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A NEW CLASSIFICATION FOR THE NON-PASSERINE BIRDS OF THE WORLD,

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INTRODUCTION.

Most ornithologists have no clear idea how the contemporaneous check-lists and classifications for the birds of the world, proposed by WETMORE (1930, 1934, 1951, 1960), STRESEMANN (1927-1934), PETERS (1931-...), MAYR & AMADON (1951) e.g. came into being. It ought to call back to mind that the approaches of these authors to the main problems of ornithosystematics are straightlined and parallel, since both PETERS, MAYR & AMADON (although with some minor changes) followed the sequence proposed by WETMORE, while this author took the work of GADOW (1893) as a starting point (1930, p. 1) : « Such changes have been incorporated as seem justified from personal research or from the investigations of others. In general, only such variations from the current order have been accepted as seem to be firmly established. Where doubt seems to attach to any proposition, the older classification has been followed; so the following scheme presents a conservative arrangement as far as possible ». Returning back to the source of all modern classifications, I quote now GADOW (1893, p. 52) : « Es ist nicht möglich, hier in der Kürze aufzuzählen, wie viel die Ornithologie FÜRBRINGER (1888) verdankt. Der anatomische Theil von BRONN's Vögeln ist schon voll davon und der vorliegende systematische Theil ist es nicht weniger. Es ist eben schwer, das Gute besser zu machen, und wo fast Alles bedacht worden, da lässt sich nicht viel Neues hinzufügen. Kein Ornithologe wird ernstlich ohne FÜRBRINGER's Werk weiter arbeiten können, aber einzelne der zahlreichen darin aufgezählten

Merkmale herauszugreifen, darauf hin die FÜRBRINGER'schen Gruppennamen in anderem Sinne zu gebrauchen und so ein « neues System » zu machen, d a m i t w i r d n i c h t v i e l e r r e i c h t w e r d e n ». « Das Ganze ist von Anfang bis zu Ende logisch durchgearbeitet. Wo Zweifel herrschen, und deren giebt es viele, ist das Für und Wider ausführlich besprochen, aber hierin liegt zugleich die Schwäche des ganzen Werkes. Der Verfasser treibt die Vorsicht zu weit ». « Es gelang FÜRBRINGER die Vögel in ungefähr 46 Gentes zu sichten, Gruppen, an denen sich mit wenigen Ausnahmen kaum etwas ändern lassen wird. Seine Gentes vereinigt er zu 24 Unterordnungen, worin aber nicht weniger als 9 intermediäre Unterordnungen einbegriffen sind. Da es nicht klar ist, zu welchen der 8 Ordnungen diese unsicheren Unterordnungen zu stellen sind, so verlieren die 8 Ordnungen in der Praxis viel an gewicht, was um so mehr zu bedauern ist, da doch gerade in der Aufstellung der grösseren und grössten Abtheilungen FÜRBRINGER ganz neue Grundzüge dargelegt hat ».

With respect to these considerations, GADOW, guided by some practical and didactical purposes, amended FÜRBRINGER's classification in the following way : the 8 orders were dropped, the 20 suborders (with suffix *-iformes*) took order status, the 40 gentes (cf. FÜRBRINGER 1902) were considered as suborders, the *Ciconiiformes* and the *Pico-Passeriformes* broken up while the *Accipitres* were raised in the hierarchy from gens to order.

GADOW's amendation, leading to a « new » scheme, had, from the viewpoint of evolutionary taxonomy, two important consequences; first, that the disintegration of the 8 groups of suborders gave rise to the idea that FÜRBRINGER's orders were the result of groping and, second, that on a basis of comparative anatomy it is quite impossible to express true relationships within the class of birds.

However GADOW's classification did not satisfy BEDDARD (1898) who dropped all FÜRBRINGER's orders and suborders, while nearly all FÜRBRINGER's gentes took order status (33). These two different expressions of FÜRBRINGER's systematics of birds were interpreted once more in recent times, GADOW's amendation by WETMORE and BEDDARD's procedure by STRESEMANN. While WETMORE accorded to GADOW's suborders order status (27 in 1960) and to nearly all GADOW's families the rank of suborder, STRESEMANN replied by raising FÜRBRINGER's gentes and even a large number of non-passerine families to the rank of order (51 in 1959), arguing « to leave the question of phyletic relationship open » (1959, p. 270).

As a result of STRESEMANN's attempt to decrease « subjectivity and bias » in systematic procedure and to deny all possibilities of phyletic arrangement in any group of birds, zoologists face at present the fact that the members of the *Aves* are divided into considerably more orders, on relatively slighter anatomical characters, than any other class of vertebrates.

On the whole we may thus say that all the check-lists and classifications presented in this century, with exception of a few minor changes, are based on the monumental work of FÜRBRINGER who, with his incomparable practical experience with comparative anatomy, was more acquainted with basic structural designs (thus with the mass of similarities in the general plan of construction and organisation of birds) than with differences. This is however a shortcoming in the practice of identifying and classifying birds, an imperfection which was fully realized by GADOW, as this author in his classification laid intentionally more stress upon observable morphological differences. This dangerous procedure has been generously applied and amplified by his successors with the consequence that the fundamental relationships between the different natural groups of birds, as they were originally conceived by FÜRBRINGER, are at present entirely obscured and even contested. It is always worth to see how the confusion has arisen and whether it can now be dispelled.

When STRESEMANN (1959, p. 275) claims that he « prefers a system that is as realistic as possible, a system in which no room is given to phylogenetic speculations », and in which the gaps in his knowledge are frankly admitted, he displays that the failures of contemporaneous avian classifications may be either the failure of FÜRBRINGER's and GADOW's methodology to produce the results he anticipates, or the failure of himself to make adequate use of the principles of modern taxonomy.

IMPLICATIONS.

Today's accelerated pace of research, aided by new material, techniques and points of view, imparts to ornithology a rapidly changing character as discoveries pile up. But all of us must be aware of the fact that each new and important discovery is not just a mere addition to our knowledge as it also throws our established beliefs into question and forces us constantly to reappraise and often to reshape the foundations upon which our science rests.

We know that there is no science without a subtle framework of hypotheses, but when basic information is not re-examined, not increased, not renewed and the truth of statements not checked by the application of new techniques and methodes of investigation, hypotheses turn out to be dogmatized. From time to time one must stop and attempt to think things out for oneself instead of just accepting the most widely quoted viewpoint. But the general climate of ornithological opinion in which we work seems to be strongly opposed to this sort of scientific thinking as a considerable number of ornithologists were brought up on a sort of theological diet from which they learned to have faith and to quote selected and weighted authorities when they are in doubt. It is very depressing to find that many subjects in general ornithology and in taxonomical methodology are becoming encased in scientific dogmatism, that basic information is frequently overlooked or intentionally ignored

and that subjective opinions are expressed so loudly and so repeatedly that they take the tone of commandments.

With regard to ornithology there are indeed many implications :

— The first assumption is that the *Archaeopteryx* gave rise to modern birds though they are reptiles in the disguise of a bird (cf. HEILMANN 1926, LOWE 1944). They are members of the proavis group which may be regarded as an intermediate class *(Saururae)* connecting the *Reptilia* with the *Aves*.

— The second assumption is that the *Aves* have a monophyletic origin. This is a consequence of the first assumption. The attempt to explain all living birds in terms of an evolution from a single source, though a brave and valid attempt, is still premature and not satisfactorily supported neither by fossil, nor by present-day evidence (cf. VERHEYEN 1960f).

— The third assumption is that the *Ratitae* and some flightless Carinates have lost the power of aerial flight. This is again a consequence of the first assumption (cf. GLUTZ VON BLOTZHEIM 1958, VERHEYEN 1960h).

