A DILUVIOLOGICAL TREATISE ON THE STRATIGRAPHIC SEPARATION OF FOSSILS[†]

John Woodmorappe[*]

The author and the editor have been discussing and planning this work for nearly two years. It was received 4 October 1982, and with revisions 1 June 1983.

Calculations performed on the stratigraphic separational tendencies of fossil families show that one-third of them span 3 or more geologic periods. Also, geologic periods with 4 intervening periods between them still show double-digit percentages of familial faunal similarity.

A total of over 9500 global occurrences of major index fossils have been plotted on 34 world maps for the purpose of determining superpositional tendencies. 479 juxtapositional determinations have shown that only small percentages of index fossils are juxtaposed one with another. Very rarely are more than one-third (and never more than half) of all 34 index fossils simultaneously present in any 200 mile (320 kilometer) diameter region on earth.

Flood mechanisms (pure chance, selective preservation, differential escape and hydrodynamic selectivity, and ecological zonation) are evaluated. Independent evidence is presented to demonstrate that Phanerozoic fossils were deposited under tectonically-differentiated conditions, thus justifying the concept of TABs (Tectonically-Associated Biological Provinces) as the main cause of biostratigraphic differentiation. The TAB concept is placed in an integrated study of fossil separation, and it is shown that it explains extinction trends relative to the extant biosphere. The (near) absence of pre-latest-Phanerozoic human remains is explained through low antediluvian population (primarily); preservation factors are also scrutinized.

Plan of This Article

Introduction

The geologic column, specifically the order of appearing and disappearing fossils, is a pivotal point in both the evolutionary-uniformitarian and Creationist-Diluvialist paradigms. Evolutionists have long cited the order of fossils as evidence for evolution, but Creationists have offered alternate explanations in terms of the Universal Deluge. Whitcomb and Morris[643] noted the role of hydrodynamic sorting as well as differential escape, while Clark[645] (and many other Creationists-Diluvialists) emphasized ecological zonation. Price[644] and Burdick[646] tended to downplay the need for any specific mechanism to account for the stratigraphic separation of fossils, pointing out that many fossils overlap large parts of the geologic column and that few different types of fossils can usually be seen to superpose at any one given locality.

This work is a rigorous study of: 1) the actual stratigraphic tendencies of fossils, 2) the actual successional tendencies of fossils, and 3) models of Flood action directly bearing on these two tendencies. The term "actual stratigraphic tendency" used herein (and throughout this work) refers to the statistical tendency of fossils to be confined within a single geologic period versus the tendency to span a large part of the geologic column. The term "actual successional tendency" means the tendency for many index fossils to be found superposed at any one given locality versus the tendency for few index fossils to be locally superposed.

There is a need to clarify the relationship between organic evolution and the geologic column because Creationists have commonly been accused of misunderstanding the relationship between the two. This issue has importance not only in relation to the Flood, but also increasingly (as pointed out by Creationists Morris and Parker[647]) in relation to the basic Creation/evolution issue. It goes without saying that evolution is based on the geologic column. McLaren[648] wrote: "All historical inference in geology comes from the positional relationships of rock and mineral bodies. Stratigraphy is a special case of this general law, and our sole knowledge of the orderly evolution of life as represented by fossils, comes from their mutual rela-

---

[*] John Woodmorappe has a B.A. and M.S. in Geology and a B.A. in Biology.

[†] This work is dedicated to the observance of the 20th anniversary of the founding of the Creation Research Society.

tions in stratified bodies. *The only proof that one fossil is younger than another lies in the relative position of the two in a sequence of rock. . . .* Hypotheses of evolution of a lineage must depend on the fact of positional relationship." (italics added)

Gingerich[649] said: "Without fossils and stratigraphic ordering, evolution itself would be little more than a speculative conjecture." (Since—as will be shown-most fossils are not superposed at any one spot, evolution is nothing more than a speculative conjecture.) It is also worth noting that the study of stratigraphy is not only colored by evolutionist's presuppositions, but also uniformitarian ones. This latter fact is evident in the following statement of Watson[650]: "Stratigraphy is the senior branch of historical geology . . ."

Evolutionists and uniformitarians, however, commonly claim that: 1) the geologic column is totally independent of organic evolution, and 2) that it was Creationists who had founded the geologic column. The first point is now addressed, while the second depends on definition of the word Creationists, a point to be considered later. First of all, it goes without saying that horizons of fossils (as well as lithologies themselves) have a regional character to them that enables their use in correlation (independent of any mode of origin) locally and regionally. McKerrow[651] wrote: "Some fossils can be used as a rough working basis for stratigraphy without considering them as much more than formed stones. William Smith discovered the stratigraphical application of fossils long before the publication of Darwin's *Origin* of *Species* in 1859; and, during the second half of the nineteenth century, palaeontologists were applying their efforts to the description of new fossils and to the establishment of a stratigraphical framework based on their new discoveries. Sedgwick, Lapworth, Murchison, and John Phillips (to put them in stratigraphic order) were all concerned with the use of fossils as indicators of geological time. Looking back, it now seems amazing that none of these early giants demonstrated much in the way of evolution in fossils."

An important distinction must be made between local and regional correlations (as exemplified by William Smith), and global correlation (as exemplified by Murchison). As one moves from local all the way to global correlation by fossils, correlations become increasingly less empirical and more conceptual. This is because there are progressively greater differences (such as lithology, local fossil succession, and overall faunal character) as one moves ever further geographically from a reference section in the type area. Accordingly, global correlation cannot rest entirely (or even primarily) upon empirically-derived superpositions but must depend upon a *conceptual* foundation linking index fossils as being time-equivalent.

The oft-repeated evolutionary-uniformitarian claim that global correlations by fossils are strictly empirical and independent of any other concept can be refuted merely by pointing to the history of geology. The Wernerians believed that basic lithologies could be correlated; hence a granite could be correlated with any other granite on earth. Note that the correlation was not purely empirical but was dependent upon the *concept of time-equivalence* and/or genetic relationships of primary lithologies. Once the concept of such equivalence among primary lithologies fell into disfavor, so did the entire Wernerian system.

An analogous situation exists for correlation by fossils, as pointed out by Price.[644] Some conceptual basis is needed for assuming a time-equivalence between fossils: this conceptual basis *is* organic evolution. Correlation by fossils has meaning *only* when they are believed to have arisen at a *definite time* and become extinct at a definite time more or less contemporaneously all over the earth.

The fact that the concept of time-equivalence of index fossils depends upon acceptance of organic evolution is proved by the following discussion concerning global correlations of Lower Cambrian cited by Cowie, *et al.*:[652] "Dr. W. S. McKerrow asked the authors if they considered the three Lower Cambrian zones to be satisfactory time indicators. Could these changes be due to some environmental factor like increase in depth of water? If so, the same sequence of environments might produce the same sequence of faunas at different times in different areas, In particular, would the authors state why the faunal changes between the 'non-trilobite zone' and the succeeding 'olenellid zone' should represent a time horizon rather than a change in environment?" It is evident that the stratigraphic appearance of olenellid trilobites has meaning in global correlations *only* if this appearance is the result of an isochronous *evolutionary* outburst. If this appearance is due to an ecological as opposed to evolutionary change, then there is no conceptual basis for believing that the appearance is time-equivalent all over the earth, and the mere fact that this stratigraphic appearance of olenellid trilobites is empirical in no way validates it as a time horizon for global correlations.

Attention is now focused on the question of whether or not it was Creationists who founded the geologic column. Individuals such as Cuvier and Lyell (in his earlier years) accepted special creation *only* in the organic realm, but were always evolutionistic with regard to geology. Recall that evolution is not only considered to be operative in the organic realm, but at all these five realms: 1) cosmic, 2) geologic, 3) organic, 4) organic-human, and 5) human-cultural. Total evolution repudiates all forms of Divine action and attempts to explain the origin of existence, complexity, structure, and diversity in these five realms through materialistic processes that allegedly result in innovation, usually (though not inevitably necessarily) over immense periods of time. Special Creation in these five realms not only explains mere existence, complexity, etc., in terms of Divine action, but stresses the fact that all natural changes since then have been conservative or degenerative (as opposed to innovative).

To be a consistent (or full, or true) Creationist, one must accept special creation in all five realms, and a parallel definition exists for being a consistent evolutionist. Contemporary compromising positions such as deistic evolution, theistic evolution, so-called progressive creation, the "gap" (or ruin-reconstruction) theory, and the pre-world position are thus neither consistently Creationistic nor consistently evolutionistic. These hybrid positions mix evolutionistic with Creationistic concepts and allow both special creation and evolution to split roles among (and/or within) the five realms of origins discussed previously.

Cuvier, Lyell, and other originators of the geologic column also held to hybrid positions, so it is fallacious to say that they were really Creationists. Fossils were used for global correlation and special creation was used as the basis for their alleged time equivalence, but this whole notion of multiple repopulations is purely the result of special creation (in the organic realm only) being unequally yoked with evolution (in the geologic realm).

It has been already demonstrated that global correlation by fossils requires some concept of time-equivalence of fossils to be operative. While Cuvier and Lyell used special creation as the concept for time-equivalence, their hybrid position of multiple creations of life over immense amounts of time has been long since repudiated (in fact, Lyell himself became a total evolutionist towards the end of his life). Nowadays, it is the concept of organic evolution which provides the basis for alleged time-equivalence of index fossils. Since the distorted concept of special creation used by the originators of the geologic column was never truly Creationistic, and organic evolution has long since become the conceptual basis for time-equivalence of index fossils, modern Creationists can justifiably point out that organic evolution *is* the basis for the geologic column.

I. DETERMINING TRUE STRATIGRAPHIC AND SUCCESSIONAL TENDENCIES OF FOSSILS

A. A Measurement of the Actual Stratigraphic Tendencies of Fossils

It is a well-known fact that not all fossils are believed to have time significance, and many range through several geologic periods. In evaluating tendencies for fossils to be stratigraphically differentiated, one must first evaluate the credibility of the taxonomy involved. In my work[653] on cephalopods, I had advocated that fossil species and genera (as well as their stratigraphic ranges) not be recognized. It was extensively documented that; 1) fossil species and genera are highly subjective—even to such an extent that the number of fossil species and genera identified in a given collection often varies by more than a factor of two, 2) there is an artificially high diversity of short-range taxa, 3) the taxonomy is deliberately biased to produce short-ranged "species" and "genera," 4) the same taxa are given different names in different stratigraphic positions.

Some additional evidence is now presented. In setting up Lyellian curves for progressive extinction of marine faunas in Late Tertiary (stated to be circa 20 million years ago), a large scatter of 4 to 5 million years was noted by Stanley, *et al.*,[654] who wrote: "It is possible that at least part of the apparent disparity between the gastropods and bivalves is an *artifact of taxonomy.*" (italics added). If fossil species that often (or usually) have actual living representatives are subjective, how much more so ancient forms with no living representatives even at higher taxa! Elsewhere, Chaloner and Lacey[655] wrote: "It is the nature of palaeontology that as knowledge of material increases, particularly from a wide range of localities, concepts of generic limits change. This makes any attempt to collate records from all over the world, involving data published over a considerable amount of years, considerably vulnerable." Though they were speaking of biogeographic differentiation, the same applies for stratigraphy. The (implied) proclivity to multiply taxonomic names at different stratigraphic horizons is evident in this use of foraminifers with respect to Cretaceous stages, described by Bartenstein and Bolli[656]: "A Middle to Upper Albian assignment in Rumania by Costea (1974) is stratigraphically so young that the species determination should be checked again." In another situation, Windle[657] advocated that Carboniferous spores had been reworked into the Triassic; the spores erroneously having been given two different names by others depending on which geologic period they were in although they were nearly identical. Ethington and Schumacher[658] wrote: "We are reluctant to extend its range downward into Middle Ordovician rocks without evidence of its concurrence in Upper Ordovician strata as well as in rocks representing almost the entire Silurian System." They wanted to invoke different names for look-alike conodonts just because they were in different strata! (so-called homeomorphy).

The family level of taxonomy was taken as the basic unit for calculating the overlap of all fossils with respect to the geologic column, and the results are shown in Figure 1. The data for fossil families came from the volume by Harland.[659] He listed 2,617 fossil families (with a small admixture of slightly higher and lower taxons where necessary for approximate equivalence). They were shown as lines spanning part or all of the geologic column. The present author manually counted all 2,617 lines in terms of how many geologic periods they span and the results were thus graphed in Figure 1. Although fossil genera are not recognized as valid entities, they were included in Figure 1 be-

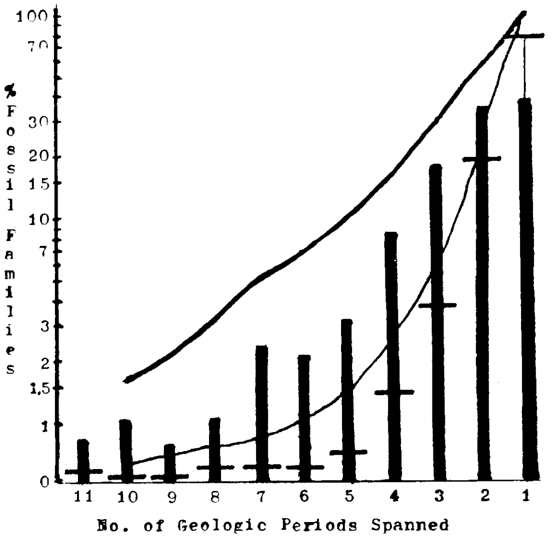


Figure 1. A Quantitative Breakdown of the Stratigraphic Overlap of Fossils with Respect to the Geologic Column. The horizontal line segments and thin cumulative-frequency curve refer to fossil genera: the thick vertical bars and thick cumulative frequency curve refer to fossil families.

cause they were already available from the work of Raup[660] in direct numerical form (in contrast to the stratigraphic lines for fossil families). The total number of fossil genera is 19,805.

Caution must be used in interpreting the data because of the following reason given by Cutbill and Funnel[661] concerning all such quantitative manipulations of bulk taxonomic data: "Moreover, we are not at all convinced that there is any real equivalence in rank even between nominally equivalent taxa." Thus one is in the proverbial situation of mixing apples with oranges. Nevertheless, the data in Figure 1 do give an idea of the degree of stratigraphic overlap of fossils. It can be seen that fossils are highly differentiated stratigraphically, but on the other hand there is significant overlap of many geologic periods. One-third of all fossil families span 3 or more of the 10 geologic periods (the present is listed in Figure 1 as an 11th geologic period). The number of all fossil families spanning the entire geologic column, while a very small minority, is still measureable on the percentage scale. At the same time, only one-third of all fossil families are stratigraphically confined to only one geologic period. The net result of the data shown in Figure 1 is that, while the Creationist-Diluvialist must account for the stratigraphic differentiation of fossils, the evolutionist-uniformitarian must resort to special pleading in using fossils as time markers because of the fact that he must ignore many fossils that span a large portion of the geologic column.

It must be realized that even the stratigraphic confinement of families is self-fulfilling to a considerable extent because circular reasoning plays a major role in biostratigraphy and because most index fossils do not actually overlie one another; both points are extensively discussed in subsequent chapters. Even taking Figure 1 just at face value, one must note many reasons for shifting both the histograms and curves leftwards (towards increasing stratigraphic overlap of fossils). First of all, the subjectivities discussed in conjunction with the rejection of fossil species and genera apply to a certain extent to fossil families. Koch[662] showed that there is an artificially low diversity of long-range taxa because they, having little or no stratigraphical utility, have not been as well studied as short-range taxa. He concluded: "The published fossil record has significant bias in favor of common and biostratigraphically important taxa . . ." Simultaneously, there is an artificially high diversity of short-range taxa caused by taxonomic oversplitting by stratigraphers. This was amply demonstrated in this author's work[653] on the cephalopods. Elsewhere, in a study of Archaeocyathids, Sepkoski[663] noted an "excess of families" probably caused by their "biostratigraphical value."

Even when taxa are accepted as valid there is a noteworthy trend for stratigraphic ranges to increase with further collecting. As a matter of historical interest, Kielan-Jaworska[664] wrote: "Not until 1925 were remains of the placental mammals found in pre-Tertiary deposits, specifically from the Cretaceous." There are numerous recent instances of significant stratigraphic-range increases, and some of these are summarized by the Creationist Lubenow[665] and also by the present author in his work on cephalopods,[653] his first Anthology,[666] and his second Anthology;[667] not to mention over 200 stratigraphically-anomalous fossils tabulated in his second Anthology[667] (and explained away by uniformitarians as being reworked). In just the last few years there have been interesting developments in the area of extention of stratigraphic ranges. Shu said:[668] "It is still necessary to explain why so many Paleozoic plants persisted into earliest Triassic time in South China." Bengston[669] wrote: "In all the investigated characteristics, *Atractosella* is indistinguishable from a modern soft coral of the family Alcyoniidae. It is interpreted as the earliest known representative of the octocoral order Alcyonaceae, extending the range of this group from the Lower Jurassic to the Lower Silurian." Collins and Rudkin[670] reported a find of barnacles that extends their range downward from "the Upper Silurian to the Middle Cambrian" and they also noted that it is ". . . a barnacle of such modern aspect."

Such stratigraphic-range extensions are not exceptional, and one can never be certain that a sufficiently large number of stratigraphic observations of a taxon have been made, for the following reason given by Crick:[198] "Chances of fragmenting the fossil record and truncating stratigraphic ranges are increased if small geographic areas are sampled." Cutbill and Funnel[661] wrote: ". . . collection failure usually tends to produce bunched and shortened ranges." In his work on fossil genera (here graphed in Figure 1), Raup[660] said: "If the early members of a genus are not preserved . . . then that genus may be placed in a later cohort in ignorance of its earlier history. Another general effect of non-preservation is to truncate geologic ranges . . ." There is thus no way of knowing whether the stratigraphic ranges of taxa shown in Figure 1 are reasonably final. At the same time, there is evidence presented by Raup[671] and by Simpson[672] that most fossil lower taxa have already been discovered, so it is unlikely that future discoveries of short-range taxa will statistically offset the continual increase of stratigraphic ranges exhibited by currently-known taxa.

The factor of circular reasoning will be discussed in a later chapter; but some of its employment is mentioned here because of its bearing in terms of the artificial exaggeration of the number of short-range taxa in relation to long-range ones; again justifying a leftward shift in Figure 1. Cutbill and Funnel[661] wrote: "It seems to us that the number of taxa shown in our figures as commencing or ending their ranges at major Era or System boundaries may well be influenced at least in part by preconceptions on the part of systematists on the limiting effect of these boundaries." The consequences of such circular reasoning were well described by Maheshwari:[673] "Fossils are relied on to provide an indication of geologic age; if age is accepted as a criterion for taxonomic distinction, a perfect circularity of reasoning results that would nullify one of the important purposes of paleontologic work." When considering the implications of Figure 1, one should keep in mind that there is a significantly greater share of long-range taxa than shown because of the factors just discussed.

										RECENT –
									TERTIARY –	80,* 89
								CRETACEOUS –	70, 51	60,* 82
							JURASSIC –	83, 52	64, 29	57, 49
						TRIASSIC —	67, 49	61, 27	50, 16	48, 30
					PERMIAN –	52,* 65	40, 36	37, 21	32, 13	31, 24
				CARBONIFEROUS –	72, 71	39,* 48	31, 27	29, 16	25, 10	25, 19
			DEVONIAN –	58, 54	42, 38	24,* 28	18, 15	18, 9.1	15, 5.8	15, 10
		SILURIAN –	85, 59	52, 33	39, 25	26, 20	19, 11	19, 6.9	16, 4.2	15, 7.5
	ORDOVICIAN –	70, 68	61, 41	39, 25	31, 19	21, 16	17, 9.3	17, 5.8	14, 3.5	11, 6.1
CAMBRIAN –	55, 20	37, 13	36, 8.7	27, 6.1	24, 5.4	20, 5.6	18, 3.7	18, 2.3	17, 1.5	15, 2.5

Table 1. The Tendencies for Sharing of Fossil Families Between Geologic Periods. The numbers are percentages of fossil families reciprocally shared between Geologic Periods. For example, 29% of all families that cross at least part of the Carboniferous also cross at least part of the Cretaceous; 16% of all families crossing Cretaceous also cross Carboniferous. The asterisks (*) indicate exceptional situations in which a younger geologic period has more families in common with an older period than vice versa.

Figure 1 gives only degree of stratigraphic overlap but does not specify the actual geologic periods where the taxa occur. Table 1 was constructed to show quantitatively how fossil families spread stratigraphically across geologic periods with respect to specific geologic periods versus each other. Each geologic period has a definite number of fossil families that cross it stratigraphically; irrespective of whether they originate, terminate, or totally span the period. Two percentages are given in Table 1: the former is the total number of families in common between two periods divided by the total number of families crossing the older geologic period (times 100), the latter is the total number of families in common with the two periods divided by the total number of families crossing the younger geologic period (times 100).

The raw data are from the Harland[659] volume, and the percentages were computed by manually reducing all 2,617 families to a numerical abundance relative to all possible stratigraphic ranges: Cambrian-Cambrian, Cambrian-Ordovician. . . . Cambrian-Recent, Ordovician-Ordovician, . . . Ordovician-Recent. . . . . Recent-Recent. The total number of possible Phanerozoic ranges is 66 (= 11 + 10 + 9 + . . . 1). An example is now presented to show how the entries in Table 1 were computed: Silurian vs. Triassic. The first term is given by: S+T+(100x)/(S+T+ plus S+T−) whereas the latter term is given by: S−T+(100x)/(S+T+ plus S−T+). The S and T stand for Silurian and Triassic, whereas a (+) sign to the right of the letter denotes that a family crosses it and the opposite is the case for a (−) sign. Thus S+T+ means families common to both Silurian and Triassic. S+T+ equals: Σ(Cambrian-Triassic+ . . . Cambrian-Recent) + (Ordovician-Triassic+ . . . Ordovician-Recent) + (Silurian-Triassic+ . . . Silurian-Recent). S+T− means families crossing Silurian but not Triassic and equals: Σ(Cambrian-Silurian+ . . . Cambrian-Permian) + (Ordovician-Silurian+ . . . Ordovician-Permian) + (Silurian-Silurian+ . . . Silurian-Permian). S−T+ denotes families not present in Silurian but present in Triassic and equals: Σ(Devonian-Triassic+ . . . Devonian-Recent) + (Carboniferous-Triassic+ . . . Carboniferous-Recent) + (Permian-Triassic+ . . . Permian-Recent) + (Triassic-Triassic+ . . . Triassic-Recent).

Probably the most interesting result of Table 1 is the fact that, in all but 5 out of 55 cross-comparisons, the per cent value at left is greater than the right. This means that, in all but the few exceptional cases, older geologic periods have more of their families in common with younger periods than younger ones have their families in common with older ones. In other words, the main trend going stratigraphically upwards is not as much the disappearance of old forms as the addition of brand new forms. If this trend in Table 1 had been shown as a Venn Diagram, the older geologic period would be represented with a smaller circle than the younger and thus the area of overlap of the circles would be a smaller share of the larger circle than of the smaller.

The trend shown in Table 1 may be primarily an artifact of biostratigraphic methods, and reveal in its own way how the fossil record is artificially made to appear more stratigraphically differentiated than it really is. This takes place because stratigraphic conflicts are resolved by allowing old taxa stratigraphically to range into younger strata in preference to allowing younger taxa to range downward into the older strata. Thus stratigraphic differentiation is made to appear more compelling by having as many groups as possible not appearing until late in the geologic column. A concrete example of this was provided by Karamlov,[674] who observed an anomalous stratigraphic coexistence of Riphean-Cambrian algae with Devonian Brachiopods, Corals, and Crinoids. He commented: "Since it is quite impossible for the host strata here to be Riphean or Riphean-Cambrian age, the conclusion that the range of the above forms is limited to the Riphean and early Cambrian can be queried." Karamlov did not even consider the possibility that the conflict could be resolved by allowing the Devonian forms to range downward into the

Riphean-Cambrian! How the trends seen in both Table 1 and Figure 1 relate to the Flood will be discussed in a later chapter, taking into consideration both stratigraphic differentiation and overlap.

