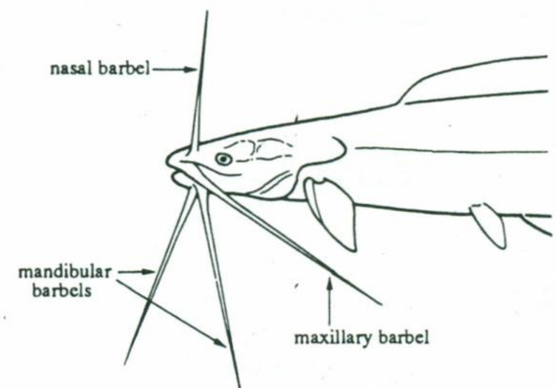
types of mouth



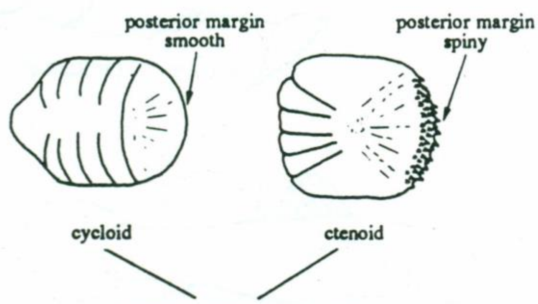
most common



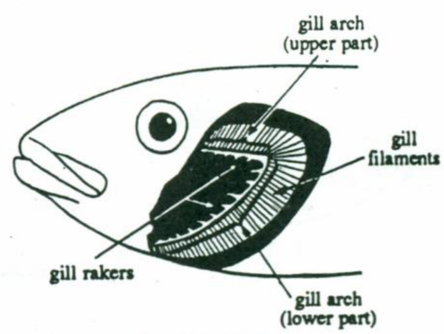
adipose eyelid



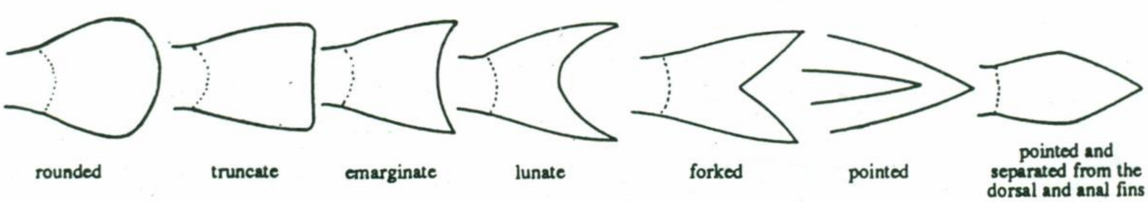
types of barbels



schematic examples of scales

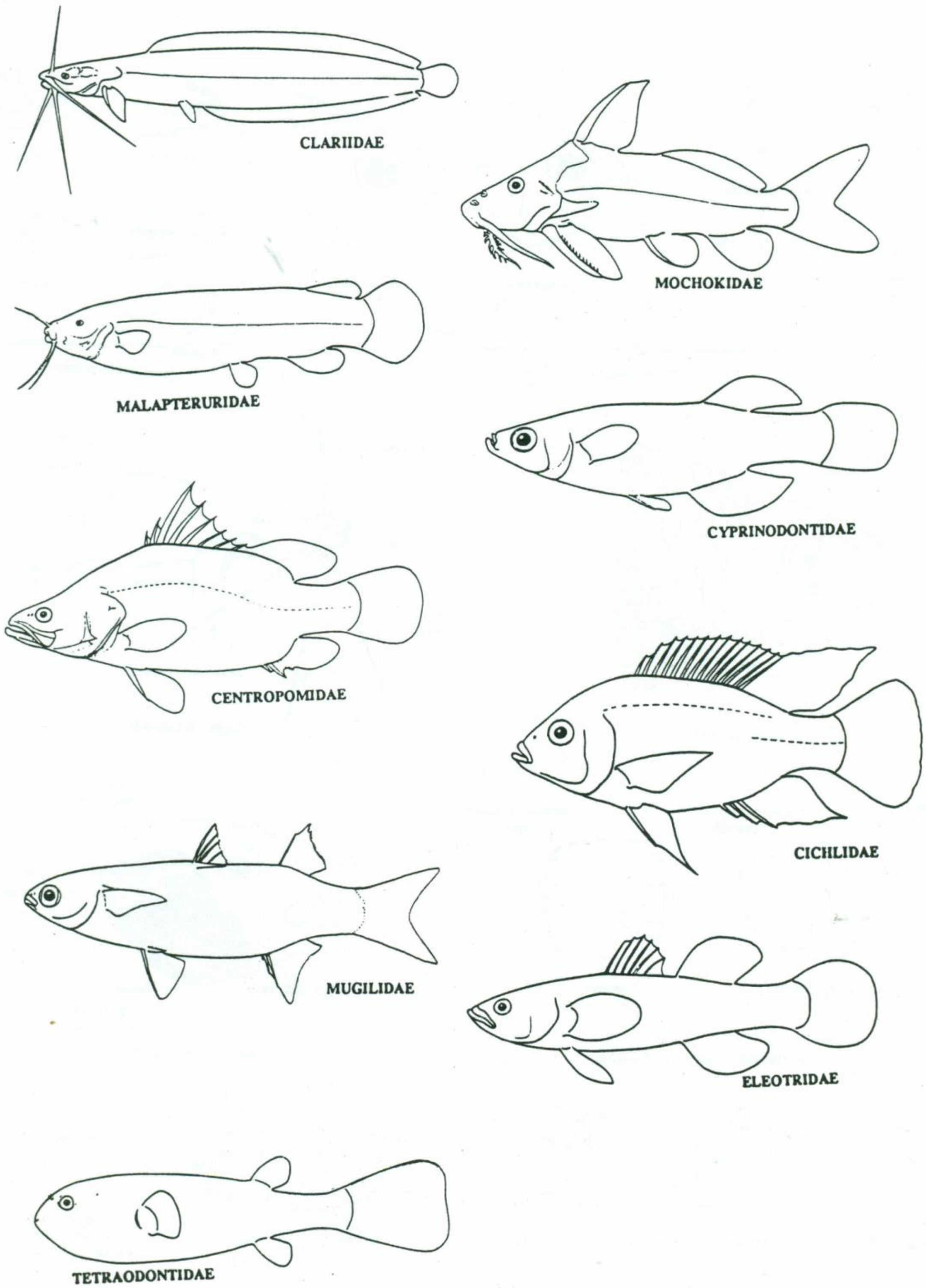


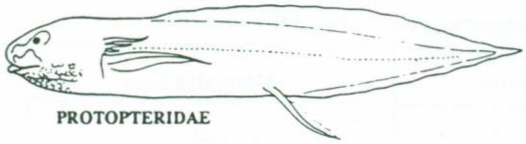
first left gill arch



most common types of caudal fin

A PICTORIAL INDEX TO FAMILIES





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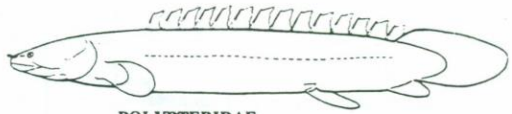

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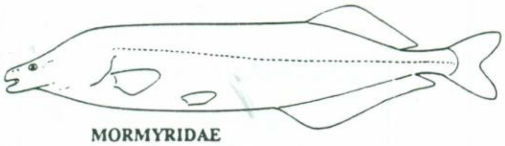

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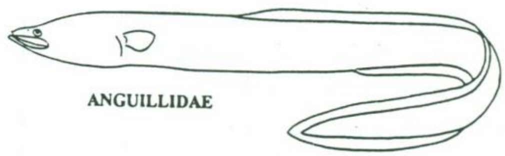

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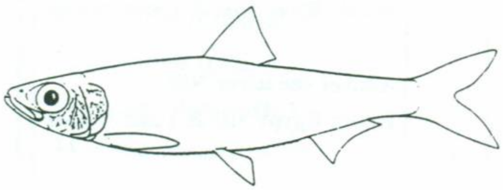

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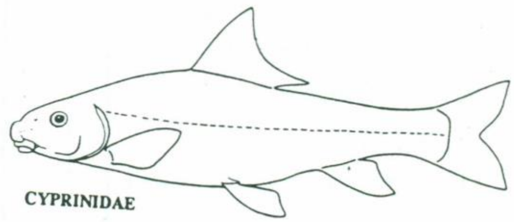

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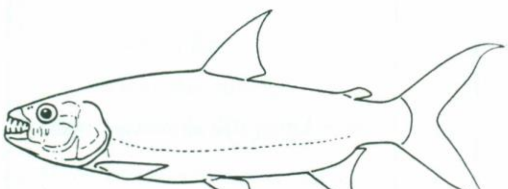
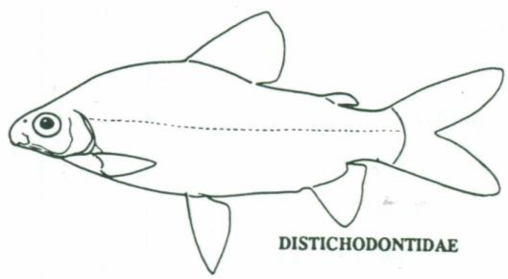


CHARACIDAE



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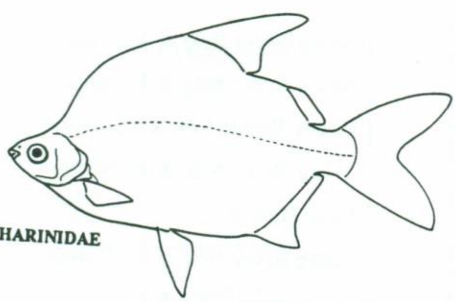

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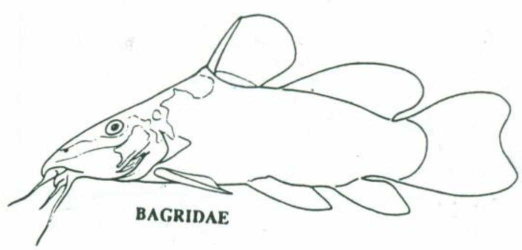
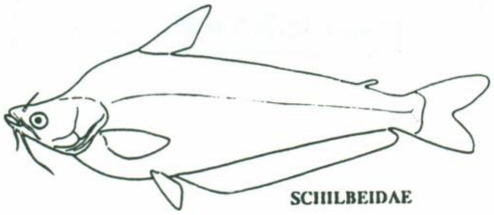


BAGRIDAE



SCHILBEIDAE

PART II

AMPHIBIANS

Key to the Egyptian

la. Back warty . . ………………………….. . **Bufonidae**
lb. Back not warty . ……………………………….. . 2
2a. Digits with adhesive pads…………….. **Hylidae**
2b. Digits with no adhesive pads…………. **Ranidae**

FAMILY BUFONIDAE

Genus *Bufo* Laurenti, 1768

Key to the Egyptian species of genus *Bufo* (adults)

la. First finger shorter than second…………………………… ***Bufo kassasii***
lb. First finger longer than second. 2
2a. Dark spots on back smaller than tympanum………………. ***Bufo dodsoni***
2b. Dark spots on back larger than tympanum 3
3a. A long continuous gland behind angle of mouth and beginning below tympanum ……………………………………………….. . . ***Bufo regularis***
3b. Small round warts behind angle of mouth ………………….***Bufo*** *viridis*

FAMILY RANIDAE

Key to the Egyptian genera of family Ranidae
1. Outer metatarsal tubercle present; in life 8 to 10 longitudinal ridges on skin of back.
…………………………………………………………………. . *Ptychadena*
2. Outer metatarsal tubercle absent; in life, one pair of longitudinal ridges of skin on back
……………………………………………………………………*Rana*

PART III

REPTILIES OF EGYPT

Key to the Egyptian Reptiles
la. Limbs absent **Snakes**
1b. Limbs present 2
2a. Body encased in a shell **Turtles**
2b. Body without shell. 3
3a. Teeth exposed with the mouth closed : **Crocodile**
3b. Teeth not visible with mouth closed ' **Lizards**

I. LIZARDS

Key to the Egyptian Families of Lizards
1a. Digits in opposable bundles, tail prehensile; body compressed ... Chamaeleontidae
1b. Digits not in opposable bundles; tail not prehensile, body round or depressed 2
2a. Head covered with large shields 3
2b. Head covered with small scales 4
3a. Ventral scales distinctly larger than most dorsal scales, femoral pores present .
. . . . Lacertidae
3b. Ventral scales about the same size as dorsal scales, femoral pores absent. .
. . . . Scincidae
4a. No movable lower eyelids Gekkonidae
4b. Lower eyelids present and movable 5
Sa. ostril very close to the end of snout; tongue broad, fleshy, not deeply forked
.~. . . . . Agamidae
5b. Nostril closer to the eye than to the snout or midway between the two; tongue long, slender and deeply forked at tip Varanidae