— There are morphological structures in a bird's organism which are said to be of an adaptive nature. The fourth assumption is that changing of habitat conditions or the colonization of new ecological niches affects the genetical background of these structures in such a peculiar way that the new generations would become gradually adapted to the altered habitat conditions or to their new environment. This is a consequence of the Darwinian and later evolutionary morphology which assume that structural change is usually adaptive and advantageous. It is said that « adaptive » evolutionary trends are worthless in phylogenetic procedure.

— The fifth assumption concerns the topic of relationships. The present consensus of opinion is that exceedingly different groups of birds (*Impennes* and *Tubinares, Gressores* and *Accipitres,* e. g.) may be closely allied, while quite similar groups *(Phaëthontidae-Lari; Pelecanoididae-Alcidae; Tinamidae-Galli)* are generally considered as the result of convergent evolution. The detection of convergence is however fairly simple, but this should be a matter of scientific research (cf. VERHEYEN 1958c, e, 1959a; CAIN & HARRISON 1960, p. 6).

— The sixth assumption is that the patience of the investigator and systematist is limited and that the study of a single group of taxonomical characters, through the whole class or through a heterogeneous group of birds, may be sufficient indicative to recognize true relationships.

— It is said that systematics on a phylogenetic basis must be constructed principally with the help of fossils. As there is virtually no palaeontological documentation which has revealed such important information on the phylogeny of birds as has been the case with the other classes of vertebrates, the seventh assumption is that true affinities

can not be expressed in avian classifications and that the arrangement of birds in a system ought to be always a matter of convenience.

— The eight assumption is that birds, on a world-wide basis, are more completely known than any other group of organisms. This may be right in the field of taxonomy up to the level of the species. But with regard to comparative anatomy, though still far from complete, the living mammals are, at present, and in most divisions, the best known organisms of the world.

— The ninth assumption is that there are still a few fortunate ornithologists in the world with such an acute intuitive insight in the problems of classification and relationships that laboring and time-devouring investigations in the field of comparative anatomy and basic systematics remain completely superflous.

— Due allowance being made : « The standard of taxonomic work in ornithology is remarkably low » (CAIN 1959, p. 312).

ARRANGEMENTS, CLASSIFICATIONS AND SYSTEMATICS.

The following definitions will be found necessary in the course of this paper :

— When a system or a part of a system is based on a single or a few convenient characters for the purpose of sorting or identification, it has always be called an artificial classification; here arrangement (= CAIN & HARRISON 1960; a « key », in SIMPSON 1961).

— When a system makes use of some selected characters, considered as very important, and which aims to show the degree of relationships and the course of evolution by weighting and interpreting, it is called phylogenetic or evolutionary classification; here classification.

— When a system makes use of an unlimited number of characters of the forms concerned, without any selection, weighting or interpreting of the data obtained from various subsciences of ornithology and from other disciplines and is thus based on the overall-resemblance procedure, it has been called natural; here systematics (= phenetic and phyletic arrangements : CAIN & HARRISON 1960).

Separate consideration is given to these three topics even though they are almost inextricable linked together.

Arrangements are very numerous. They are useful to the taxonomists although they might vary confusingly from one author to the next. They are quite good in some ways for producing keys and suited to record information about individuals and species, not to record genetical, nor phenetic resemblance or phylogeny. Because an arrangement involves no principle of priority it has a purely arbitrary sequence. « Die künstliche Systeme sind meistens nur « Schlüssel » zum bestimmen. Gegen solche « Schlüssel » lässt sich vom praktischem Standpunkte aus

garnichts einwenden; sie sind meistens desto besser, je unwissenschaftlicher sie sind » (GADOW 1893, p. 63).

« All that can be concluded from arrangements is that their promotors sensed « natural » groupings by observation and that sort of appreciation which one owes to simple common sense and improves by practice, but without submitting these glimpses to any rule »(CAIN 1959). The procedure applied here is intuitive and empirical and it must be recognized that in this way the earlier ornithosystematists achieved some gropings which as yet are considered as excellent examples of natural groups. Among such groups are the *Sphenisci, Columbae, Psittaci, Galli, Trochili, Pici, Lari, Striges* and others, which are, in fact, so sharply demarked that there has never been the slightest disagreement among ornithologists about which species should be included in those natural groups. Nevertheless it will be agreed that an activity in which we must rely on intuition, to save us from error, is not particularly scientific, however convenient it may be.

When taxonomic concepts include ideas about the ways how birds should be grouped and for what purposes, we may say that, from utilitarian viewpoint, an arrangement satisfies the curators of skin-collections but not the ethologists, anatomists, physiologists, zoögeographers, geneticists nor the palaeontologists who, when devising a grouping, have accepted in practice the aim to make one in accordance with true relationships and probable phylogeny.

Since it is much easier and lesser time-consuming to appreciate differences than similarities in the basic design of general construction and inasmuch as each species has an enormous number of taxonomical characters, the taxonomist, when devising a c l a s s i f i c a t i o n , generally may use some rule of economy in his procedure : he claims that one or another behavioural, morphological, physiological feature or a group of organic structural complexes is very important from its use, origin or role and has a greater influence than the other characters or complexes over the whole organisation or on the conservation and evolution of the species. Consequently the classifyer is necessary subjective in his choice and weighting of taxonomic characters.

This procedure was recommanded or amended by DE CANDOLLE (1813), LAMARCK (1809), DARWIN (1859) (cf. CAIN 1959), was used by MERREM (1813), L'HERMINIER (1827), MÜLLER (1846), HAECKEL (1866), HUXLEY (1867), GARROD (1873-1875) e.g. and is as yet applied by BEECHER (1953) accepting the jaw musculature as the main guiding criterion; by GLENNY (1954, 1955, 1957) using the main arteries in the region of the heart; by TIMMERMANN (1957) accepting the host-parasite relationships as a save guide to recognize true affinities; by SIBLEY (1960) dealing with the electrophoretic patterns of avian egg-white proteins; by STRESEMANN (1960) using the moult-scheme of the primaries within the *Falconiformes* (cf. also MITCHELL 1901, DAWSON 1920, LOWE 1926, CLAY 1951, VON

BOETTICHER & EICHLER 1954, MAINARDI 1958, 1960, STARCK 1959, BOCK 1960, VERHEYEN 1961a, e.g.).

In short, the practitioners of this procedure are classifying characters (parts or attributes) and not classifying organisms by using the characters as evidence. But the fact remains that if we arrange the groups of birds, according to the pattern of a single anatomical character, the resulting series does parallel parts of arrangements based on some other anatomical criteria, while in many groups the type of pattern may be quite consistent and indicative throughout.

Single-characters classifications are without any doubt very valuable contributions to science. They are generally the result of laboreous accurate investigations. However, they may give rise to illusion that the configuration, the conformation, the constantness, the series of modifications in palaeontological lines and during ontogenic development of a single peculiar structural character or complexe, is to homologize with phyletic lines involving series of w h o l e organisms. Consequently, efforts to reconstruct the phylogeny of birds on the basis of a single character, are not very rewarding.

The discovery of many sorts of structural characters and their expression in ways that make them suitable for taxonomic use brought up the balancing procedure of characters. But how can be determined the degree of importance to any given organ in a complex of functions ? What are the most essential characters which have the greatest influence over the others or on the preservation of the species ? Why is phylogeny only apparent in a small number of « conservative », « primitive » or « ancestral » characters (and how may they be recognized with certainty ?) which are said to have been relatively unaffected by evolutive trends ? Why to give precedence to some structures also found in recent specialized reptiles ? Is it not wholly gratuitous to assume that more c o n c e n t r a t e d genetic information can be obtained from egg-white proteins (SIBLEY 1960) when the electrophoretic patterns of the proteins composing the various avian organ-complexes have as yet not been studied thoroughly ? « Those avian taxonomists who are unaware of the difficulties of simple comparison in taxonomy and systematics as worked out by classical anatomists will simply repeat all the previous mistakes in new fields » (CAIN 1959, p. 311) (cf. also RABAEY 1959, CAIN & HARRISON 1960, p. 6 : Primitive characters; VERHEYEN 1961b).