B. The Study of Juxtapositional Tendencies of Index Fossils: A Global Geographic Approach

Whenever one considers biostratigraphic differentiation (Figure 1, Table 1), one is saddled with the tacit assumption that the fossils actually overlie each other on earth. When the Diluvialist is challenged by the question, for example, why Cambrian Trilobites never are in stratigraphic coexistence with Tertiary mammals, the question has meaning only if Cambrian trilobites and Tertiary mammals have a chance ever to have become mixed; a situation true only if the two fossils actually overlie one another somewhere on earth. Even after it is shown that there are such locations, the fact that they are few in number makes biostratigraphic differentiation largely vacuous or at least highly amenable to nonevolutionary, nontemporal explanations.

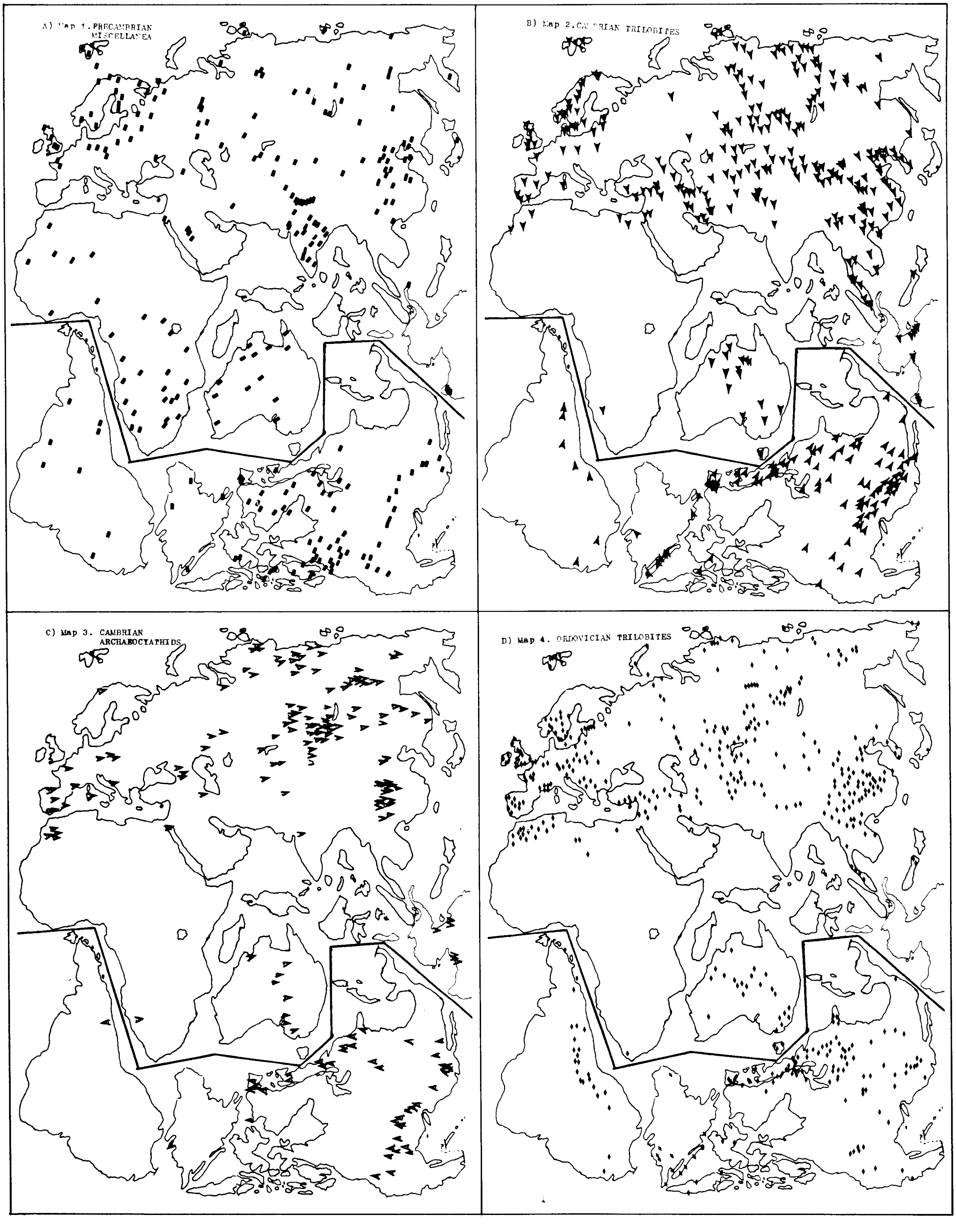
Table 2. Summary of data used in constructing Maps 1-34. The "No. of Localities" refers to the number of fossil localities plotted on a given map; whereas the "Data-Base References" denotes the reference nos. of the articles used in compiling global fossil occurrence data for each map.

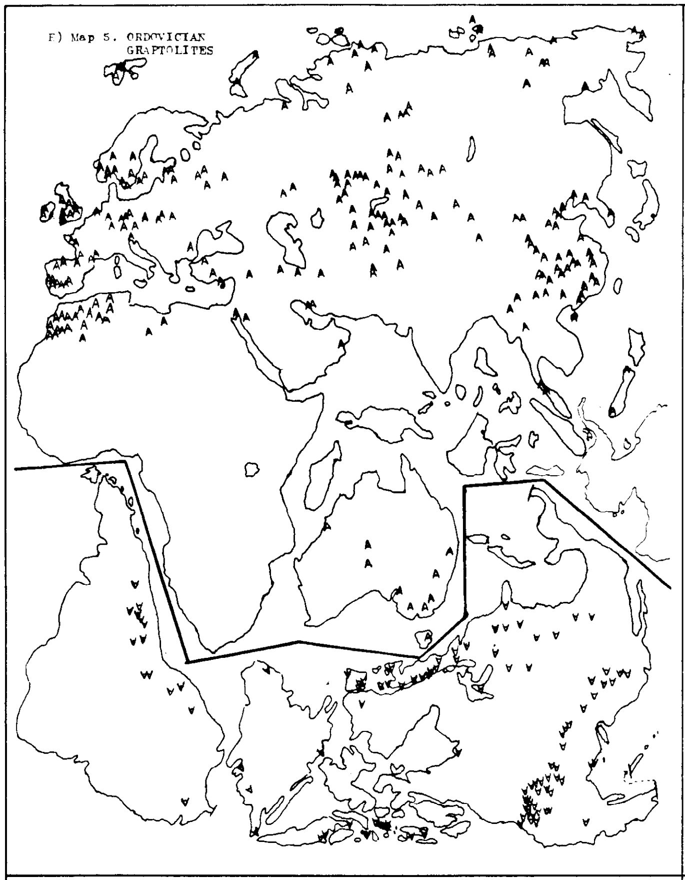
Map No.	Age and Fossil	Some Prominent Representatives of Fauna/Flora	No. of Localities	Data-Base Reference No.
1	Precambrian Miscellanea	*Eosphaera, Kababekia, Stratifera, Eostion, Eomycetopsis, Conophyton*	250	2-28, 549-51, 731-4
2	Cambrian Trilobites	*Olenellus, Paradoxides, Redlichia, Conaspis, Geragnostus*	354	29-58, 110, 552-3, 731-2, 735-6
3	Cambrian Archaeocyathids	*Archaeocyathus, Zonocyathus, Aldanocyathus, Coscinocyathus, Radiocyathus*	174	4, 30-1, 33, 36-8, 59-70, 555-7, 732, 736-7
4	Ordovician Trilobites	*Selenopeltis, Chasmops, Bathyurellus, Illaenus, Cyclopyge, Symphysurina*	482	31-2, 34, 71-128, 134-6, 175, 203, 341, 552, 554, 570, 572
5	Ordovician Graptolites	*Monograptus, Dictyonema, Tetragraptus, Clonograptus, Climacograptus, Nemagraptus*	319	31-2, 35, 97-109, 111, 122, 126, 130, 132-3, 137-62, 175, 203, 558-61, 571, 738
6	Ordovician Brachiopods	*Spirigerina, Zygospira, Platystrophia, Leptaena, Christiania*	262	31-2, 34, 98-117, 122-4, 130, 163-8, 175, 203, 400, 570-2, 739-41
7	Ordovician Conodonts	*Cordylodus, Periodon, Amorphognathus, Belodina, Pygodus, Oistodus*	279	31, 53, 104-6, 123-33, 169-89, 562, 570, 572, 742
8	Ordovician Nautiloids	*Ellesmeroceras, Endoceras, Discoceras, Actinoceras, Tarphyceras, Baltoceras*	218	31, 34-5, 101-8, 113-22, 127-9, 131, 139, 190-203, 563-5, 570-2, 742-3
9	Siluro-Ordovician Echinoderms	*Mitrocystella, Pemphocystis, Pisocrinus, Petalocrinus, Scyphocrinites*	205	31, 175, 204-12, 226, 228, 566, 570, 741
10	Silurian Brachiopods	*Stricklandia, Atrypoidea, Pentamerus, Eocoelia, Clarkeia*	303	31, 98, 106, 180, 209-28, 567-9, 740
11	Siluro-Devonian Graptolites	*Glyptograptus, Linograptus, Monograptus hercynicus, M. turriculatus, M. thomasi*	287	31-2, 98, 137-8, 175, 210-1, 228-36, 272, 568-70
12	Siluro-Devonian Fish	*Bothriolepis, Cephalaspis, Psammosteus, Thelodus, Logania*	188	175, 237-56, 270, 573-6, 744-50
13	Siluro-Devonian Trilobites	*Acernaspis, Dalmanites, Encrinurus, Warburgella, Acastella, Coniproetus*	314	31, 140, 175, 209-11, 217, 226-8, 257-75, 568-70, 577-80, 746, 751-3
14	Devonian Floras	*Zosterophyllum, Callixylon, Dawsonites, Phacophyton, Cooksonia*	137	32, 140, 272, 276-89, 578, 581-4, 746, 754-9
15	Devonian Ammonoids	*Cabrieroceras, Imitoceras, Manticoceras, Foordites, Cheiloceras*	161	200-1, 217, 270-2, 290-7, 570, 577-8, 585-8, 751, 759-63
16	Devonian Coelenterates	*Heliophyllum, Moravophyllum, Hexagonaria, Salairophyllum, Favosites*	305	31, 175, 270-2, 298-306, 577, 589

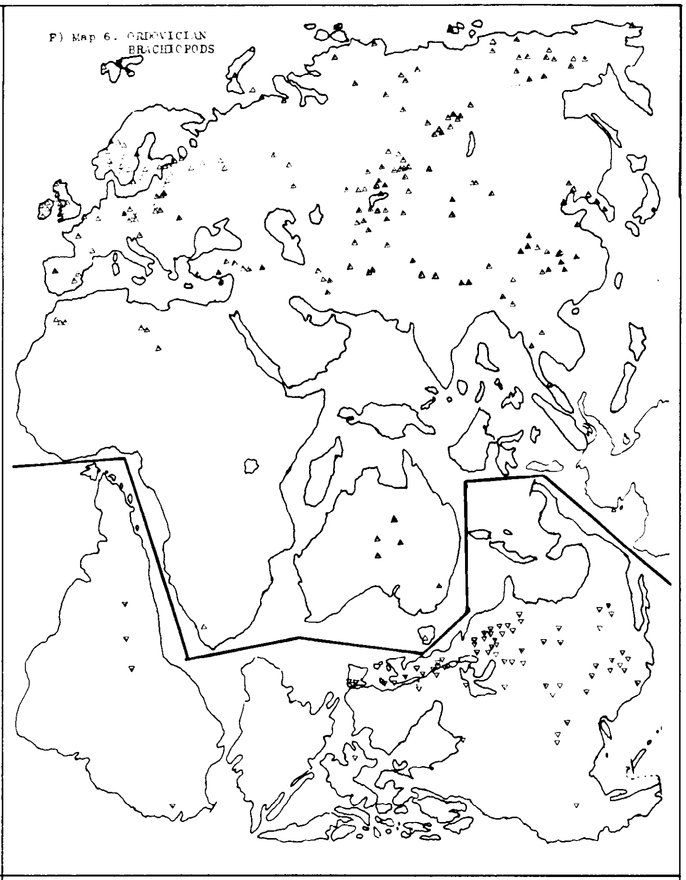
Map No.	Age and Fossil	Some Prominent Representatives of Fauna/Flora	No. of Localities	Data-Base Reference No.
17	Devonian Brachiopods	*Isorthis, Stringocephalus, Howellella, Strophochonetes, Basilicorhynchus*	307	140, 175, 217, 227, 270-2, 297, 307-18, 570-1, 578, 590-4, 740, 746, 748, 751-3, 759-60, 764-6
18	Carboniferous Ammonoids	*Orthoceras, Protocanites, Eoasianites, Muensteroceras, Reticuloceras*	183	140, 175, 200, 217, 230, 305, 319-40, 462, 570, 587, 595-603, 767-9
19	Carboniferous Fusulinaceans	*Wedekindellina, Eostaffella, Triticites, Schubertella, Beedeina, Eofusulina*	238	324, 341-50, 601, 604-10, 770
20	Permo-Carboniferous Floras	*Lepidodendron, Cordaites, Glossopteris, Pecopteris, Sphenophyllum*	505	175, 285, 351-64, 741, 754, 771
21	Permo-Carboniferous Corals	*Kueichouphyllum, Cyathaxonia, Syringopora, Parawentzellella, Waagenophyllum*	262	301, 325, 365-77
22	Permian Fusulinaceans	*Veerbeekina, Neoschwagerina, Codonofusiella, Reichelina, Palaeofusulina*	236	348-50, 375, 378-86, 570, 612, 772
23	Permian Brachiopods	*Crytospirifer, Meekella, Richthofenia, Urushthenia, Linoproductus*	356	325, 354, 375, 387-93, 611, 741, 773
24	Permian Ammonoids	*Xenodiscus, Cibolites, Uraloceras, Timorites, Cyclolobus*	145	140, 217, 305, 325, 375, 394-410, 602-3, 611-8, 741, 774
25	Permian Ectoprocts	*Fenestella, Hexagonella, Streblascopora, Polypora, Fistulipora*	147	325, 375, 411-4, 570, 612, 775
26	Permo-Triassic Reptiles	*Dimetrodon, Cynognathus, Rutiodon, Lystrosaurus, Kannemeyeria, Mesosaurus*	255	200, 415-38, 619-23, 776-9
27	Triassic Fish	*Semionotus, Redfieldius, Palaeolimnadiopsis, Boreosomus, Dictopyge*	147	200, 417-20, 439-50, 623-30, 780-3
28	Triassic Ammonoids	*Owenites, Tirolites, Cochloceras, Proavites, Otoceras*	157	200, 341, 401, 442, 451-60, 631-3, 784-5
29	Triassic-Jurassic Floras	*Sagenopteris, Araucaria, Nilssoniopteris, Gingko, Marattia, Cycadeoidea*	244	461-71, 733, 754, 786-9
30	Jurassic Ammonoids-Belemnites	*Ameoboceras, Phylloceras, Epipeltoceras, Amaltheus, Cylindroteuthis*	440	472-81, 638, 741, 790-5
31	Jurassic-Cretaceous Dinosaurs	*Ankylosaurus, Iguanodon, Brachiosaurus, Stegosaurus, Pteranodon, Titanosaurus*	188	438, 482-500, 634-7, 796-9
32	Cretaceous Ammonoids-Belemnites	*Turrilites, Protexanites, Hoplites, Clioscaphites, Actinocamax*	499	480, 501-4, 63, 794-5, 800-3
33	Tertiary Mammals	*Unitatherium, Coryphodon, Bathyopsoides, Eumys, Hipparion*	535	505-28, 640-2, 804-6
34	Tertiary Foraminifers	*Globigerina, Globorotalia, Lepidoclina, Cycloclypeus, Fabiania, Miogypsina*	478	529-48, 807
			TOTAL: 9,560	

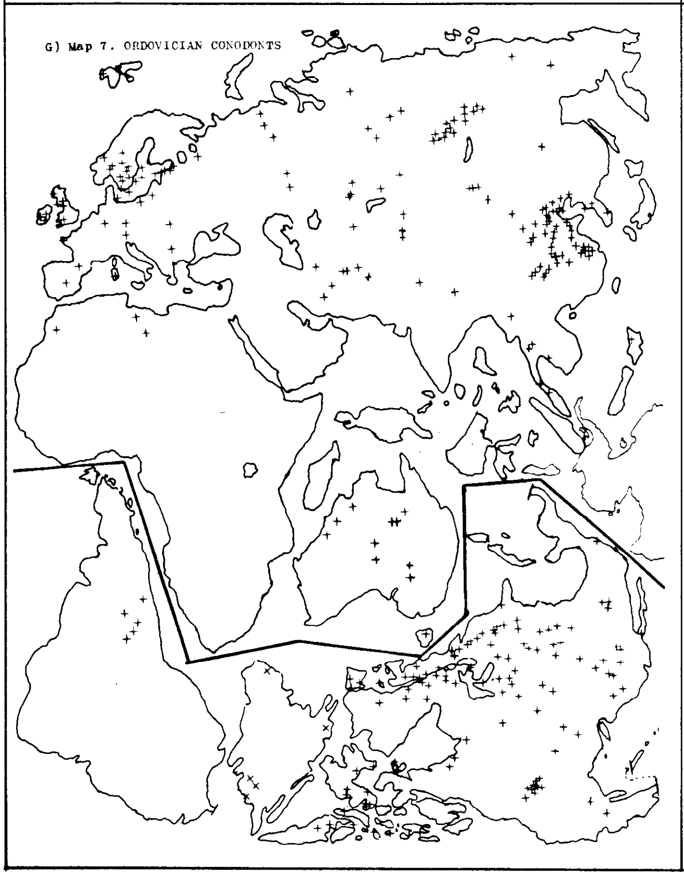
The only method for determining how index fossils of different geologic periods actually overlie one another is to construct locality maps for each type of fossil and then superimpose such maps, e.g., over a light table, to determine superpositions of fossils. This has been done (Table 2, Maps 1-34). Data were meticulously gathered from hundreds of sources; the sources including individual (particularly recent) fossil discoveries, sources yielding mapped fossiliferous regions or provinces, and sources already providing global fossil occurrence data. All 34 fossil occurrence maps had all three types of sources utilized; but the preponderance of references for Paleozoic fossils (Table 2) reflects the fact that fewer comprehensive fossil-occurrence sources had been available for that part of the geologic column. All data were pre-screened for accuracy; authors who used many small and overlapping symbols on either regional or world maps were used, because usage of many small symbols indicated that the cited authors were concerned with accurate representation of fossil-bearing localities, while overlapping symbols indicate that the symbols represent true localities and thus are not merely crude schematic representations of fossil occurrence. A latitude-longitude grid map was made (shown as Map 35 for any reader wishing to make a transparency of it to determine the

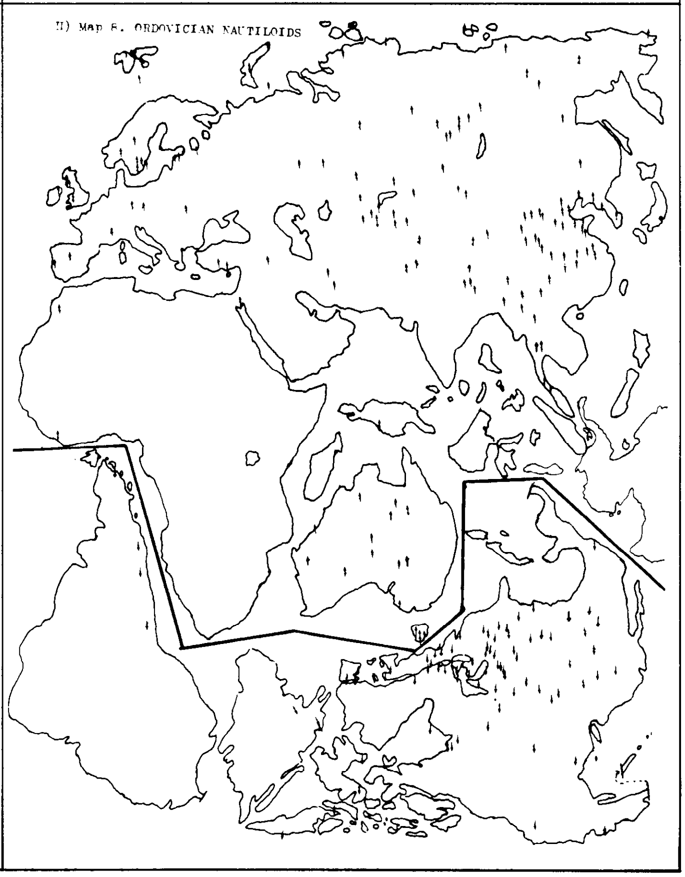
Maps 1-37. These maps, on the next few pages, show where the fossils have actually been found, as is explained in the text. Note that the small region shown at the middle right is that part of Antarctica for which data are available.

