A system of world mammal faunal regions
I. Logical and statistical derivation of the regions

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ABSTRACT. Philosophies underlying past classifications of world faunal regions have fostered the view that such units can have little more than heuristic value. Contributing to this feeling is the difficulty attending assessment of rank relationships among the regional elements of a particular system. In the present study, logical constraints upon the meaning of a satisfactorily efficient hierarchical faunal classification are identified and operationalized into a system of world mammal faunal regions via an iterative procedure involving multidimensional scaling. The result is a classification consisting of four regions and ten subregions, each of the latter of which is as unique as it can be with respect to all other subregions while still contributing to logical hierarchical order relationships within the system. The classification is compared to the Sclater–Wallace system and is shown to be both more efficient and more internally consistent. Summary data and statistics pertaining to the new classification are presented and briefly discussed.

Introduction

Once it became apparent to the travelling naturalists of the early nineteenth century that the world's fauna could be viewed in terms of regional associations of organisms, classifications of these non-random patterns began to emerge. Such early classifications reflected a number of biases, the most important of which centered on the investigator's choice of organisms and the related matters of how reliably these had been taxonomically and distributionally described by that date. The matter of parsimony, however, also entered into the systemization process. Clearly, classifications featuring extremes of redundancy or under-specification could be of little aid in understanding regional characteristics and their evolution. It is to the interpretation of the meaning of parsimony in biogeographic region classification, a still poorly reconciled problem, that this multi-part work first addresses itself.

The first enduring classification of regional faunas was that by Sclater (1858) for birds, a group that had been reasonably well described by that date. Gunther (1858) then established a wider applicability for Sclater's scheme by showing that it did a good job of accounting for the general distribution of reptiles. Wallace (1859, 1860, 1876) further solidified the popularity of the Sclater model by making it the basis for his system of 'geographical zoology'. In the third work, however, he argued that mammalian characteristics made them the more ideal forms through which to approach general regional faunal delineation ('zoological geography'). In addition, he augmented the original classification by subdividing each of Sclater's six regions into four subregions. The Sclater–Wallace regionalization (minus the subregional divisions) is shown for reference purposes in Fig. 1.

The Sclater–Wallace system has proven to be a heuristic device of considerable value. None the less, it has experienced contin-
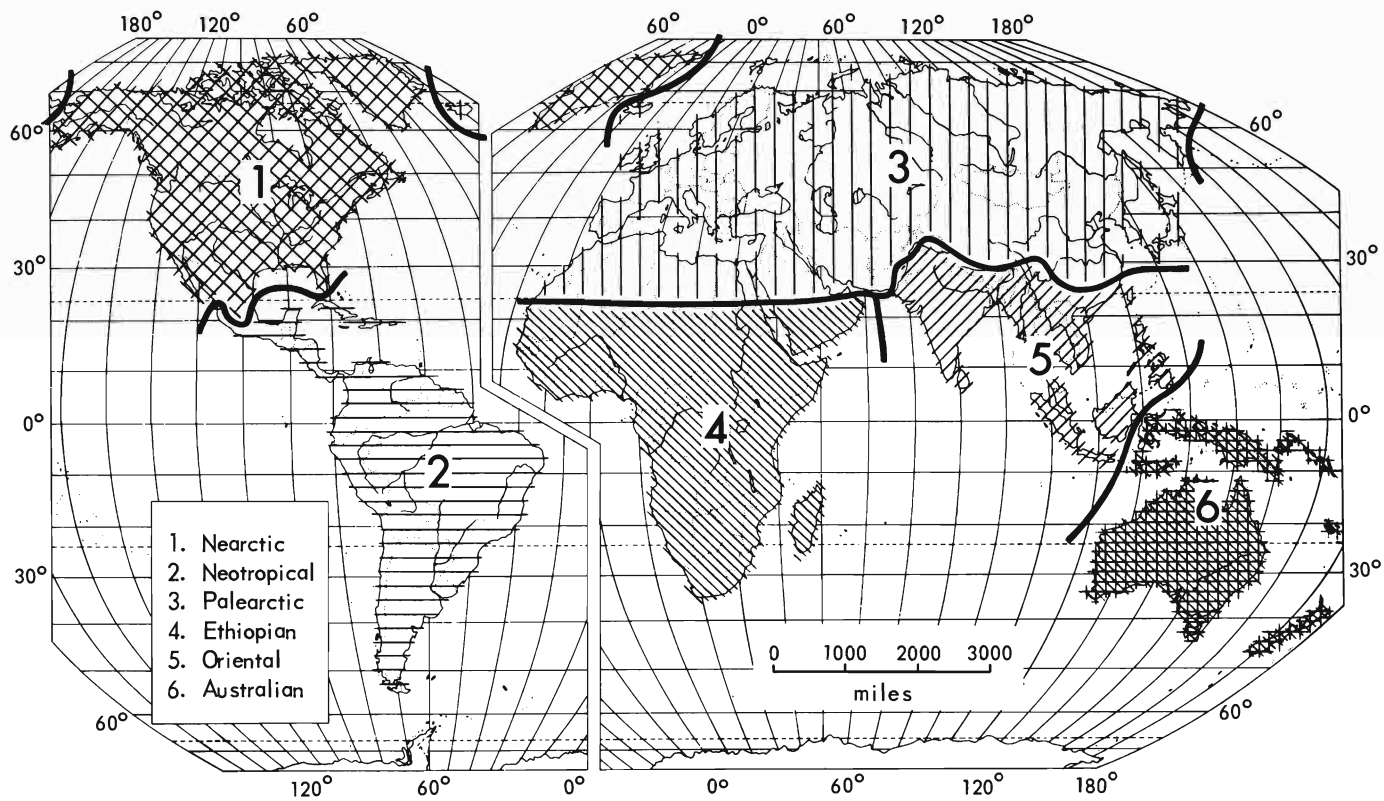
FIG. 1. The six major faunal realms of the Sclater—Wallace classification.