Selection, weighting and interpreting (cf. SIMPSON 1945) an aggregate of characters may lead to several possible genealogical classifications of the organisms concerned; they are subjective for the very reason that they do require explanations which may or may not be true. We must be aware of the fact that it is the worst thing to decide beforehand what taxonomical characters must be most important and to classify in order to satisfy a set of guiding principles. The thinking done by a systematist is profoundly influenced by the state of knowledge of the group of organisms on which he specializes, as well as the very nature of that

group. For example, the herpetologist and the mammalogist generally know considerably more about the general anatomy of most of the organ-complexes of the living members of their group than the ornithologists do, but it can not be denied that they derive their major classifications chiefly from the abundant fossil record of only one organ-system : the skeleton. Why are casts, scales, teeth, jaws, vertebrae, parts of skulls or limbs and even complete fossils representative for the whole animal ?

Fossils are to classify on the basis of their fossil characters. Consequently a sound classification for both extinct and living vertebrates should be founded exclusively on skeletal characters. But when characters of fossils and skeletons are weighted and interpreted even with sufficient accuracy, there is no room for objectiveness as systematics deal with whole organisms and with their natural environments, both biotic and physical.

Nevertheless, in spite of many deficiences, skeletons provide a sound basis for classifying, since they are as yet much better known and understood than the innervation of muscles of the appendages, the physiological background of reproduction, heredity and behaviour, the microstructure of the brain, the respiratory-bloodcirculatory systems, the pattern of the intestinal convolutions and other anatomical criteria. Owing to its numerous individual bones and articulations, apophyses, ridges, crests, grooves, canals, impressions, foramina, sutures, bridges, fenestrae, degrees of pneumacity, osteological indices, magnifications and reductions, the skeleton is much more than a plastic bony substance as it furnishes attachment to a large number of muscles, protection to the brain, ear, eye, urogenital system, important nerves, veins and arteries, as peculiar aspects of skeletal complexes are intimately correlated with habitus, locomotion and foodgetting types. All these structural characters can be described with whatever degree of completion the available series of skeletons permit, but it is a quite different case in fossils where, aside from extremely rare examples of preservation, complete fossils, with all the parts in position of articulation are, on the whole, exceptional. Consequently, classifications have to depend more on recent animals than on fossils, for the very reason that the skeletons of living organisms can be described objectively with minutiae of resemblance and multiplicity of similar organic associations, while the principles of taxonomy applied by palaeontologists in classifying fragmentary fossils interfere with what SIMPSON (1961, p. 227) calls « an art with canons of taste, of moderation and of usefulness » which is less certain, less objective and, from the viewpoint of phylogeny, more hypothetical and more subject to individual interpretation. Even when adequate data are at hand, a classification cannot depend more on fossils than on living groups of much better known animals. The contemporaneous classifications for the vertebrates of the world have been achieved by palaeontologists (SÄVE-SÖDERBERGH, STENSIÖ, JARVIK, BERG,

ROMER, WETMORE, LE GROS CLARK, SIMPSON, e.g.) and when imperfections appear in their most valuable contributions to evolution they are invariably due to their selecting-weighting-interpreting procedure and furthermore to their taxonomic data, which are most fragmentary and morphological, though only as a matter of necessity and not of principle. Hence, there should be no antagonism between « zoological » and « palaeontological » classifications, but those proposed by neontologists ought to be, in principle, the most complete and the least subjective.

S y s t e m a t i c s deal principally with still living forms. It is the scientific study of the kinds and diversity of organisms and of any and all relationships among them (SIMPSON 1961). It is based on comparative anatomy and palaeontology in addition to every life process of the organisms concerned. In other terms : systematics ought to be an objective synthesis of all information taken from all known single-character arrangements and classifications. Consequently systematics should have a practical and a theoretical background.

It has been stated that classifications, based on overall osteological similarities, are very instructive and useful in classifying both fossil and living vertebrates. But when one devises to classify w h o l e animals, organ-systems other than skeletons should also be taken into consideration with preference such in which structural and functional complications are not correlated with modifications in the skeleton, i.e. the epidermic productions, the digestive system, the main arteries in the region of the heart, the systemic circulation, the trigeminus-complex, the electrophoretic patterns of organ-proteins, the parasite-host relationships, the configuration of the syrinx, the reproductive behaviour, etc.

Most investigations on epidermic structures have been carried out during the past century and were concerned with the different forms of the bill, the scutellation of the feet, the disposition of the toes, the configuration and relative development of the nails, the structure, succession and differentiation of the feathers, the color-pattern and distribution of the pterylae, the number, form and relative length of specialized feathers (remiges, rectrices, bristles, ornamental plumes), the occurrence of the hyporachis, uropygial gland, wattles, webs and polymorphism in the plumage, the moult-schemes, etc. Some new or complementary investigations have been made in this century but, on the whole, we may say that all morphological peculiarities, which cannot be appreciated at a glimpse, are still insufficiently known. This is the very case in the *Passeriformes* which have received less attention than any other group of birds (cf. VERHEYEN 1953, BOCK 1960). But when the complete external morphology, the digestive system, the trigeminus-complex, e.g. of any living species would be worked down to its minor details and when, with the aid of this information, classifications of birds are elaborated, whether by the overall-resemblance procedure or by weighting and interpreting, the results will have the same properties : soft-organ classifi-

cations are completely unpractical and therefore without any interest to palaeontologists, however one cannot deny that they may express true relationships at least in the lower categories of the taxonomical hierarchy. As the same remarks may also be applied to any classification based on ethological characters (vocal, visual, terrestrial, aerial displays, nest-building activities, breeding and feeding behaviour of both sexes, head-scratching and wing-stretching, etc.) there seems to exist a very important gap between « zoological » and « palaeontological » classifications which cannot be bridged with the help of the selecting-weighting-interpreting procedure. « Man kann nicht einmal behaupten, dass die äusseren Merkmale viel weniger beständig seien als die inneren. Ein kleiner Ausschnitt am Schnabel, eine elfte terminale Handschwinge, oder ihre Deckfeder, vererbt sich bisweilen ebenso hartnäckig, trotz aller anscheinend noch so wichtigen sonstigen Unterschiede, wie die Gestalt der Spina sterni » (GADOW 1893, p. 64).

When classifications based on external morphology, on reproductive behaviour, on biochemical patterns, e.g. are unpractical to palaeontologists and, when those founded on overall-similarities in the skeletons and fossils are without any interest to students engaged in identifying and classifying skins, it is reasonable and highly desirable that a compromise would be found in order to satisfy every practitioner and theoretician. The one solution which makes a general agreement possible is to combine all known arrangements and classifications of birds, based on scientific information, and to construct with them a synthetic classification, which would be nothing more than a sort of combined highest common factor. This procedure was advocated by ADANSON (1763), was applied (partly with weighting) by CUVIER, DARWIN (cf. CAIN 1959) and GADOW (1893) and is used at present as a quantitative approach to various problems in general systematics and phylogeny by VAN NIEL (1946), STROUD (1953), VERHEYEN (1956-1960), SNEATH (1957), MICHENER & SOKAL (1957), OLSE & MILLER (1958), CAIN & HARRISON (1958), JOLICŒUR (1959), BECKNER (1959), SCHELL (1960), e.g.

« The leading principle is : observe and record as many characteristics as possible and then group them accordingly to the majority of shared characters. One cannot say of modern Adansonians that they are wrong, but only that their work is shallow and incomplete as it lacks the interpretation and the evaluation to be supplied by evolutionary taxonomy » (SIMPSON 1961). In other terms : the Adansonian principle is irrelevant to palaeontology, but when series of single-character classifications are available the resultant systematics may approximate more closely to a phylogenetic one, as the only known cause of overall-resemblance of organic beings is the community of descent.