FAMILY AGAMIDAE Gray, 1827

Key to the Egyptian genera of the family Agamidae

1a. Tail with regular whorls of hard spinose scales 2
1b. Tail without regular whorls of hard spinose scales 3
2a. Each tail whorl consists of two rows of scales dorsally *Laudakia stellio*
2b. Each tail whorl consists of one row of scales dorsally *Uromastyx*
3a. third toe longer than fourth *Pseudotrapelus sinaitus*
3b. fourth toe longer than third 4
4a. Enlarged spines on sides of head and neck *Agama agama*
4b. No enlarged spines on sides of head and neck *Trapelus*

FAMILY GYKKONIDAE

Key to the Egyptian genera of family Gekkonidae

1a. Pupil of the eye circular. *Pristurus flavimaculatus*
1b. Pupil of the eye vertical. 2
2a. Digits strongly dilated (possessing pads) 3
2b. Digits not dilated (without pads) 4
3a. Each digit dilated at base forming an oval disk, with double row of lamellae beneath .Distal portion of digits slender. *Hemidactylus*
3b. Each digit dilated at apex, terminating in a fan-like expansion with fine lamellae heneath, claw lying in longitudinal groove dividing the apical expansion . · . . . . *Ptyodactylus*
3c. Digits dilated, their undersides without a longitudinal groove. lamella in a single row · . . *Tarentola*
4a. Dorsal scales uniform, smalJ and homogeneous S
4b. Dorsal scales heterogeneous 6
Sa. Dorsal scales overlapping. . . . . *Tropiocolotes*
Sb. Dorsal scales granular, fingers slender or depressed *Stenodactylus*
6a. Lower jaw with a single row of enlarged scales near the chin . · *Bunopus tuberculatus*
6b. Lower jaw with two rows of enlarged scales near the chin *Cyrtopodion*

FAMILY LACERTIDAE

Key to the Egyptian genera of family Lacertidae
la. Eyelids immovable, eye covered with a transparent shield *Ophisops*
lb. Eyelids movable. . 2
2a. Nostril separated from first upper labial by lower nasal shield. Ventral scales in eight or more longitudinal rows *Mesalina*
2b. Nostril in contact with first upper labials or separated from supralabial by very narrow brim . . . 3
3a. Digits with lateral fringes *Acanthodactylus*
3b. Digits with no lateral fringes. Ventral scales in less than eight longitudinal rows .. 4
4a. Longitudinal mid-dorsal scale rows distinctly enlarged .. *Philochortus intermedius*
4b. Longitudinal mid-dorsal scales similar to other dorsal scales .
· . . . . *Latastia longicaudata longicaudata*
Genus *Acanthodactylus* Fitzinger, 1834
Key to the Egyptian species of genus *Acanthodactylus*
la. Dorsal scales large and imbricate posteriorly, small and granular anteriorly; ventral scales in 10, rarely 12 straight longitudinal rows; three rows of scale around fingers ....
· . . . . *Acanthodactylus boskianus asper*
lb. Dorsal scales small and granular throughout. 2
'-
2a. Ventrals in 16 oblique longitudinal rows; enlarged, sharply keeled scales on dorsal surface of forelimb and tibia; four rows of scales around fingers .
. . . . .*Acanthodactylus longipes*
2b. Ventrals in 14 oblique longitudinal rows; scales on dorsal surface of forelimb and tibia are small and slightly keeled; four rows of scales around fingers .
· . . . . *Acanthodactylus scutellatus scutellatus*

2c. Ventrals in 12 straight longitudinal rows; three rows of scales around fingers .
. . . . *Acanthodactylus pardalis pardalis*

FAMILY SCINCIDAE

Key to the Egyptian genera of family Scincidae
la. Toes with broad fringes. . *Scincus scincus scincus*
lb. Toes without broad fringes 2
2a. Dorsal scales keeled. . *Mabuya*
2b. Dorsal scales not keeled 3
3a. Snout with sharp horizontal edge *Sphenops*
3b. Snout with round edge. . 4
4a. Eyelids absent, pupil always visible *Ablepharus kitaibeli*
4b. Lower eyelid present and movable 5
5a. Anterior border of ear opening with a fringe of conical scales; lower eyelid .scaly ...
. . . . *Eumeces schneideri*
5b. Anterior border of ear opening smooth; lower eyelid with a transparent disk .
. . . . . . *Chalcides ocellatus ocellatus*

FAMILY VARANIDAE

Genus *Varanus* Merrem, 1820

Key to the Egyptian species of genus *Varanus*

1a. Tail round at base, slightly compressed posteriorly; nostril an elongate slit very close to eye' *Varanus griseus griseus*

lb. Tail compressed, with a well-defined dorsal ridge, nostril small, round and about midway between eye and end of snout *Varanus niloticus niloticus*

FAMILY CHAMAELEONTIDAE

Genus *Chamaeleo* Laurenti, 1768

Key to the Egyptian species of genus *Chamaeleo*

la. Occipital dermal lobe.............................. ***Chamaeleo africanus***

lb. Occiptal dermal lobe present and reaching apex of the casque , 2

2a. Occipital flap index* less than 16 ***Chamaeleo chamaeleon chamaeleon***

2b. Occipital flap index more than 16 ***Chamaeleo chamaeleon musae***

* Occipital flap index: Largest width of occipital flap, the maximum horizontal length of the lobe measured from its free edge to its attachment to the bony casque of the head x IOO/length of the mouth (Hillenius & Gasperetti, 1984).

II. SNAKES

Key to Egyptian families of snakes

1a. Scales around body of uniform size (no enlarged scales on venter) 2

lb. Scales on venter greatly enlarged, much larger than dorsal scales) 3

2a. Ocular shield borders the mouth; tail at least three times longer than broad .
· . . . . Leptotyphlopidae

2b. Ocular shield not bordering the mouth, tail only slightly longer (if longer) than broad . . . . **Typhlopidae**

3a. Head covered with small scales, with more than 3 scales between eyes 4

3b. Head covered with large shields, with no more than 3 shield between eyes 5

4a. Head not distinct from neck and covered with flat and smooth scales; ventral shields extend only part way across venter; dorsal scales small and smooth; no fangs .
· **Boidae**

4b. Head distinct from neck and covered with juxtaposed or imbricate scales; ventral scales as broad (or nearly as broad) as the body; tail short; front fangs **Viperidae**

Sa. Loreal shield present **Colubridae** (most species)

5b. Loreal shield absent. 6

6a. Dorsal scales keeled throughout entire length of body. . . . .
· **Colubridae** *(Dasypelis scabra)*

6b. Dorsal scales smooth in at least the anterior half of the body 7

.

7a. Anal plate single 8

7b. Anal plate divided 9

8a. Subcaudals single; eyes small, with round pupils, head not distinct from neck .
· . . . . . **Atractaspididae**

8b. Subcaudals paired (or at least they become so in the distal 2/3 of the tail) , large head plates; eyes moderate or small with round pupils **Elapidae**

9a. Rostral large, extends onto upper surface of snout and partially separates internasals; maxillary teeth 6-8 **Colubridae** (genus *Rhynchocalamus)*

9b. Rostral not exceptionally large, does not extend noticeably onto upper surface of snout and does not partially separate internasals; maxillary teeth 12-20 .
. . . . **Colubridae** (genus *Eirenis)*

FAMILY TYPHLOPIDAE

Key to the Egyptian species of family Typhlopidae

1a. Nasal shield incompletely divided; nasal cleft proceeding from 2nd labial . . . . *Typhlops vermicularis*

lb. Nasal shield completely divided; nasal cleft proceeding from preocular. . . . . *Ramphotyphlops braminus*

FAMILY LEPTOTYPHLOPIDAE

Genus *Leptotyphlops* Fitzinger, 1843

Key to the Egyptian species of genus *Leptotyphlos*
1a. Underside of rostral rounded; snout not hooked in profile ***Leptotyphlops cairi***
lb. Underside of rostral concave; snout hooked in profile .
. . . . ***Leptotyphlops macrorhynchus***

FAMILY BOIDAE
Genus *Eryx* Daudin, 1803

Key to the Egyptian species of genus *Eryx*
la. Scales between eyes across the head 5-8; mental groove absent or very faint .
. . . . *Eryx jaculus jaculus*
lb. Scales between eyes across the head 19015; mental groove present. .
. . . . *Eryx colubrinus colubrinus*

FAMILY COLUBRIDAE

Key to the Egyptian genera of family Colubridae
1a. Loreal shield absent; dorsal scales keeled throughout the body *Dasype(tis scabra*
lb. Loreal shield present. . 2
2a. Upper labials do not border orbit (separated by a series subocular scales) .
. .. . . . *Spalerosophis*
2b. One or more upper labials border orbit. 3
3a. Some or all dorsal scales keeled. . . 4
3b. All dorsal scales smooth 5
4a. One apical pit present on each scale; all scale rows, except occasionally outer row, keeled. . . . *Natrix tessellata tessellata*
4b. Two apical pits present on each scale; 5-7 middorsal scale rows usually keeled, others smooth. . . . *Coluber*
Sa. Pupil of eye round. . 6
5b. Pupil of eye vertically elliptic 12
6a. Dorsal surface of snout with median longitudinal concave furrow or profile of head distinctly and sharply convex *Malpolon*
6b. Dorsal surface of snout flat 7
7a. Scales in 15 longitudinal rows on anjerior third of the body, usually 15 at midbody; one anterior temporal present, in contact with a single postocular 8
ib. Scales in 17 or more longitudinal rows on anterior third of body; two or more anterior temporals present, usually in contact with two or more postoculars 9
8a. Rostral large, extends onto upper surface of snout and partially separates internasals; maxillary teeth 6-8 . . *Rhynchocalamus melanocephalus*
8b. Rostral not exceptionally large, does not extend noticeably onto upper surface of snout and does not partially separate internasals; maxillary teeth 12-20 *Eirenis*
9a. Loreal elongate, about twice as long as broad 10
9b. Loreal more or less square, not twice as long as broad; scales in 19 or more longitudinal rows on anterior third of body; posterior maxillary teeth not grooved ... 11
l0a. Head distinct from body; dorsal scales in 17 longitudinal rows on anterior third of body; subcaudals more than 80 *Psammophis*
l0b. Head slightly distinct from neck; dorsal scales in 19-25 longitudinal rows; subcaudals less than 80 *Macroprotodon*
11a. Nostril a narrow oblique slit between nasal shields *Lytorhynchus*
11b. Nostril circular, moderate to large; subpreocular scale present *Coluber*
12a. Head large, oval, very distinct from neck; nostril circular; loreal elongate, longer than deep, usually bordering orbit; posterior maxillary teeth grooved *Telescopus*
12b. Head slightly distinct from neck, not exceptionally large; 13

13a. Nostril a narrow oblique slit between two nasal shields; loreal more or less square, not bordering orbit; dorsal scales without apical pits; rostral large folded back on the upper surface of the head, and at a sharp angle laterally in front of the nasal; posterior maxillary teeth not grooved *Lytorhynchus*

13b. Nostrils round, between two nasal shields; loreal elongate; rostral much broader than high, slightly visible from above; dorsal scales with apical pits.. . ..*Macroprotodon*

FAMILY ELAPIDAE

Key to the Egyptian genera of family Elapidae
1. Anal plate entire; subcaudals divided; scales smooth .*Naja*
2. Anal plate divided; subcaudals 1-13 entire and the remainder divided; dorsal scales on the posterior body and the tail keeled; uniformly black . . . .
.*Walterinnesia*

FAMILY VIPERIDAE

Key to the Egyptian genera of family Viperidae
la. Subcaudals single . . *Echis*
lb. Subcaudals paired . . . 2
2a. Gulars, ventrals, and subcaudals smooth; keels of lateral scales smooth .
. . . . *Pseudocerastes*
2b. Gulars ventrals, and subcaudals keeled; keels of lateral scales serrated .
. . . . . .'. *Cerastes*

III. CROCODILES
FAMILY CROCODYLIDEA

Genus *Crocodylus* Laurenti, 1768
Crocodylus niloticus Laurenti, 1768

CrocodyLus niloticus: Laurenti, 1768: 53.
CrocodiLus niLoticus: Boulenger, 1889: 283.
CrocodiLus niLoticus: Anderson, 1898: 1.
CrocodyLus niLoticus: Flower, 1933: 755.
Crocodylus niloticus: Wermuth & Mertens, 1961: 364.
CrocodyLus niLoticus: Marx, 1968: 43.
Common name: Nile Crocodile; *Timsali Nili*.
Range: Southwest Asia, Africa, Madagascar, Comotos and Seychelles.
Distribution in Egypt: Lake nassir, and rarely down stream of Aswan to Cairo.
Ecology: In Lake Nassir crocodiles are frequently seen on exposed sand bars and on vegetated shores of uninhabited, dendritic branches of the lake. They are normally very shy, quickly divining into the water with the least disturbance. Nests are dug among shore vegetation and vigorously defended by the female. It feeds mostly on fish, but may also take birds or mammals. At certain areas in Lake Nassir, crocodiles appear to be specially fond of feral domestic dogs. Hiding among shore vegetation, or submerged in the water, crocodiles snatch, with lightening speed, unsuspecting dogs which frequent the lake shores to feed on dead fishes. Attacks on humans, although rare, are known to have occurred within Lake Nassir.
Status: Vulnerable.
Remarks: The construction of dams along the Nile stream in Egypt as well as the persistent persecution of crocodiles have resulted in the extinctions of crocodiles down stream from Aswan. Reports of crocodiles occasionally seen near Cairo are probably of animals escaping from a crocodile farm which operated for a number of years in Helwan near Cairo.