uous criticism on a variety of counts since its conception. One of these, the problem of the possible inequivalence of its component regions, is central to the present discussion. Wallace (1876, 1894) felt the granting of region status to be primarily a matter of convenience, but in supporting the Sclater system presented statistical measures of inter-regional dissimilarities that at least confirmed that major differences did exist among the faunas of the areas. But he could do no better than informally defend the fact that the classification contained specifically six primary units. This lack of attendance to a fairly fundamental issue has underlain a discussion on ideal levels of parsimony that has lasted down to the present day as the matter has been tackled from a variety of standpoints by a long succession of workers (see Schilder, 1954; Schmidt, 1954; Udvardy, 1969; and Nelson & Platnick, 1981; for related reviews).

In the present work, a means of deriving compatible world regional faunal units is introduced and a suggested re-classification of primary and secondary world mammal faunal regions based on the method is presented. Part I consists of a description of the systemization process and the classification obtained itself. In part II, the distribution of mammal families within these faunal units is explained as a function of system most-probable-state and contiguity effect factors. A future work will examine claims of global extinction/origination rate equilibrium for mammalian evolution from a spatial modelling perspective related to the present classification.

Logical and hierarchical constraints on faunal region classification

Biological systematics is fundamentally a matter of hierarchical classification. For such classification to make any sense, it is imperative that the basal units out of which more general categories are constructed be logically equivalent to one another. Grobstein (1973: 31–32) has expressed this notion more formally in speaking of the 'comparable sets' upon which hierarchical classification is based: '. . . If S is a set consisting of identi-fiable components A, B, C . . . N, then the components make up a level of order when they are in a determinate association R which is the sum of the relationships among the components. The set so defined is a level of order because it has unitary properties at that level which stem not only from the properties of the components but from the particular relationships among them. The set belongs to a system which is hierarchical when the set so defined has components which are also sets and when it itself is a component in a more encompassing set. Thus in a hierarchical system each component is a set

$$S = (A, B, C \ldots N)^R$$

where S itself is a component of a set and A, B, C and N also are comparable sets.'

Identification of the 'comparable sets' associated as R is usually relatively easy when discrete sub-units are involved in the hierarchy (e.g. cells grouping into organs). The task is somewhat more difficult, however, when only partially discrete elements are involved (e.g. phylogenetic classification), and even more difficult when sub-systemization is very complex and not characterized by discretely bounded units. The last set of conditions obtains for the delineation of biogeographical units, on which a variety of constraints operate to develop entities that have no clear boundaries in either space or time. None the less, I feel that a rational derivation of such boundaries can be accom-plished if one starts with the premise that 'comparable sets' status should only be assigned to derived regional sub-units once they have met certain collective standards of construction and logic.