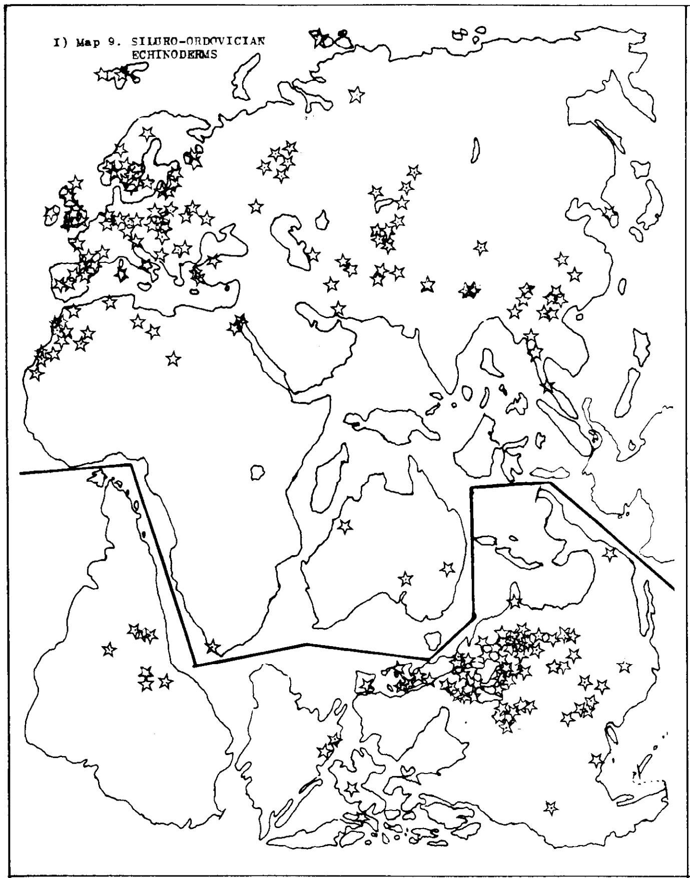

A) Map 1. PRECAMBRIAN MISCELLANEA
B) Map 2. CAMBRIAN TRILOBITES
C) Map 3. CAMBRIAN ARCHAEOCYATHIDS
D) Map 4. ORDOVICIAN TRILOBITES