IV. TURTLES
ORDER TESTUDINATA

Key to the Egyptian families of order Testudinata
1a. Carapace and plastron (dorsal and ventral shells) with shields or horny plates
2
lb. Carapace and plastron soft or leathery, without horny plates 4
2a. Front limbs in the form of elongate flippers without digits, with one or two claws; marine habitats . . . . **Cheloniidae**
2b. Front limbs non in the form of elongate flippers without digits 3
3a. Limbs elephantine, digits are not webbed, terrestrial habitat **Testudinidae**
3b. Hind limbs are not elephantine, digits are fully webbed, fresh water habitat .
. . . Emydidae
4a. Snout pointed, snorkel-like; fresh water habitat **Trionychidae**
4b. Snout rounded and blunt; marine habitat **Dermochelyidae**

PART IV

BIRDS KNOWN TO OCCUR IN EGYPT

Bird Classification and Evolution

Birds belong to Vertebrates, the group of animals with a vertebral column. More precisely, Birds belong to the Tetrapods, the four-limbed vertebrates, which also include amphibians, mammals and all reptiles.

Evolution

Archaeopteryx, the oldest bird yet discovered, is known from several fossils recovered from fine slate deposits in Germany. This magpie-size animal lived in a tropical environment about 150 million years ago. *Archaeopteryx* had flight feathers and a fused furcula (ie, wishbone) resembling those of modern birds; these features are, so far, unique in Jurassic animals. Its solid bones and lack of a keel on the breastbone limited its powers of flight. This made it more a glider than a powered flyer and it may have been capable only of gliding from perch to perch. *Archaeopteryx* had many features that are also present in theropod Dinosaurs, and many scientists now believe that birds have evolved from feathered dinosaurs.

Most fossil birds from the Cretaceous period (142-65 million years ago) belong to extinct groups, such as the Enantiornithines or "opposite birds," characterized by shoulder girdle articulations and leg bone features that are opposite to those of modern birds. The birds that survived the catastrophic extinctions at the end of the Cretaceous diversified into species modern in appearance and often can be referred to modern groups of birds.

Classification

Modern Linnaean classification groups species according to how closely related they are to one another. Species belonging to the same genus have a more recent common ancestor than those placed in different genera. The same is true for grouping genera into families and families into orders. Studies comparing the DNA of bird species have shed new light on the relationships of birds (and is continuing to do so), but many of the groupings originally based on morphological grounds have nevertheless proved valid.

Although birds are perhaps better known than of any other animal group, new species are still discovered almost yearly. Nearly 10 000 species of recently identified birds are known and they are grouped in more than 200 families, more than 2200 genera and 29 orders. About two-thirds of known species (close to 6000 species) belong to the order Passeriformes (perching birds). The remaining 4000 species or so belong to 28 orders divided in nearly 100 families and about 1000 genera. The following summary of how birds are currently classified in different orders, families and genera, gives an indication of the diversity of bird species.

Tinamiformes

Tinamiformes (one family, 9 genera, 47 species; none in Canada). Tinamous. Medium-size ground-dwelling birds; New World distribution.

Struthioniformes

Struthioniformes (5 families, 6 genera, 14 species; none in Canada). Ostriches, rheas, cassowaries, emus, kiwis. Large birds, except kiwis; flightless and cursorial (ie, running); found mostly in the Southern Hemisphere.

Galliformes

Galliformes (5 families, 80 genera, 290 species; 16 breeding species in Canada). Megapodes, curassows, chachalacas, guineafowl, quails, turkeys, grouse, ptarmigan, pheasants, peafowl, partridge. Small to very large chickenlike birds; occur almost worldwide.

Anseriformes

Anseriformes (3 families, 52 genera, 162 species; 39 breeding species in Canada).
Screamers, geese, swans, ducks, teals, mergansers. Medium-size to very large swimming birds with 3 webbed toes and lamellate bill, except screamers (restricted to South America), which have unwebbed feet, chickenlike bills and wading habits; worldwide distribution. The Labrador duck, formerly found in Canada, is extinct (*see also* Endangered Animals).

Sphenisciformes

Sphenisciformes (one family, 6 genera, 17 species; none in Canada). Penguins. Medium-size to large diving birds with flipperlike wings; found in the Southern Hemisphere.

Gaviiformes

Gaviiformes (one family, one genus, 5 species; 4 breeding species in Canada). Loons. Large diving birds with 3 webbed toes and straight, pointed bill; found in the Northern Hemisphere.

Procellariiformes

Procellariiformes (4 families, 26 genera, 112 species; 4 breeding species in Canada). lbatrosses, fulmars, shearwaters, storm-petrels, diving-petrels. Very small to very large oceanic birds with 3 webbed toes and tubular nostrils; nest on land; found on all oceans.

Podicipediformes

Podicipediformes (one family, 6 genera, 22 species; 6 breeding species in Canada). Grebes. Small to large diving birds with lobed toes and straight, pointed bills; worldwide distribution.

Phoenicopteriformes

Phoenicopteriformes (one family, 3 genera, 5 species; none in Canada). Flamingoes. Large wading birds with long legs and necks; bill thick with lamellae (ie, tiny, comblike structures) and bent sharply downward at midpoint; toes webbed; colonial nesters, mainly in tropical and sub-tropical areas.

Ciconiiformes

Ciconiiformes (3 families, 39 genera, 116 species; 10 breeding species in Canada). Bitterns, herons, egrets, storks, ibises, spoonbills. Small to very large wading birds with long legs and necks; bill varies from long and spearlike to broad, flat and shovellike or downward curved; worldwide distribution.

Pelecaniformes

Pelecaniformes (8 families, 10 genera, 65 species; 6 breeding species in Canada). Tropicbirds, frigatebirds, pelicans, boobies, gannets, cormorants, anhingas. Medium-sized to large aquatic birds, pointed or hooked bills; primarily colonial nesters; worldwide distribution.

Falconiformes

Falconiformes (3 families, 83 genera, 304 species; 19 breeding species in Canada). Falcons, vultures, secretary birds, kites, hawks, eagles, osprey. Very small to very large diurnal birds of prey; legs short to very long; wing shape highly variable from very pointed to broad and rounded; hunters or carrion feeders; worldwide distribution.

Gruiformes

Gruiformes (11 families, 61 genera, 212 species; 8 breeding species in Canada). Bustards, mesites, seriemas, kagus, rails, gallinules, coots, sun-grebes, trumpeters, cranes, limpkins, buttonquails. Very small to very large birds; structure diverse, most have cursorial habits; worldwide distribution.

Charadriiformes

Charadriiformes (17 families, 88 genera, 367 species; 84 breeding species in Canada). Thick-knees, sheathbills, oystercatchers, crabplovers, avocets, plovers, painted-snipes, jacanas, sandpipers, phalaropes, pratincoles, gulls, terns, skimmers, jaegers, skuas, auks, sandgrouse. Small to large birds; many species with long legs, cursorial habits; some with webbed feet and aquatic or diving habits; structure and habits diverse; worldwide distribution. Great auk, which nested in Canada, is extinct.

Columbiformes

Columbiformes (one family, 44 genera, 311 species; 4 breeding species in Canada). Dodos, pigeons, doves. Very small to very large birds; solitary to highly gregarious; arboreal or terrestrial; worldwide distribution. Dodo, native to the Mascarene Islands, and passenger pigeon, formerly very common in Canada, are extinct.

Psittaciformes

Psittaciformes (one family, 85 genera, 364 species; none in Canada). Cockatoos, lories, budgerigars, parakeets, parrots. Very small to large birds with brightly coloured plumage, strong hooked bill; 2 toes in front, 2 behind; mainly in tropical and sub-tropical areas. Carolina parakeet, formerly of North America (possibly southern Ontario), is extinct.

Opisthocomiformes

Opisthocomiformes (one family, one genus, one species; none in Canada). Hoatzin. Medium-size arboreal birds that feed on green leaves; young has claws on wings; South America.

Musophagiformes

Musophagiformes (one family, 6 genera, 23 species; none in Canada). Turacos and plantain eaters. Medium-size birds with long tails; chiefly arboreal; Africa.

Cuculiformes

Cuculiformes (one family, 35 genera, 138 species; 2 breeding species in Canada). Cuckoos. Small to large birds with long tails; 2 toes in front, 2 behind, or fourth reversible; many species have parasitic nesting habits; mostly arboreal, a few terrestrial species; worldwide distribution.

Strigiformes

Strigiformes (2 families, 29 genera, 195 species; 16 breeding species in Canada). Owls. Small to large birds; primarily nocturnal and arboreal; raptorial habits, noiseless flight; large eyes directed forward; worldwide distribution.

Caprimulgiformes

Caprimulgiformes (5 families, 22 genera, 118 species; 4 breeding species in Canada). Oilbirds, frogmouths, potoos, goatsuckers, nightjars, nighthawks. Small- to medium-size birds; bill usually with wide mouth surrounded with bristles; small, weak feet; nocturnal or crepuscular insect or fruit eaters; worldwide distribution.

Apodiformes

Apodiformes (3 families, 124 genera, 429 species; 9 breeding species in Canada). Swifts, hummingbirds. Small birds with weak feet. Swifts, distributed worldwide, have long, strong wings; hummingbirds, restricted to New World, have slender, pointed, long bills, and generally iridescent plumage.

Coliiformes

Coliiformes (one family, 2 genera, 6 species; none in Canada). Mousebirds or colies. Small birds with long tails; gregarious and arboreal; Africa.

Trogoniformes

Trogoniformes (one family, 6 genera, 39 species; none in Canada). Trogons, quetzals. Colourful, small- to medium-size birds with long tails; solitary and arboreal; tropical areas.

Coraciiformes

Coraciiformes (7 families, 34 genera, 149 species; one breeding species in Canada). Rollers, kingfishers, todies, motmots, bee-eaters. Small to large birds; strong bill; some toes fused at base; worldwide distribution.

Bucerotiformes

Bucerotiformes (4 families, 17 genera, 60 species; none in Canada). Hornbills, hoopoes. Small- to large-size birds, with long bill and some toes fused at base; Old World distribution.