To begin with, it seems central that the comparable sets derived exhibit degrees of inter-unit similarity satisfying simple logical constraints. For non-trivial cases of multi-element associations, the simplicity of structure of a system is probably most conveniently judged by its degree of obser-vance of system-wide triangle inequality relationships; that is, for any three elements within the system, metric distance repre-sentations of the similarities between any two pairs of the three should always sum to a value greater than the similarity between the remaining pair. Any system of

relatable elements whose collectively measured similarities contain repeated violations of this relationship can be condemned as being to one degree or another illogical and/or poorly specified (with regard to the internal structure of its designated units). In the special case of spatial OTUs – 'OGUs' (Crovello, 1981) – such a condition is likely to mean that the elements have not been areally differentiated in such a fashion as to specify a clear meaning for R.

A further constraint on the systemization of distributional characteristics here is the hierarchical framework within which regional delineation must take place. Whatever the faunal association measure used or classification procedure applied, we should expect that each emerging regional unit will be comprised of subregions whose faunas are each at least as similar to one another as to the fauna of any subregion that belongs to a different regional unit. Any classification lacking this property is difficult to defend as being either hierarchical or logical.

It is also necessary to keep in mind that a fundamental goal of any systematic representation attempt is to capture as much of the information inherent in the original data as possible. It should be clear that any number of classifications of faunal distributions meeting the logical and hierarchical constraints described above might be developed, but that most of these will be ill-advised for their unparsimonious character. To avoid this problem, we should necessarily build into our classification methodology some measure of within-system redundancy levels that provides us with an ultimate standard of worth of a particular result.

Complicating any joint solution to the constraints identified above is the fact that the most efficient combination of number of regions and subregions appropriate for a particular data set will not be known beforehand. This suggests the necessity of relying on some kind of iterative procedure to force an optimum solution. However, not just any such procedure will do here. A straightforward clustering approach, for example, is inappropriate: such would rely on the assumption that the elemental units being grouped already constitute logically equivalent (comparable) sets, a contradictory

position for a procedure seeking to identify such sets. Moreover, just what constitutes an 'optimum solution' to begin with? We would like to have our constraints force a stable classification, but it is not obvious how to accomplish this in the absence of an initial statement about the principles of within-system hierarchical organization themselves. In short, in the specification of an S to be composed of non-discrete sub-elements, it becomes necessary to take an *a priori* stand on the meaning of the associated organizing principle R. I shall take the position that in such instances, R should define a state of collective maximum independence of relation among the sub-elements of S, and that this state of maximum independence should correspond to a particular configuration grouping $(A, B, C \ldots N)$ the elements of which individually constitute logically equivalent entities. The 'optimum' solution is that one which best mirrors this understanding of the relationship R, and is reached when within system redundancies are minimized subject to the retention of the simple structure characteristics being used to specify logical and hierarchical relationships.

In sum, the general position here is that if we wish to be able to judge the effectiveness of a given faunal regions classification, we need to know two general pieces of information about it: (1) its relative efficiency; and (2) whether it can specify hierarchical and logical relationships among its sub-elements. Standard multivariate statistical approaches to classification usually provide us with some inkling of how we stand relative to the first matter but are weak in their attention to the second. Multidimensional scaling techniques, however, provide a degree of flexibility within which we can make progress toward the eventual goal of an overall optimum solution.

Multidimensional scaling

The usual purpose of multidimensional scaling ('MDS') is to provide a portrait of the relative similarities of all n objects compared within the context of an n by n similarities matrix. Such a matrix can be constructed through a number of means, but in general may be said

to be composed of the 'distances' between all rated objects. The objects may be rated along either ordinal or interval/ratio scales; analysis may proceed within either a metric or non-metric framework. In the field of psychology, where the technique originated (Richardson, 1938; Torgerson, 1952, 1958, 1965; Shepard, 1962; Coombs, 1964) and where it has been most extensively applied, it is often used to assess perceived similarities or dissimilarities among a set of objects rated with regard to some attribute or set of attributes. Once the ratings and the resulting matrix have been completed, the scaled similarities among objects are transformed into a configuration of co-ordinate locations set with a one- to many-dimensional space. Euclidean distances between all pairs of locations can then be retrieved via the Theorem of Pythagoras; variation in these distances will correspond to the relative similarities among the objects being compared.