F) Map 5. ORDOVICIAN GRAPTOLITES

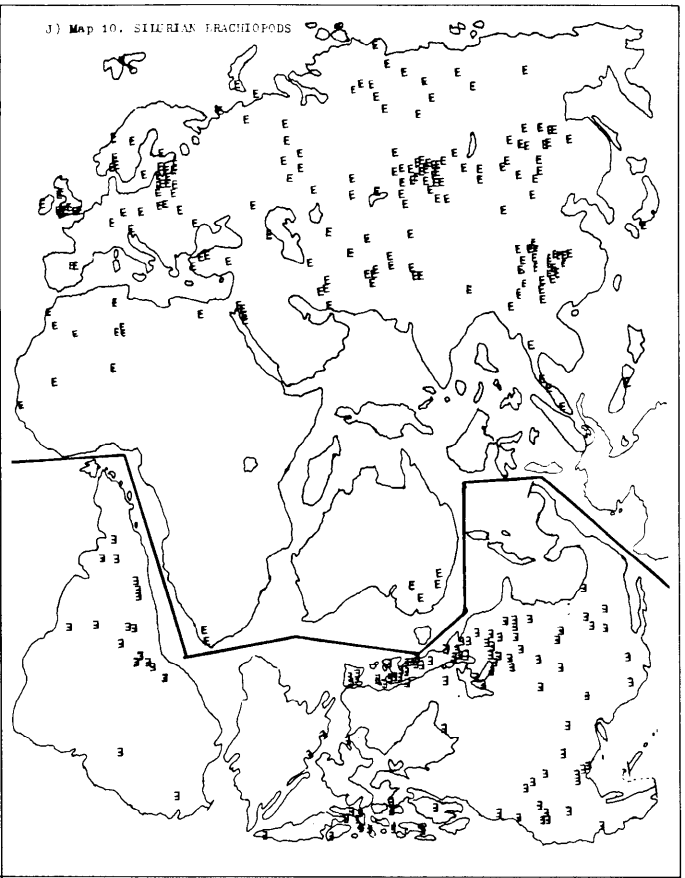

F) Map 6. ORDOVICIAN BRACHIOPODS


G) Map 7. ORDOVICIAN CONODONTS

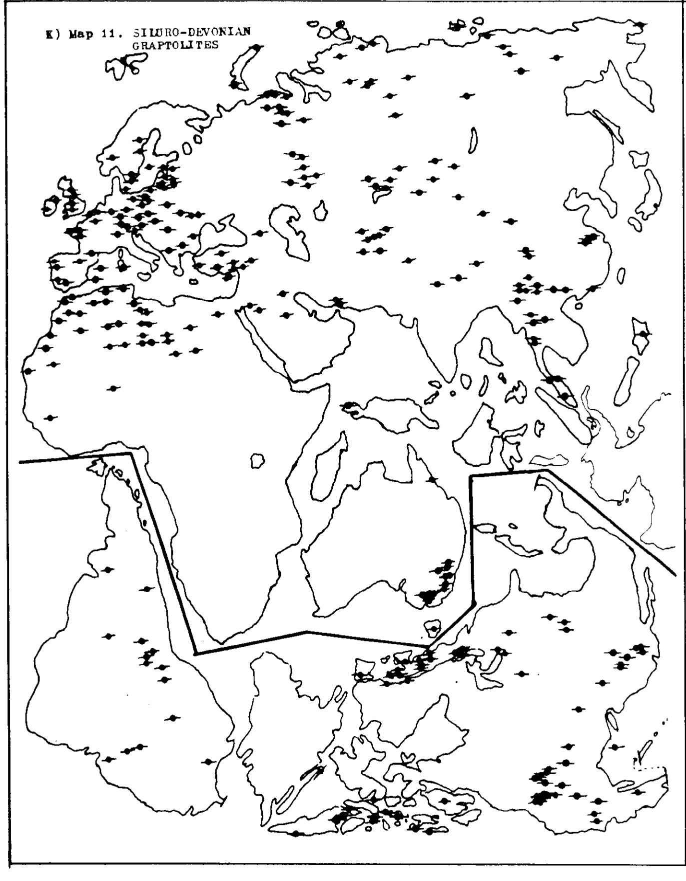

H) Map 8. ORDOVICIAN NAUTILOIDS



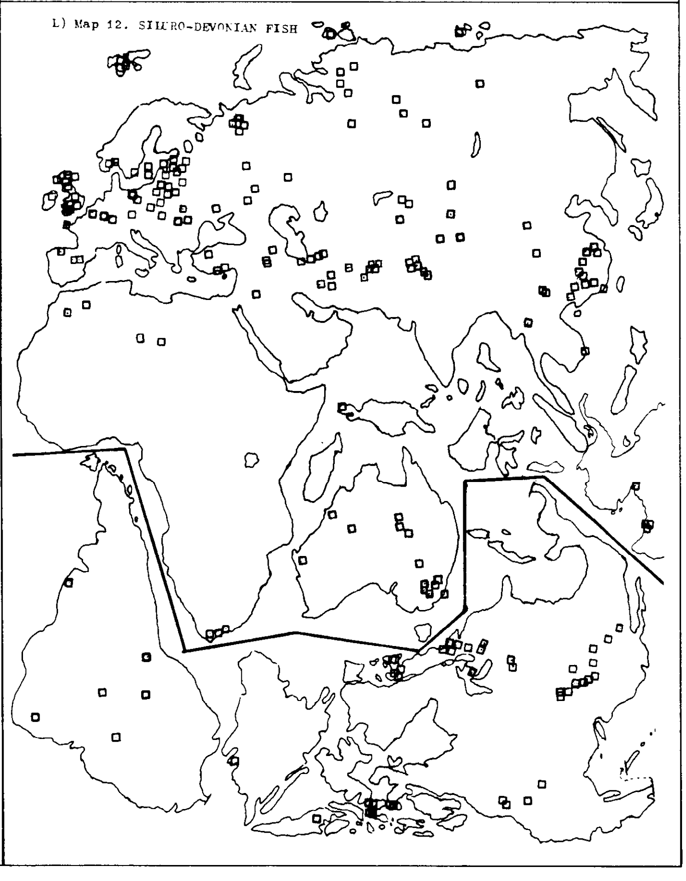
I) Map 9. SILURO-ORDOVICIAN ECHINODERMS



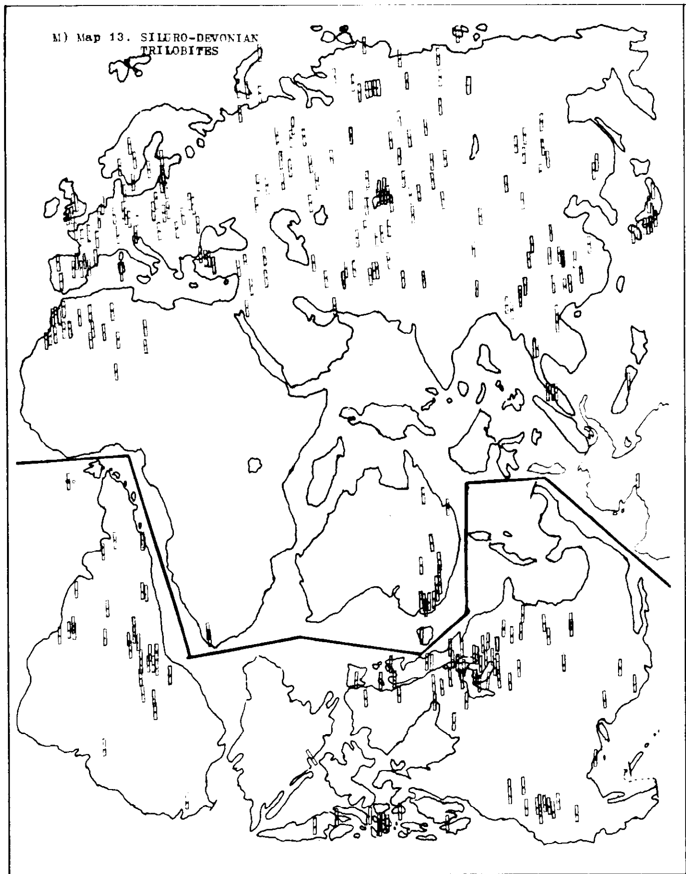
J) Map 10. SILURIAN BRACHIOPODS

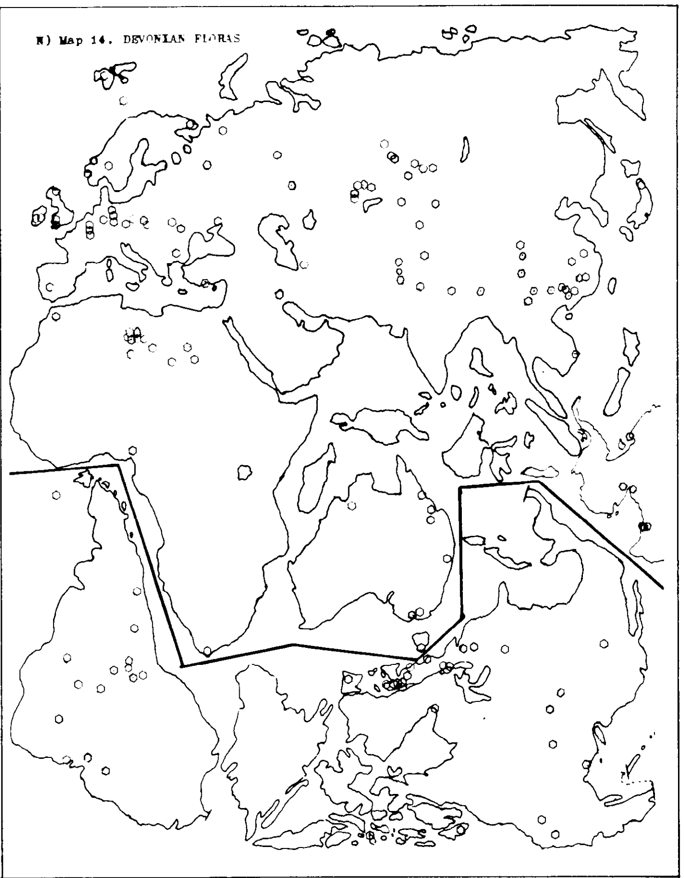


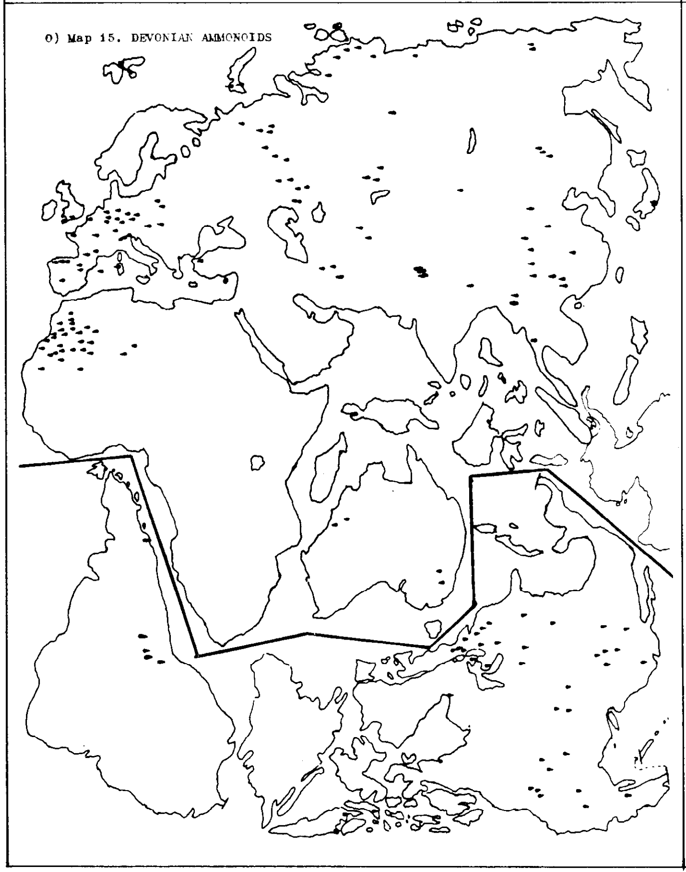
K) Map 11. SILURO-DEVONIAN GRAPTOLITES

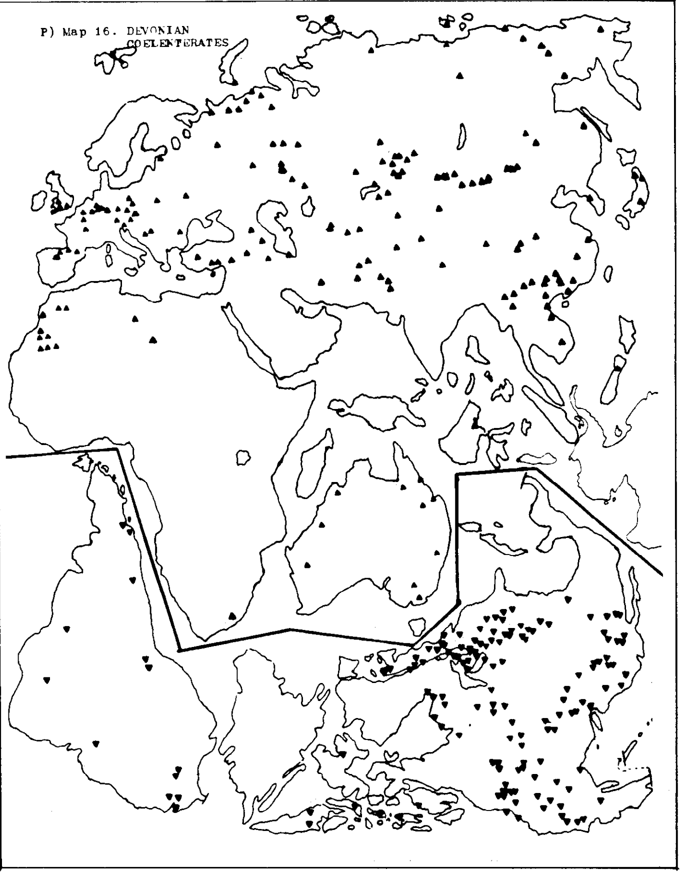


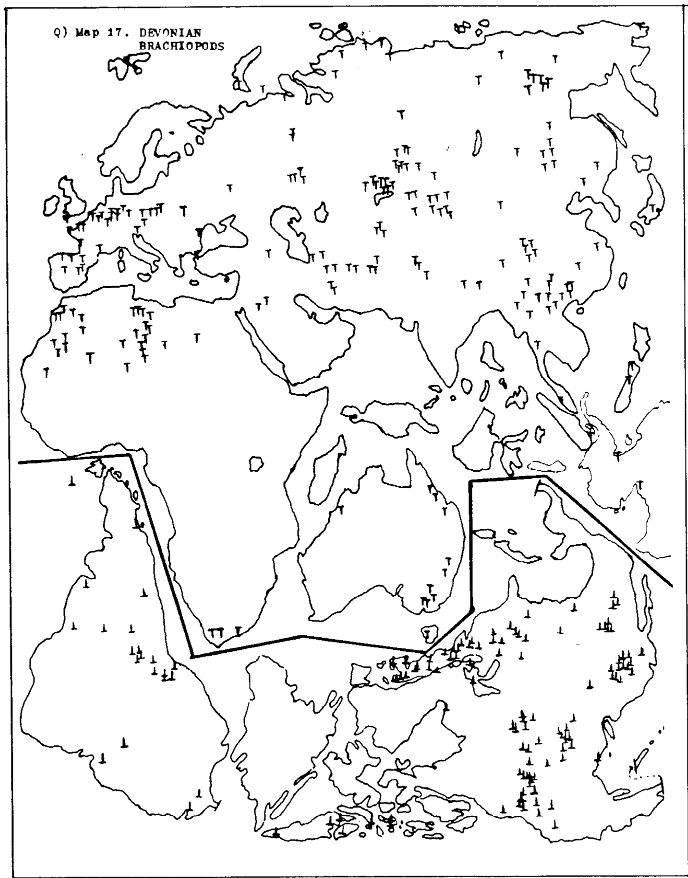
L) Map 12. SILURO-DEVONIAN FISH


M) Map 13. SILURO-DEVONIAN TRILOBITES

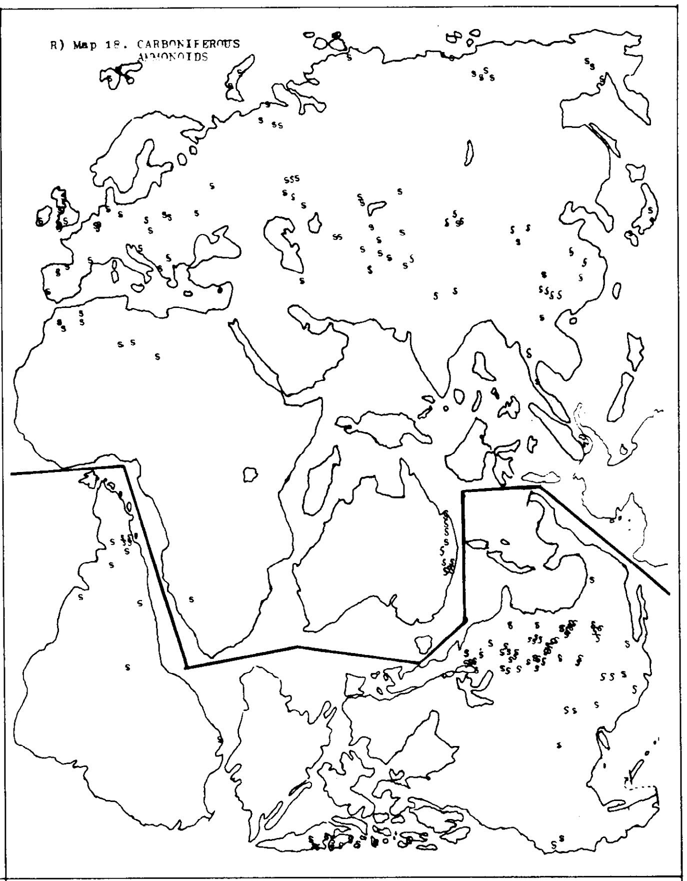

N) Map 14. DEVONIAN FLORAS


O) Map 15. DEVONIAN AMMONOIDS

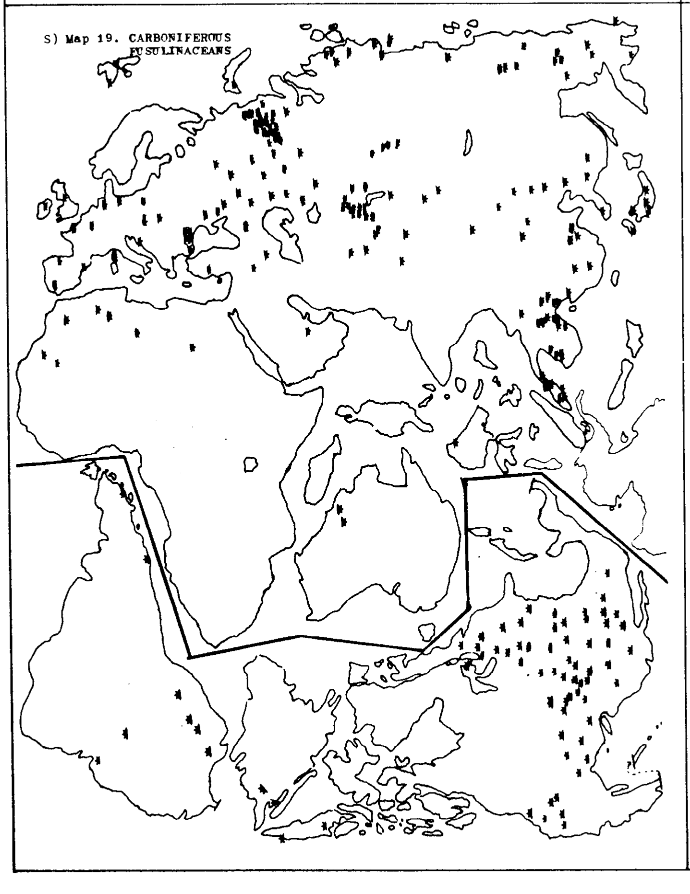

P) Map 16. DEVONIAN COELENTERATES



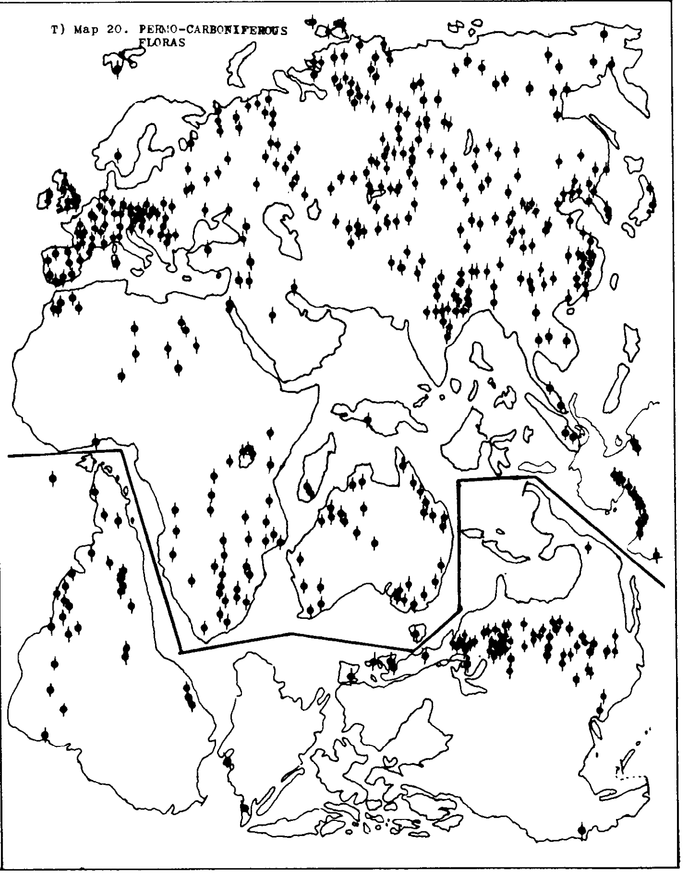
Q) Map 17. DEVONIAN BRACHIOPODS



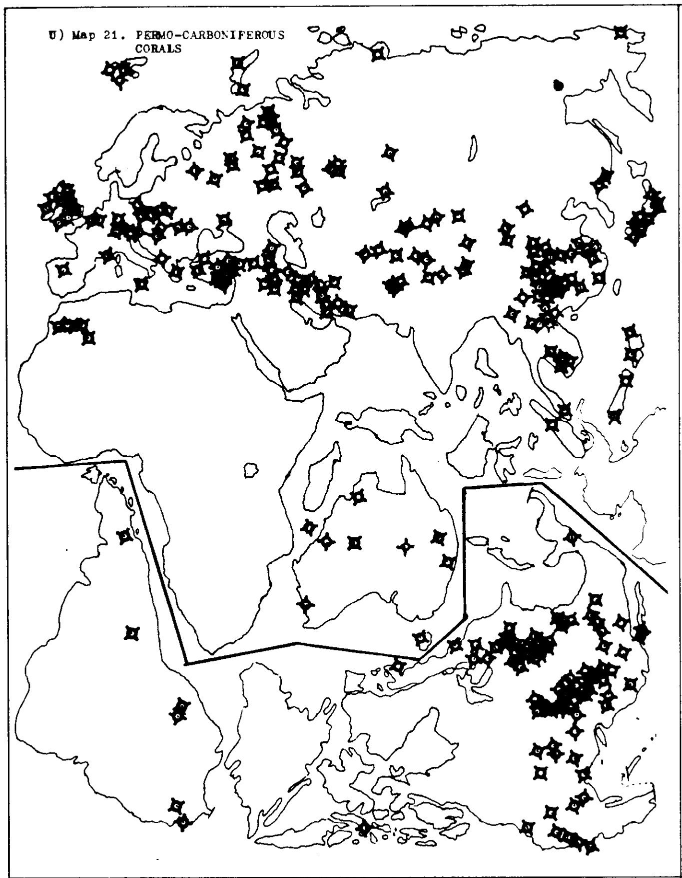
R) Map 18. CARBONIFEROUS AMMONOIDS



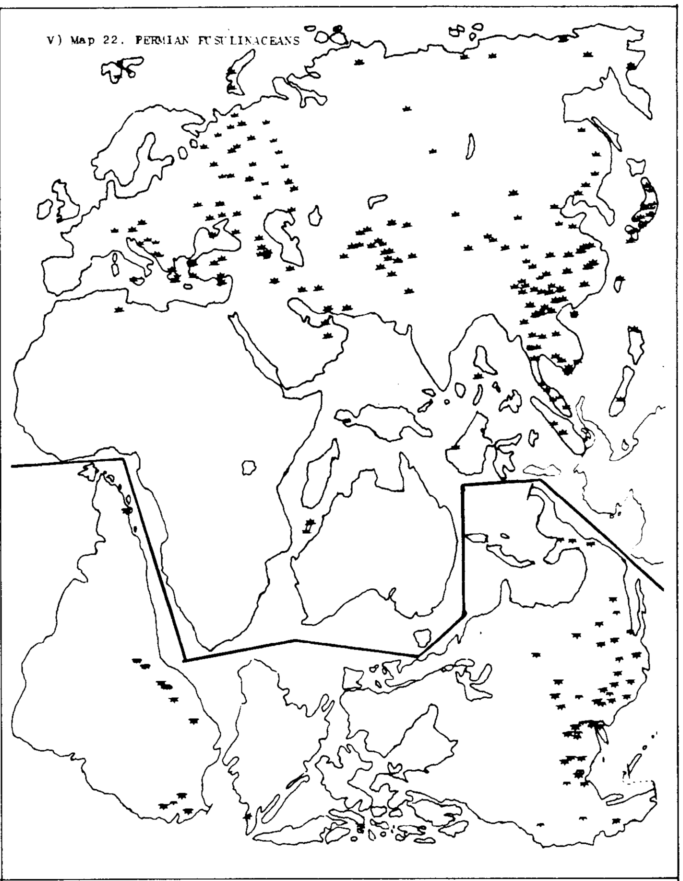
S) Map 19. CARBONIFEROUS FUSULINACEANS



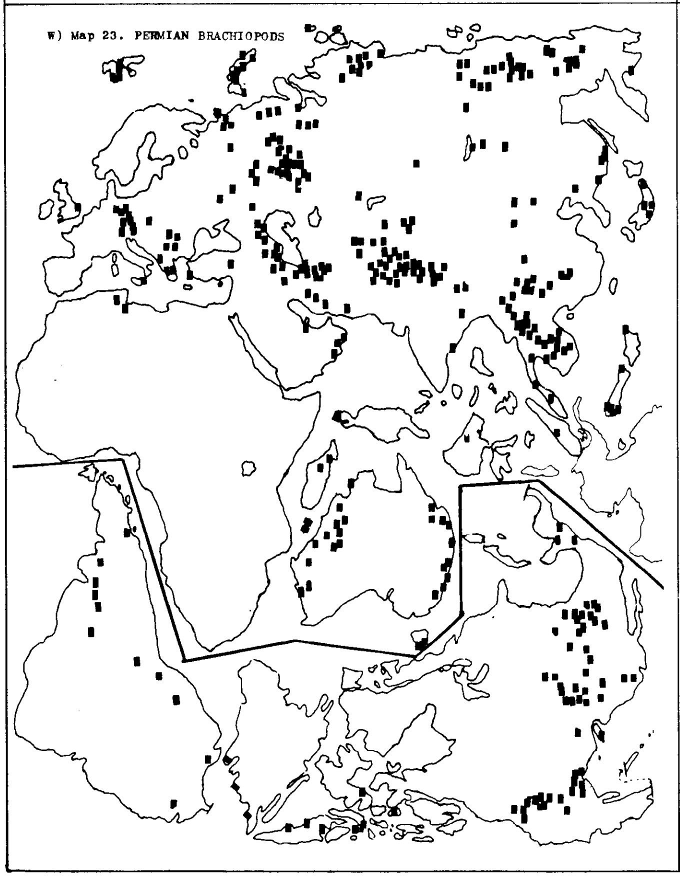
T) Map 20. PERMO-CARBONIFEROUS FLORAS



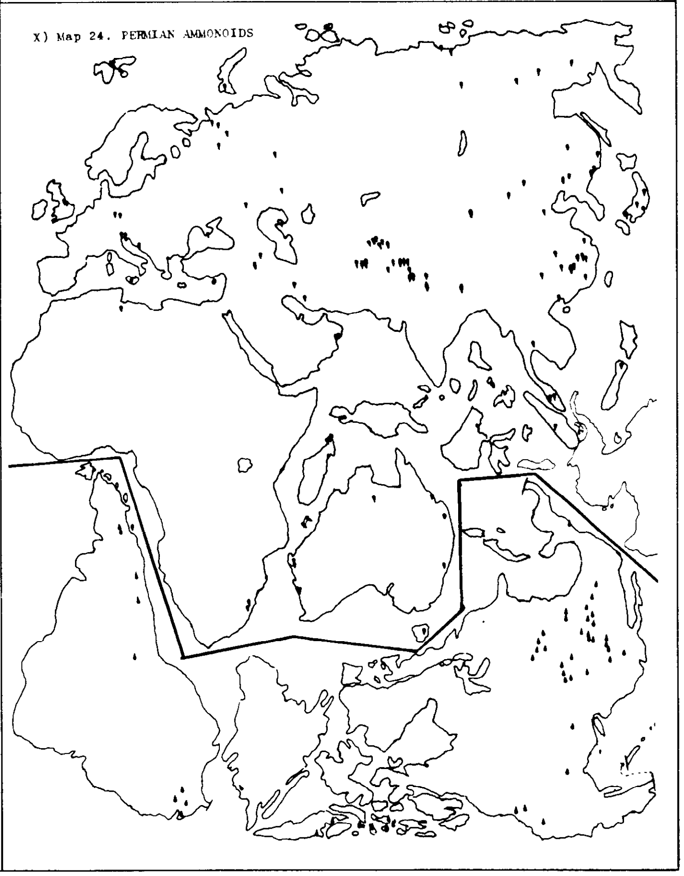
U) Map 21. PERMO-CARBONIFEROUS CORALS



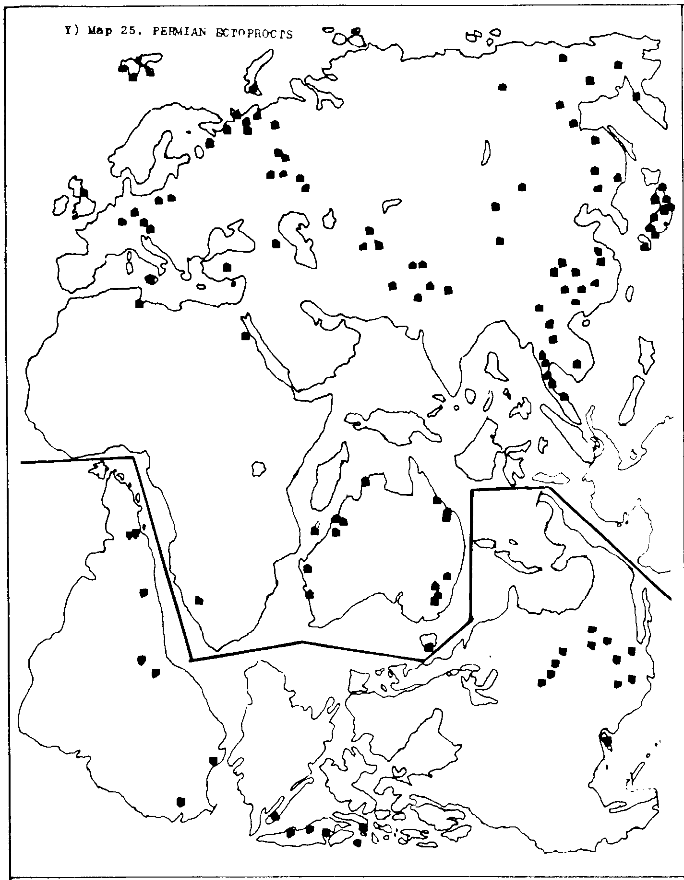
V) Map 22. PERMIAN FUSULINACEANS



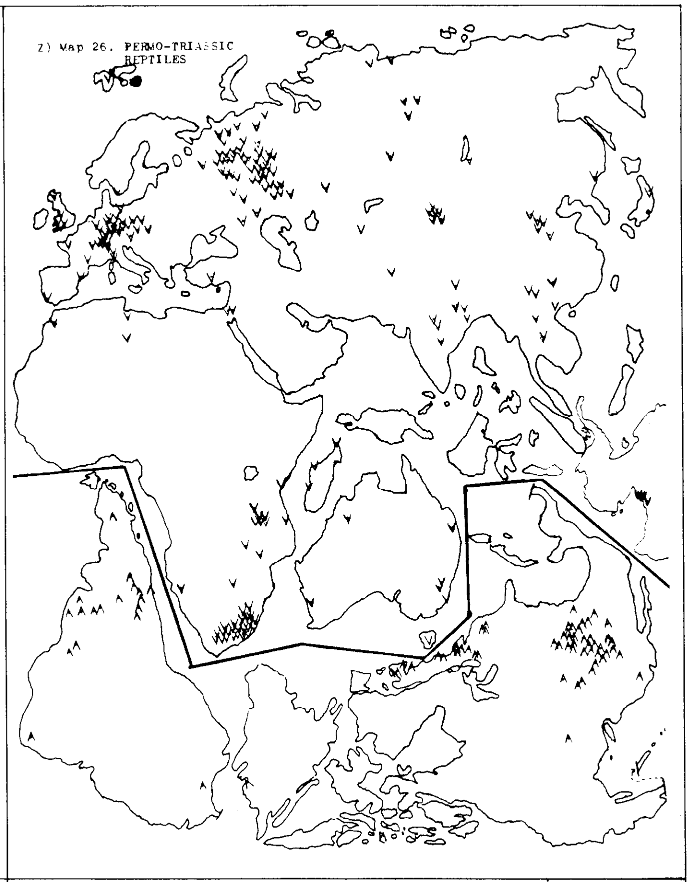
W) Map 23. PERMIAN BRACHIOPODS



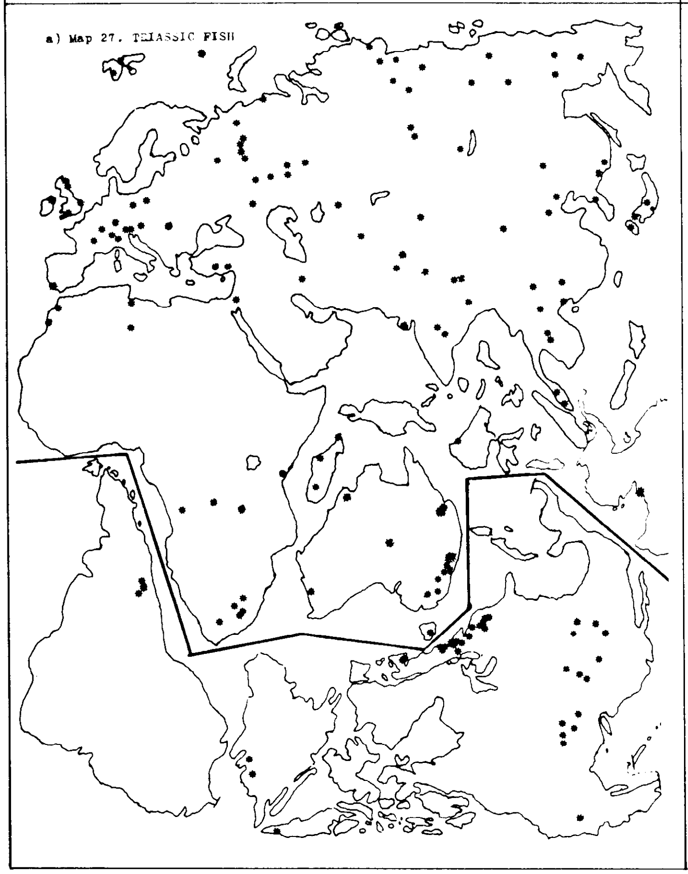
X) Map 24. PERMIAN AMMONOIDS



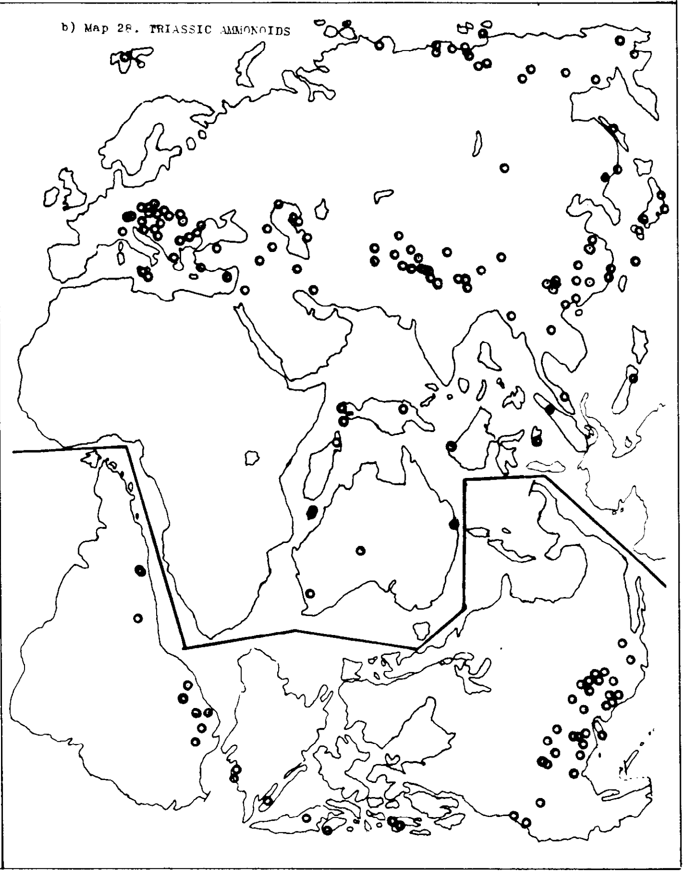
Y) Map 25. PERMIAN ECTOPROCTS



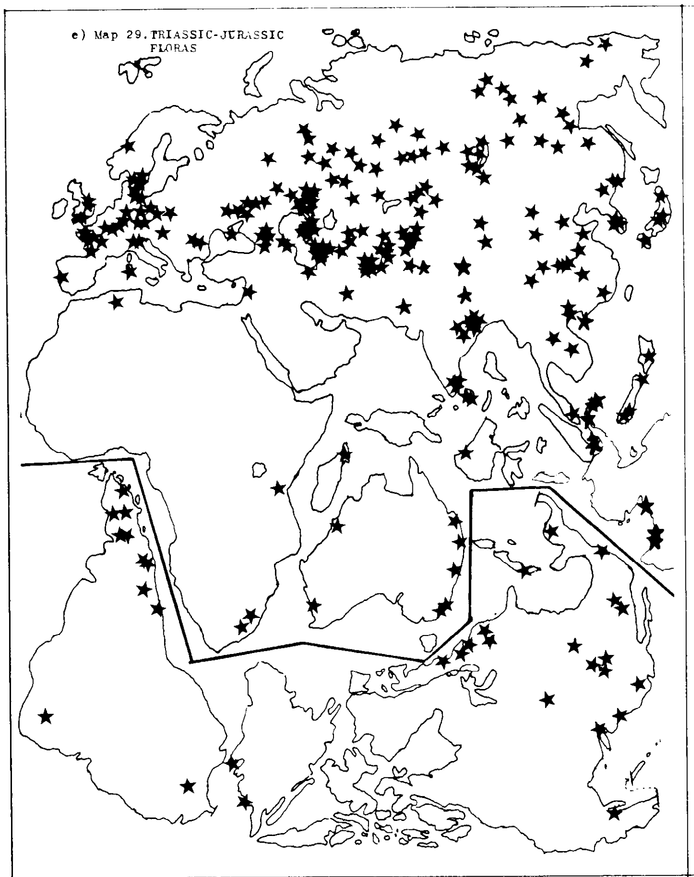
Z) Map 26. PERMO-TRIASSIC REPTILES

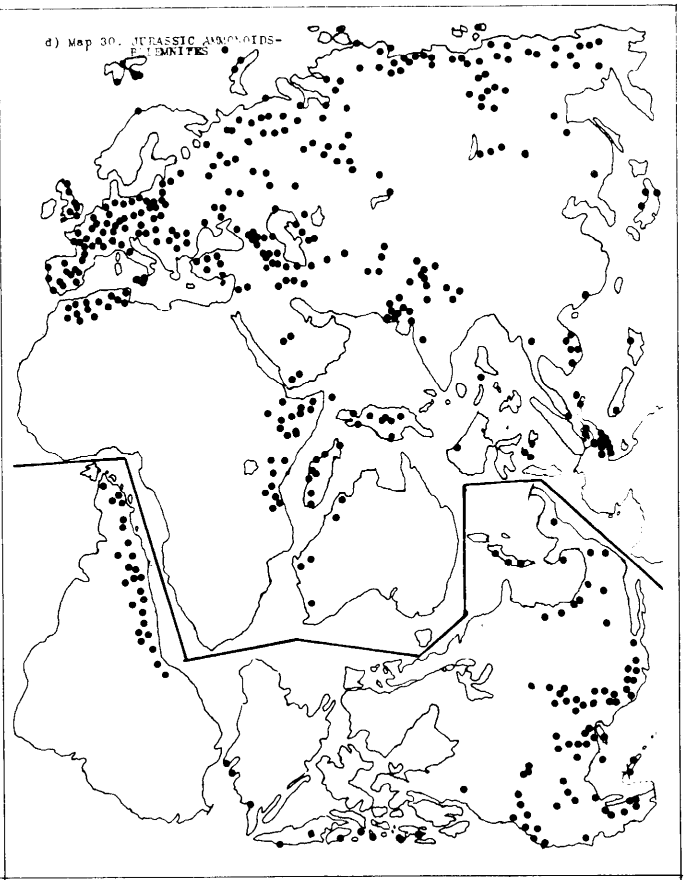


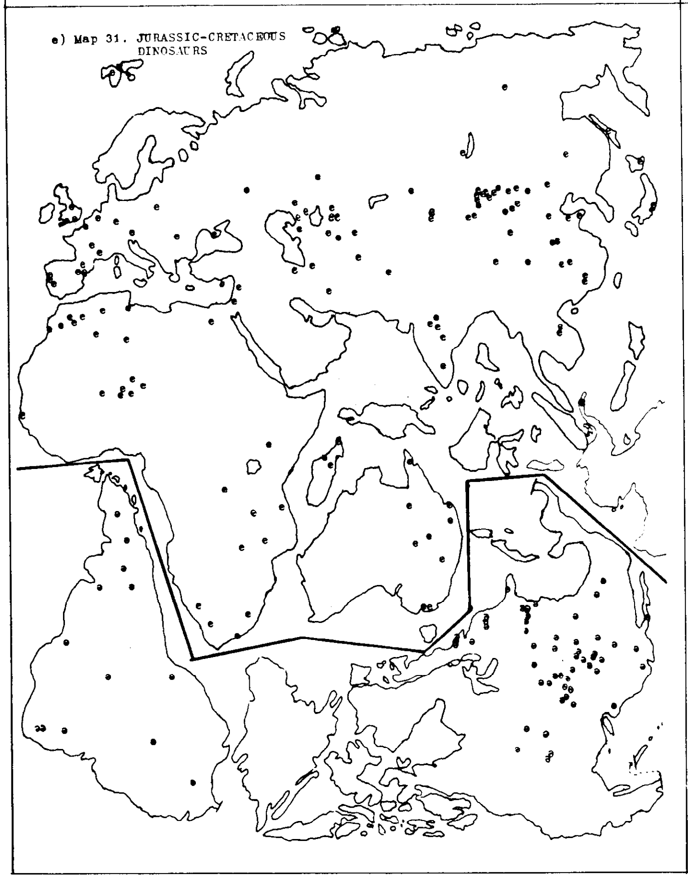
a) Map 27. TRIASSIC FISH

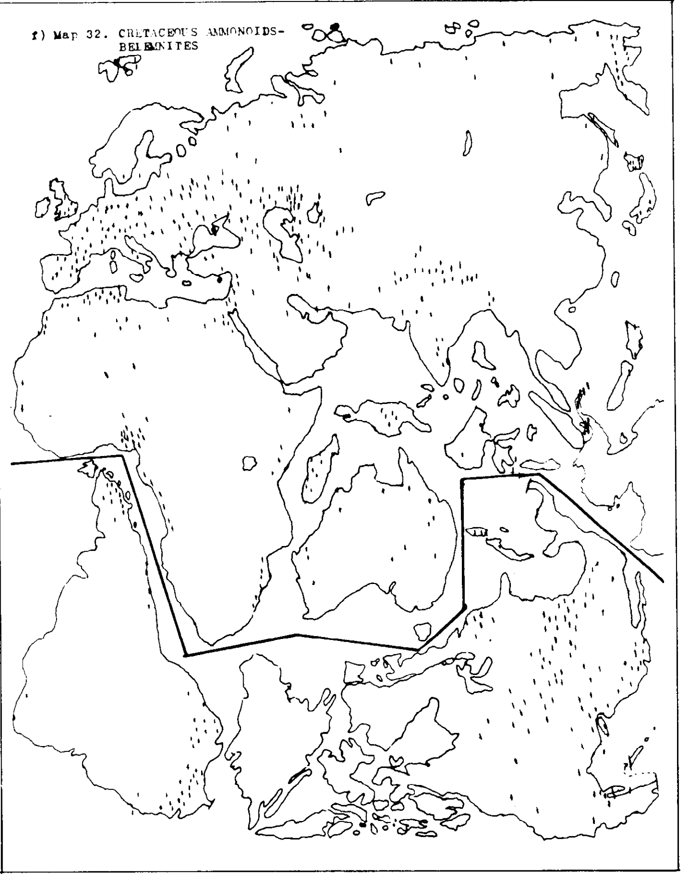


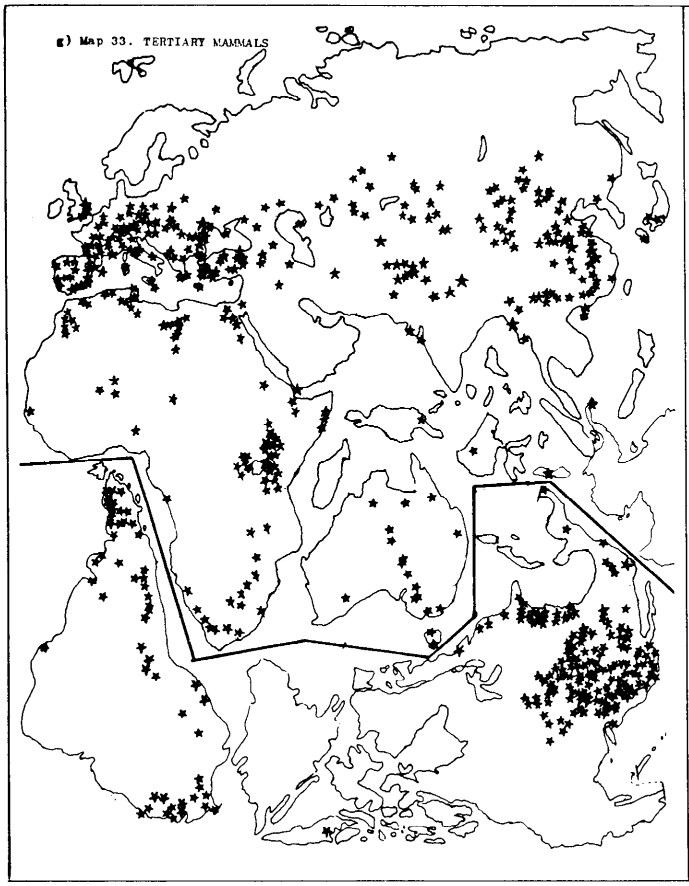
b) Map 28. TRIASSIC AMMONOIDS

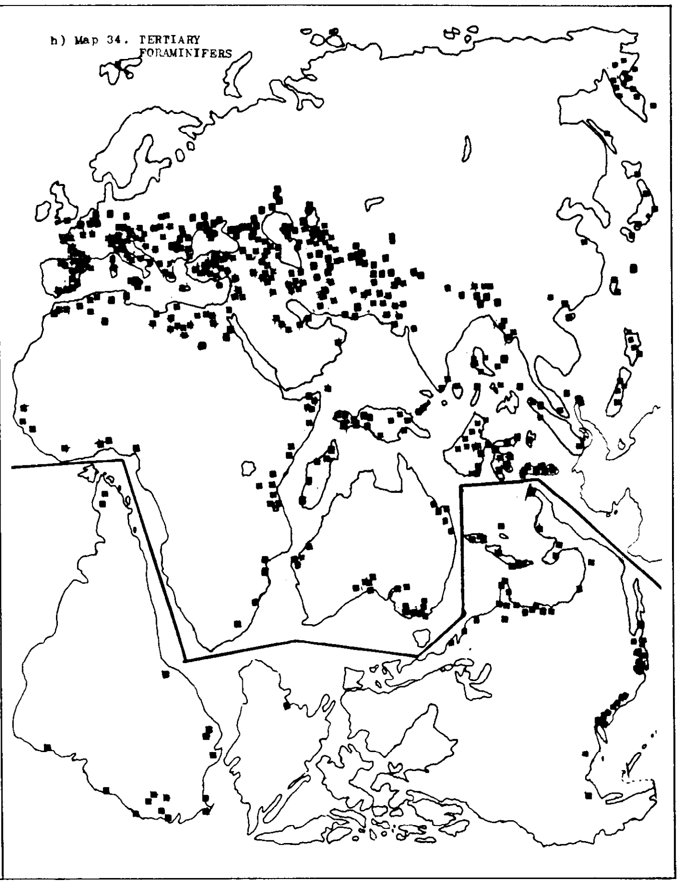

c) Map 29. TRIASSIC-JURASSIC FLORAS


d) Map 30. JURASSIC AMMONOIDS-BELEMNITES


e) Map 31. JURASSIC-CRETACEOUS DINOSAURS


f) Map 32. CRETACEOUS AMMONOIDS-BELEMNITES



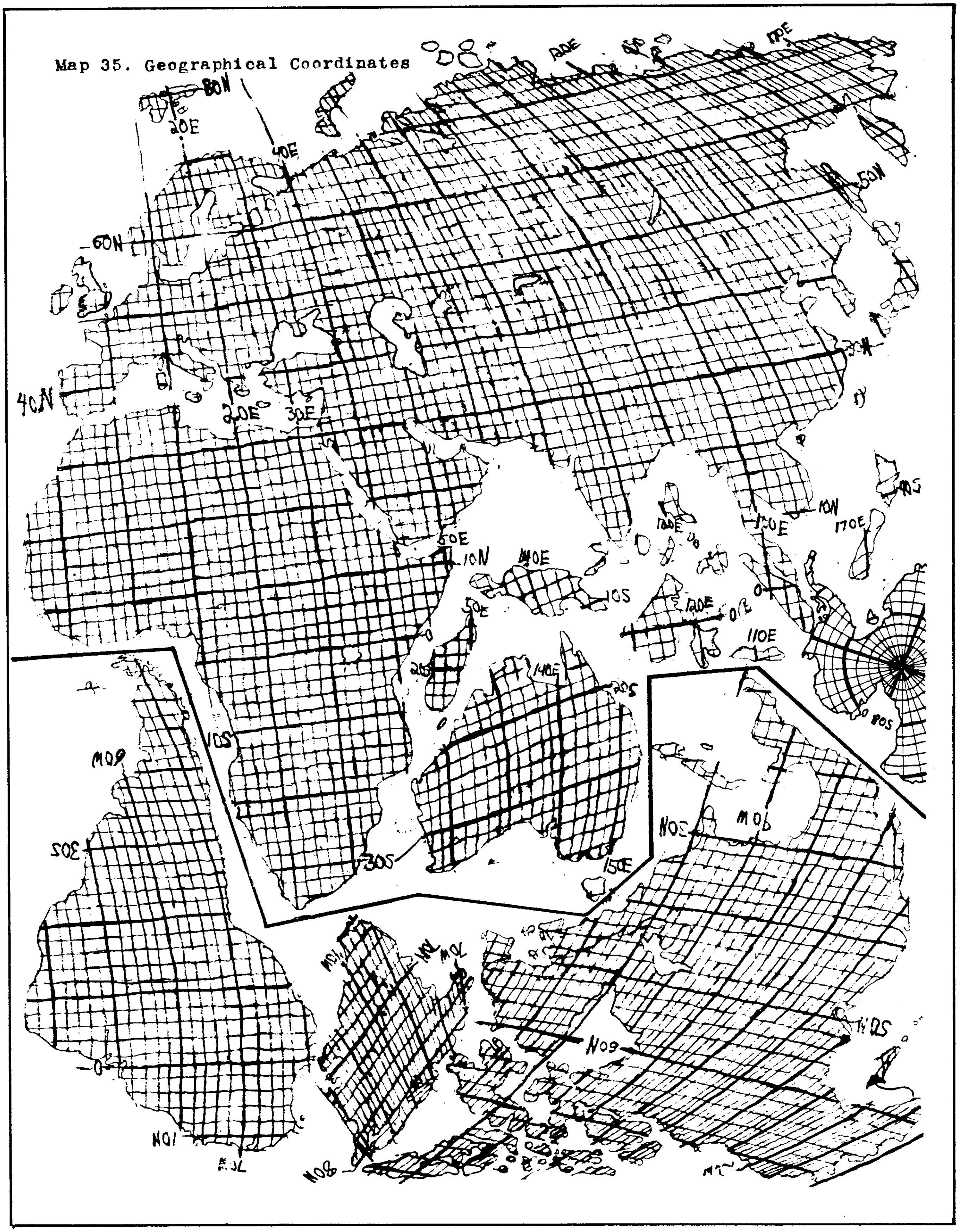


exact location of any fossil or juxtaposition) in order to plot fossil localities accurately. The Winkel's Triple Projection was used as the world base map in order to synchronize all data with the world maps already available from the *Atlas of Palaeobiogeography.*[1] However, the continents were repositioned to eliminate ocean space so that continents could be shown at the largest possible scale. (Each map originally covered an entire page when made and when juxtapositional determinations were performed, but the maps had to be drastically reduced here as a result of space limitations. A Winkel Map in its natural form can be seen ahead in Figure 8).

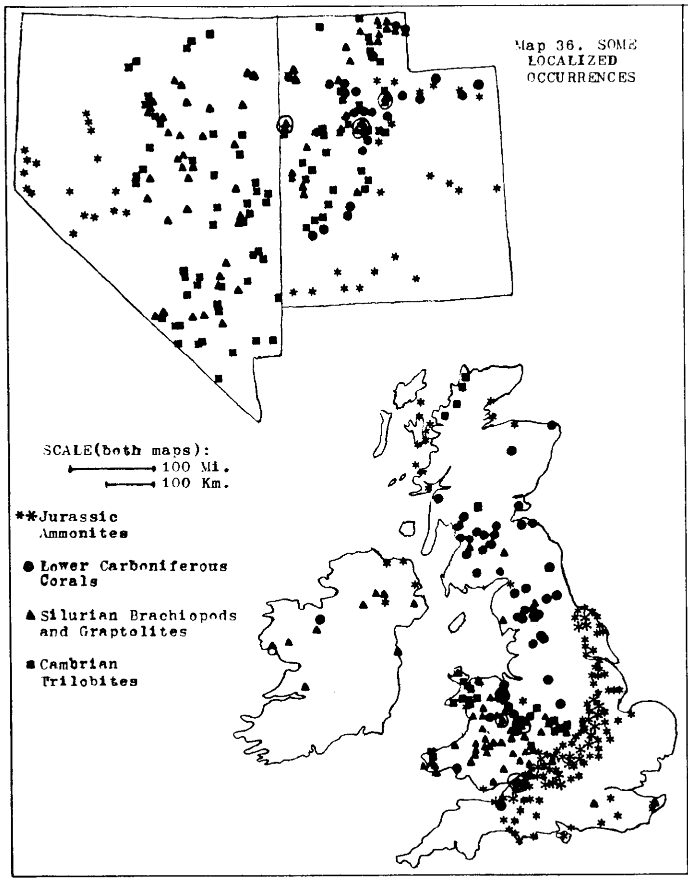
It is necessary to define what is meant by juxtaposition. Obviously fossils that can be seen superposed in an outcrop face or drill core are juxtaposed; but fossiliferous beds (and sedimentary strata generally) have a regional character to them, so fossils occurring several tens of kilometers apart but in different strata levels must also be recognized as superposed (provided that the region is tectonically uncomplicated). However, such extrapolation can not be extended much beyond this. In speaking of the discovery of Jurassic Corals on Sakhalin Island, Krasnov and Savitskiy[675] wrote: "The age of this series was thought to be late Paleozoic, but this dating was based only on its lithological similarity to the Paleozoic of Japan and the continental part of the Far East." Clearly, lithological similarity did not agree with the stratigraphic order of fossils. At the other end of the spectrum, the character of fossil assemblages changes over short distances. In discussing fossil succession, Harper[676] commented: "Owing to facie changes, the principle is best restricted, where possible, to individual sites where superpositional order can be seen in outcrop or when it is obvious as in a borehole in a structurally uncomplicated area."

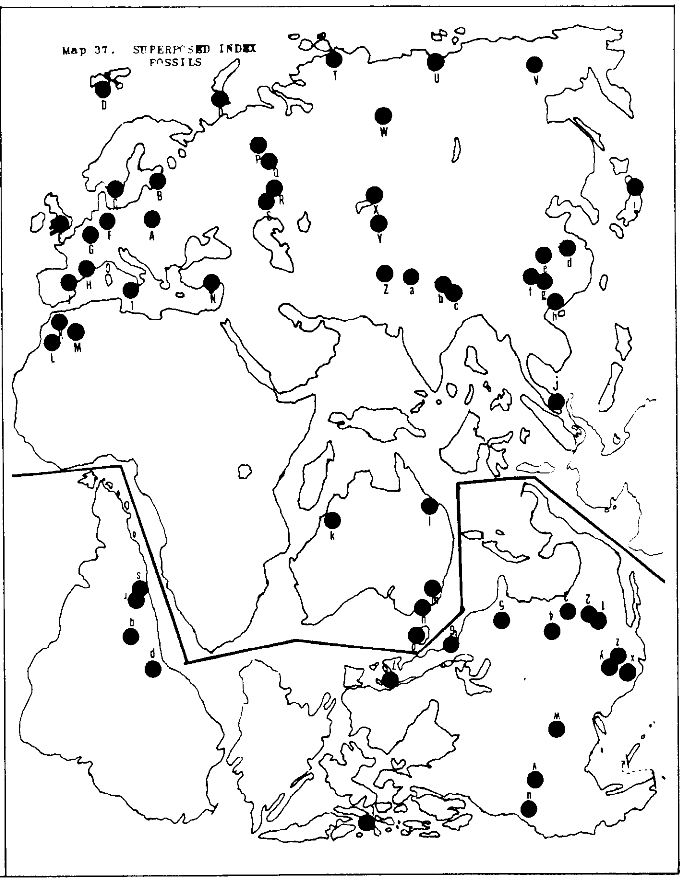
Since strata have a (however justifiably limited) regional character to them, the level of resolution of Maps 1-34 is sufficient for juxtapositional determinations to have been made (bear in mind that there must be allowed a margin of error of several tens of kilometers for each fossil locality plotted. Incidentally, the fossil-occurrence symbols on all maps are unequal in significance. One symbol may denote a locality where a solitary questionable fragment was found, while another may indicate a cluster of outcrops yielding thousands of specimens of wide taxonomic diversity). While the level of resolution of fossil localities in Maps 1-34 is several tens of kilometers, it is worthwhile to consider juxtapositions of index fossils on a regional level—so that fossil occurrences only several kilometers apart could be resolved. Map 36 was constructed especially for this purpose; showing fossil localities in Utah-Nevada and the British Isles. The fossils and the respective reference numbers for sources of data are: Cambrian Trilobites (42, 677-9), Silurian Brachiopods and Graptolites (211, 220, 680), Lower Carboniferous Corals (365, 370, 681-2), Jurassic Ammonites (683-6).

It is difficult to say which method (world Maps 1-34 or the regional one-Map 36) offers a "truer" picture of fossil juxtaposition. The high resolution of Map 36 ob-



Map 35. Geographical Coordinates





viously offers great detail, but because of this, detail is more vulnerable to outcrop availability bias and the exaggeration of other local factors. However, Map 36 shows that very seldom are 3 of the 4 cited fossils within a few tens of miles of each other (encircled areas show those locations). Juxtapositions of two fossils at a time are more common, but this is offset by the fact that all fossils shown are actually a single regional occurrence and so every individual fossil-locality manifestation on Map 36 should not really count as a separate candidate for juxtaposition.