Finding numerous, not causally related, taxonomical characters (used as clues to uncover relationships) is a major undertaking and it is surely possible to consider all the major parts of the organisms concerned

without introducing some bias by selecting : a representative number of peculiarities from all parts of the skeleton, epidermic structures, organ-systems and from the general behaviour connecting with reproductive activities. This method will be far more time-consuming than any other procedure as the whole organism is now to be taken into consideration in order to acquire an estimate of the overall resemblance, so that a sudden aberration or an evolutionary trend in one or another aggregate of characters may be counterbalanced by similarity in others.

A large number of data obtained from various subsciences of ornithology represent, in a genetic sense, a random sample of the total taxonomical potentiality, thus a random sample of genetic stability and variation. And I agree with SIMPSON (1961, p. 88) when he remarks that « it is a sound principle of all taxonomy that conclusions on affinities are stronger the more characters involved. The probabilities are cumulative (although not by simple mathematic addition), and many low probabilities taken together may produce a high probability ». Finally we may add that, when a considerable number of trustworthy taxonomical characters are taken into account, the use of some additional data might not materially alter the results. This means stability.

METHODOLOGY IN SYSTEMATICS.

— First principle. — The species is the basic unit of biology. It groups a series of geographic populations with the same biology and origin, with a common gene-pool and which is isolated from any other species by psychological, ecological and physiological barriers. Each species has a basic design of structural organisation which is uncovered by observation and comparison and described with the aid of technical terms from the vocabularies of the morphologists, anatomists, physiologists, ecologists and ethologists. This description constitutes the taxonomical monograph or potentiality of the species concerned (cf. VERHEYEN 1960b).

As numerous characters are to be investigated simultaneously, in order to qualify the relations between the species, the inventorisation of the taxonomical potentiality of each species should be a matter of scientific research. But it is absolutely impossible, in the present state of techniques, to determine all the characteristics of even one species; hence, when an estimate of the static relationships between two or more species is devised, it is recommended to use at least a hundred (with preference 150-200) characters uncovered in the major parts of the skeleton, epidermic structures and reproductive behaviour. To avoid the pitfalls of single-character classifications the procedure of sampling characters should be of the random type while the gathered data should be weighted equally.

— Second principle. — The genus groups a series of related species. It is the fundamental unit of arrangements and classifications.

Whatever the principle of grouping used, the general procedure to construct a genus is always comparison. When two or more species are thoroughly compared and their basic design of construction (= taxonomical potentiality) found similar, with the exception of a few constant details (which are said to have diagnostic value), they are qualified as nearly similar and related.

As it is much easier to appreciate a few salient differences than the bulk of similarities, the species were known and groped in genera long before studies of relationships started. This is the very case in arrangements in which the community of basic design is only the sake of intuitivness or chance and in which a genus is always separated from an other by a decided gap in external morphology. In arrangements most genera are « large » for the simple reason that the number of characters implicated is always very small. On the other hand, in classifications a genus may be characterized by a general trend, or tendency, towards a certain condition or structural complication, towards a specialisation, magnification or reduction of a certain organic or behavioural complex. When in a group of species an underlaying evolutionary pattern can be traced in one or another structure, with differences in details from one species to an other, all may belong to the same genus when the other available characters, through the whole group, reflect a common basic design of construction or organisation, thus a general resemblance due to common ancestry.

But how different overall must a species be from its nearest relatives before it must be put into a different genus ? There has always been much discussion among ornithologists about where the boundary lines of the genus in arrangements and classifications should be drawn. In order to make superfluous the disputes between « lumpers » and « splitters », I made a proposal (1958), namely to group tentatively in a single genus all those species having at least 90 % of their taxonomical characters in common. This limit has been checked thoroughly while studying the conventional genera of the *Falconiformes, Lariformes* and *Alciformes*. In most genera the percentage of character-similarity approached 95 %. When the percentage of characters-in-common was inferior to 90 % this coincides generally with a gap not only in the morphological structure but also with rather important differences in the skeleton and general behaviour. The 90 % rule parallels the 75 % rule applied when the validity of geographical races is discussed (cf. AMADON 1949). Consequently two species with a quite different colour-pattern in the plumage should not be placed in different genera when these dissimilarities are not accompanied with significant modifications in the skeleton nor with a more or less distinctive gap in the general behaviour.

In Ornitho s y s t e m a t i c s the genus groups a certain number of species with a nearly identical gene-pool, the same evolutionary trends and which differ the one from the other in a few distinct dissimilarities found either in their external and internal morphology or in their general

behaviour pattern. The characters remaining constant through all the individuals and populations of a certain species or through all the species of a certain genus represent neither the type, nor the archetype of that species or that genus but only this part of their common gene-pool characterized by temporal stability. The extrapolation of the characters-in-common has nothing whatever to do with typology.

— Third principle. — The family is the basic unit of systematics (= evolutionary classification, phylogenetic systematics). It expresses evolution and groups both living and extinct related species and genera. As there is no natural separation between the contemporaneous groups and their common ancestry, the family is monophyletic and said to have a time dimension. Since the origin of the living organisms lies in the remote past, their fossil ancestors are to be incorporated into the living families or to be connected with them.

Families are generally considered as the end twigs of a widely deviding phylogenetic branche, but owing to the time-dimension principle some families may also be parts of a single interrupted evolutionary line. The grouping of recent genera of birds into families on a objective basis (overall-resemblance in the fundamental design of general construction) is essential, while the connecting of fossils with living forms, on the basis of their skeletal peculiarities, is of secundary importance.

To form a natural family, grouping of organisms of common ancestry is crucial. Propinquity of descent is to be judged not only on multiple associations of resemblance but also on sequences of varying characters (evolutionary trends) which both are directly indicative of true relationships.

It is now understood that the history of the horse skeleton is made up of the interaction of several different, mostly non-correlated, evolutionary trends, i.e. increasing of the body size, lengthening of the faciocranium, molarization of the premolars, continued growth of the teeth(-C), strengthening and lengthening of digit III and of the corresponding metapodia, reduction of the other digits. There is no evidence that all these evolutionary trends started simultaneously and that the evolution of the living Equidae is straigthlined. Without any doubt there has been a multitude of « equid » forms with evolutionary trends starting at different geological levels and leading to numerous diverging branches. From the systematic viewpoint the Equidae are thus starting when all the higher mentioned evolutionary trends are simultaneously, but at different degrees, in competition : from the oligocene *Mesohippos*. As a result of their evolutionary trends the equids share a very peculiar habitus, even by superficial observation, and at once discernable from the tapirids and elaphoids e.g. which also have their own habitus.

For a long time it has already be known that the families of birds are characterized by their habitus, a notion, which is however subjective. But

recently it has been shown that a bird's habitus can be defined by a set of osteological indices (VERHEYEN 1960d) and that each family may be considered as the result of the interaction of a series of evolutionary trends. Furthermore it has been realized that the *Non-Passeres* group is composed of a larger number of families than have been recognized hitherto in the current arrangements and classifications, which assume wholly gratuitously that each apparently natural group *(Anseres, Psittaci, Columbae, Charadrii, Falconiformes, Striges)* is monophyletic.

Relationships between families can be ascertained by the overall-resemblance procedure which makes also apparent the phenomenon of paramorphogenesis (VERHEYEN 1958c; which is called « patristic similarity » in CAIN & HARRISON 1960, p. 3, and « homology » in SIMPSON 1961, p. 78). Paramorphogenesis is a repeated demonstration of long evolutionary trends in which separate, but related, lineages pass indepently through the same sequence of morphological changes, either simultaneously or at different geological times [cf. VAVILOV's law of homologous series in the inheritance of variability (1949-50); cf. BULMAN (1955), who analysed the persistent tendencies in many lines of primitive graptolites; cf. COLBERT (1955), who deals with common trends for increased body size and brain size in mammals; cf. CAIN & HARRISON (1960, p. 6), who also made a sharp distinction between convergence and patristic similarity; cf. VERHEYEN (1961a)].