The goal of the iterative procedure leading to the configuration space solution is to minimize degree of 'badness of fit' between the original data and the configuration solution. This is accomplished within the computing algorithm through a continuing series of checks (and appropriate adjustments) that ensure that system-wide violations of triangle inequality relationships are reduced to a minimum for a particular dimensional solution. The actual procedure is relatively complicated; for present purposes it is enough to know that badness of fit of a given solution in x dimensions is usually assessed by a measure known as 'stress.' A low stress value indicates that most of the variance in the original similarities matrix has been accounted for in the x-dimensional solution specified (that is, that few violations of the triangle inequality rule remain in that x-dimensional solution).

Despite its popularity among workers in the behavioural sciences, MDS has only rarely been applied within a biological context (but for some good examples of its use there, see Tobler, Mielke & Detwyler, 1970; Cohen, 1978; and Jensen & Barbour, 1981). It is not possible to present more on the nature of MDS here; the interested reader should consult Beals, Krantz & Tversky (1968), Shepard (1974) and Kruskal & Wish (1978)

for more detailed introductions to the subject. In the analysis discussed here, MDS was used primarily as an aid in determining when the derived subregions of a particular regional classification met the logical requirements of hierarchical organization.

Methods

The first steps in arriving at a parsimonious classification of mammal faunal regions involved choosing distributional data and an appropriate measure of faunal association. Distributional information at the familial level was selected as the data base for its compromise between precision and manageability of treatment. The second choice was more complicated. Most faunal association indices in use (for example, those of Jaccard, 1902; or Schilder, 1955) are in one sense or another proportional computations. Proportional comparison, however, implicitly biases system reduction efforts; it cannot be assumed *a priori* that varying absolute diversities among regions are to be avoided in the assessment of logical equivalency among them. If we wish our solution to be as self-determining as possible, it is counterproductive to begin an analysis with a measure of association that compromises information characteristic of the system as a whole. For this reason, I eventually settled upon a simple association measure computed by subtracting the total number of families found in one of two faunas but not in the other from the number of pairs of families found in both, or:

$$(A_i \cap A_j) - [(A_i - A_i \cap A_j) \\ + (A_j - A_i \cap A_j)],$$

where the values of A are the total familial diversities of each region. Common families are thus not given double weighting, as in Sorensen (1948). The range of possible negative and positive values along this scale is limited only by the absolute diversities involved; an index value of zero signifies a situation in which $(A_i \cap A_j) = [(A_i - A_i \cap A_j) + (A_j - A_i \cap A_j)]$. This scale has the advantage of being explicit about absolute magnitude of dominance relationships between sub-units. It also has the advantage

of being translatable into a combinatorial framework that can be related back to simple set theory constructs.

The taxonomic classification and distributional data for the 115 families of mammals used in the study were taken from Anderson & Jones (1967). The distributions of all extant mammal families were considered except: (1) those that are wholly marine (Balaenidae, Eschrichtiidae, Ziphiidae, Balaenopteridae and Physeteridae); and (2) man (Hominidae). Since the data being treated consisted of mapped distributions (a sampling approach was not employed), simple conventions had to be set prior to analysis to allow decisions as to when a portion of a family's range in a given subregion was great enough to warrant its inclusion in the tally for that area. Such was allowed when either 10% or more of a given family's range extended across a given subregion *or* 10% or more of a given subregion was covered by a given family's range.

Classification proceeded iteratively to a final solution as a function of several operational constraints. To begin, I arbitrarily selected an existing regional classification system, that of Wallace (1876). I then catalogued the mammal fauna of each of the twenty-four subregions of that system. Once these data were obtained, intersubregional faunal comparisons were carried out and a 24 × 24 matrix of similarities was created. These data formed the initial input for the first analysis using the non-metric version of the KYST MDS package (Kruskal, Young & Seery, 1973).

The two-dimensional solution (stress = 0.101) may be viewed in Fig. 2. Note that the solution suggests considerable redundancy of classification (especially within the Ethiopian and Oriental Realms) and several cases of set mis-specification (two of the most obvious being subrealms within the Neotropical and Ethiopian groups which are more similar in this rating to the Australian group than to the other subdivisions of their own realm). Re-classification proceeded through the subjective collapsing into single units/resetting of boundaries of obviously redundant subregions, the compiling of a new similarities matrix, the performing of another MDS analysis, and so forth.
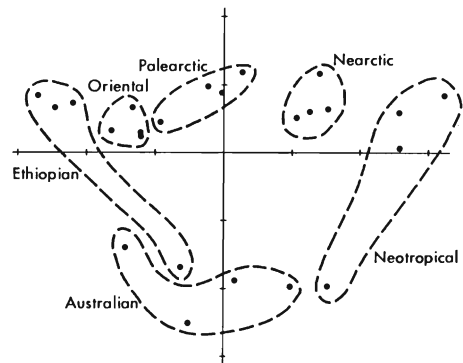

FIG. 2. Two-dimensional MDS configuration solution (stress = 0.101) to within-system similarities among the twenty-four subrealms of the Sclater—Wallace regional classification. Higher-dimensional solutions yield significantly lower stress values, but still exhibit the classification inconsistencies noted in the text.