Galbuliformes

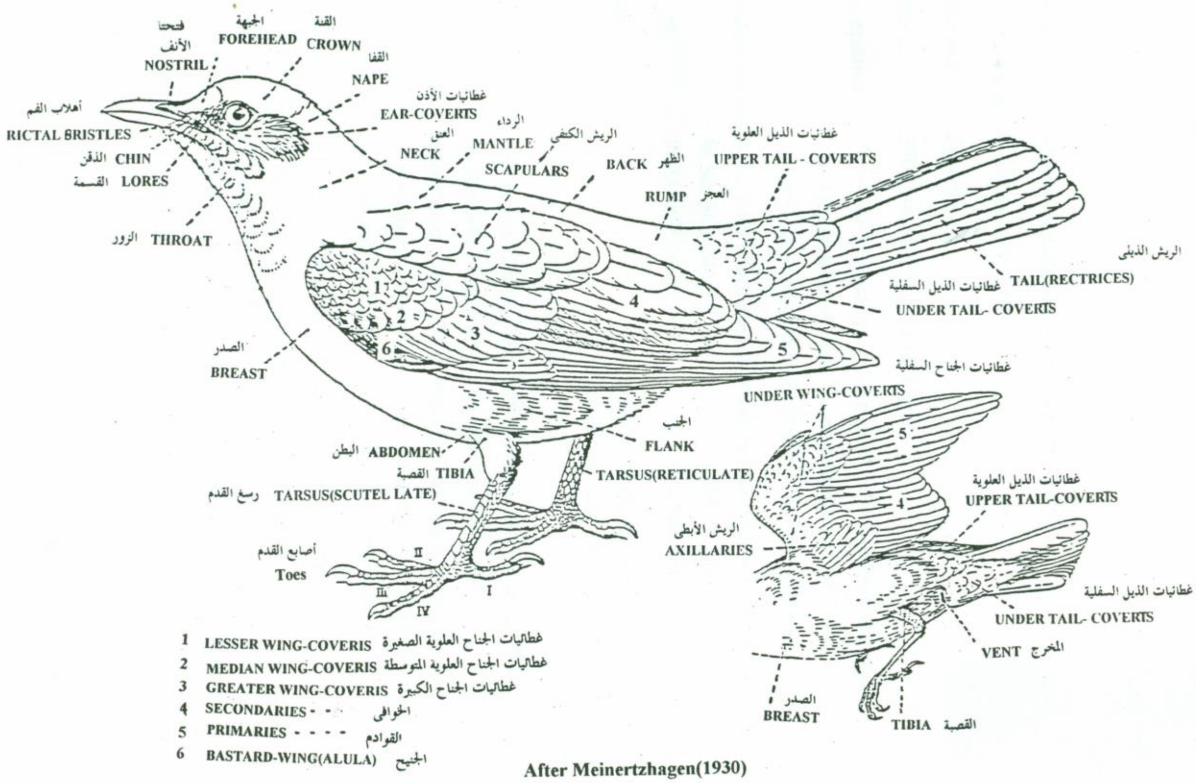
Galbuliformes (2 families, 15 genera, 61 species; none in Canada). Jacamars, puffbirds. Small- to medium-size tropical birds; strong bill; some toes fused at base; New World distribution.

Piciformes

Piciformes (3 families, 53 genera, 347 species; 14 breeding species in Canada). Barbets, toucans, honeyguides, wrynecks, piculets, woodpeckers. Small to large birds; most species solitary and arboreal; bill highly variable, from short, straight and pointed to very large; 2 toes in front, 2 behind, some species have only 3 toes; worldwide distribution, except for Australian region.

Passeriformes

Passeriformes (97 families, more than 1200 genera, about 5800 species; 195 breeding species in Canada). Perching birds: flycatchers, shrikes, vireos, jays, magpies, crows, ravens, waxwings, chickadees, swallows, larks, kinglets, wrens, gnatcatchers, nuthatches, creepers, mockingbirds, thrashers, starlings, thrushes, robins, dippers, pipits, finches, warblers, meadowlarks, blackbirds, grackles, orioles, buntings, tanagers, cardinals, grosbeaks, sparrows. Comprises more species than all other orders together; highly diversified; adapted to perching, 3 toes in front, one behind; small to medium size; contains all songbirds; worldwide distribution.



After Meinertzhagen(1930)

Checklist of Birds Known to Occur in Egypt
Species Re WV SV AP SP Ex En
,
Order: STRUTmONIFORMES
Family Struthionidae
Struthio camelus camelus S
Order: PROCELLARIIFORMES
Family Procellariidae
Calonectris diomedea diomedea S S
PuJ.TznuspuJ.Tznusyelkouan S S S
Puffinus griseus R R
Family Hydrobatidae
Oceanites oceanicus oceanicus R
Oceanodroma leucorhoa leucorhoa A
Family Diomedeidae
Diomedea cauta A
Order: GAVDFORMES
Family Gaviidae
CTcrviastellata stellata R
Gavia arctica arctica +
Order: PODICIPEDIFORMES
Family Podicipedidae
Tachybaptus ruficollis ruficollis C
Podiceps grisegena grisegena A'':
Podiceps cristatus cristatus C
Podiceps nigricollis nigricollis ~
Order: PELECANIFORMES
Family Phaethontidae
Phaethon aethereus indicus R
Family Phalacrocoracidae
Phalacrocorax carbo sinensis C R C C
Phalacrocorax aristotelis desmarestii R
Phalacrocorax africanus africanus +
Family Anhingidae
Anhinga rufa rufa A
Family Sulidae
Sula bassana bassana R R R
Sula leucogaster plotus S
Family Pelecanidae
Plecanus onocrotalus R C C

Plecanus rufescens R R R
Plecanus crispus R
Order: CICONDFORMES
Family Ardeidae
Ardea cinerea cinerea **UC** C S
Ardea goliath R R R
Ardeapurpureapurpurea R R C C
Ardeola ralloides R S C C
Nycticorax nycticorax nycticorax R C C C
Botaurus stellaris stellaris R 0
Ixobruchus minutus minutus C C C C
Egretta alba alba S S S
Egretta gularis schistacea S
Egretta ibis ibis C C C C
Egretta garzetta garzetta S C C C
Family Ciconiidae
Ciconia ciconia ciconia R R C C
Ciconia nigra R R S S
Mycteria ibis 0
Family Threskiornithidae
Plegadis falcinellus A S C
Threskiornis aethopicus aethopicus +
Geronticus eremita R
Platalea leucordia leucordia R S R S S
.**Order: PHOENICOPTERIFORMES Family: Phoenicopteridae**
Phoenicopterus ruber roseus S C
Order: ANSERIFORMES
Family Anatidae
Cygnus olor R
Cygnus cygnus R l
Anser anser anser A
Anser albifrons albifrons R
Anser erythropus A
Anserfabalis fabalis A

Branta leucopsis +

Branta bernicla bernicla A
Alopochen aegyptiacus C C
Tadorna ferruginea R R R

Tadorna tadorna C
Anas platyrhynchos platyrhynchos C C C C
Anas crecca crecca C C C
Anas strepera strepera S S S
Anas penelope C C C
Anas acuta acuta C C C
Anas querquedula C C
Anas clypeata C C C
Marmaronetta angustirostris R
~raleucocephala +
Netta rufina S
Aythya ferina C C C
Aythya nyroca C C C
Aythya fuligula C C C
Plectropterus gambensis gambensis A
Mergus serrator serrator R
Mergus albel/us R
Melanitta fusca fusca A
Order: ACCIPITRIFORMES
Family: Accipitridae
Pernis apivorus apivorus R S C
Elanus caeruleus caerulerus C
Milvus milvus milvus R R
Milvus migrans migrans S C C
Milvus migrans aegyptius S C C
Haliaeetus vocifer A
Haliaeetus albicilla 0
Gypaetus barbatus meridionalis R
Neophron percnopterus percnopterus R
Gyps fulvus fulvus 0
Gyps rueppellii rueppellii 0
Aegypius monachus R R R
Torgos tracheliotus negevensis R
Circaetus gallicus gallicus C

Circus cyaneus cyaneus R R R
Circus macrourus S S S
Circus pygargus 0 R R
Circus aeruginosus aeruginosus S S S
Accipiter brevipes C C

Accipiter nisus nisus S C C
Accipiter gentilis gentilis R
Micronisus gabar A
Buteo buteo vulpinus C C
Buteo rufinus cirtensis C
Buteo rufinus rufinus C S S S
Tetrathopius ecaudatus R
Aquila pomarina pomarina R C C
Aquila clanga R R R
Aquila heliaca heliaca 0 R R
Aquila verreauxii R
Aquila chrysaetos homeyeri R
Aquila rapax belisarius A
Spizeetus nipalensis nipalensis R R C C
Hieraaetus jasciatus jasciatus R R R R
Hieraaetus pennatus pennatus R S S
Family: Pandionidae
Pandion haliaetus haliaetus C S S S
Order: FALCONIFORMES
Family: Falconidae
Falco naumanni naumanni C 0 S C
Falco tinnunculus tinnunculus C
Falco tinnunculus rupicolaeformis C
Falco vespertinus vespertinus R S S
Falco columbarius aesalon R
Falco subbuteo subbuteo R S S
Falco biarmicus tanypterus S
Falco eleonorae R R
Falco concolor **S.b**
Falco cherrug cherrug R R R
Falco pelegrinoides pelegrinoides S
Falco peregrinus peregrinus R R R

Order GALLIFORMES
Family Phasianidae
Alectoris barbara barbata R
Alectoris graeca sinaica C
Ammoperdix heyi nicolli C +
Ammoperdix heyi heyi C
Ammoperdix heyi cholmleyi C +

Coturnix coturnix coturnix S **UC** C C
Gallus gallus gallus C
Family Numididae
Numida meleagris meleagris C
Order GRUIFORMES
Family Gruidae
Grus grus grus 0 C C
Anthropoides virgo R R R
Family Otididae
Otis tetrax orientalis +
Chlamydotis undulata undulata R R
Chlamydotis undulata macqueenii R R
Family Rallidae
Rallus aquaticus aquaticus C C
Porzana porzana S C C
Porzana prava C S S S
Porzana pusilla intermedia R R R R
Crex crex S S
Gallinula chloropus chloropus C AD AD AD
Porphyrio porphyrio madagascariensis C
Porphyrio alleni S~
Fulica atra atra R AD R
Order CHARDRIIFORMES
Family Rostratulidae
Rostratula benghalensis benghalensis C

Family Haematopodidae
Haematopus ostralegus ostralegus C R S S
Family Recurvirostridae
Himantopus himantopus himantopus R R C C
Recurvirostra avosetta R C R
Family Dromadidae
Dromas ardeola **S,C**
Family Burhinidae
Burhinus oedicnemus oedicnemus C C
Burhinus oedicnemus C
Burhinus senegalensis inornatus C
Family Glareolidae
Pluvianus aegyptius aegyptius +
Cursorius cursor cursor C

Glareola pratincola pratincola C R C C
Glareola nordmanni R R
Family Charadriidae
Charadrius hiaticula tundrae C 0 C C
Charadrius dubius curonicus R R S S
Charadrius pecuarius allenbyi S +
Charadrius alexandrinus alexandrinus C C C C
Charadrius leschenaultii 0 C C C
Charadrius mongolus atrifrons R R
Charadrius asiaticus R R
Eudromias morinellus S
Pluvialis squatarola S **UC** C C
Pluvialis apricaria apricaria S
Vanellus vanellus C C C
Chettusia leucura R R
Chettusia gregaria 0 R R
Hoplopterus spinosus 0
Family Scolopacidae
Calidris canutus canutus 0 0 R R
Calidris alba C· C C
Calidris temminckii R S S
Calidris ferruginea R S S
Calidris minuta **AD UC** AD AD
Calidris alpina alpina **AD** AD **AD**
Calidris alpina schinzii C C C

Limicola falcinellus falcinellus 0 R R
Tryngites subruficollis +
Philomachus pugnax C R C C
Lymnocryptes minimus S S S
Gallinago gallinago gallinago C C C
Gallinago media 0 R R
Scolopax rusticola R
Limosa limosa limosa R R C C
Limosa lapponica lapponica R R R
Numenius phaeopus phaeopus R R S S
Numenius arquata arquata S R S S
Numenius arquata orientalis S R S S
Numenius tenuirostris R R R
Tringa erythropus S C C

Tringa totanus totanus C 0 C C
Tringa nebularia S R C C
Tringa ochropus S R C C
Tringa glareola S R C C
Tringa stagnatilis S S S
Actitis hypoleucos S C C
Xenus cinereus . R R
Arenaria interpres interpres S S S
Family Phalaropodidae
Phalaropus lobatus R R
Phalaropus fulicarius R R R
Family Stercorariidae
Stercorarius skua skua A
Stercorarius pomarinus R R R R
Stercorarius parasiticus S S S S
Stercorarius longicaudus R R
Family Laridae
Larus hemprichii S,C S
Larus leucophthalmus C UC
Larus ichthyaetus R R R
Larus melanocephalus S R
Larus minutus - S
Larus ridibundus AD S AD AD
Larus genet S C C C C

Larus audouinii R R
Larus canus canus R
Larus fuscus fuscus C R C C
Larus argentatus cachinnans R C S
Rissa tridactyla tridactyla R
Chlidonias niger niger R R S S
Chlidonias hybrida hybrida 0 S C C
Chlidonias leucoptera C C C
Gelochelidon nilotica nilotica R S S
Hydroprogne caspia caspia C S S S
Sterna bengalensis par C R R
Sterna hirundo hirundo S C C
Sterna repressa C