— Fourth principle. — The ordering of the different families and genera in a system is a task involving a few compromises. As most taxonomists plainly do attach some meaning to a linear sequence it should be an important aim in any new classification to keep related groups as close together as possible. Hence, « position » should now be interpreted as an expression of relationship of an assemblage under examination with the preceeding and following natural groups. This means that in some circumstances, and owing to the position-principle, a genus, a family, a suborder and even a certain order may be included into its nearest preceeding or following family or (sub) order, when for practical purposes, and this is the first compromise, the exclusion of an « aberrant » group of forms is considered in order to confer a higher degree of homogeneity to the treated familia or ordo. The next compromise is that « branching » should be indicated by the use of appropriate terms (first lineage, second lineage, ...) which means propinquity of the natural group under examination with at less two other groups. The applied procedure includes ideas about common ancestry, but none about primitivness.

— Fifth principle. — The accurate and complete taxonomical description as well as the diagnosis of each family are essential. These of the super-orders deserve merely a few salient characters taken in isolation or in combination.

OUTLINE OF A NEW ORNITHOSYSTEMATICS.

« It is desirable that classifications should not remain static but should change continually as pertinent knowledge expands » (SIMPSON 1961, p. 111).

The purpose of this paper is to determine in a system (that does not include fossil forms) the correct position of each avian family. I have of course incorporated in my previous studies, as well as in this paper, the work of others whenever known to me. The proposed scheme should not be considered as definitive in all its subdivisions since its basic principles are exclusively founded upon factual information which, in the light of new techniques of sampling, more objective methodology and by means of more realistic procedures, grows constantly.

As this outline of new ornithosystematics is the result of an extensive comparative study of numerous external morphological structures and of a considerable number of skeletons, and furthermore since all information concerning similarities and differences in the general behaviour, in the explored anatomical features, in the host-parasite relationships and in other data, has been summarized and equally weighted, I hope that the new scheme may be regarded as a solid basis for discussion and additional research.

If the class of birds is considered in the light of the principles laid down, without any preconceptions based on the divisions formerly admitted by FÜRBRINGER, GADOW, SHARPE, BEDDARD, WETMORE, STRESEMANN and so many others, and regarding only the basic structure and organisation of birds, not the greater or lesser knowledge we have of one of more non-correlated physiological, structural or behavioural complexes, it would be found that in many respects this outline of new systematics parallels the original classification of FÜRBRINGER (1902) based on the selecting-weighting-interpreting procedure of an already important number of anatomical characters. Is the mentioned parallelism to be considered as a shortcoming, as a pure coincidence or as an argument in favour of the overall-resemblance procedure applied in the new scheme ?

In view of the continuing accumulation of trustworthy information, any system is susceptible of improvement. There should be no exception.

MAJOR SUBDIVISIONS OF THE CLASS AVES.

Major subdivisions of the class Aves. — With regard to the systematics of the contemporaneous birds, the following subdivisions are recognized :

Superorder DINORNITHES

Order *Apterygiformes*

Superorder HYGRORNITHES

Order *Sphenisciformes*
Order *Procellariiformes*
Order *Alciformes*

Superorder LIMNORNITHES

Order *Pelecaniformes*

First lineage	Second lineage
Order *Lariformes*	Order *Ardeiformes*
Order *Charadriiformes*	Order *Ciconiiformes*
Order *Jacaniformes*	Order *Phoenicopteriformes*
Order *Podicipediformes*	Order *Anseriformes*
Order *Ralliformes*	Order *Anhimiformes*

Superorder CHAMAEORNITHES

First lineage	Second lineage
Order *Struthioniformes*	Order *Gruiformes*
Order *Galliformes*	Order *Cariamiformes*

Superorder DENDRORNITHES

First lineage	Second lineage
Order *Columbiformes*	Order *Falconiformes*
Order *Psittaciformes*	Order *Cuculiformes*
Order *Coraciiformes*	Order *Coliiformes*
Order *Caprimulgiformes*	Order *Piciformes*
Order *Strigiformes*	Order *Passeriformes*

Superorder DINORNITHES.

Order *Apterygiformes*. — The Kiwis are placed at the top of the linear sequence of avian families. The subfossil Moas *(Dinornithidae)* are, on the one hand, their nearest relatives (cf. PARKER 1893) and owing to a series of peculiar morphological structures and evolutionary trends they are, on the other, distantly allied with the Penguins (VERHEYEN 1960a; 1961a). There is no convincing evidence in the general organisation and morphology of the Kiwis arguing in favour of the hypothesis that they have derived from flying ancestors.

Superorder HYGRORNITHES.

Order *Sphenisciformes*. — « The Penguins with their extreme specialization as the highest form of divers, must, it appears to me, have been Penguins since the day they acquired their peculiar mantle. I am under the impression that Penguins never possessed quills » (PARKER 1890, pp. 90-91). The question concerning the loss of the power of flight has been re-examined (LOWE 1933, VERHEYEN 1958c) and in the light of more evidence conclusion was drawn that there is no convincing argumentation for sustaining the hypothesis that the Penguins would descend from flying ancestors. The uniform pterylosis, the extreme specialization of the wing, the incomplete fusion in the metatarsal elements, the erect position in standing and walking, are selected, weighted and interpreted by WETMORE (1960) who, guided by the appraisal of the peculiarities in question, raised the Penguins to the superorder of *Impennes* (cf. VON MENZBIER 1887).

Order *Procellariiformes*. — Owing to the selection and weighting of a few unique anatomical features the Shearwaters and allies have been considered as distantly allied with the Penguins (cf. FÜRBRINGER 1902). The overall-resemblance procedure leads to the same conclusion in spite of the different habitus displayd by these two natural groups (VERHEYEN 1958 a, d) and the electrophoretic pattern of their egg-white proteins (SIBLEY 1960, p. 233).

The Diving Petrels have been merged with the *Alciformes* as their basic design is more like that of the Auk group (VERHEYEN 1958c). This statement is a consequence of the overall-resemblance procedure, since 65 % of the 105 skeletal characters examined are similar in both *Pelecanoides urinatrix* and *Plautus alle* and furthermore as the osteological indices, evolutionary trends and moult type of the primaries of the Diving Petrels are typical alciform (VERHEYEN 1961a). How can we agree with CAIN (1959, p. 314) and WETMORE (1960, p. 6) who claim that all the observed similarities between the Little Auks and the Diving Petrels « are due to convergence » when the necessary information to verify the suggested relationships between the Diving Petrels and the *Procellariiformes* is completely lacking in their papers ?

Order *Alciformes*. — The Auks, Murries and allies are to be linked with the *Procellariiformes*, their nearest relatives, while they are more distantly allied with the *Sphenisciformes* (VERHEYEN 1958c; compare also in FÜRBRINGER's system the position of these two natural groups). Three suborders are recognized : the *Pelecanoidea*, the *Alcae* and the *Gaviae* (VERHEYEN 1959f). While, on the one hand, the Diving Petrels are indicative of relationship with the *Procellariiformes*, on the other, the *Uria* share a considerable number of structural features with the Loons (VERHEYEN 1961a).

The opinion of GADOW (1893, p. 128) about the relationships of the Loons is without ambiguity : « ...Trotzdem ist nicht zu verkennen, dass *Sphenisci, Tubinares, Steganopodes* and *Colymbi* auf einen gemeinsamen Verband hinweisen ». With regard to the electrophoretic profiles of the egg-white proteins I am unable to find a fundamental antagonism between the Loons and the Auks (cf. SIBLEY 1960, p. 266 and p. 269).