Distance relationships within the MDS solution configuration provide a means through which to identify redundancies within a given classification, but classification *per se* cannot be pursued to any productive length without the introduction of further constraints on the meaning of an acceptable improvement in systemization. This is a matter of being able to judge objectively whether a particular alteration of subregional domains results in a classification of higher net efficiency. Such can be accomplished by focusing on the relationship between the $(A_i \cap A_j)$ and $(A_i - A_i \cap A_j) + (A_j - A_i \cap A_j)$ values through the computation of the following fraction:

$$I = \frac{\sum\limits_{i=1}^{n} \sum\limits_{j=1}^{n} g_{ij}}{\sum\limits_{i=1}^{n} \sum\limits_{j=1}^{n} h_{ij}}$$

where g_{ij} is the number of pairs of families common to the faunas of subregions i and j, and h_{ij} is the number of families in i or j not common to the fauna of the other subregion. 'I' is a good measure of intrasystem redundancy; minimizing this value has the effect of insuring that each elemental unit in the classification is as different from every

other unit as it possibly can be. It also has the effect of minimizing the total sum of intraconfiguration distances retrievable from the associated MDS solution configuration.

Re-classification thus continued (through further aggregations and other boundary line changes) until the value of '*I*' was minimized, but subject to one further constraint. This was that the associated MDS solution maintained (or developed) reasonably simple structure; i.e. that its stress remained low for an appropriately small dimensionality. This constraint is vital here; without it there can be no defendable aggregation of elemental units (subregions) into logically consistent sets (regions) once the classification is completed. The reason for this is that there can be no confidence in the intraconfiguration distance matrix derived from a high stress MDS solution, and the lack of such confidence makes it impossible to defend the logic of any particular hierarchical grouping of elemental units. In short, we cannot know under such circumstances exactly how similar one unit is to any other unit, and therefore cannot fulfil the requirement that the members of any given set must be at least as similar to one another as to any member of any other set. 'Vague' solutions in this sense cannot be considered solutions.

Once an acceptable solution was arrived at and subregional domains were established, regional delineation could begin. This was accomplished by aggregating subregional units such that the logical/hierarchical constraints discussed earlier were met with respect to each regional set of subregions. The end result was a conjoint solution in which within-regional faunal variation was maximized and between-subregional faunal similarity was minimized. The particular regional solution obtained here was verified through a cluster analysis of the final similarities matrix that produced identical groupings.

In sum, re-classification proceeded under the dual constraints of maintaining logical equivalence of units *and* parsimony of result. MDS was used as both a subjective aid in the subregional delineation process and a means through which to keep track of the logical/ hierarchical characteristics of the unfolding solution. This approach to regional classifi-cation is time-consuming, but, I believe, quite effective.

Results

The analysis produced a four region, ten sub-region classification. This is mapped in Fig. 3; its MDS configuration in two dimensions (stress = 0.044) is shown in Fig. 4. I have taken a few liberties in naming the regions and subregions produced; hopefully the nomenclature decided upon will not cause undue confusion. Regarding Fig. 3, it will be noted that regional delineations in the new classification differ considerably from those in the Wallace classification as a result of the considerable agglomeration and re-grouping. Where boundaries between units have undergone modification (for example, the Neotropical–Nearctic and Oriental–Palearctic boundaries), the re-definitions have been associated with minimization of distri-butional overlaps between units. This is a departure from past practices in which boundaries have usually been associated with the most prominent 'breaks' in distributional patterns. The wisdom of this change might be questioned, but can be defended on the grounds that it produces both a less redundant classification and one of greater internal order.