Sterna anaethetus C
Sterna albifrons albifrons C
Sterna saundersi A A
Thalasseus bergii velox R
Thalasseus sandvicensis sandvicensis C S C C
Family: Rynchopidae
Rynchops flavirostris R +
Family: A1cidae
Alca torda islandica R R
Order PTEROCLIDIFORMES
Family Pteroclididae
Pterocles lichtensteinii lichtensteinii C
Pterocles orientalis orientalis 0
Pterocles alchata caudacutus A
Pterocles senegal/us C
Pterocles coronatus coronatus C
Pterocles exustus floweri R +
Order COLUMBIFORMES
Family Columbidae
Columba oenas oenas R
Columba livia schimperi C +
Columba livia dakhlae C
Columba livia livia C

Columba livia gaddi C
Streptopelia roseogrisea arabica C
Streptopelia decaocto decaocto C
Streptopelia turtur turtur C C
Streptopelia turtur arenicola C C
Streptopelia turtur isabellina C
Streptopelia senegalensis aegyptiaca AB +
Streptopelia senegalensis senegalensis AB
Oena capensis capensis R
Order rsrrr**ACIFORMES**
Family Psittacidae
Psittacula krameri manillensis C
Order CUCULIFORMES
Family Cuculidae
Cuculus canorus canorus S S
Clamator glandarius **R,b**

Centropus senegalensis aegyptius C **+**

Order STRIGIFORMES

Family Tvtonidae

Tyto alba alba C

Family Strigidae

Bubo bubo ascalaphus C

Asio otus otus **UC**

Asio flammeus flammeus S S S

Otus scops scops S S

Athene noctua glaux C

Athene noctua saharae • C

Strix butleri R

Order CAPRIMULGIFORMES

Family Caprimulsddae

Capr.imulgus europaeus europaeus S S

Caprimulgus europaeus meridionalis S S

Caprimulgus aegyptius aegyptius S

Caprimulgus aegyptius saharae S

Order APODIFORMES

Familv Anodidae

Cypselus parvus parvus **+**

Apus affinis galilejensis R R

Apus apus apus C C

Apus pal/idus brehmorum C

Apus pa/lidus illyricus C

Apus melba melba R R R

Order CORACIIFORMES

Family Coeaciidae

Coracias garrulus garrulus S S

Coracias abyssinica **+**

Family Alcedinidae

Alcedo atthis atthis 0 C C C

Ceryle rudis rudis C

Halcyon smyrnensis smyrnensis **l**

Family Meropidae

Merops orientalis cleopatra C **+**

Merops apiaster **R,b** C C

Merops superciliosus persicus C C

Family Upupidae

"

Upupa epops epops C C C
Upupa epops major C +
Order PICIFORMES
Family Picidae
.*Jynx torquilla torquilla* 0 S S
Junx torquilla tschusii R R

Order Passeriformes
FamilyEUrundUrldae
Riparia riparia riparia S AB AB
Riparia riparta shelleyi A,b
Riparia riparia diluta S AB AB
Ptyonoprogne rupestris rupestris R,I
Ptyonoprogne obsoleta obsoleta C
Ptyonoprogne obsoleta arabica C
Hirundo rustica rustica R C C
Hirundo rustica transitiva R C C
Hirundo rustica savigmii AB +
Hirundo daurica rufula C 0 0
Delichon urbica urbica 0 R C C
Family Alaudidae
Eremopterix nigriceps melanauchen C
Ammomanes deserti deserti C
Ammomanes deserti isabellinus R
Ammpmanes cincturus arenicolor C
Alaemon alaudipes desertorum C
Alaemon alaudipes alaudipes C
Chersophilus duponti margaritae S
Calandrella cinerea brachydactyla I S AB AB
Caiandrella cinerea hermonesis I s AB AB
Calandrella rufescens longipennis I S AB AB
Calandrella rufescens minor C
Calandrella rufescens nicolli C
Calandrella rufescens heinei R
Melanocorypha calandra calandra S
Melanocorypha bimaculata rufescens A C
Rhamphocorys clot-bey R R,I R,I

Eremophila bi/opha C

Galerida cristata nigricans AD +
Galerida cristata maculata AD
Galerida cristata altirostris AD
Galerida theklae superjIua C
Lullu/a arborea arborea R
Lullu/a arborea pallida R
A/uda arvensis cantarella C
Family Motacillidae
Anthus novaeseelandiae richardi R
Anthus campestris campestris S C C
Anthus campestris griseus S C C
Anthus trivialis C C
Anthus pratensis pratensis C
Anthus cervinus AD AD AD
Anthus spinoletta coutellii C C C
Motacilla jIava jIavissima **UC** C C
Motacilla jIava jIava **UC** C C
Motacilla jIava cinereocapilla **UC** C C
Motacilla jIava pygmaea C +
Motacilla jIava thunbergi **UC** C C
Motacilla jIava /e/degg C C
Motacilla cinerea cinerea C C C
Motacilla alba alba AD AD AD
Motacilla aguimp vidua R
Order Passeriformes
Family Laniidae
Lanius collurio collurio I C C
Lanius collurio isabellinus **R,I R,I**
Lanius nubicus S S

Lanius senator senator R R
Lanius senator niloticus 0 S S
Lanius minor minor .. C C
Lanius excubitor elegans C
Lanius excubitor aucheri C
Lanius excubitor pallidirostris C
Rhodophoneus cruentus cruentus C
Family Oriolidae
Oriolus oriolus oriolus C C

Family Sturnidae
Sturnus roseus R,I R,I
Sturnus vulgaris vulgaris C
Sturnus vulgaris purpurascens C
Sturnus vulgaris poltaratskyi C
Onychoganathus tristrami tristrami C
Family Corvidae
Pyrrhocorax pyrrhocorax docilis R
Corvus splendens splendens S
Corvus frugilegus frugilegus **R,I**
Corvus corone cornix C
Corvus corone sardonius C
Corvus ruficollis ruficollis C
Corvus corax tingitanus R
Corvus rhipidurus C
Corvus monedula soemmeringii +
Family Bombycillidae
Hypocolius ampelinus **R,I**
Family Pycnonotidae
Pycnonotus barbatus arisnae C
Pycnonotus barbatus xanthopygos C

Family Prunellidae
Prunella modularis modularis R,I
Prunella modularis obscura R,I
Family Sylviidae
Cettia cetti orientalis UC
Locustella luscinioides luscinioides I S S
Locustella luscinioides fusca I S S
Locustella fluviatilis R R
Locustella naevia naevia R R
Acrocephalus melanopogon S,I S,I
melanopogon
Acrocephalusschoenobaenus I C C
Acrocephalus palustris S S
Acrocephalus scirpaceus fusca UC 0
Acrocephalus stentoreus stentoreus AB
Acrocephalus arundinaceus S S
arundinaceus
Acrocephalus arundinaceus zarundnyi UC 0

Acrocephalus paludicola R R
Hippolais icterina icterina 0 S A
Hippolais pallida pallida AB
Hippolais pallida elaeica C C
Hippolais olivetorum R R
Sylvia nisoria nisoria R R
Sylvia hortensis crassirostris I R R
Sylvia borin borin C C
Sylvia atricapilla atricapilla S S
Sylvia communis communis C C
Sylvia communis icterops C C
Sylvia curruca curruca C C

Sylvia curruca affinis R R
Sylvia nana nana R R
Sylvia nana deserti R R
Sylvia ruppelli ruppelli R C C
Sylvia melanocephala melanocephala C C C
Sylvia melanocephala momus C C C
Sylvia melanocephala norrisae C
Sylvia melanocephala melanothorax A
Sylvia melanocephala mystacea **R,I R,I R,I**
Sylvia cantillans albistriata S S
Sylvia conspicillata conspicillata S
Sylvia sarda sarda A
Cercotrichas galactotes galactotes R C C
Phylloscopus trochilus trochilus C C
Phylloscopus trochilus acredula C C
Phylloscopus collybita collybita AB AB
Phylloscopus collybita abietina C C
Phylloscopus bonelli bonelli R C C
Phylloscopus bonelli orientalis R C C
Phylloscopus sibilatrtx sibilatrtx **UC UC**
Phylloscopus si bilatrix flavescens **UC** C
Phylloscopus inornatus inornatus **R,I R,I**
Regulus regulus regulus **R,I**
Regulus ignicapillus ignicapillus A
Prinia gracilis gracilis AB **+**
Prinia gracilis deltae AB **+**
Prinia gracilis palestine AB

Prinia gracilis natronensis AB +
Prinia gracilis carlo AB

Scotocerca inquieta inquieta C
Cisticola juncidis juncidis AB
Family: Muscicapidae
Ficedula hypoleuca hypoleuca R C
Ficedula albicollis albicollis R C
Ficedula albicollis semitorquata R C
Ficedula prava prava R S R
Muscicapa striata striata I C C
Family Turdidae
Saxicola rubetra rubetra C C
Saxicola torquata armenica C C C
Saxicola torquata rubicola C C C
Oenanthe oenanthe oenanthe I C C
Oenanthe pleschanka pleschanka R R R
Oenanthe pleschanka cypriaca UC,I UC,I UC,I
Oenanthe hispanica melanoleuca I C C
Oenanthe lugens lugens C
Oenanthe lugens halophila C
Oenanthe lugens persica C
Oenanthe deserti deserti C
Oenanthe deserti homochroa C
Oenanthe ftnschii ftnschii R
Oenanthe moesta moesta C
Oenanthe xanthoprymna S,C
xanthoprymna
Oenanthe isabellina C C C
Oenanthe monacha C
Oenanthe leucura syenitica A
Oenanthe leucopyga leucopyga C
Oenanthe leucopyga ernesti C

Oenanthe leucopyga ernesti C
Cercomela melanura melanura C
Cercomela melanura lypura C
Monticola saxatilis saxatilis I S C
Monticola solitarius solitarius 0 C C C
Monticola solitarius longirostris 0 C C C

Phoenicurus ochruros gibraltariensis C C
Phoenicurus ochruros phoenicuroides C C
Phoenicurus ochruros semirufus R R
Phoenicurus phoenicurus phoenicurus C
Phoenicurus phoenicurus samamisicus C
Erithacus rubecula rubecula C
Luscinia (= *Erithecus) megarhynchos* S C
megarhynchos
Luscinia luscinia C S
Luscinia (=Erithacus) svecica svecica C C C
Luscinia (=Erithacus) svecica C C C
cyanecula
Turdus pilaris I
Turdus ruficollis atrogularis A
Turdus torquatus alpestris I
Turdus torquatus amicorum R
Turdus merula merula C C
Turdus merula syriacus C
Turdus iliacus iliacus S,I
Turdus phi/omelos phi/omelos C
Turdus vis civorus viscivorus R,I
Family Timaliidae
Turdoides squamiceps squamiceps C
Turdoides fulvus acaciae +

Family Remizidae (=Paridae)
Remiz pendulinus menzbieri R
Family Nectariniidae
Anthreptes platurus metallicus C
Nectarinia habessinica he//mayri C
Nectarinia osea osea C
Family Esterildidae
Amamkwaama~aamamkwa C
Euodice cantans orientalis C
Family Passeridae
Passer luteus C,b C
Passer domesticus niloticus A
Passer domesticus halfae R
Passer domesticus biblicus AB
Passer domesticus italae A

Passer hispaniolensis hispaniolensis AB 0 AB AB
Passer hispaniolensis transcaspicus AB 0 AB AB
Passer montanus montanus A
Passer simplex simplex A
Passer moabiticus moabiticus A
Caprospiza brachydactyla R,I R,I s;
Family Ploceidae
Ploceus manyar peguensis C
Family Fringillidae
Fringi//a coelebs coelebs S
Fringilla montifringitla R
Serinus pusi//us R
Serinus serinus C
Serinus canaria syriacus R
Carduelis chloris chloris C C
Carduelis chloris aurantiiventris C C
Carduelis chloris chlorotica C C
Carduelis spinus S
Carduelis carduelis carduelis C
Carduelis carduelis niediecki C
Acanthis (= *Carduelis) cannabina* C
cannabina
Rhodopechys (= *Bucanetes)* C
githaginea
Rhodopechys (= *Bucanetes)* C
githaginea zedlitzi
Carpodacus erythrinus kubanensis **R,I** A
Carpodacus synoicus synoicus C +
Coccothraustes coccothraustes R
coccothraustes
Family Emberizidae
Emberiza (= *Milaria) calandra* C C C
calandra
Emberiza cineracea semenowi A
Emberiza hortulana 0 C C
Emberiza caesia C C
Emberiza cirlus cirlus A
Emberiza striolata striolata C
Emberiza striolata sahari C
Emberiza rustica rustica A A

Emberiza melanocephala R R
Emberiza schoeniclus schoeniclus A
Emberiza schoeniclus intermedia A
"

Re = Resident; WV = Winter Visitor; SV = Summer Visitor; AP = Autumn Passer
SP = Spring Passer; Ex = Extinct,
S = Scarce; A = Accidental; 0 = Occasional; R = Rare; C = Common;
UC = Uncommon; b = Breeder; En = Endemic, I = Irregular

GENERAL CHARACTERS OF MAMMALIA

Animals belonging to class Mammalia are referred to as mammals. Mammals are one of the most evolved species in the animal kingdom categorized under vertebrata.
They exhibit advanced characteristics which set them apart from all other animals. They are characterized by the presence of mammary glands through which they feed their younger ones.
They are distributed worldwide and have adapted well to their surroundings – from oceans, deserts and polar regions to rainforests and rivers etc.
Let us have a detailed look at the characteristics and classifications of the animals belonging to the class Mammalia.