Superorder LIMNORNITHES.

Order *Pelecaniformes.* — All pelecaniform birds share (nearly) full webbed feet, a peculiarity which has been used with too much confidence in the past as a most reliable basis for classification. In fact, this single taxonomical character is still weighted as non-adaptive and not subject to convergent evolution, while all the other available anatomical, physiological, parasitological and ethological characters are considered as variable and not reliable to express true relationships (cf. STRESEMANN 1959). On account of host-parasite evidence (cf. also VANZOLINI & GUIMARAES 1955, CLAY 1951, 1957) TIMMERMANN (1957, 1958) drew the pertinent conclusion that the Tropicbirds are more « charadriiform » than « pelecaniform ». His proposal to dissociate the *Pelecaniformes* was checked by the application of the overall-resemblance procedure which produced furthermore valuable information about the supposed interrelationships of the main pelecaniform groups. Three suborders are recognized *(Pelecani, Sulae, Anhingae)* while the Frigate-birds and the Tropicbirds, on account of their rachid formulae, habitus and other peculiarities have been removed and assigned to the *Lariformes* which are their nearest relatives (VERHEYEN 1960 f, g).

With regard to the Cormorants and the Snake-birds, MAYR & AMADON (1951, p. 51) have pointed out : « *Anhinga* is so much like *Phalacrocorax* that it would seem to require no more than subfamily status ». However nothing whatever is published in explanation. On account of their great number of distinctive anatomical peculiarities family status is required for both (cf. LANHAM 1947, WETMORE 1960, VERHEYEN 1960g).

First lineage. — Order *Lariformes.* — Owing to the position-principle in a linear sequence of natural groups, the Frigate-birds and the Tropicbirds link the *Pelecaniformes* s. str. to the *Lari.* The members of the three suborders have the same rachid formulae and are brevihumeral.

Order *Charadriiformes.* — This order has various ties with the *Lariformes* and *Jacaniformes* and is indirectly related to the *Ciconiiformes.* A review was carried out on a anatomical basis which is the correct procedure for dividing it up into the most natural groups. In the light of additional information (VERHEYEN 1958b, 1960f, 1961a; VON FRISCH 1961) two suborders are now recognized : the *Chionides* and the *Charadrii*

(with seven families). The Sheatbills are closest to the *Lariformes* and the Painted Snipe to the next order.

Orders *Jacaniformes, Ralliformes* and *Podicipediformes.* — The order of *Gruiformes* (WETMORE 1960) includes a heterogeneous assemblage of 12 relictual groups which, according to STRESEMANN (1959) are to put into 10 separate orders. A complete overhaul and new additional information (VERHEYEN 1957a, c, d, 1958a, 1960f, 1961a) gave rise to a new arrangement. It is to be noted that the brevihumeral Jaçanas, Sunbittern, Kagu, Roatelos and *Monias* are, in many respects charadriiform, while the longihumeral Sungrebes are to be linked with the Grebes, which are a specialized offshoot of the ralline stock (VERHEYEN 1959f).

Second lineage. — Order *Anseriformes.* — In contradiction with the general accredited opinion Swans, Geese, Ducks and allies constitute a polyphyletic group of birds which are distantly related to the Screamers and the Flamingos as well as to the Loons. These relationships are clearly expressed in FÜRBRINGER's classification (1902, p. 649). In the light of more and new information (YAMASHINA 1952; COTTER 1957; GRAY 1958; KURODA 1959; SIBLEY 1960; JOHNSGARD 1960, 1961; VERHEYEN 1960d, f, 1961; WOOLFENDEN 1961) and according to a more mature practice gained in balancing the different taxa within the whole group of *Non-Passeres* birds, my previous classification of the *Anseres* (1955a) has been reviewed in the present study.

The scientific side of systematics is concerned with reaching approximations which should be successively closer as sciences progresses towards understanding of relationships among fossils and the different groups of contemporaneous organisms. Consequently gathering more objective data and applying more various and precise criteria can be sufficiently definitive. According to the principle of physiological isolation, included in the definition of the species, the results gathered from experimental and natural hybridization have been heavily weighted by MAYR (1941) and SIBLEY (1957), though evidence was accumulating that the interbreeding situation, in a group of more or less related species, is general and, likewise any other organic feature, susceptible to vary in its numerous attributes from group to group. The Mallard *(Anas platyrhynchos)* has hybridized in captivity with some 45 other species, including *Tadorna, Aythya, Cairina, Mergus* and *Anser.* This indicates an « overwhelming evidence of close relationships » (SIBLEY 1960, p. 241) though information about causality, nature and the physiological background of hybridization is still highly desirable (cf. also CAIN & HARRISON 1960, p. 29).

On the basis of cranial and axial osteology, of a series of osteological indices (VERHEYEN 1955a, 1960d, f), of postcranial osteology (WOOLFENDEN 1961) of nearly all the genera of waterfowl of the world and in the light of all the work of others on the subject known to me, the following classification of the *Anseres* is proposed :

Anatidae : Somateriinae (Somateriini, Tachyeresini, Melanittini, Bucephalini, Clangulini, Mergini), *Merganettinae, Oxyurinae, Heteronettinae, Anatinae* (Dafilini, Anatini, Cairiini, Aixini, Nettapini, Malacorhynchini, Amazonnettini), *Tadorninae* (Neochenini, Chloëphagini, Plectropterini, Tadornini), *Stictonettinae, Aythyinae* (Aythyini, Rhodonessini).

Dendrocygnidae : Dendrocygna, Ctenanas, Prosopocygna.

Anseridae : Cygninae, Coscorobinae, Cereopsinae, Anserinae.

Order *Anhimiformes.* — The Screamers deserve ordinal rank; they are closest to the *Anseranates* (VERHEYEN 1956b) and distantly related to the *Casuarii* (VERHEYEN 1960e).

Order *Phoenicopteriformes.* — The Flamingos have various links, both with the *Anseriformes* and the *Ciconiiformes.* Owing to their great number of anatomical peculiarities ordinal rank is given to them.

Order *Ardeiformes.* — This order groups the specialized *Ardeae* and the very peculiar Whale-headed Stork which has pelecaniform characteristics (cf. COTTAM 1957, VERHEYEN 1959e). The Boatbilled Heron deserves family rank as there are sufficient trenchant characters (cf. WETMORE 1960). Its resemblance with *Balaeniceps* is due to paramorphogenetic evolution.

Order *Ciconiiformes.* — The *Ciconiae* and the *Scopi* have various links with the preceeding order, with the Flamingos and the *Charadriiformes.*

Superorder CHAMAEORNITHES.

First lineage : Order *Struthioniformes.* — Relationship is much obscured here by over-specialization and regressive evolution. It has been suggested that the palatine conditions « palaeognathous » and « neognathous » would be reversible (VERHEYEN 1960e). The three natural groups require only suborder status. There is no convincing evidence that they derive from flying ancestors (cf. GLUTZ 1958, VERHEYEN 1960e).

Order *Galliformes.* — The Rheas are distantly related to the Tinamous. With the *Galli* the Tinamous share a considerable number of characters acquired by paramorphogenesis. This opinion, which is also supported by FÜRBRINGER (1902) and GADOW (1893) (cf. also MCDOWELL 1948, TH. CLAY 1957, HANKE 1955, CHANDLER 1916, VERHEYEN 1960 c, e) is not followed by WETMORE (1930-1960) and this without any explanatory element. In his single-character classification SIBLEY (1960, p. 230) claims that « there is nothing in the electrophoretic profiles to suggest a relationship to the *Galliformes* », but, in my opinion, some anodal segments in the published profiles of *Meleagris gallopavo, Coturnix coturnix japonica* and *Gallus gallus* are quite alike those of the investigated Tinamous.