It thus appears best to judge juxtapositions on a global scale. Table 3 has been drafted to show the results of superposing Maps 1-34 against each other. There are 479 cross-comparisons: every fossil versus every other that belongs to another geologic period. It can be seen that only small percentages of all localities of any given fossil overlie, or are overlain by, any other single fossil of another geologic period. Thus fossils of different geologic periods invariably tend to shun each other geographically, and this in itself may be taken as *prima facie* evidence that all fossils are ecological and/or biogeographic equivalents of each other—negating all concepts of evolution, geologic periods, and geologic time. To the Diluviologist, this tendency of any two different-"age" fossils to be geographically incompatible not only allows an understanding of fossils in light of the Universal Deluge, but also makes mechanisms of fossil separation (discussed extensively in the next two chapters), for the juxtapositions that do occur, workable without any need of unrealistic efficiency on their part.

From Table 3 it is evident that fossils which are closer in biostratigraphic "age" tend to have more geographic juxtapositions in common with each other. But the apparent significance of this is offset by the fact that fossils of close biostratigraphic age (Figure 1, Table 1) have a considerable number of other fossils in common. Viewed in the opposite direction, the smallness of the number of fossil families in common between geologic periods at opposite ends of the geologic column is made vacuous by the very small number of opportunities for those fossils ever to have had a chance to become mixed during the Flood (note the preponderance of bar symbols—denoting very small percentages of juxtaposition—at the lower right of Table 3).

Whereas Table 3 only shows the juxtapositions of two fossils at a time, Table 4 shows regions on earth where many index fossils are possibly juxtaposed. "Possibly juxtaposed" is used here because the circles shown on Map 37 cover large areas (they have a diameter of over 200 miles or 320 kilometers): the largeness of the encircled areas being made necessary to allow a large margin of propagated error resulting from multiple juxtapositions. The numbers of juxtaposed fossils portrayed in Table 4 are thus an exaggeration. The 59 regions of juxtaposition shown are those where at least 7 of the 34 index fossils occur in the same encircled area though not all 7-occurrence localities have been shown due to space limitations. Note that there are only singular instances on earth where over 10 of the 34 index fossils are possibly juxtaposed, and no case at all where half of all index fossils are possibly juxtaposed.

There does not appear to be any trend for individual fossils to be exceptionally commonly juxtaposed or non-juxtaposed with others. A positive correlation exists between the number of fossils present on a given map and the commonness of that fossil's presence among the 59 biostratigraphic columns of Table 4. In Table 3, fossils which have relatively few numbers of occurrence have either exceptionally high or exceptionally low rates of juxtapositions with other fossils, indicating the somewhat erratic effects of relatively small numbers of occurrences. The number of occurrences of a given fossil (Table 2) are primarily a function of their abundance in their respective ancient faunas. For example, ammonoids are rare constituents of Paleozoic marine faunas, but very abundant constituents of Mesozoic marine faunas.

II. THE SEPARATION OF ORGANISMS DURING BURIAL BY THE FLOOD: PROCESSES AND MECHANISMS

A. Indeterministic Factors Leading to Stratigraphic Differentiation of Fossils

This work thus far measured the degree of stratigraphic differentiation and local succession of fossils; the remainder, commencing with this section, concerns itself with causes of these phenomena in terms of the Flood. Let it be noted, first of all, that there is nothing particularly "natural" about an evolutionary-uniformitarian explanation for the stratigraphic differentiation of fossils. In describing interpretations of faunal lists from two fossil populations, Raup and Crick[687] wrote: "If two lists have no taxa in common, it can be assumed that *something* was different. The possible causes vary from ecological differences (marine vs. fresh water; shallow vs. deep water, etc.) to temporal differences (complete evolutionary turnover) to biogeographic differences (provinciality, separation by geographic barriers, etc.)." (italics theirs) It is thus clear that, even within the evolutionary-uniformitarian paradigm, evolutionary turnover is only one of several potential lines of evidence for interpretation of differentiated fossils, so there is nothing exotic about the Creationist-Diluvialist Paradigm considering non-evolutionary, non-temporal explanations for fossil separation.

The most mundane cause for stratigraphic separation of fossils is pure chance. It would be odd indeed if, even with all other causes eliminated, organisms buried by the Flood were equally present at all stratigraphic horizons. At the same time, the fact that most index fossils do not actually overlie each other (Table 3) allows chance to have a significant role in generating biostratigraphic differentiation.

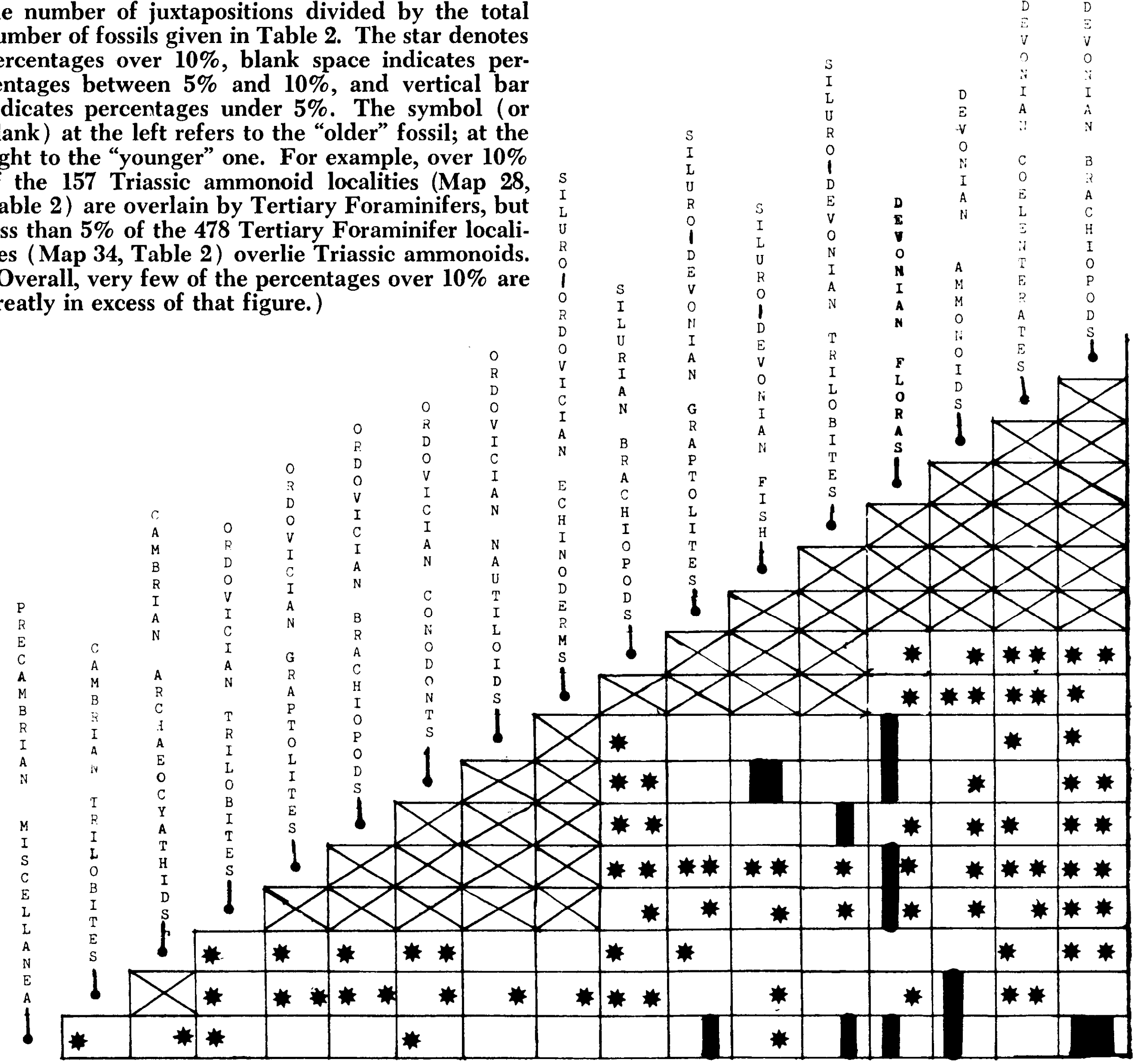
Figure 2 has been drawn to illustrate this principle. Note that there are few cases where fossils N, P, and/or S occur in the same stratigraphic section. The only possible combinations (two at a time, with or without overlap) are: N/P and P/N, N/S and S/N, P/S and S/P. If there were many mutual juxtapositions of these fossils, then all six combinations would occur and hence there would be no global biostratigraphic differentiation. But since actual juxtapositions are few, one or more of these six combinations may never occur; solely by chance. This follows from a well-known principle in statistics that artifactual (i.e., apparently significant) trends can occur when the population sampled is sufficently small. For example, it would be highly significant if 500 out of 600 coin tosses were "heads" but not so if 5 out of 6 were "heads" because of the small population in the latter case. The Founder Effect in Population Genetics is another example.