Characteristics Of Mammals

Following are a list of distinct characteristics of mammals that separates them from other classes:

1. Mammals are warm-blooded animals who give birth to their younger ones.
2. They are the most dominant form of animals found in almost all types of habitats.
3. They have mammary glands that help them produce milk to feed their younger ones
4. Presence of region of the brain known as Neocortex
5. Their skin possesses oil glands (sebaceous glands) and sweat glands (sudoriferous glands).
6. The fur of hair throughout the body which helps animals adapt to their environment.
7. They are heterodont, i.e., possess different types of teeth.
8. Mammals also possess cervical vertebrae.
9. The skull is dicondylic.
10. The trunk is divided into thorax and abdomen.
11. The mammals respire through lungs.
12. Good sense of hearing as mammals are aided with 3 middle ear bones
13. Mammals have a four-chambered heart. The sinus venous and renal portal system are absent.
14. Presence of single-boned lower jaws.
15. The brain is well developed divided into cerebrum, cerebellum and medulla.
16. They possess 12 pairs of cranial nerves.
17. Exhibit one of the most advanced forms of Diaphragms.
18. The mammals can lay eggs also. They are known as viviparous.

Classification Of Mammals

Mammalia has the largest class in the animal kingdom. Based on their reproduction, they are classified into three subclasses:

- Eutheria
- Metatheria
- Prototheria

Definition of Mammals:

Among vertebrates, mammals became most fully suited for life on land. There are many species of mammals in which the process of life are carried on under conditions far remote from those in which life first arose.

The information in their DNA provides them with numerous special adaptive devices. The success of the mammals in maintaining life in strange environments is largely due to the remarkable powers they possess of keeping their own composition constant.

Besides the regulation of temperature, there is also regulation of nearly all components of the blood, which are kept constant within narrow limits. Therefore, the most characteristic features of the modern mammals are seen to be largely in their behaviour and soft structures.

Mammals can be defined as ‘highly percipient and mobile animals, with large brains, spiral cochlea, warm blood, left aortic arch, and water-proof, usually hairy skin, whose young are born alive, and are nourished by milk.

General Characters of Mammals:

1. Body of mammals is covered by epidermal hair.

2. Integumentary glands are — sweat (sudoriferous), sebaceous (oil), scent (odoriferous) glands.

3. Mammary glands are present to supply milk for the nourishment of suckling young.

4. External fleshy pinna is present in mammals.

5. Eyes with upper and lower eyelids and often with eyelashes.

6. Nictitating membrane is translucent and hairless; it is vestigial in higher mammals.

7. A muscular diaphragm is present in between the thoracic and abdominal cavities.

8. Endo-thermal homoeotherm animals.

9. RBCs are non-nucleated, biconcave and usually circular in form.

10. The four-chambered heart is highly powerful.

11. Only left aortic arch is present in the arterial system.

12. Cerebral hemispheres are very large and highly convoluted.

13. Cerebellum is large, complex and solid in mammals.

14. There is a single urinary bladder in mammals.

15. Testes remain in scrotal sacs.

16. Small eggs are devoid of yolk. Fertilisation is internal.

17. Mammals are viviparous animals.

18. The skull has double occipital condyles. Quadrate absent.

19. A bony palate is formed by the union of premaxillae, maxillae and palatines that separates the nasal passage from the buccal cavity.

20. The lower jaw is composed of a pair of bones — the dentaries.

21. Vertebrae are acoelous type.

22. Ribs are double-headed — capitulum and tuberculum.

23. The teeth are heterodont, thecodont and diphyodont type.

24. Molars are tribosphenic (three-cusped).

25. Paired forelimbs and hind limbs are present in mammals.

26. The digits of the limbs are provided with either claw or nail or hoof.

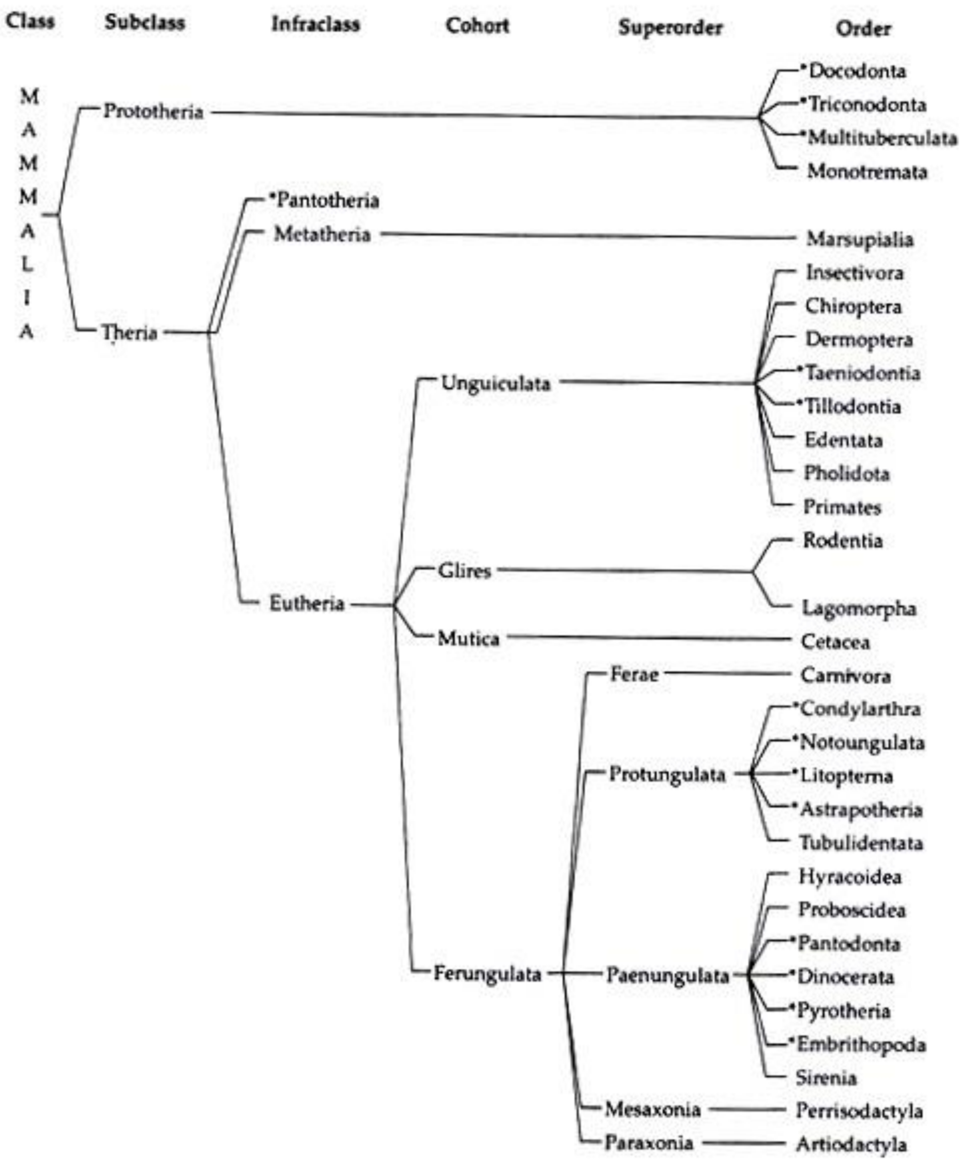
27. Cranial nerves twelve pairs.

28. Kidneys are metanephric type.

Scheme of Classification of Mammals:

Like other chordates, the classification of mammals is a very controversial and complex matter. There are several schemes of classification that exists in different literatures. But none of the existing classifications is beyond criticism.

However, in the present text, classificatory scheme of mammals as proposed by J. Z. Young (1981) is followed. In the scheme all the groups up to order are mentioned. But, for description, only living groups are considered. The extinct groups are marked with asterisks (*):



Subclass — Prototheria (Greek: protos = first, therion = beast):
General Characters:

1. The females lay eggs.

2. The testes are abdominal.

3. The cloaca receives the openings of urinary bladder, vas deferens and ureters.

4. Ribs possess single head.

5. The mammary glands lack teats.

6. External pinna absent.

7. In childhood, teeth are present but adults lack teeth.

This subclass includes four orders of which only Monotremata is the living group, others are extinct.

Order — Monotremata:
General Characters:
1. Body is covered over with soft hair. Hair on the dorsal side may be coarse or spine-like.

2. Webbed digits are ended in sharp claws.

3. Pinna is distinct but small.

4. In males, poison spur is present.

5. Brain lacks corpus callosum.

6. Tail may be present or absent.

7. Dental formula is i = 0/5, c = 1/1, p = 2/2, m = 3/3.

8. Body temperature varies in between 25°-28°C.

9. Pectoral girdles resemble that of reptiles.

10. Eggs are large and undergo meroblastic cleavage.

11. Tongue is long and sticky.

12. Sutures are obliterated in the skull.

Examples:
Ornithorhynchus, Tachyglossus, Zaglossus, Echidna. The monotremes occupy a most interesting position among mammals, because of their distribution,

anatomical peculiarities and systematic position. Both the reptilian and mammalian characters are present in monotremes, which lead to consider them as connecting link. Only three genera of monotremes are found in Australia, Tasmania and New Guinea.

Subclass — Theria (Greek: therion = beast):
General Characters:
1. Female members of this subclass do not lay eggs but give birth to young ones.

2. Mammary glands are provided with nipples or teats.

3. Pinna or external ear is present.

4. The ureters open directly into the urinary bladder.

5. At the end of the digestive tract an anus is present.

6. Teeth are present throughout the life period.

7. Testes are situated in the scrotum.

8. Ribs possess two heads for articulation with vertebrae.

This subclass includes three infraclasses, of which Pantotheria is extinct.

Infraclass — Metatheria (Greek: Meta = next to):
General Characters:
1. The youngs are born in an immature condition and undergo further development in the marsupium of females.

2. Mammary gland with teats opens into the marsupium.

3. Epipubic bone of the pelvic girdle protects the marsupial sac.

4. Placenta is chorioviteline type.

This infraclass includes single order.

Order — Marsupialia (Latin: Marsupium = a sac):

General Characters:
1. Body in covered with soft fur.

2. Pinna is well developed.

3. Most of the female members possess marsupium.

4. Tail is well-developed and helps in balancing.

5. The second and third toes of the hind-limb are slender and remain enclosed in a sheath of skin, i.e., syndactylous digits. The fourth toe is largest. All digits are clawed.

6. Forelimbs are shorter than the hind limbs.

7. Dental formula is i = 5/4, c = 1/1, p = 3/3, m= 4/4.

8. Caudal vertebrae are with chevron bone.

9. Atlas is incomplete and is provided with cartilage in the ventral incomplete side.

Examples:
Macropus (Kangaroo), Didelphis (Opossum), Thylacinus (Tasmanian wolf – the mystery marsupials), Myrmecobius (Banded ant-eater), Nottoryctes (Marsupial mole), Petaurus (Flying opossum), Phascolarctos (Koala bear), Vombatus (Wombat), etc.

Infraclass — Eutheria (Greek: eu = true):
General Characters:
1. The young are born as miniature adult and go through a considerable period of prenatal growth.

2. A highly-organised allantoic placenta attaches firmly with the uterine wall during developmental period.

3. Brain is highly-developed, cerebral hemispheres have well-developed neo-pallial region. The two hemispheres are connected by corpus callosum.

4. The anal and urinogenital apertures are separate.

5. The tympanic bone is ring-like and forms a tympanic bulla.

6. Dental formula is i = 3/3, c = 1/1, pm = 4/4, m = 3/3. In some forms there are modifications in dental formula, and in some cases teeth are absent.