Another specialized galliform bird is the Hoatzin. *Opisthocomus* was formerly placed as a suborder of the *Musophagiformes* (VERHEYEN 1956f), but owing to new information the bird in question is at present considered nearest to the *Cracidae* (MILLER 1953, VERHEYEN 1961a) thus in complete agreement with FÜRBRINGER (1902). The suborder *Galli* includes only three families. The *Tetraonidae, Numididae* and *Meleagrididae* (WETMORE 1960) are not sufficiently distinctive from anatomical peculiarities to require family status (cf. VERHEYEN 1956g, MAINARDI 1959, SIBLEY 1960, pp. 237-240).

The fourth suborder concerns the *Turnices* grouping two families (VERHEYEN 1958a) which, according to FÜRBRINGER (1902) and WETMORE (1960) are either ralliform or gruiform. This is however not the opinion of GADOW (1893, p. 171) : « Die *Turnix, Pedionomus* finden ihre nächst höheren Verwandten in den *Galli* », while LOWE (1923, p. 276) in reconsidering the problem wrote : « The *Turnicomorphs* are far more closely allied to the Sandgrouse and Pigeons than to the galliform order ». Owing to the overall-resemblance procedure the *Turnices* are to be considered as a connecting link between the *Galliformes* and the *Columbiformes.*

Second lineage : Order *Gruiformes.* — The Trumpeters are nearest to the *Ralliformes* (VERHEYEN 1957b), while the Bustards are distantly allied with the Ostriches (VERHEYEN 1960e). Four major subdivisions are recognized : *Psophiae, Aramides, Grues, Otides.*

Order *Cariamiformes.* — To FÜRBRINGER (1902) the Seriemas are gruine and affiliated to the Trumpeters, but, on the other hand, they are also closest to the falconiform Secretarybird (VERHEYEN 1957c) and distantly related to the fossil *Phororhacoidea* (WETMORE 1960).

Superorder DENDRORNITHES.

First lineage. — Order *Columbiformes.* — Formerly the *Pterocletes* were united with the *Turnices* (VERHEYEN 1958a). The transitorial order *Turniciformes* is now broken up since the position-principle includes ideas with reference to relationships. The Seedsnipes are the american representatives of the *Pterocletes* (paramorphogenesis). « The Seed-snipe, together with the families *Turnicidae* and *Pteroclidae,* should be regarded as the still-surviving blind-alley-offshoots or relics of an ancien generalised and basal group (now extinct) from which group sprang the *Schizomorphs* or the now dominant Pigeons, Plovers and Fowls » (LOWE 1923, p. 277).

The *Columbae* include three families which are characterized by their rachid formulae, osteological indices and a significant number of peculiarities (VERHEYEN 1957a). According to SIBLEY (1960, p. 245) there is little merit in this subdivision although the electrophoretic patterns

of the egg-white proteins of neither the *Duculidae,* nor the *Caloenadidae* have been profiled as yet (cf. also MAKINO 1956). The Pigeons and allies are the possible relatives of the Parrots (FÜRBRINGER 1888, 1902). This is corroborated by the overall-resemblance procedure.

Order *Psittaciformes.* — This order includes 5 families which are distinctive from anatomical features (VERHEYEN 1956h, 1960d, 1961a).

Order *Coraciiformes.* — This morphologically heterogeneous group is distantly related to the *Psittaciformes,* the *Cuculiformes* and the *Caprimulgiformes.* Five suborders are recognized. The Trogons are coraciiform and in a linear sequence they are to be placed nearest to the Nightjars and allies (VERHEYEN 1955c, 1956 a, c; LOWE 1938, 1948).

Order *Caprimulgiformes.* — As many other gentes of FÜRBRINGER's *Coracornithes* (1902) the *Caprimulgiformes* are very specialized. Two suborders, grouping four families, are recognized (VERHEYEN 1956c).

Order *Strigiformes.* — The Owls are probably the most specialized group of living birds of the world. They are placed at the end of the linear sequence of families and nearest to the *Caprimulgiformes* (FÜRBRINGER 1902, VERHEYEN 1956 a, c).

Second lineage. — Order *Falconiformes.* — The birds of prey have various ties with the *Cuculiformes* and with the columbi-psittacine group. SUSCHKIN (1905) based his review of the *Falconidae* on 47 characteristics which were selected, weighted and interpreted, while a less important number was taken into account when classifying the *Acciptres.* In my review (1959c) 194 characters have been studied according to the overall-resemblance procedure and 24 evolutionary trends considered. The resultant scheme is however vigorously attacked and rejected as a whole by V. § E. STRESEMANN (1960), but nothing is published in explanation, which is unthinkable in any other science. With regard to an irregularity in the typical moult type of the primaries (due to winglenght and habitat conditions) a new classification of the *Falconiformes* is presented by these authors while all the other resemblances and dissimilarities in construction and organisation are discarded (cf. also HUDSON 1948, JOLLIE 1953, VOIPIO 1955, STARCK 1959, VERHEYEN 1961a).

Order *Cuculiformes.* — This order is to be linked on the one hand, with the *Psittaci* and *Accipitres* groups and, on the other, to the *Coraciiformes* and Colies.

Three suborders are recognized : the *Musophagae,* the *Centropodes* (which are nearest to the Touracos) and the *Cuculi.* Owing to the balancing procedure of the taxa within the whole group of *Non-Passeres* my previous classification (1956d) has been reviewed : i.e. *Centropidae* (Centropinae, Phaenicophaeinae, Crotophaginae, Neomorphinae) and *Cuculidae* (Coccystinae, Cuculinae).

Order *Coliiformes*. — According to the overall-resemblance procedure the Colies are related, on the one hand, to the *Cuculiformes* and, on the other, to the Honeyguides (VERHEYEN 1956c).

Order *Piciformes*. — This order preceeds the *Passeriformes*, which are their nearest relatives (FÜRBRINGER, 1902; LOWE 1946; VERHEYEN 1955b).

SYSTEMATIC LIST OF THE NON-PASSERES OF THE WORLD.

(Fossil groups non included.)

Superorder DINORNITHES

Order **APTERYGIFORMES**

Family *Apterygidae* : Kiwis.

Superorder HYGRORNITHES

Order **SPHENISCIFORMES**

Family *Spheniscidae* : Penguins.

Order **PROCELLARIIFORMES**

Family *Procellariidae* : Shearwaters, Fulmars, Prions.
Family *Diomedeidae* : Albatrosses.
Family *Hydrobatidae* : Storm Petrels.

Order **ALCIFORMES**

Suborder PELECANOIDIDEA

Family *Pelecanoididae* : Diving Petrels.

Suborder ALCAE

Family *Alcidae* : Auks, Murres, Auklets.

Suborder GAVIAE

Family *Gaviidae* : Loons.

Superorder LIMNORNITHES

Order **PELECANIFORMES**

Suborder ANHINGAE

Family *Anhingidae* : Snake-birds.
Family *Phalacrocoracidae* : Cormorants.

Suborder SULAE

Family *Sulidae* : Boobies, Gannets.

Suborder PELECANI

Family *Pelecanidae* : Pelicans.

First lineage :

Order **LARIFORMES**

Suborder FREGATAE

Family *Fregatidae* : Frigate-birds.

Suborder PHAËTHONTES

Family *Phaëthontidae* : Tropicbirds.

Suborder LARI

Family *Rynchopidae* : Skimmers.
Family *Laridae* : Gulls, Terns.
Family *Stercorariidae* : Skuas, Jaegers.

Order **CHARADRIIFORMES**

Suborder CHIONIDEA

Family *Chionididae* : Sheatbills.