It is useful to compare via simple statistics the parsimony of the present classification with Wallace's. The index of efficiency '*I*' for the Wallace system is 0.407; for the new one it is 0.375. This difference indicates that the new classification is in fact more efficient with respect to its maximization of the mean per subregion difference between families held in common with other subregions and families not held in common. The mean number of subregions per family in the twenty-four sub-region Wallace classification is 5.77, whereas in the new one it is 2.61. This indicates an un-avoidable loss of specificity of distributional status in the new ten subregion classification as compared to the old one. This comparison neglects the difference in internal logic of the two systems, however. Inter-subregional simi-larities within the Wallace regionalization lead to a scaled solution in four dimensions accompanied by a stress of 0.045; a three-dimensional solution of the present system

1A. Nearctic
1B. Palearctic
2A. Neotropical
2B. Argentine
3A. Mediterranean
3B. Ethiopian
3C. Oriental
4A. Australian
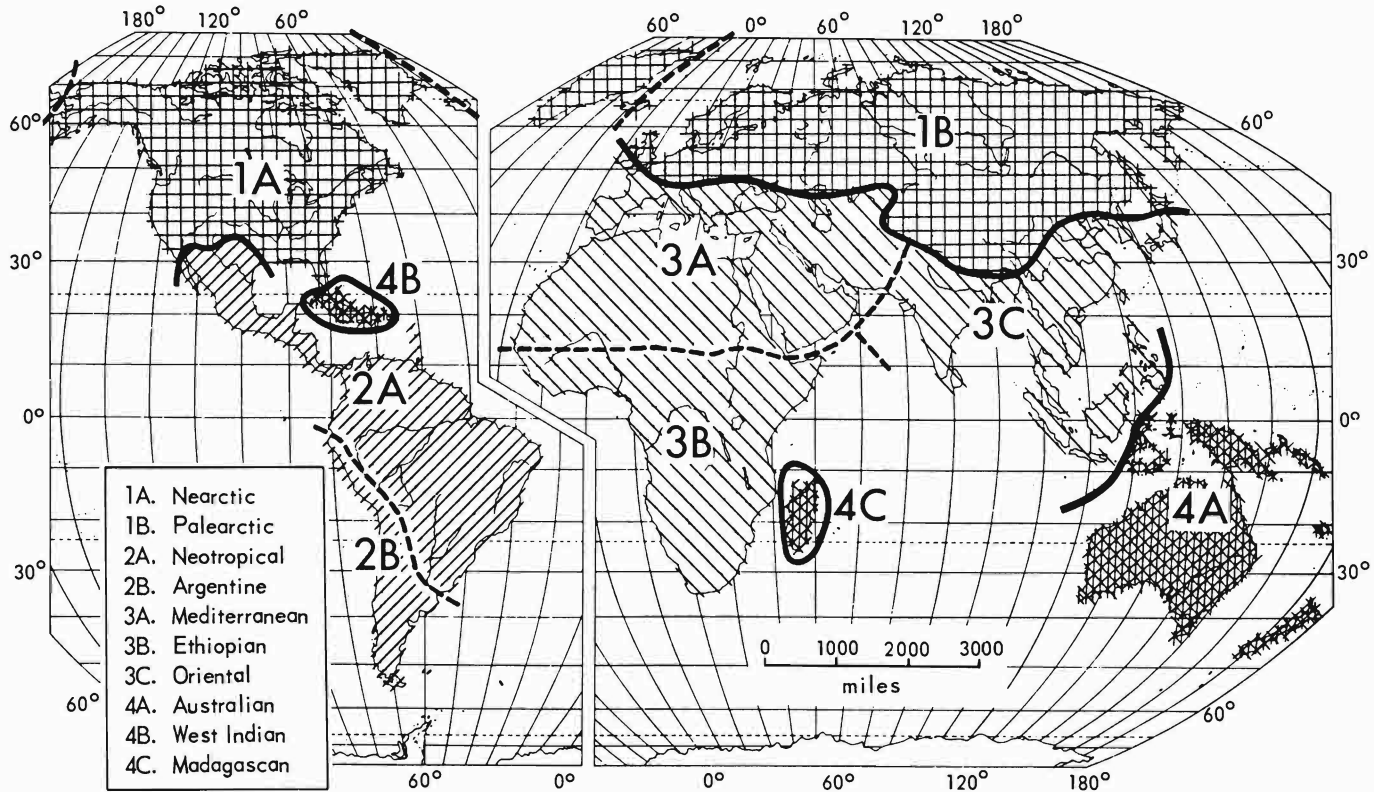4B. West Indian
4C. Madagascan