7. Epipubic bone in the pelvis is absent.

Cohort — Unguiculata:
General Characters:
1. These eutherians possess nails or claws in their digits.

This Cohort contains eight orders, of which two are extinct.

Order — Insectivora (Latin: insecta= in sects; voro = to eat):
General Characters:
1. Body covered with hair. Some members possess dorsal spines which are modified hair.

2. Nocturnal animals with long snout are insectivorous.

3. Skull is constricted in the middle.

4. The zygomatic arch and bony palate are incomplete.

5. Teeth have sharp molar cusps.

6. Each limb possesses five digits with claws.

7. Locomotion is plantigrade type.

8. Caecum in the intestine is small or absent.

9. Scrotum is absent and the testes are internally situated.

10. Uterus is bicornuate type.

11. Mammary glands are many and are distributed all along the two milk-lines on the ventral surface.

Example:
Talpa (Mole), Tupaia (Tree- shrew), Erinaceus (Hedgehog), Sorex (Shrew), Desmana (Water mole), Chrysochloris (Golden mole), Neomys (Water shrew).

Order — Chiroptera (Latin: cheir = Hand; pteron = wing):
General Characters:
1. The forelimbs are modified to form wings.

2. The bones of the digits of the forelimbs are elongated except pollex. These bones support a membrane that runs between forelimbs and hind limbs. This membrane is called as patagium.

3. An inter-femoral membrane is present between the femurs. It is supported by a cartilaginous calcar of the ankle.

4. A short tail is often included in the inter-femoral membrane.

5. The wings are having direct arteriovenous connections.

6. Pollex is small, free from the wing and bears claw.

7. The hind limbs are weak, having five clawed-digits.

8. Pinna is well-developed.

9. These are nocturnal animals. They are able to fly and catch prey in the dark with the help of their special radar system. This capacity is called echolocation.

10. The sutures of the skull is obliterated.

11. The ribs are flat and fused with the vertebrae to become rigid during flight.

12. The hind limbs are rotated, so the knee is directed backward.

13. The testes are abdominal in position.

14. Only one young is born at a time.

15. The sternum is provided with a flat keel for the attachment of pectoral muscle.

Examples:
Pteropus (Fruit bat) (Fig. 1.129A and C), Rhinolophus (Horseshoe bats), Desmodus (Vampire bats) (Fig. 1.129B), Vespertilio (European bats) (Fig. 1.129D).

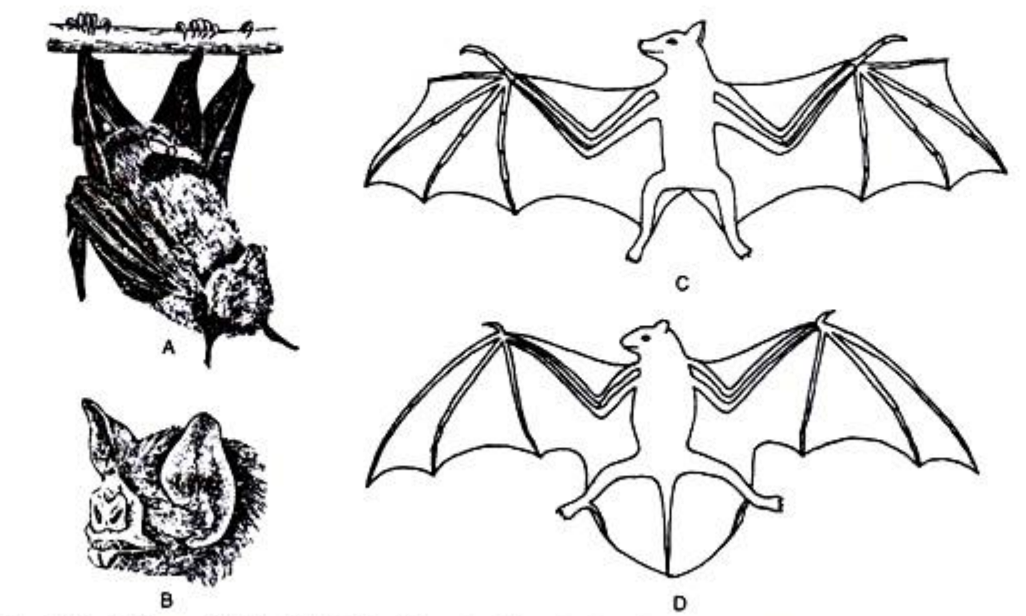


Fig. 1.129 : A. *Pteropus* (Fruit bat), B. Head of *Desmodus* (Vampire bat). C. & D. Diagrammatic figure of *Pteropus* and *Vespertilio*, respectivey. Note the patagium between the hind limbs in two groups of bats and the presence of tail in the latter

Fruit bat (Pteropus) is the member of suborder Megachiroptera and others are member of suborder Microchiroptera. The chiropterans are the only mammals that truly fly, by flapping their wings, as distinct from the soaring of flying phalangers, colugos and others. In acquiring the power of flight they have evolved many features in parallel with birds.

The method of flight of many forms is specialised to give the great maneuverability needed for catching insects by echolocation at short distances rather than by vision. The wings vary greatly but are thin aero foils, often with high camber, giving high lift at low speed.

The evolutionary history of chiroptera is inadequately known. The first known bats are reported from the Eocene period. The bats are numerous and their distribution is worldwide.

Order — Dermoptera (Latin: Derma = skin; pteron = wing):
General Characters:
1. These are herbivorous, tree-living and their size is like that of a large squirrel.

2. The lower incisors are combed.

3. The tympanic ring forms the bulla and the lower margin of the external auditory meatus.

4. Brain is primitive and the optic lobes are not covered by cerebrum.

5. A broad fold of hairy skin extends between the legs and up to the tail, with which it glides long distances from one tree to another.

6. Fingers are not elongated to support the wings as in bats.

Example:
Cynocephalus (= Galeopithecus) (Flying lemur or colugo).

Order — Edentata (Latin: E/ex = without; dens = tooth):
General Characters:
1. Incisors and canines are absent but molars are long and similar in appearance.

2. Enamel and root of the teeth are absent but pulp cavity is persistent.

3. Tongue is sticky in nature.

4. Skull is small in comparison to body size.

5. The zygomatic arch is reduced or absent.

6. Olfactory lobe of the brain is well-developed.

7. In the pectoral girdle, clavicle is present but the coracoid and acromion are fused.

8. In the pelvic girdle, ischium is united with anterior caudal vertebrae.

9. Posterior thoracic and lumbar vertebrae are with additional pair of zygapophyses.

Example:
Dasypus (Nine banded armadilo), Myrmecophaga (Giant ant-eater),

Cyclopes (Two toed ant-eater), Bradypus (Three toed sloth), Choloepus (Two-toed sloth).

Order — Pholidota (Greek: pholis = scale):
General Characters:
1. Horny scales are present in an imbricated fashion. On the dorsal side of the head, body and tail. Few hair peep through these scales.

2. The ventral side of the body is covered with hair.

3. Eyes are small and pinna is ill-developed.

4. Tail is long and tapering.

5. The short and powerful limbs possess five clawed-digits in each.

6. The claws of the forelimbs are curved and sharp.

7. Locomotion by hind limb is plantigrade in nature.

8. The facial part is prolonged to form a short muzzle.

9. Tongue is long, sticky and protrusible and is retained in a sac.

10. Teeth are absent.

11. Skull is long and cylindrical.

Example:
Manis crassicaudata (Indian Pangolin), M. pentadactyla (Chinese Pangolin).

Order — Primates (Latin: primus = first; Primate = One first in rank):
General Characters:
1. Body is covered with thick hair except the palm, sole and some parts of the face.

2. Neck is short and mobile.

3. Forelimbs are shorter than hind limbs.

4. Pentadactyl limbs possess digits with flat nail.

5. The pollex or thumb, hallux or first toe are smaller than other digits and are opposable.

6. Locomotion is plantigrade type.

7. A tail is present.

8. Mammae are two and thoracic in position.

9. Testes lie in scrotal sac.

10. Highly developed brain possesses much convoluted cerebral hemispheres.

11. The eyes are directed forward and the vision is binocular and stereoscopic.

12. Teeth show reduction in number.

13. The skull is more inclined to the vertebral axis.

14. Zygomatic arch is complete.

15. Foramen magnum faces downward.

Example:

Homo sapiens (Man), Gorilla, Presbytis (Langur), Macaca (Rhesus monkey, Macaque), Papio (Babon), Hylobates (Gibbon), Pongo (Orangutan), Pan (Chimpanzee), Callithrix (= Hapale) (Marmoset), Loris (Slender loris), Lemur, etc.

The term 'primate' carries with it the implication that the animals in the group are not only the nearest to man but are also in some sense the first or most completely developed members of the animal world. But these are not so specia-lised as they are believed to be.

The primates have retained many primitive and generalized eutherian characters. They are primarily arboreal and return to land as a secondary condition. These are omnivorous in habit.

Cohort — Glires:
General Characters:

1. Teeth are specialized for gnawing.

2. Skull is long and low.

3. Temporal fossa widely opens to the orbit.

4. Brain is small with small cerebral hemispheres.

5. Limbs are pentadactyle.

6. Radius and ulna are separate.

This cohort is divided into two orders — Rodentia and Lagomorpha.

Order — Rodentia (Latin: rodere = to gnaw):
General Characters:

1. Body is covered with soft hair.

2. Eyes are small but pinna is well-developed.

3. Limbs are provided with blunt claws.

4. Forelimbs are smaller than the hind limbs.

5. Locomotion is plantigrade type.

6. Jaw muscles are well developed for gnawing. Intestine and caecum are large.

7. Testes are inguinal.

8. Prolifically reproducing animals. Females possess abdominal teats.

9. Single pair of large, chisel-shaped incisors are present both in upper and lower jaws.

10. Canine and anterior premolars are absent forming a diastema between incisors and cheek teeth.

11. There are two premolars in the upper jaw and one in lower jaw.

12. The scapula is provided with acromion process.

Example:
Sciurus (Squirrel), Petaurista (Flying squirrel), Rattus (Rat), Mus (House mouse), Hystrix (Porcupine), Cavia (Guinea- pig) (Fig. 1.130), Bathyergus (Mole-rat), Cricetus (Hamster), Mesocricetus (Golden hamster), Microtus (Vole), Dipus (Jerboa), Castor (Beaver), Geomys (Pocket gopher), Dipodomus (Kangaroo rat), Citellus (Ground squirrel), Marmota (Moarmot, woodchuck).

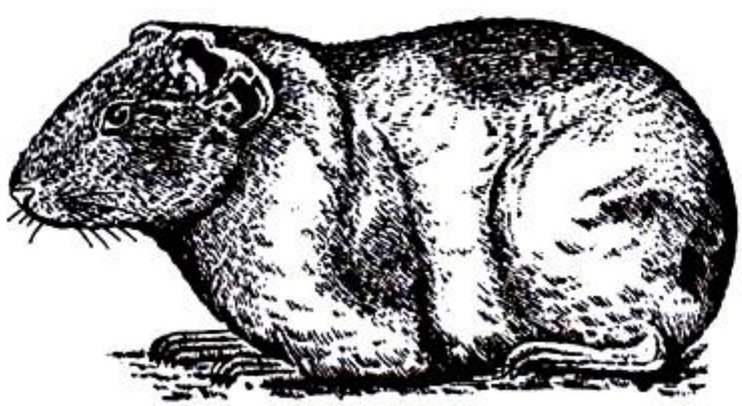


Fig. 1.130 : *Cavia* (Guineapig)

Order — Logomorpha (= Duplicidentata) (Latin: logos = hare; morph = form):

General Characters:

1. Body is covered with soft hair.

2. Eyes are large and pinna is long.

3. Pentadactyle limbs possess clawed digits.

4. Hind limbs are larger than forelimbs.

5. The upper lip is provided with a cleft in the middle.

6. Tail is almost vestigial.

7. Masseter muscles are enormously developed but temporal muscles are weak.

8. Testes lie inside the scrotum.

9. Mammary glands are abdominal in position.

10. Maxillae are laterally fenestrated.

11. There are two pairs of incisors in the upper jaw, while it is one pair in lower jaw.

12. The incisors of the upper jaw are unequal. A larger pair situated in front and smaller pair lie behind it.

13. Canine absent and diastema is present.

14. There are three premolars in upper jaw and two in lower jaw.

15. Scapula is with acromion and metacromion process.

16. Tibia and fibula are fused.

Example:

Lepus (Hare), Oryctolagus (Rabbit), Ochotona = Lagomys (Pika, Cony), Lepus nigricollis (Indian hare), Ochotona roylei (Himalayan mouse hare), Caprologus hispidus (Hispid hare of Himalaya).