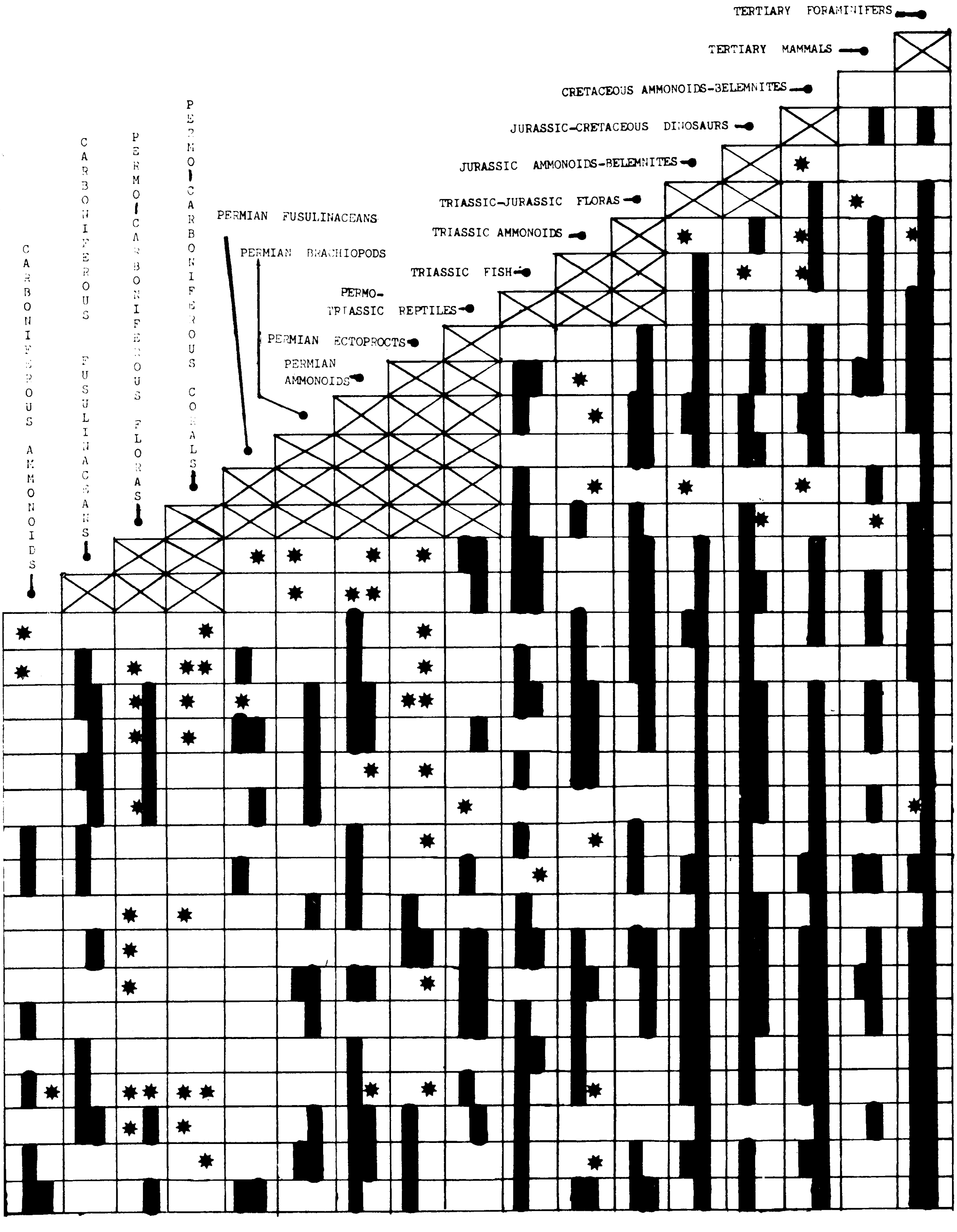
Applying this principle to biostratigraphy, one should note that in Case 1 of Figure 2 the combination N/S never occurs. In Case 2, the Flood is hypothetically allowed to happen all over again. This time, it is the combination P/S that never occurs. Keeping in mind that index fossils shun each other geographically (Table 3), one can see a directly comparable situation with Figure 2; in both cases there are few opportunities for any two index fossils of different "ages" to mix with each other, so many non-mixings can occur by chance. Since in Case 1 S/N is the only way fossils S and N are stratigraphically related to each other (since N/S never occurs, by chance, due to the rarity of instances where fossils N and S occur in the same location), then uniformitarians imagine that S and N are index fossils relative to each other and thus delineate different spans of geologic time. The time horizon has been drawn in to show how the sections are time-correlated according to this "knowledge." The boundary is firm (and thus drawn as a solid line where both N and S occur in the same section) but indeterminate (as in stratigraphic section no. 4) when neither occur. Where one of the two index fossils is present, then the boundary is capable of being placed under S or above N but not with exactness. In Case 2, it is S and P that are index fossils and it is N that has no time significance.

The principle of the origin of biostratigraphic differentiation by chance can be extended to multitudes of fossils, in contrast to the mere 3 shown in Figure 2. Again, the fact that most index fossils are geographically incompatible relative to each other (Table 3, Figure 2) makes it possible. In such a group of fossils, some stratigraphic combinations will fail to occur (by chance); these will be the source of index fossils. Other combinations will occur, and these fossils will be rejected as index fossils. Since adjacent geologic periods have a majority (or very large minority) of families stratigraphically common to each other (Figure 1, Table 1), the principle of chance by itself may be sufficient to account for the biostratigraphic differentiation of any three adjacent geologic periods. The geologic column and its fossil population can be therefore broken down into four principle divisions; these divisions needing deterministic factors to account for their biostratigraphic differentiation relative to each other. Such deterministic factors are the topic of the succeeding chapter.

A major ramification of the origin of biostratigraphic differentiation by chance is the fact that many (if not most) stratigraphic occurrences of index fossils are solitary (see occurrence nos. 4, 5, 11, 17, and 19). Once fossils are elevated to index fossil status, their time-stratigraphic confinement becomes largely circular and therefore self-fulfilling. Creationists have commonly pointed out the circular reasoning in the use of index fossils but, in view of the fact that evolutionists-uniformitarians have commonly sought to deny this fact, it is worthwhile to provide additional evidence. Potapenko and Stukalina[688] wrote: "The crinoids found here rule out a Precambrian or Cambrian age for the host limestone because no reliably identified primitive crinoids have ever been found in Paleozoic rocks older than Early Ordovician." The use of crinoids in ruling out a Precambrian-Cambrian age is justified by the "fact" that such crinoids have never been found in Precambrian-Cambrian rocks, and then the circle of reasoning closes by claiming that rocks are not Precambrian-Cambrian solely because they contain such crinoids! In being uncertain whether to date a certain lithology as Precambrian or Cambrian until a trilobite was found, Yochelson and Stump said:[689] "The trilobite fragment precludes a Precambrian age." In another situation, Skehan, *et al.*,[690] wrote: "Middle Cambrian trilobites of Acado-Baltic affinities have been found in southern Narragansett Bay, Rhode Island, in phyllites previously mapped as part of the Pennsylvanian stratigraphy of the Narragansett Basin." The claim that certain trilobites are confined to the Cambrian begs the question because rocks are dated as Cambrian (and not some other geologic period) often solely because they contain such trilobites. Many other examples could be given.

Table 3. The Actual Geographic Compatibilities and Incompatibilities of Index Fossils: A Quantitative Tabulation. Each row-column intersection shows the juxtapositional tendencies of two index fossils relative to each other. There are 479 possible different-"age" juxtapositional combinations of the 34 index fossils; all of these are shown. The symbols indicate percentages of fossils juxtaposed based on the number of juxtapositions divided by the total number of fossils given in Table 2. The star denotes percentages over 10%, blank space indicates percentages between 5% and 10%, and vertical bar indicates percentages under 5%. The symbol (or blank) at the left refers to the "older" fossil; at the right to the "younger" one. For example, over 10% of the 157 Triassic ammonoid localities (Map 28, Table 2) are overlain by Tertiary Foraminifers, but less than 5% of the 478 Tertiary Foraminifer localities (Map 34, Table 2) overlie Triassic ammonoids. (Overall, very few of the percentages over 10% are greatly in excess of that figure.)




CARBONIFEROUS AMMONOIDS
CARBONIFEROUS FUSULINACEANS
PERMO-CARBONIFEROUS FLORAS
PERMO-CARBONIFEROUS CORALS
PERMIAN FUSULINACEANS
PERMIAN BRACHIOPODS
PERMIAN ECTOPROCTS
PERMIAN AMMONOIDS
PERMO-TRIASSIC REPTILES
TRIASSIC FISH
TRIASSIC AMMONOIDS
TRIASSIC-JURASSIC FLORAS
JURASSIC AMMONOIDS-BELEMNITES
JURASSIC-CRETACEOUS DINOSAURS
CRETACEOUS AMMONOIDS-BELEMNITES
TERTIARY MAMMALS
TERTIARY FORAMINIFERS

Still another major factor in the origin of biostratigraphic differentiation by chance is preservation bias. Collier[691] wrote: "When similar living faunas are preserved in the fossil record, they become much less similar, due to incomplete habitat representation and small sample size." This factor, applied to biostratigraphy, can be visualized by referring to Figure 2 (Case 2). In stratigraphic section 5, only P is found but there may have been N and/or S also originally present that had not been preserved. If any occurrence of N or an occurrence of S above the P had in fact been preserved, it would have made no difference on the special S/P relationship and on the use of S and P as index fossils. But if there had originally been a mixture of S with the P or else an instance where P overlay S in section 5, then the fortuitous non-preserving circumstance with respect to S in section 5 would have spared the whole S/P relationship. Thus, in Figure 2, there were many instances where there were additional fossils in given sections that had not been preserved and at times this non-preservation eliminated would-be biostratigraphic conflicts.

B. Deterministic Factors leading to Stratigraphic Differentiation of Fossils: The Primacy of TAB's (Tectonically-Associated Biological Provinces)

This section considers how the physical, ecologic, and biogeographic properties of organisms led to their biostratigraphic differentiation; emphasis being placed upon possible connections between biogeographic realms of antediluvian organisms and their tectonosedimentary environment. These factors are complementary to the indeterministic ones discussed in the previous chapter and also make considerable use of the fact that there is considerable net biostratigraphic overlap (Figure 1, Table 1) and that index fossils tend not to superpose (Tables 3 and 4, Figure 2).

Creationists have cited deterministic factors which lead to a stratigraphic differentiation of fossils, and these factors have their greatest realization because index fossils shun each other geographically (Table 3, Figure 2). Consider hydrodynamic sorting and differential escape, proposed by Whitcomb and Morris,[643] in the light of the information in Figure 2, Case 1. Suppose that, when in the same geographic area, fossil S has 70% chance of being buried later than fossil N due to sorting and/or differential escape. The fact that S and N so rarely coexist geographically enables the 30% tendency of N/S never to occur. In Case 2, the Flood is allowed to happen all over again and this time the 30% situation of N/S does occur and so N and S are not made into index fossils relative to each other. However, in Case 2, hydrodynamic sorting and/or differential escape cause a burial bias where P is buried before S, say 80% of the time, the same bias having been thwarted by the 20% chance in Case 1. It can thus be seen that factors such as hydrodynamic sorting and differential escape do not have to be overly efficient in order to generate biostratigraphic differentiation This overcomes objections about the turbulence of Floodwater: since index fossils rarely superpose relative to each other (Table 3, Figure 2) the sorting, etc., need work consistently only a few times relative to any two organisms in order for them to be buried in consistent biostratigraphic order.

The factor of ecological zonation (discussed by Clark[645] and also applied to fossil cephalopods by the present author[692]) probably is more efficient in generating biostratigraphic differentiation than passive sorting or differential escape. Nevertheless, ecological zonation also does not need to be highly efficient to generate biostratigraphic differentiation for the same reason as was discussed in the preceding paragraph for hydrodynamic sorting and differential escape. Examining Figure 2, it can be seen that (in Case 1) N could be in a lower habitat than S. The combination S/N would then be generated through ecological zonation if: N was benthic while S was pelagic, N was either benthic or pelagic while S was planktonic (both situations in marine ecology were discussed in my work[692] on cephalopod ecological zonation), N lived on lower ground while S lived on higher ground. Again, the fact that S and N rarely coexist geographically means that ecological zonation needs to work consistently only several times for the S/N biostratigraphic relationship to be established. The process for S and N is applicable to any other situation where index fossils are members of different ecological habitats.

Ecological zonation is in many instances so prominent that it not only plays a major role in total biostratigraphic differentiation, but also causes biotal incompatibilities *within* geologic periods. Many fossils are rejected as index fossils because they are facies fossils-fossils restricted to some particular lithology or well-defined sedimentological circumstance. Yet even index fossils show by their predominance in certain lithologies that they were ecologically-controlled and hence capable of flourishing only in certain environments. For instance, Nelson[693] cited: ". . . the extreme rarity of graptolites in limestone." In view of this fact of ecological dependence of even the most ideal index fossils, there is no *a priori* reason why the role of ecological zonation cannot be extended beyond faunal differences within (alleged) time-horizons to differences between (alleged) time-horizons (that is, between different geologic periods).

Thus far, the factors discussed (hydrodynamic sorting, differential escape, preservation bias, and ecological zonation) are well known to informed Creationists. The present author now proposes a whole new mechanism to account for biostratigraphic differentiation of fossils. It is based on the fact that sedimentation in the Phanerozoic record is strongly influenced by tectonics, and at the same time on the fact that fossil organisms are not only ecologically zoned but also biogeographically zoned. If tectonics and biogeographic zonation are linked (see Figure 3) then biogeographic provinces must be superposed in a consistent manner, thus resulting in biostratigraphic separation of fossils. The Flood model herein proposed that envisions such linkage is termed *the concept of TAB's (Tectonically-Associated Biological Provinces),* and will be discussed later. There is a major trend of changes in tectonics going stratigraphically upward in the Phanerozoic and this trend (to be discussed later) may be taken as independent evidence for the existence of TAB's. But first the role of biogeography in the fossil record is described.

It is common when considering modern examples of biogeography erroneously to think of it only in terms of climatic differences (tropical plants versus the high-latitude pines of Canada and Siberia) or continental differences (the marsupials native to Australia and South America versus placentals elsewhere). Many factors, in actuality, cause biogeographic zonation and such zones need not cover large areas. Looking at paleobiogeographic examples, even within the context of geologic periods, bears this out. For instance, the *Tuvaella* fauna[223] is a distinctive Silurian brachiopod biogeographic zone, and it is restricted to only Mongolia and adjacent parts of the USSR and China. One need only consult the *Atlas of Palaeobiogeography*[1] to see how fossil organisms of all geologic periods are divided up into paleobiogeographic provinces. Thus, the evolutionist-uniformitarian will note (to give another example) that Ordovician trilobites differ markedly in different places on earth and ascribe such differences to paleobiogeographic provinces (such as the bathyurid province, remopleuridid province, etc.).[72-3] At the same time, he will note differences between Ordovician and Silurian trilobites and ascribe such differences to evolution and geologic time. The Creationist-Diluvialist can reject such a dualism and view the same fundamental biogeographic processes that cause faunal differences *within* Ordovician trilobites to be the basic cause of differences between Ordovician and Silurian trilobites. In fact, biogeographic differences between marine faunas ascribed to the same geologic periods are so pronounced that Sheehan[694] proposed that there is a major breakdown in any comparison between extant marine communities and ancient ones. Since biogeographic differentiation *within* geologic periods is so considerable, there is nothing farfetched about the Creationists-Diluvialists' use of the same basic mechanism (when developed in the TAB model) to explain faunal differences *between* geologic periods.

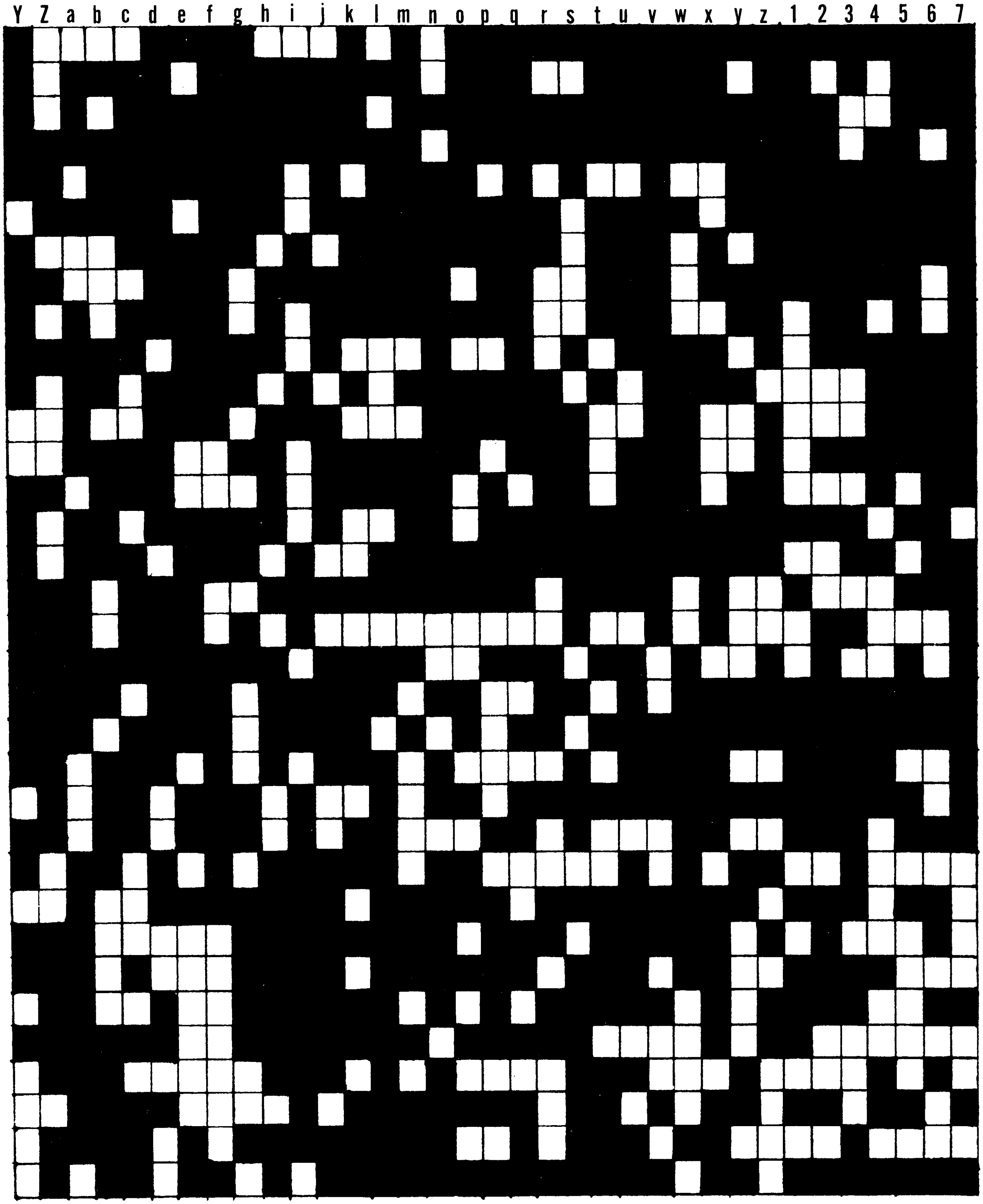
It is worthwhile to make a distinction between ecological zones and biogeographic zones. Taylor and Forester[695] point out that biogeographic zones (which, as they note, can also be termed faunal provinces or biofacies) may be ecologically controlled; hence the definitions, strictly speaking, overlap. The working definitions used in this work are as follows: The term ecological zonation refers to organisms that are mutually proximate but do not live together because they occupy different habitats or have different environmental tolerances. The term biogeographic zonation refers to organisms that are geographically separated, irrespective of whether or not they occupy the same ecological niche. The term biome would apply to organisms that are both ecologically different (such as those possessing different climatic tolerances) and biogeographically zoned. When organisms are members of the same ecological niche but biogeographically zoned, then they could live together were it not for their geographical separation and any geographic barriers that enforce it.

A contrast is now made between the evolutionary-uniformitarian and Creationist-Diluvialist paradigms with respect to the origins of ecological zonation and biogeographic zonation. In the evolutionary-uniformitarian paradigm, ecological zonation is caused by organisms evolving to match their environment: biogeographic zonation is caused by organisms evolving in a distinct geographic area and being imprisoned in that (or somewhat larger) area by geographic barriers. The Creationist-Diluvialist, not confined by the implicitly atheistic presuppositions of the evolutionist-uniformitarian, is free to explore possible Divine causes in the origins of ecological as well as biogeographic zonation. In attempting to "think God's thoughts after Him," it is worthwhile to note the fact that both ecological and biogeographic zonations are means by which a higher diversity and number of organisms can be supported on earth. There is also less conflict for space and for food when organisms are ecologically partitioned or geographically separated. Thus God may have created ecological and biogeographic zones in order to be able to Create a far wider variety of organisms than would have been the case had He Created only one ecological niche or only one global biogeographic zone. His actions with respect to His New Creation (the Church) may help clarify His Creative actions with respect to the Old Creation (the natural world). We are told that: "Now there are varieties of gifts, but the same Spirit." (1 Corinthians 12:4 NASB). Just as the Spirit gives different gifts so that believers can occupy different "spiritual niches?" so also God Created different organisms suited for their respective ecological niches. (Ecological zonation may itself have Scriptural basis—see Isaiah 41:19-20). Biogeographic zonation may find its analogy within the New Creation in the form of geographic separation of ministries (such as in the geographically differentiated preaching of the Gospel—Romans 15:20). Just as the Spirit can multiply the number of ministries if each has definite geographic boundaries, so God can Create more organisms if each is subject to biogeographic partitions.