FIG. 3. The four regions and ten subregions of the present mammal regions classification. Subregion names as noted in the legend on the map. Regional names: (1) Holarctic; (2) Latin American; (3) Afro-Tethyan; (4) Island.
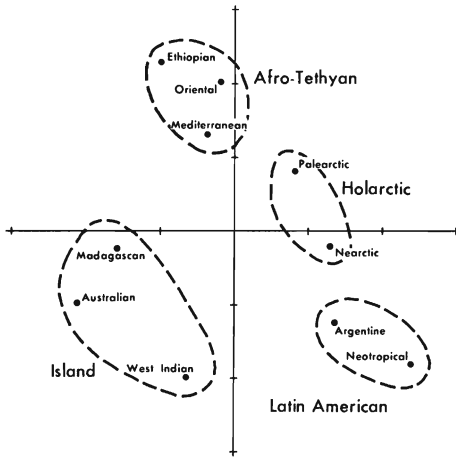
FIG. 4. Two-dimensional MDS configuration (stress = 0.044) to within-system similarities among the ten subregions of the present mammal faunal regions classification.

produces a very low stress of 0.012. Thus, while the precision of the former is relatively greater, the accuracy of the latter is greater (that is, R is more clearly specified). Moreover, the precision difficulty could easily be overcome anyway through further hierarchical subsystemization.

Tables 1–5 provide some further statistics and data relating to the new scheme. (A more complete treatment of such will appear in a forthcoming work.) Table 1 lists the number of families endemic to each subregion. Table 2 lists how many endemic families, endemic orders, and total families each region

TABLE 1. Number of mammal families endemic to each subregion in the present classification

Subregion	No. families endemic to
Nearctic	1
Palearctic	0
Neotropical	9
Argentine	2
Mediterranean	2
Ethiopian	8
Oriental	6
Australian	9
West Indian	2
Madagascan	4
Total	43

TABLE 2. Number of mammal families endemic to, number of mammal orders endemic to, and total number of mammal families present in, each region in the present classification

Region	No. families endemic to	No. orders endemic to	Total no. families
Holarctic	6	0	36
Latin American	20	1	48
Afro-Tethyan	29	5	65
Island	15	1	35

contains. Table 3 consists of the final matrix of similarity values used to produce the MDS solution configuration in Fig. 4. Tables 4 and 5 contain in some respects the most interesting descriptive information presented here. Table 4 is a tally of the number of families that can be found in a particular number of subregions, regardless of which (of either). It can be seen that the vast majority are found in only one or two subregions, and that there are very few families that are ubiquitous or anywhere close to it. Table 5 reverses this perspective by indicating the mean number of subregions that the familial elements of the fauna of a particular subregion are found in. This information (along with the accompanying standard deviations) provides a good general portrait of each subregion's fauna that can be related to characteristics of system organization (which will be discussed at length in later parts of this work).

Some surprises emerge in the new classification. The most interesting, perhaps, is the range in both area and diversity of the ten subregions. This seems to suggest that neither is of much importance in influencing mammal faunal region structure at the world level. (Flessa (1975) has demonstrated a relationship between the areas of continents and their mammalian diversities, but neither is necessarily related to the historical trends of association among these areal units.) Some individual regional characteristics are possible to identify, however, partly in conjunction with information contained in the marginal statistics of Table 3 and the data of Table 5. High contiguity with other subregions can be associated with faunal characteristics of the Nearctic, Palearctic, Mediterranean and Oriental subregions. Low contiguity with

TABLE 3. Symmetric matrix of similarities of sub-regional mammal faunas compiled as described in the text. Column marginal statistics are population means and standard deviations.

	Nearctic	Palearctic	Neotropical	Argentine	Mediterranean	Ethiopian	Oriental	Australian	West Indian	Madagascan
Nearctic	27	2	−17	−14	−21	−38	−28	−34	−25	−29
Palearctic	2	28	−39	−21	−4	−24	−20	−35	−29	−30
Neotropical	−17	−39	44	−4	−44	−55	−42	−51	−33	−46
Argentine	−14	−21	−4	26	−32	−46	−36	−33	−24	−31
Mediterranean	−21	−4	−44	−32	36	1	2	−31	−34	−17
Ethiopian	−38	−24	−55	−46	1	47	3	−36	−42	−25
Oriental	−28	−20	−42	−36	2	3	46	−38	−44	−27
Australian	−34	−35	−51	−33	−31	−36	−38	19	−20	−15
West Indian	−25	−29	−33	−24	−34	−42	−44	−20	10	−15
Madagascan	−29	−30	−46	−31	−17	−25	−27	−15	−15	17
Mean	−17.7	−17.2	−28.7	−21.5	−14.4	−21.5	−18.4	−27.4	−25.6	−21.8
SD	18.37	19.36	28.38	19.41	22.47	29.06	26.64	18.03	14.69	15.65