Suborder CHARADRII

Family *Charadriidae* : Oystercatchers, Avocets, Stilts, Lapwings, Plovers.
Family *Calidrididae* : Sandpipers, Turnstones, Phalaropes.
Family *Scolopacidae* : Snipes, Woodcocks.
Family *Glareolidae* : Pratincoles, Coursers.
Family *Dromadidae* : Crabplover.
Family *Burhinidae* : Thick-knees.
Family *Rostratulidae* : Painted Snipe.

Order **JACANIFORMES**

Suborder MESITORNITHES

Family *Mesitornithidae* : Roatelos, *Monias*.

Suborder RHYNOCHETI

Family *Rhynochetidae* : Kagu.

Suborder EURYPYGAE

Family *Eurypygidae* : Sunbittern.

Suborder JACANAE.

Family *Jacanidae* : Jaçanas.

Order **PODICIPEDIFORMES**

Family *Podicipedidae* : Grebes.

Order **RALLIFORMES**

Suborder HELIORNITHES

Family *Heliornithidae* : Sungrebes.

Suborder RALLI

Family *Rallidae* : Rails, Gallinules, Coots.

Second lineage :

Order **ARDEIFORMES**

Suborder BALAENICIPITES

Family Balaenicipitidae : Whale-headed Stork.

Suborder ARDEAE

Family Cochleariidae : Boat-billed Heron.
Family *Ardeidae* : Herons, Bitterns.

Order **CICONIIFORMES**

Suborder SCOPI

Family *Scopidae* : Hammerhead.

Suborder CICONIAE

Family *Ciconiidae* : Storks, Jabirus.
Family *Threskiornithidae* : Ibises, Spoonbills.

Order **PHOENICOPTERIFORMES**

Family *Phoenicopteridae* : Flamingos.

Order **ANSERIFORMES**

Suborder ANSERES

Family Anatidae : Ducks, Pochards, Scoters, Eiders, Mergansers, Shelducks.
Family *Anseridae* : Swans, Goose.
Family *Dendrocygnidae* : Whistling Ducks.

Suborder ANSERANATES

Family *Anseranatidae* : Magpie Goose.

Order **ANHIMIFORMES**

Family *Anhimidae* : Screamers.

Superorder CHAMAEORNITHES

First lineage :

Order **STRUTHIONIFORMES**

Suborder STRUTHIONES

Family *Struthionidae* : Ostriches.

Suborder CASUARII

Family *Casuariidae* : Cassowaries.
Family *Dromiceiidae* : Emus.

Suborder RHEAE

Family *Rheidae* : Rheas.

Order **GALLIFORMES**

Suborder TINAMI

Family *Tinamidae* : Tinamous.

Suborder OPISTHOCOMI

Family *Opisthocomidae* : Hoazin.

Suborder GALLI

Family *Cracidae* : Curassows, Guans.
Family *Megapodiidae* : Megapodes.
Family *Phasianidae* : Quails, Pheasants, Peacocks, Grouses, Fowls, Turkeys.

Suborder TURNICES

Family *Turnicidae* : Bustardquails.
Family *Pedionomidae* : Plainwanderers.

Second lineage :

Order **GRUIFORMES**

Suborder PSOPHIAE

Family *Psophiidae* : Trumpeters.

Suborder ARAMIDES

Family *Aramidae* : Limpkins.

Suborder GRUES

Family *Gruidae* : Cranes.

Suborder OTIDEA

Family *Otididae* : Bustards.

Order **CARIAMIFORMES**

Family *Cariamidae* : Seriemas.

Superorder DENDRORNITHES

First lineage :

Order **COLUMBIFORMES**

Suborder THINOCORES

Family *Thinocoridae* : Seedsnipes.

Suborder PTEROCLETES

Family *Pteroclidae* : Sandgrouses.

Suborder COLUMBAE

Family *Caloenadidae* : Nicobar and Crowned Pigeons, Dodo.
Family *Columbidae* : Pigeons, Doves.
Family *Duculidae* : Fruit-pigeons.

Order **PSITTACIFORMES**

Family *Platycercidae* : Parrakeets, Rosellas.
Family *Strigopidae* : Owl-parrot.
Family *Kakatoeidae* : Cockatoos.
Family *Psittacidae* : Parrots, Lovebirds.
Family *Trichoglossidae* : Lorikeets.

Order **CORACIIFORMES**

Suborder CORACIAE

Family *Leptosomatidae* : Cuckoo-Rollers.
Family *Coraciidae* : Rollers, Groundrollers.
Family *Alcedinidae* : Kingfishers.
Family *Todidae* : Todies.
Family *Momotidae* : Motmots.
Family *Meropidae* : Bea-eaters.

Suborder UPUPAE

Family *Bucerotidae* : Hornbills.
Family *Upupidae* : Hoopoes.
Family *Phoeniculidae* : Woodhoopoes.

Suborder TROCHILI

Family *Trochilidae* : Hummingbirds.

Suborder APODI

Family *Hemiprocnidae* : Crested Swifts.
Family *Apodidae* : Swifts.

Suborder TROGONES

Family *Trogonidae* : Trogons.

Order **CAPRIMULGIFORMES**

Suborder CAPRIMULGI

Family *Caprimulgidae* : Nightjars.
Family *Aegothelidae* : Owlet-frogmouths.
Family *Podargidae* : Frogmouths, Potoos.

Suborder STEATORNITHES

Family *Steatornithidae* : Oilbird.

Order **STRIGIFORMES**

Family *Strigidae* : Common Owls.
Family *Tytonidae* : Barn Owls.

Second lineage :

Order **FALCONIFORMES**

Suborder SAGITTARII

Family *Sagittariidae* : Secretarybird.

Suborder CATHARTES

Family *Cathartidae* : New World Vultures.

Suborder FALCONES

Family *Polyboridae* : Caracas.
Family *Falconidae* : Falcons.

Suborder PANDIONES

Family *Pandionidae* : Ospreys.

Suborder ACCIPITRES

Family *Buteonidae* : Harriers, Eagles, Hawks, Kites. Buzzards.
Family *Aegypiidae* : Old World Vultures.
Family *Elanidae* : Black-winged Kite.
Family *Pernidae* : Honey Buzzard.

Order **CUCULIFORMES**

Suborder MUSOPHAGAE

Family *Musophagidae* : Louries.

Suborder CENTROPODES

Family *Centropodidae* : Roadrunners, Anis, Couas, Coucals.

Suborder CUCULI

Family *Cuculidae* : Coucous.

Order **COLIIFORMES**

Family *Coliidae* : Colies.

Order **PICIFORMES**

Suborder PICI

Family *Indicatoridae* : Honeyguides.
Family *Capitonidae* : Barbets.
Family *Ramphastidae* : Toucans.
Family *Picidae* : Woodpeckers, Piculets.

Suborder GALBULAE

Family *Bucconidae* : Puffbirds.
Family *Galbulidae* : Jacamars.

Order **PASSERIFORMES**

SUMMARY.

All modern classifications of birds are indirectly based on FÜRBRINGER's scheme, which was interpreted and amended (in some major subdivisions profoundly altered) by GADOW, SHARPE, BEDDARD, WETMORE, PETERS, STRESEMANN, MAYR & AMADON, e.g. This succession of interpretations has progressively obscured the meaning attached by FÜRBRINGER to the different ranks of his classification and to the relationships of the different natural groups recognized by him. To get out of this imbroglio an attempt was made to understand FÜRBRINGER's and GADOW's methodology while the opportunity examining thoroughly their argumentation was endeavoured.

With regard to their morphological potentialities all the non-passerine natural groups of birds have been reviewed and in order to clarify their relationships the overall-resemblance procedure was applied. The result of this comparative study is that 5 superorders, grouping 28 orders or 108 families of non-passerine birds are now recognized and that the linear sequence adopted in this outline of ornithosystematics expresses at present static affinity with a higher degree of probability.

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