Having reflected upon teleological considerations with respect to ecology and biogeography, attention is now focused upon how biogeographic provinces could have been linked with tectonics and thus have been the primary source of biostratigraphic differentiation (the TAB concept-see Figures 3 and 4). Note that in Figure 3 biogeographic provinces repeat themselves; on the land surface of the world each biological province may occupy an area with a transverse distance across it of up to a few hundred miles, the same province appearing again several hundred miles away. But, according to the TAB concept, the same biogeographic province is linked with the same tendency for tectonic downwarp irrespective of where it occurs on earth. Thus, note that in Figure 3 the biogeographic province symbolized by solid rectangles is always linked with the areas on earth having the greatest tendency for tectonic downwarp. Actually, there is greater biogeographic differentiation than tectonic differentiation (as evidenced by the previously-discussed fact that even biotas *within* geologic periods exhibit biogeographic differentiation). This is shown in Figure 3 in the form of asterisk-type stars sharing the same tectonic proclivity (the next to greatest) with ovals. Most other symbols in Figure 3 show the same effect. It is thus not special pleading to invoke the TAB concept as the major causative factor for total biostratigraphic differentiation in view of the fact that there would actually be more biogeographic differentiation than tectonic.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
Tertiary Foraminifers	□	■	■	■	■	■	□	□	□	□	□	■	■	□	■	■	■	■	□	■	■	■	■	■
Tertiary Mammals	■	■	■	■	■	□	■	□	□	□	■	□	■	□	■	■	■	■	■	■	■	■	■	■
Cretaceous Ammonoids-Belemnites	□	■	□	■	■	□	□	□	■	□	■	■	■	□	■	■	■	■	□	■	■	■	■	■
Jurassic-Cretaceous Dinosaurs	■	■	■	■	■	■	■	■	■	□	□	■	■	■	■	■	■	■	■	■	■	■	■	■
Jurassic Ammonoids-Belemnites	□	■	■	□	□	■	■	■	□	□	□	■	■	□	■	□	■	■	■	■	□	□	■	□
Triassic-Jurassic Floras	□	■	□	■	■	□	□	■	■	■	■	■	■	■	■	■	■	■	□	■	■	■	■	■
Triassic Ammonoids	■	■	■	■	■	■	■	■	□	■	■	■	■	■	■	■	■	■	■	■	□	■	■	■
Triassic Fish	■	■	■	□	■	■	■	■	■	■	■	■	■	□	■	■	■	□	■	■	■	□	■	■
Permo-Triassic Reptiles	■	■	□	■	□	□	■	■	■	■	■	■	■	□	■	■	□	□	□	■	■	■	■	■
Permian Ectoprocts	■	■	■	□	■	■	■	■	□	■	■	■	■	■	□	■	■	□	■	■	■	■	■	■
Permian Ammonoids	■	■	■	■	■	■	■	■	□	■	■	■	■	■	□	■	□	■	■	■	□	■	■	■
Permian Brachiopods	■	■	■	□	■	□	■	■	□	■	■	■	■	■	■	□	□	■	■	□	■	■	■	■
Permian Fusulinaceans	■	■	■	■	■	■	■	■	□	■	■	■	■	□	□	□	□	□	■	■	■	■	□	■
Permo-Carboniferous Corals	□	■	■	□	□	■	■	■	□	■	■	□	□	□	□	■	□	■	■	■	■	■	■	□
Permo-Carboniferous Floras	□	■	■	□	□	□	□	□	■	□	□	■	□	■	■	□	□	□	■	■	■	■	□	□
Carboniferous Fusulinaceans	■	■	■	□	■	■	□	■	■	■	■	■	■	□	□	□	□	■	□	□	□	□	■	■
Carboniferous Ammonoids	□	■	■	■	□	■	□	■	■	■	□	■	■	■	■	■	■	□	■	□	□	■	■	■
Devonian Brachiopods	□	■	■	■	□	□	□	□	■	□	■	□	□	■	□	■	■	□	■	■	■	□	□	□
Devonian Coelenterates	□	□	■	■	□	■	□	■	■	■	□	□	■	□	■	■	□	□	■	■	□	□	■	■
Devonian Ammonoids	□	■	■	■	■	□	■	□	■	■	■	□	□	■	■	□	■	□	■	□	■	■	■	■
Devonian Floras	■	■	■	■	■	□	□	■	■	■	□	■	■	■	■	■	□	■	■	■	■	■	■	■
Siluro-Devonian Trilobites	□	■	□	■	■	□	■	□	■	□	■	□	□	■	■	□	■	■	■	■	■	■	□	□
Siluro-Devonian Fish	□	□	□	□	■	■	□	■	■	□	■	■	□	□	■	■	■	□	■	■	■	■	□	■
Siluro-Devonian Graptolites	□	□	□	■	□	■	■	□	■	■	□	■	■	□	□	■	■	■	■	■	■	□	■	■
Silurian Brachiopods	□	□	■	■	□	■	■	■	■	□	■	□	■	■	□	■	■	□	■	■	■	■	■	■
Siluro-Ordovician Echinoderms	□	□	□	■	■	□	■	□	■	□	□	□	□	■	■	■	□	■	■	■	■	■	□	■
Ordovician Nautiloids	■	□	■	□	■	□	■	■	■	■	■	■	■	□	■	■	■	■	■	■	■	■	□	□
Ordovician Conodonts	■	□	□	■	□	■	■	■	■	■	■	□	■	■	■	□	■	□	■	■	■	□	□	■
Ordovician Brachiopods	□	□	■	■	■	■	■	□	■	□	■	■	■	□	■	■	■	■	■	■	■	■	□	□
Ordovician Graptolites	□	□	□	□	□	■	■	□	■	■	□	□	□	□	■	■	■	□	□	□	■	□	□	□
Ordovician Trilobites	□	□	□	□	□	■	□	□	■	■	□	□	□	□	■	■	■	□	■	□	■	□	□	□
Cambrian Archaeocyathids	□	■	■	■	■	■	■	□	■	■	■	□	■	■	■	■	■	□	□	□	□	□	■	■
Cambrian Trilobites	□	□	□	■	□	■	■	□	■	□	■	□	■	□	■	■	■	■	■	□	□	□	□	■
Precambrian Miscellanea	■	■	□	□	□	□	■	■	■	■	■	■	■	■	■	■	□	■	□	■	■	■	■	■

Table 4. The Global Successional Tendencies of Index Fossils. The Table shows which of the 34 index fossils can be seen superposed at the localities shown on Map 37: the localities shown being those where the greatest number of index fossils can be seen to superpose. Blacked-out rectangles denote absence of that given fossil at that given locality.


Y Z a b c d e f g h i j k l m n o p q r s t u v w x y z 1 2 3 4 5 6 7

One may wonder if there is any independent evidence for such a proposed linkage between tectonics and biogeography, and also if there are plausible reasons to account for such a linkage. The answer to both question is yes; and so the concept of TAB's can be independently justified. Studies on modern marine biogeography described by Taylor and Forester,[695] and Crick,[696] have shown that oceanic current patterns result in biogeographic differentiation (a differentiation that is also biomic in character), temperature of the water being the major factor. Salinity is another. Crick added that water-temperature patterns of oceanic current flow can be controlled by submarine topography. This concept can be applied to antediluvian epicontinental seas. Suppose that the entire Phanerozoic is divided into four divisions—I, II, III, and IV: these are simultaneously four antediluvian biogeographic provinces and also are approximately equivalent to Eras. Thus, no. I (see Figure 4) represents the biogeographic province (roughly corresponding to Lower Paleozoic in biotal content) that is associated with the regions on earth showing the greatest tectonic proclivity. Returning to the discussion concerning Crick,[696] one can see that, in this instance, the no. I biogeographic province could have had uniform temperature of water, and that this temperature could have been regulated by submarine topography. Submarine topography could have, in turn, been a reflection of the tectonic stability of the region. This is one possible causal connection between biogeography and tectonics. Another temperature-based biomic situation could result from the fountains of the deep (Genesis 7:11) having been partly geothermal springs and underground rivers. The temperature and number of such springs in a region could have depended upon the tectonic proclivity of the region; more numerous and hotter springs being generated in regions of greatest tectonic proclivity because of numerous deep fissures (no. I of Figure 4), the biotic contents of the associated biological province living at a high temperature environment due to the number and temperature of the geothermal springs. Note that in the examples discussed thus far (marine currents and geothermal springs), the temperature of the water was the causal factor of the TAB's and also the factor linking the tectonic proclivity with the biogeographic provinces. Still another connecting factor between biogeography and tectonics could have been the chemistry (eH — pH nutrients, trace elements) of the seabed and seawater (in marine regions of biogeographic provinces) and the chemistry of soils (in land regions of same). Geothermal springs, once again, could have been the causal connection between tectonic proclivity and chemistry (and thus biogeography).

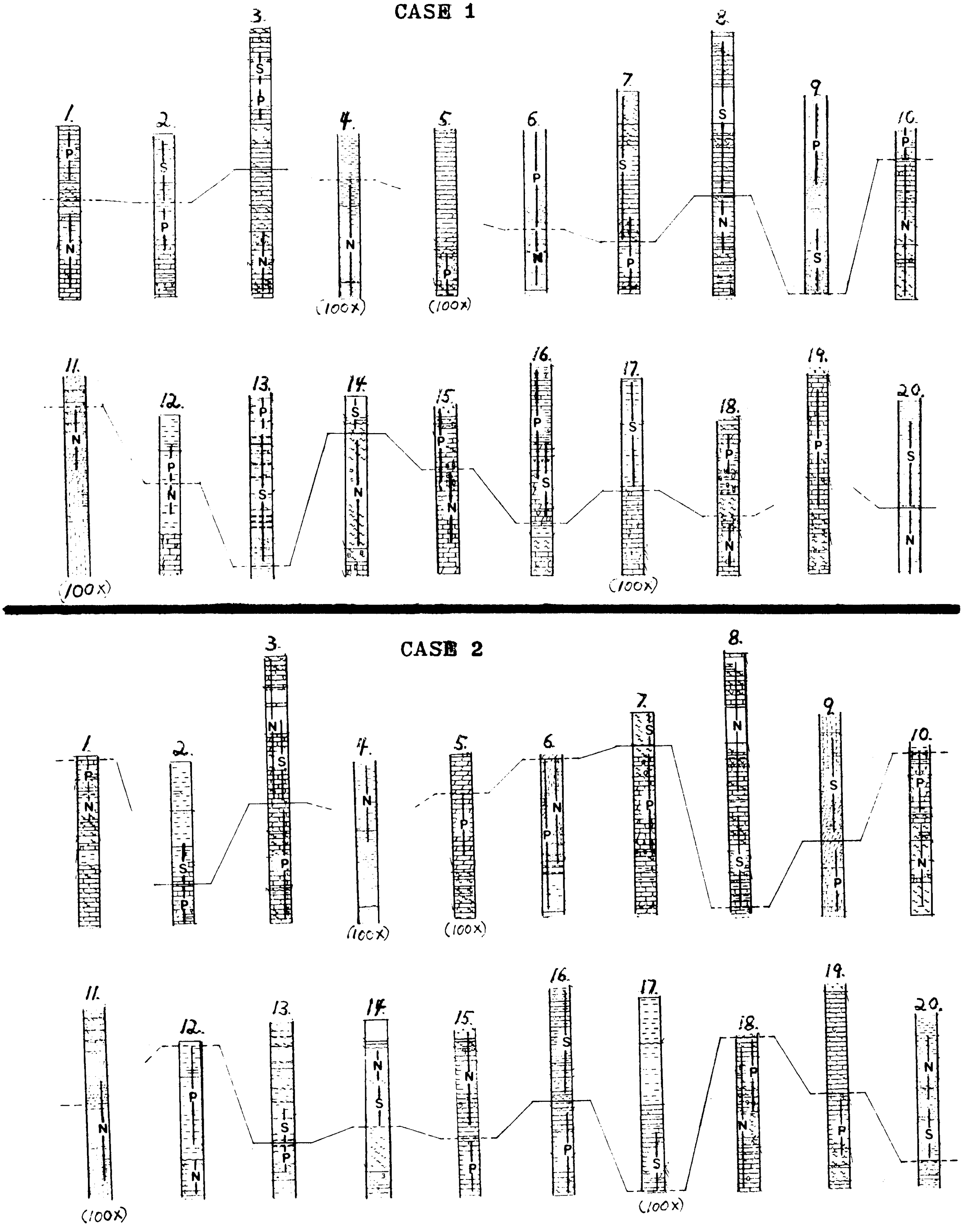
An example from modern ecology where biogeographic distribution is regulated by chemistry is discussed by Parker and Toots:[697] "Proboscidians are highly advanced in the evolution of their dentition but are primitive in their sodium metabolism. Because of the latter fact, distribution of elephants in modern Africa is closely correlated with high environmental sodium levels (Weir 1972), and elephants are known to depend on food that is particularly rich in sodium."

TAB's could have also been Created without any ecological (biomic) character to them; the tectonic proclivities being part of the structure of geographic barriers designed to prevent significant migration of organisms from one biogeographic province to another. (It should be emphasized that TAB's did not arise from trial-and-error migrations but were present since the Creation and were based on teleological design.)

Independent evidence that there is a connection between biostratigraphic segments of the Phanerozoic and tectonics of sedimentation is now presented. When the present author conceived the TAB process, he predicted that, if it is valid, then the lower part of the Phanerozoic column should contain evidences of sedimentation under more tectonically-active conditions than the upper part of the same. *After* making such a prediction, it was discovered that such is indeed the case. First of all, note that in Table 3, Lower Paleozoic fossils have a greater tendency to superpose among themselves than is the case for fossils of adjacent geologic periods higher in the geologic column (this is clearly manifested by the concentration of star symbols in the left half of Table 3 and simultaneous negative concentration of bars). This indicates that Lower Paleozoic fossils have been deposited in smaller geographic areas than was the case for higher fossils, indicating that tectonic downwarp was greatest for Lower Paleozoic and thus forced the concentration of those fossils into geographically restricted areas. Other lines of evidence, presented by other authors, bears this out. Note that geosynclines are regions of greater tectonic activity (downwarp followed by uplift) than platforms. Ronov[698] did extensive calculations on the areas and volumes of Phanerozoic rock with respect to geologic periods. He showed (his Figure 32) that geosynclines occupy 40% of the area of oldest geologic periods but less than 20% of the recent ones. The present author performed calculations on the data presented by Ronov[699] in another article. It was determined that the Mesozoic-Cenozoic (roughly corresponding with TAB's III and IV) contains 57.4% of the total volume of Phanerozoic platform sediments but only 41.3% of the total volume of Phanerozoic geosynclinal sediments. The ratio (by volumes) of geosynclinal to platformal sediments (taking the Phanerozoic as a whole) is 2.4. A clear trend is evident between the Eras (and sub-Eras). In the Lower Paleozoic (TAB I), the ratio is 3.1; in the Upper Paleozoic (TAB II), it is 3.4; in the Mesozoic (TAB III) it is only 1.8; and in the Cenozoic (TAB IV), it is but 1.6. The trends discussed in this paragraph demonstrate that there is a tectonic trend going stratigraphically upward in the geologic column: this trend provides independent evidence for the TAB concept.

Some ramifications of the TAB concept should be discussed; both biogeography and tectonics being considered. The reason why the Phanerozoic was divided into four lateral equivalents (the biogeographic provinces I through IV) was because (as demonstrated in the earlier chapter on indeterministic factors) geologic periods adjacent to each other share a great many families between them (Figure 1, Table l), so that there are really only four (not more nor less) groupings of Phanerozoic faunas. This approximately corresponds to Eras and Sub-Eras in terms of a "natural" division of the Phanerozoic. Furnish, *et al.,*[615] wrote:

Figure 2. A schematic representation of the effects of pure chance on stratigraphic ranges. Note that Stratigraphic Sections 4, 5, 11, and 17 are numerically weighted 100 times, so there are actually 416 different sections shown per case. Relatively rare mutual stratigraphic occurrences of fossils P, N, and /or S generate *apparent* stratigraphic incompatibilities. Explained in Text.



CASE 1

CASE 2

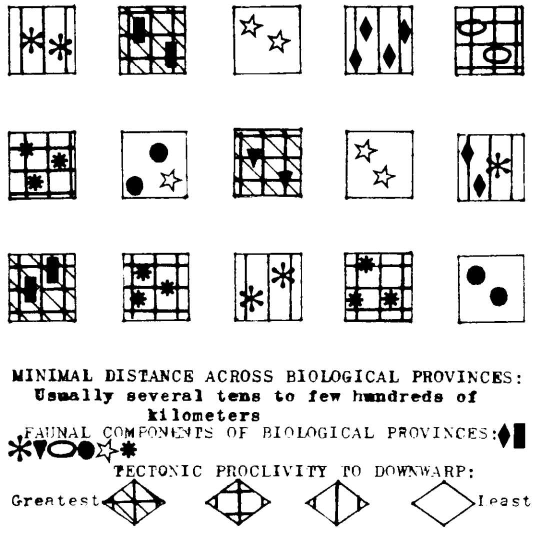


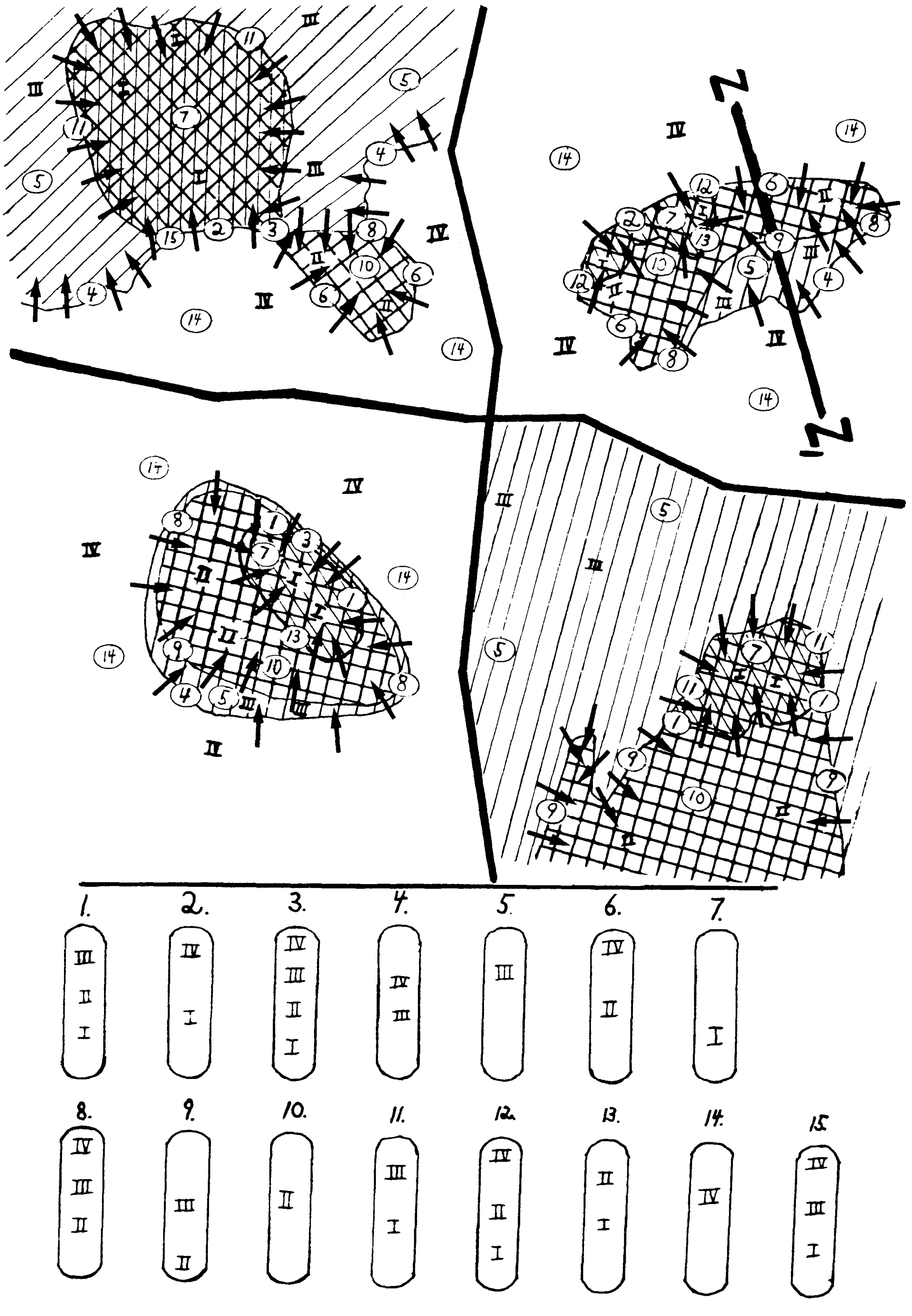
Figure 3. The Approximate Geographic Congruence of Antediluvian Biogeographic Provinces with Differentiated Tectonically-Prone Regions. The squares symbolize different areas on earth, and show given organisms associated with areas having the same tendency to downwarp. Explained in text.

"Since the first half of the 19th century, it has become apparent that assemblages of fossil organisms can be grouped as 'ancient,' 'medial,' or 'recent' in overall aspect. These groupings formed the basis for Phillips' definition (1) of the geological eras: Palaeozoic, Mesozoic, and Kainozoic. Even casual comparison reveals basic differences between marine invertebate faunas of those three eras, with the era boundaries representing intervals of faunal crisis." In considering tectonic proclivities, it should be pointed out that the tectonic proclivities became operable upon the application of great subterranean stress, irrespective of the source of the stress. Just as a dark fabric will get hotter than a similar white fabric regardless of the source of heat (be it sunlight, ordinary fire, or a nuclear explosion), so also note that the TAB process will have worked regardless of whether the stress was imposed by direct Divine will, passive Divine will (such as undirected flow of Divine energy), or providentially-timed naturalistic causes (such as providentially-timed release of earth-interior stress that had been built-in into the earth since Creation Week, gravitational stresses from a passing celestial body, or a bolide impact). Thus it should be clear that the TAB concept can be incorporated into the theories of other Creationists-Diluvialists, since it does not matter what the overall causal factor of the Flood was: the TAB process operated regardless of cause. However, it should be noted that the exact process by which earth-interior stress becomes manifested as crustal tectonic movements is not yet clarified. Hobson and Tiratsov[700] cited: "Tectonic forces, the nature of which are still only partly understood . . ." This partial knowledge applies to both uniformitarian and Diluvialist understandings of tectonic action: uniformitarians are certainly not deterred by this fact from proposing models of tectonic action, so neither should the Diluvialist be discouraged from accepting TAB's. Just as the TAB concept operated regardless of the ultimate cause of earth-interior stress, so also it operated regardless of the mechanism by which earth-interior stresses get converted into crustal tectonics. The lack of knowledge of cytological and biochemical genetics in the 19th century did not prevent Gregor Mendel from proposing his laws of inheritance; neither should the overall partial knowledge of tectonics hinder the Diluvialist. The TAB process finds its greatest realization with respect to tectonics by the clear geological evidences of tectonic motion. Stokes[701] cites troughs, grabens, downwarps, depressions, rifts, and "pull apart" structures (not to mention orogens and geosynclines) and concludes: "As a matter of fact, negative features should be even more common than positive ones. The forces that cause uplift must work against gravity, while those causing depression work with it."

TAB's are not equivalently distributed over the earth. Thus, the reason why ocean floors are almost exclusively Mesozoic and Cenozoic is because they were exclusively overlain by TAB's II and IV. (The percentage of all 15 possible combinations of TAB successions with respect to earth's land surface will be discussed later in conjunction with Figure 6.) TABs have been described in terms of Phanerozoic biotas, but Precambrian biotas can be assigned to TAB I; one need realize that the sum of Precambrian biotas is minute in comparison with the number and diversity of Phanerozoic biotas, and that Precambrian biotas can be attached to TAB I because they commonly range into Lower Paleozoic and because (as previously mentioned in conjunction with trilobites) the Cambrian-Precambrian boundary is circularly defined. Dott,[702] in an anti-Creationist article, completely misses the mark when he asserts that the Noachian Deluge would need to have deposited all Precambrian, along with Phanerozoic, sedimentary rock. Only a vanishingly small percentage of Precambrian is fossiliferous and therefore must be post-Creation Week. Even if this were not so, Late Precambrian (Riphean and Vendian, which together are ascribed to the time span 1600 m.y. to 600 m.y. ago and in which the vast bulk of Precambrian biotas are concentrated), volumetrically occupy only 16% of the total combined volume of Riphean-Vendian-Phanerozoic sediment, according to Ronov.[699] When intensely metamorphosed equivalents are included, the figure rises to 27%, but again only a very small percentage of even this volume is fossiliferous and therefore must be Diluvial in origin.

The Lower Paleozoic (TAB I) contains almost exclusively marine fossils, and this indicates that the biological province was exclusively marine. All other geologic periods, while containing land faunas and floras, are still dominated by marine biotas. This indicates that TAB's II, III, and IV contained both marine and terrigenous regions. When a particular regional TAB was land in entirety, then the geologic periods deposited had only land faunas. For example, the Gondawana Formations of South Africa were primarily TAB III of nearly entirely terrigenous geography. Many TAB's, by contrast, contain alternations of marine and nonmarine biotas, indicating that the particular regional manifestation of a given TAB si-

Figure 4. The Generation of Biostratigraphically-Differentiated Strata through the Operation of TAB's (Tectonically-Associated Biological Provinces). The four quadrants depict four representative depositional regions during the Flood (from anywhere on earth). The denotation for Tectonic Proclivity is identical to that in Fig. 3. The biogeographic components of the areas are shown by the numerals I-IV (corresponding approximately to a fourfold division of Phanerozoic life) replacing the geometric symbols of life shown in Figure 3. The numbers in ovals show the type of local biostratigraphic succession generated; the age possible successions are shown on the bottom of the diagram. The arrows show how Floodwater deterministically flows across regions, irrespective of whether it is progressional, intra-Flood, or recessional. Explained in text.



multaneously contained both land and marine areas. Every regional manifestation of a TAB is independent from any other regional manifestation in terms of sedimentology and most sediment is regional in origin, so there are no major global volumetric tendencies with respect to primary lithologies. Thus, Ronov[699] showed that every geologic period has sandstone, shale, carbonate, etc., in percentages that fluctuate considerably going from one geologic period to the next, but without any major volumetric trends across the whole Phanerozoic.