other subregions is an evident factor in the evolution of the faunas of the Argentine and Australian subregions. The effects of isolation and/or inaccessibility are reflected in the nature of the Neotropical, Argentine, Ethiopian, Australian, West Indian and Madagascan faunas. Three subregions contain eight or more endemic families: the Neotropical, Ethiopian and Australian. Cosmopolitan faunas dominate the Nearctic, Palearctic and Mediterranean subregions. The faunas of the West Indian and Madagascan subregions are characterized by high proportions of both cosmopolitan and endemic groups.

Another interesting result is the emergence of a region comprised of non-contiguous island subregions. This should cause little distress if one considers the fact that isolation is the primary force of faunal evolution on any island, and that for highly isolated islands, this commonality will outweigh contiguity — and all other — considerations. We feel little reluctance, after all, in technically classifying southern California as Mediterranean in climate — regardless of its remoteness from the Mediterranean Sea area — since the climate of the two areas arises as a result of a common set of general causal forces. The philosophy here is that elemental affinities should be isolated in the classification process, and that the contiguity relationships that happen to surface should represent food for post-analysis only.

A third unexpected result is the integrations of Wallace's Nearctic and Palearctic and Mediterranean, Ethiopian and Oriental into single regions. A Holarctic Region was first proposed by Heilprin (1887), but his classification recognized a Mediterranean area subregion within that unit. In the present system, the Mediterranean subunit exhibits closer logical affinities with the Ethiopian and Oriental subregions, and is placed with them in an 'Afro-Tethyan' Region. There seems to be little historical precedent for such a unit, though Engler's (1882) 'Paleotropical', a phytogeographic kingdom, is similar in geographic extent.

Final remarks

The mammal faunal region classification presented here is to my knowledge the first

TABLE 4. The 115 mammal families of this study grouped according to the number of subregional faunas of the present classification each is present in

No. subregions found in	No. families
10	1
9	3
8	0
7	5
6	5
5	6
4	6
3	9
2	37
1	43
Total	115

TABLE 5. Statistical characteristics of cosmopolitanism of the mammal faunas of the present classification. Values in the first column represent the mean number of subregions that the families of a particular fauna are found in; values in the second column are the associated population standard deviations.

Sub-region	Mean	Standard deviation
Nearctic	4.85	2.72
Palearctic	4.86	2.42
Neotropical	3.43	2.58
Argentine	4.42	2.87
Mediterranean	4.78	2.37
Ethiopian	3.94	2.50
Oriental	4.17	2.43
Australian	3.79	3.07
West Indian	4.80	3.68
Madagascan	4.94	3.00
Mean	4.40	2.76
SD	0.509	0.387

arrived at which explicitly treats regional units as internally consistent logical elements of a world set. Despite this advantage, however, it should be remembered that the subjective iterative solution necessary to derive it precludes its defence as the most perfect that can possibly be obtained. Although considerable attention was given to investigating possible competing classifications before rejecting them, the possibility remains that a slightly better one exists. Moreover, different taxonomic bases may yield slightly different overall results (though this was not substantially so for two other such systems I briefly investigated). In any case, such possible improvements would be debatable. The perfection of the system ultimately rests on the elimination of present unresolved difficulties in the taxonomic and/or distributional status of some of the families considered here.

Regardless, the method used to elicit this system provides a reasonable solution to a problem that has plagued descriptive regional biogeography for as long as it has existed: that of how to go about defining a logical and operational meaning for 'equivalence' among the subunits of a world regional classification system. While it certainly cannot be argued that the approach presented here should be the *only* way of delineating world faunal regions, it does provide a classification with a number of appealing properties. These include: (1) an explicitly logical and hierarchical basis; (2) a relatively low degree of redundancy of representation among the elements of the system; (3) a hierarchical structure that is indefinitely extendable; and (4) the fact that the system can be applied to the consideration of issues of process. The fourth point above will be explored at some length in the second part of this work.

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