Cohort — Mutica:
General Characters:
1. These animals lack vocal cords and are known as silent animals. But can emit sound for various purposes, which is called 'whale song'.

2. These animals are completely aquatic throughout their life cycle.

Order — Cetacea (Latin: cetas = whale):
General Characters:
1. The large, torpedo shaped body devoid of hair.

2. The skin is smooth and skin glands are absent.

3. The nictitating membrane of eye, pinna of ear and nail of the digits are absent.

4. Forelimbs are modified to form flippers, hind limbs are absent.

5. The nasal openings are asymmetrical, located far back on the upper surface of the head and can be closed by valves.

6. The tail terminates in a horizontal fin, called fluke. It is a neomorphic structure.

7. Dorsal fin is fleshy; it is also a neomorphic structure.

8. A thick subcutaneous fat layer, called blubber, is present.

9. The lungs are highly elastic and extensible.

10. Brain is highly developed but olfactory lobe is reduced.

11. Two mammary glands are located in the inguinal area.

12. Single, large, well-formed young is born at a time.

13. The cranium is dorsoventrally flattened and the facial part is elongated.

14. Cervical vertebrae are fused to form a bony mass.

15. Sacral vertebrae are absent.

16. Caudal vertebrae are with chevron bones.

17. Ribs lack heads.

18. Number of digits are either reduced to four or increased to more than five (hyperdactyly). Numbers of phalanges are more than the usual number in second and third digits (hyperphalangy).

19. Humerus is short, stout and its head moves freely in the glenoid cavity.

Example:
Platanista (Ganges dolphin), Physeter (Sperm whale), Delphinus (Dolphin), Phocaena (Porpoise), Balaenoptera (Blue whale), Balaena (Right whale).

Cohort — Ferungulata:
1. Modern carnivores and hoofed animals, all are members of this group.

2. From the fossil records it is evident that all of them arose from a common ancestral population in Palaeocene period.

The cohort Ferungulata is divided into five super orders for the convenience of classification.

Superorder — Ferae:
1. All the living members of this group are carnivorous.

Order — Carnivora (Latin: carno = flesh; voro = to eat):
General characters:
1. Pentadactyle limbs, with digits ending in sharp claws and claws may be retractile.

2. Locomotion is either digitigrade or plantigrade type.

3. Intelligence in the form of mental alertness and coordinated actions is evident.

4. Brain is highly developed.

5. Intestine is short and caecum is small or absent.

6. Testes are present in scrotal sac.

7. Mammae are abdominal in position.

8. Placenta is deciduate and zonary.

9. Uterus is bicornuate in shape.

10. Skull is short. Sagittal and lambdoidal crests are well-developed.

11. Zygomatic arch is strongly built.

12. Each jaw possesses three pairs of incisors. Canines are large, sharp and pointed.

13. The last upper premolar and first lower molar transformed into blades, and act as incisors — they are jointly known as carnassial teeth.

14. The atlas is large and is provided with wing like lateral processes.

15. Thoracolumbar vertebrae are 20 to 21 in number.

16. Sternum is long narrow and made up of 8 to 9 sternibrae. Sternal ribs are not calcified.

Examples:
Canis (Wolves, Dogs, Jackals etc.), Vulpes (Fox), Ursus (Bear), Procyon (Raccon), Ailurus (Panda), Ailuropoda (Giant Panda), Viverra (Civet), Herpestes (Mongoose), Hyaena (Hyena), Felis (Cats, Pumas, Leopards, Lions, Tigers, Jaguars), Eumetopias (Sea lion), Odobenus (Walrus), Phoca (Seal), Mephitis (Shunk), etc.

Superorder — Protungulata:

All the members of this group are unguiligrade and herbivorous. This super order includes five orders, among which four are extinct.

Order — Tubulidentata (Latin: tubulus = small tube; dens = teeth):
General Characters:
1. Body is covered by a dull-grey skin with unevenly distributed hair.

2. Head is elongated to form a tubular snout.

3. Pinna is long in size.

4. Four toed forelimbs possess clawed digits. Hind limbs possess five toes with clawed digits. The limbs are powerful.

5. Small mouth possesses long, protrusible tongue.

6. The cheek teeth are 4 or 5 in number, which lack enamel but a coating of cement is present. Incisors and canines are absent.

7. These are ant-eater in habit.

Example:
There is only one representative species present till now. Orycteropus after (ardvark) living in Africa and known as cape ant-eater.

Superorder — Paenungulata:
General Characters:
1. They are all herbivorous animals.

2. The legs are with long upper segments, ulna and fibula complete.

3. They possess several digits, with nail but no well-marked hoofs.

4. The incisors and canine become reduced to single pair of large tusks in each jaw and the molars are specialised for grinding, with development of cross-ridges.

Simpson (1945) suggested the name paenungulata (= near ungulates).

Order — Hyracoidea (Greek: hyrax = shrew; eides = form):
General Characters:
1. These are rabbit-like animals, with short tail and short pinna.

2. Locomotion is plantigrade type.

3. Forelimbs possess four functional digits and fifth one remains as vestige.

4. There are three digits in each hind limb. First and third digits possess hoof while second digit is clawed.

5. The caecum has a pair of caecal pouches.

6. Abdominal testes are present.

7. Mammae are pectoral in position and two in number.

8. Uterus is paired; the placenta has an annular avascular allantois and haemochorial in nature.

9. Single pair of large and curved upper incisors with persistent root is present. Canines are absent.

10. The lower incisors are comb-like and four in number.

11. There is a diastema and seven grinding molariform teeth of bunoselenodont type, with transverse ridges.

12. Brain is of macro somatic type.

Example:
Procavia (= Hyrax), Dendrohyrax (Tree hyrax).

Order — Proboscidea:
General Characters:
1. These are largest living land vertebrates.

2. Thick skin with scanty hair.

3. An enormously elongated nose and upper lip, with appropriate muscles and sensitive grasping tip makes the proboscis.

4. Only one pair of continually growing upper incisors forming the two enormous un-curved tusks. These are composed of solid dentine except for a temporary cap of enamel at the tip.

5. Nostrils are situated at the tip of the trunk.

6. Eyes are small but pinna is large.

7. Pentadactyle limbs are pillar-like. Digits are hoofed.

8. The weight of the head is reduced by extensive development of air sinuses between the inner and outer tables of bones of the skull.

9. The immensely large hypsodont molars with numerous sharp transverse ridges are parts of the powerful grinding apparatus.

10. The skeleton shows typical graviportal features. The backbone is based on a 'single girder' plan, with twenty ribs and high thoracic neural spines.

11. The ilium is nearly vertical and expanded transversely for the attachment of large muscles.

12. Cerebral hemispheres are relatively small and leave the cerebellum uncovered.

13. Stomach and intestine are simple. There is no special chamber in stomach for fermentation of herbaceous food.

14. The caecum is long and sacculated and there is an ileocaecal sphincter.

15. Testes lie close to kidneys, no scrotal sac is present.

16. The two horns of the uterus remain separate, though united externally.

17. Only one young is born at a time. Gestation period 22 months.

18. Placenta have at the poles, areas of diffuse, non-deciduate structure, while in an annular zone round the middle there is much invasion of the trophoblast.

Example:
Elephas (Asian elephant), Loxodonta (African elephant).

Order — Sirenia (Greek: siren = sea nymph):
General Characters:
1. These are herbivorous animals, highly adapted for aquatic life.

2. They have a streamlined body form, with few hair and thick blabber.

3. The muzzle is round and the upper lip is protruding.

4. Nostrils are located on the upper surface of head and are provided with valves.

5. Neck is short and pinna is absent. Eyes are small with muscular eyelids.

6. There are no hind limbs and the pelvic girdle remains only as small rods.

7. The forelimbs are large; the digits are joined to form paddles, with a full pentadactyle structure.

8. Caudal vertebrae are well-developed.

9. A strong terminal horizontal fin is present.

10. Ribs are round and the diaphragm is oblique.

11. Lungs contain large air sacs.

12. Brain is small and the ventricles are exceptionally large.

13. The front parts of the jaw carry no teeth at the front, but have horny pads. The teeth form a series of pegs, with two transverse ridges.

14. Stomach is complex and intestine is very long.

15. Testes are abdominal. Uterus is bicornuate.

16. Placenta shows a zonary arrangement and haemochorial structure,

17. The young are born in water and nursed at pectoral teats.

Example:
Dugong (= Halicore) (Sea cow), Manatus (= Trichechus) (Manatee).

Superorder — Mesaxonia:
1. Axis of the limbs passes through the third digit (middle axis). This is called the mesaxonic condition. The remaining digits are reduced.

Order — Perissodactyla (Greek: perissos = odd; daktylos = finger):
General Characters:
1. These are large, herbivorous mammals having streamlined body.

2. The neck and facial parts are elongated.

3. Tail is with long tuft of hair.

4. The powerful limbs are suitable for fast movement.

5. The lower part of the limbs became elongated and the upper segments shortened.

6. One distal carpal, the capitate (magnum), become enlarged and interlocked with the proximal carpals.

7. Of the five digits, the first and fifth digits are lost. The second and fourth digits remain as splints. The middle or third digit is stout and is provided with hoof.

8. Stomach is simple and undivided.

9. Digestion of cellulose takes place by symbionts in the caecum and large intestine.

10. Brain is relatively small and macrosmatic type. Olfactory lobe is highly developed.

11. Skull is elongated.

12. The incisors are three in each quadrant of the jaws. The incisors having pit on the free surface.

13. The canine may be reduced or absent and there is often a diastema.

14. The molars have developed an elaborate grinding surface with the formation of a longitudinal ectoloph along the outer edge of the upper molar and parallel transverse ridges, the protoloph and metaloph.

15. Ulna and fibula are reduced.

16. The femur is provided with a prominent process on the other surface of the shaft. The process is called third trochanter.

17. Astragalus has a double-keeled pulley-shaped surface for articulation with tibia.

18. The third metatarsal of the hind limb is long and erect and is known as cannon bone.

19. Uterus is bicornuate. Placenta is of diffuse epitheliochorial type, with a large allantoic sac.

20. The yolk sac grows to a large size and forms a yolk sac placenta during the early part of the development.

Example:
Tapirus (Tapir), Rhinoceros (Rhinos — Indian and Javan), Dicerorhinus (Horses, Asses, Zebras).

Superorder — Paraxonia:
1. Axis of the limbs passes through the third and fourth digits.

Order — Artiodactyla (Greek: Artios = even; daktylos = finger):
General Characters:
1. These are even toed ungulates and latest mammalian herbivores.

2. Neck is elongated but tail is small.

3. Usually possess a pair of epidermal horns. Horns may be hollow or solid and are located on the frontal bone of the skull.

4. The characteristic of the limbs is the equal development of third and fourth digits, with reduction of the rest.

5. Gait is digitigrade type. Hoofs have developed on the toes.

6. The long metapodials have become united to make the cannon bone.

7. The presence of two digits has led to the retention of two bones in the distal row of carpals, the hamate (unciform) and fused magnum-trapezoid. These articulate in interlocking fashion with the three proximal carpals.

8. In the hind foot the two cuneiforms are fused to provide thrust upon the third digit, while the fourth sends its thrusts to the cuboid and the latter is fused with the navicular.

9. The eyes are large with horizontal pupil. Pinna is large with an acute sense of hearing.

10. Tongue is long, mobile, prehensile and pointed.

11. The upper incisors are lost, which crop up by means of the lower incisors biting against the hardened gum of the pre- maxilla.

12. The canine may form tusks.

13. Molars are of hypsodont and solenodont (moon-tooth) condition.

14. Stomach is complicated and divided into several chambers.

15. Intestine is short and a short caecum is present.

16. Mammae are abdominal or inguinal in position and may be more than one pair.

17. Brain is moderately developed. The olfactory organ and related parts of the brain are well-developed.

18. The uterus is bicornuate type.

19. Placenta of pig is of diffused epitheliochorial type. In ruminants there is a cotyledonary placenta, but the contact between maternal and foetal tissues is never very close (Syndesmochorial) and the allantois is usually large.

Examples:
Sus (Pig), Hippopotamus (Hippo), Camelus (Camel, dromedary — Asia), Moschus (Musk deer), Ceruus (Red deer), Dama (Fallow deer), Rangifer (Rein deer), Giraffa (Giraffe), Gazella (Gazelles), Bos (Cattle, Yak), Bison (Buffalo), Capra (Goat), Ovis (Sheep).