TAB's have thus far been discussed in terms of their biogeographic and tectonic components, as well as in terms of their implications and ramifications. The following discussion concerns their *modus operandi* with respect to the Flood (see Figures 4 and 5). Note that Floodwater (and its transported sedimentary particles and organisms) always flows from an area of lesser tectonic proclivity to a higher one. This is because an area of greater tectonic proclivity always downwarps before an area of lesser tectonic proclivity. Thus the sequence of TAB's: IV/III/II/I is always preserved in that relative order no matter how many of the four TAB's are actually present in a given area. Note that in the regions illustrated in Figure 4, stratigraphic successions of multiple TAB's are generated only at and near junctions of TAB's. In geographic centers of large representatives of specific TAB's only biotic members of that same TAB are superposed. This is shown in Figure 4 under stratigraphic succession numbers 5, 7, 10, and 14. On the earth, such singular successions are seen in the form of thick geosynclinal deposits containing a few mutually-adjacent geologic periods (for example, very thick Lower Paleozoic Caledonian geosynclinal accumulations) and also platform deposits with singular geologic periods represented.

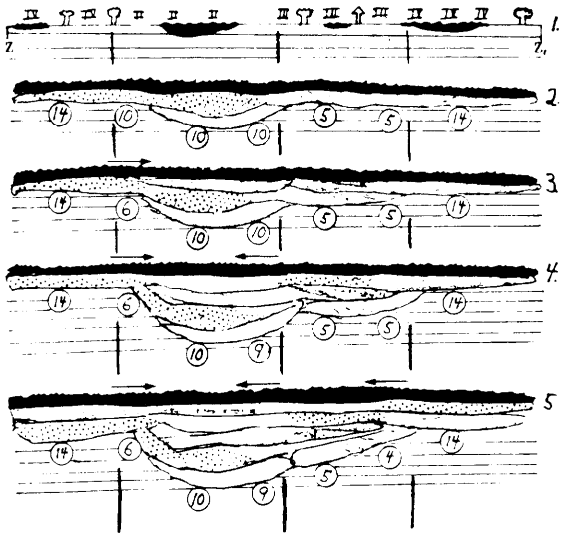


Figure 5. A cross-section showing how biotic members of TAB's become superposed throughout the course of the Flood. The section dissected is shown by the line segment Z-Z, in the upper-right quadrant of Fig. 4. The denotation for Roman numerals and for numbers in ovals is identical to that of Figure 4 (except that the situation in Figure 4 is in plan (areal) view whereas this figure is in cross-section). No. 1 (at right) refers to the antediluvian section: the projections symbolize trees whereas the black symbolizes antediluvian epicontinental seas. The thin, continuous horizontal lines indicate antediluvian regolith; the thick horizontal line segments indicate boundaries of TAB's and their respective tectonic proclivities. Nos. 2-5 refer to progressive stages of Flood deposition; the black band denotes the surficial cover of Floodwater whereas the thin arrows indicate the net direction of Floodwater and its sediment transport in response to the sequential downwarp of TAB's. The vertical scale is approximately 1 centimeter to a few thousand meters; the horizontal is 1 centimeter to a few tens of kilometers. Explained in text.

In order to get an idea of how TAB's would be geographically proportioned (wide TAB representatives which would have given singular successions versus small and narrow representatives sharing boundaries with other similar TAB's and hence yielding multiple-TAB successions), the earth's land surface was divided into the 15 possible TAB successions shown in Figure 4 (the 16th possibility being a region having none of the four TAB's present there). The raw data came from Table 1 of the author's previous work[703] on the nonexistence of the evolutionary-uniformitarian geologic column. The results, shown in Figure 6, indicate that over half the earth's land surface has 2 or fewer of the 4 TAB's superposed at any one locality. This indicates that the dominant mode of sedimentation during the Flood involved little tendency for TAB constituents to be transported much beyond their boundaries; hence less than half of earth's land surface has more than 2 locally superposed TAB's. When oceanic data are included (only TAB's III and/or IV), this tendency is increased to such an extent that only about 15% of the earth's entire surface has more than 2 locally superposed TAB's. It is interesting to note (from Maps 11-15 of the author's previous work[703]) that regions of greatest completeness of the geologic column are also regions of greatest sedimentary thickness (that

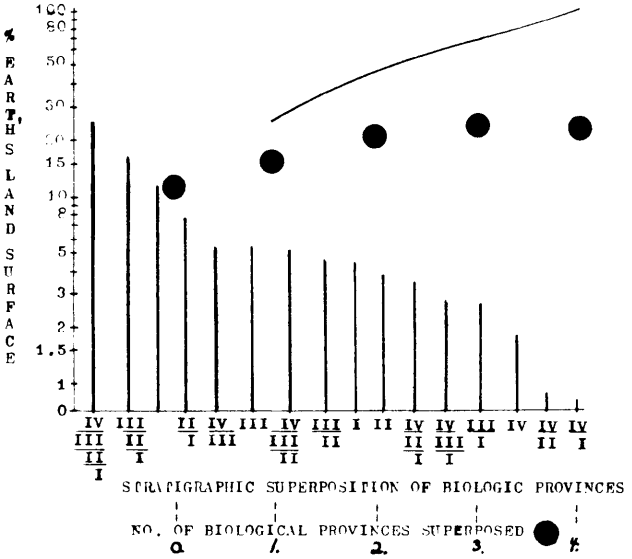


Figure 6. A quantitative breakdown showing tendencies of superposition of TAB's over the earth's land surface. The superposed Roman numerals show every possible combination of TAB's; listed from most to least frequent going rightward together with the per cent of earth's land surface each covers. The black circles and cumulative frequency curve refer to the absolute number of TAB's and their per cent occurrence. Explained in text.

is, the geosynclines). Map 37 also indicates this in its own way: areas of most superposed index fossils tend to be geosynclines. Both these trends are logically explicable in terms of TAB's; in fact, they may be yet another independent evidence for the existence of TAB's. Regions that have most or all TAB's locally superposed will naturally tend to have the greatest thickness of accumulated sediment because they have the most sources of sediment (multiple TAB's) all delivering their sediment into those regions.

It is worthwhile to consider how TAB's operate during the Deluge in terms of a specific representative region: this is shown in Figure 5. Note that only TAB's II, III, and IV are present in the cross-section pictured. Stage 1 is the antediluvian situation. Stage 2 the earliest part of the Flood, erosion and deposition taking place thus far only within TAB's (shown as successions 5, 10, and 14 in both Figures 4 and 5). The Flood progresses on to Stage 3, and TAB II begins to downwarp. As a result, the Flood transports (as indicated by arrow) sediment and organisms from TAB IV on top of the sediment already deposited within TAB II; hence the succession no. 6 (IV/II) is generated. In Stage 4, the downwarp of TAB II continues and now the Floodwater (again shown by arrow) transports sediment and organisms from TAB III unto the previously-deposited sediment of TAB II; thus succession no. 9 (III/II) is produced. (There is a greater differential between IV and II than between III and II, so succession no. 6 starts to form somewhat before succession no. 9.) Finally, TAB III begins to downwarp (Stage 5) so sediment from IV becomes transported on top of III and succession no. 4 (IV/III) is generated. The sequential downwarp of TAB's is largely independent of the hydrologic stages of the Flood (encroaching, prevailing, and recessional). Thus the covering of Floodwater (shown as black film in Figure 5) is already prevailing on land in Stages 2-5. (While TAB I starts downwarping, it may be occurring just as Floodwaters encroach on land, but it need not be.)

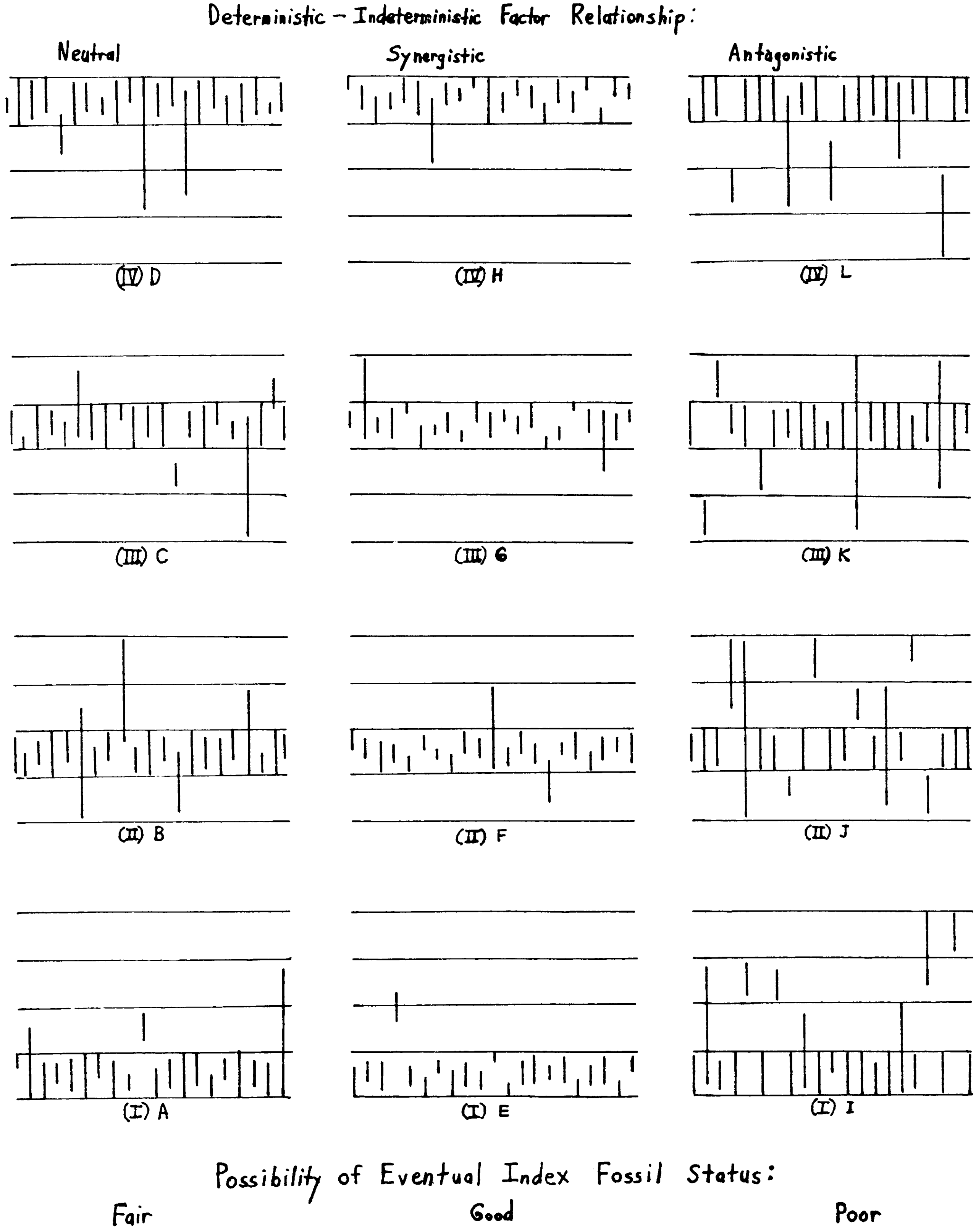
The TAB concept firmly rebuts the objection to the Flood that great thicknesses of sediment could not be laid down in one global Flood. Since sedimentation is primarily controlled by tectonics, and sequentially-downwarping TAB's operate throughout the duration of the Flood, there is constant impetus for mass Floodwater transport of sediment from one region to another. Thus the caricature of the Flood being merely a passive rise and fall of ocean levels (with then only relatively small extent of erosion and deposition—certainly not tens of thousands of feet) is shown to be just that. (Not to mention the probable fact that antediluvian regolith was unconsolidated and thick; hence easy to erode.) The anti-Creationist Milne[704] did a farcical misrepresentation of the Flood by claiming that, if it had occurred, then organisms in the fossil record would be uniform and identical to those organisms that are extant. Such a straw-man situation would have had validity only if the Flood had been merely a passive rise of water (like a river flood but global in extent). Once the geologic record is consulted and uniformitarian preconceptions are dispelled, the record in all its catastrophic implications testifies to the fact of the Deluge; the TAB concept showing how the paleontological details of the fossil record can be understood in terms of the Flood. In fact, a Diluvian interpretation (such as the TAB Concept espoused in this work) is scientifically superior to the evolutionary-uniformitarian view because the Diluvian interpretation explains fossil succession with less multiplication of concepts and hypotheses, and less special pleading, than the evolutionary-uniformitarian interpretation. A concrete example of this, where Occam's Razor favors the Diluvian interpretation, is shown by biostratigraphic differentiation itself. The uniformitarian must resort to special pleading in citing some fossils as being index fossils, while disregarding long-range forms. The Diluvialist can consistently explain both in the TAB concept, and need not imaginatively ascribe time properties to selected fossils. The Diluvian interpretation of the fossil record is simpler and more direct because it does not proliferate grandiose unobserved processes (such as organic evolution) but offers a more mundane cause for biostratigraphic differentiation. Also, the TAB concept is a more unifying cause than evolution and geologic time, because the former is a single-shot cause while the latter is a proliferation of (imagined) causes and (imagined) processes. The Diluvialist can use ecology, biogeography, etc. to explain fossil differentiation, while the uniformitarian must not only utilize those causes but also invoke evolution with geologic time. Thus the uniformitarian position multiplies hypotheses to a greater extent than the Diluvian position, which again is why Occam's Razor favors the Diluvian position and makes it more scientific. Why invoke evolution and geologic time in addition to ecology and biogeography as causes of biostratigraphic differentiation when the latter two causes are sufficient?

C. The Stratigraphic Separation and Succession of Fossils: a Diluvial Synthesis

This chapter unites all the factors involved in the stratigraphic separation of fossils; that is, all the factors discussed in the previous two chapters. The TAB process is the dominant factor in fossil separation and all other factors supplement it.

Figure 7 has been drafted in order to illustrate how the TAB process causes organisms to be restricted to specific stratigraphic intervals. For illustrative purposes, Figure 7 has been constructed with the stipulation that sedimentation rates are identical and that all four TAB's are locally present; the stipulations only temporarily held as real so that the full scope of TAB operations can be clarified. Thus, organisms A, E, and I are TAB I organisms and hence tend to have their stratigraphic ranges confined to the lowest quarter thickness of sediment. Organisms B, F, and J are TAB II organisms and tend to be injected into the second quarter thickness (from bottom) of sediment, etc. However, organisms are not absolutely restricted to the stratigraphic interval "belonging" to their respective TAB's because biogeographic boundaries are usually gradational and because the TAB mechanism is statistically-not absolutely-efficient. Nor need it be; since most index fossils do not actually superpose locally (Figure 2, Table 3) the few cases where any two fossils A through L superpose determine which be-

Figure 7. The generation of biostratigraphic differentiation (primarily through TAB's; with an interplay (both constructive and destructive) of other relevant factors discussed in text). The 21 occurrences each of fossils A-L, shown clustered together, actually are from diverse locations from all over the world. The four horizons per fossil denote quarter-thicknesses of rate-normalized sediment accumulations over the entire earth; each TAB deterministically injecting its sedimentary and biotic constituents into one of four quarter thicknesses. Explained in text.



come index fossils—as will be discussed later in conjunction with Figure 8.

In the real world, neither sedimentation rates are constant nor are usually all four TAB's locally present. Suppose all four TAB's are present but the amount of sediment is the greatest for TAB II: TAB II organisms and sediment will be still deposited after TAB I organisms and sediment and before TAB III organisms and sediment, but the stratigraphic interval of TAB II will be greater than one quarter of the total thickness of total sediment deposited locally. Since TAB's provide both organisms and sediment, their respective absences deprive a given region of both. Thus, if a region only contains TAB's II and IV, one will not usually find organically-blank thicknesses of sediment where I and III would have been; only IV superposed over II with either a paraconformity or angular unconformity between them, depending on local tectonic dynamics.

The effects of the TAB process alone on the stratigraphic partitioning of organisms is shown under the "Neutral" column in Figure 7. All other relevant factors (pure chance, preservation bias, hydrodynamic sorting, differential escape, ecological zonation) acted either neutrally, synergistically, or antagonistically with respect to TAB's For example, if an organism was benthic (and hence tending to be buried at the lowest stratigraphic interval) but it belonged to TAB III or IV (which would have tended to have it buried at high stratigraphic intervals) then ecological zonation and TAB's were antagonistic in that situation. This would have produced an organism as K or L, with many stratigraphic occurrences smeared over several reference quarter-thicknesses or translocated outside the expected quarter-thicknesses. However, even in such cases, the dominance of the TAB process in determining what stratigraphic interval an organism was deposited guaranteed that organisms will still have tended to be confined to stratigraphic intervals "belonging" to that TAB. Where multiple effects on the burial of organisms were synergistic, then the more consistent restriction of such an organism to a particular stratigraphic interval will have increased its chances of never being found overlapping with a like organism confined to a different stratigraphic interval-and thus both being index fossils. Note also from Figure 7 that, when effects are synergistic with TAB's, not only are organisms almost totally prevented from deviating beyond their TAB's quarter-thickness of sediment or from being translocated beyond the thickness interval, but even within each quarter thickness the organisms occupy shortened stratigraphic intervals.

Keeping in mind that every individual stratigraphic occurrence (each of the 252) shown in Figure 7 is geographically discrete, one should note that each occurrence can be juxtoposed with any other one. Figure 8 has been drafted to show how index fossils are concocted from juxtapositions of the discrete occurrences portrayed in Figure 7. Each of the 252 occurrences is denoted by a letter-numeral: for example, E7 means the 7th occurrence (from left; out of the 21 possible) of fossil E. The ordered pairs denote specific juxtapositions: for example, (E7, K12) denotes a juxtaposition of stratigraphic occurrence E7 with stratigraphic occurrence K12. Compatible juxtapositions are ones where the stratigraphic occurrences involved overlap; incompatible juxtapositions are ones where they do not. It is obvious that incompatible juxtapositions (and index fossils) are generated most frequently from fossils E, F, G, and H, the organisms most rigidly restricted to stratigraphic intervals of rock.

The concoction of index fossils is an interplay of actual TAB-generated stratigraphic restrictions of organisms (Figure 7) with the limited number of opportunities for fossils to be juxtaposed (Table 3, Figure 2). The fact that there are few chances for any two fossils to juxtapose means that stratigraphic mixtures and overlaps take place only when certain combinations of TAB-generated stratigraphic ranges simultaneously occur. For instance, consider fossils F and H from Figure 7. The only possible way that the juxtaposition of F and H could result in a stratigraphic overlap would be for the juxtaposition (F11, H7) to take place. The chance of an occurrence of F to be F11 is 1 in 21, and the same probability exists for an occurrence of H to be H7. Thus, the probability that a juxtaposition of F and H will result is thus only 1 in 441. But since there are only a handful of places on earth where fossils F and H occur juxtaposed, there are few chances for that 1 in 441 combination to have ever come up. Thus, if there are 10 locations on earth where F and H juxtapose, the chances are only (10)(1/441) that F and H coexist stratigraphically. The same principle of limited opportunities for juxtaposition governs all fossils. Thus, in Figure 8, the limited opportunities (six shown) for juxtaposition of any combinations of two fossils is schematically illustrated by six lines emanating from representative places on earth where juxtapositions may have actually occurred.

Uniformitarians take the results of juxtapositional situations and imaginatively ascribe time-stratigraphic significance upon them. Seeing that the combinatons EC, IH, IC, HE, and CH (see Figure 8) are consistently incompatible, they imagine that each fossil denotes a time horizon relative to the other fossil and that such (imagined) time-horizons can be correlated with other such (imagined) time-horizons. Thus (referring to the right side of Figure 8) E is always stratigraphically below C, and C is always stratigraphically below H: the time-relationship E-C-H (going chronostratigraphically from earliest to latest) is concocted. Other fossils are rejected as index fossils because they are found to be partly or totally compatible stratigraphically with each other, J is found to be compatible with both C and E (no relationship with H nor I is shown developed in Figure 8). I is found to be incompatible (and below) H, but the (imagined) time-relationship is refined by noting that I is also incompatible (and below) C. However, I is found to be compatible with E, so it is regarded as being time-equivalent with E but not ranging stratigraphically higher (and earlier) than E because, like E, fossil I is incompatible with (and stratigraphically below) C. In summary, fossils E, C, and H are the main index fossils while I is an auxiliary one; J is dismissed as an index fossil and considered to be a long-ranging form. The same line of thinking discussed in conjunction with Figure 8 applies to actual index fossils. In conclusion, the TAB process pro-

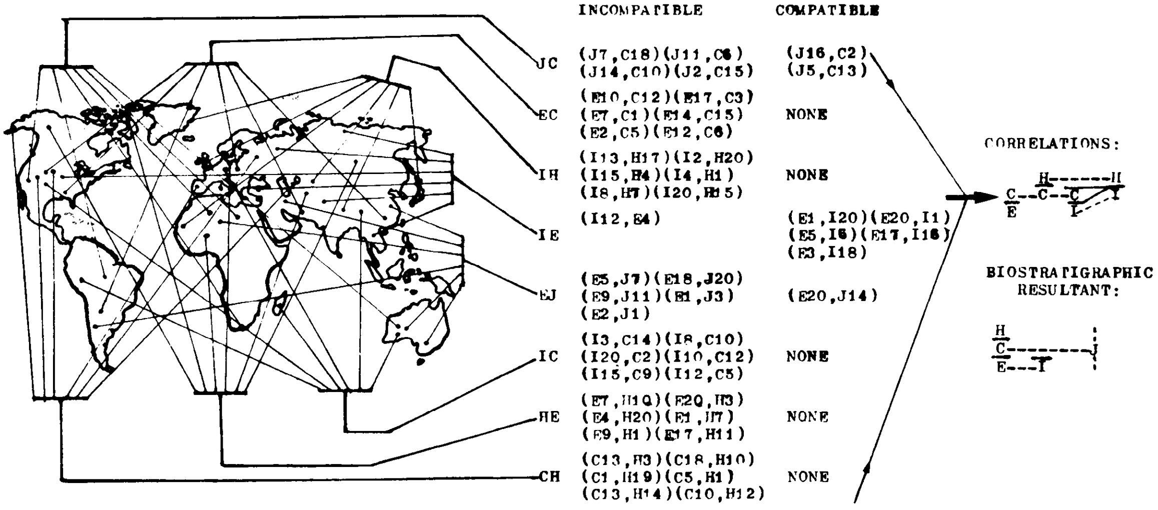


Figure 8. The selection of index fossils: a synthesis. The letters denote the same fossils as they do in Fig. 7, with the numbers indicating the numbered stratigraphic occurrences. The ordered pairs indicate which types of occurrences (of Fig. 7) participate in the juxtapositions. Incompatible combinations are those where stratigraphic occurrences do not overlap each other; only these can be index fossils. How the fossils are placed in an (imagined) time-stratigraphic relationship is illustrated on the right. Explained in text.

vides the main source of actual biostratigraphic differentiation, while the general non-superposition of fossils adds a large element of imagination to the whole concept of such differentiation.

D. Biostratigraphically-Progressive Extinctions with Respect to the Extant Biosphere: An Explanation in Light of the TAB Concept

In previous chapters the focus of attention was biostratigraphic differentiation; the why of fossils being different from one rock horizon to another. This chapter considers why there is progressive extinction; why the lower one goes into the geologic column, the fewer are the taxons still extant (and, conversely, why the present biosphere has the greatest number of taxons in common with the most recent geologic periods and the least number common with the most remote ones). This trend is quantitatively illustrated in Table 1; the rightmost column showing the percentage of families shared between Recent and the different Phanerozoic geologic periods. The periods of the Lower Paleozoic have only 11-15% of their families extant while the figure rises to 60-80% for the most recent geologic periods. An even sharper trend is shown for the number of families in the present biosphere in common with geologic periods; only 2.5% of all presently-living families are to be found in Cambrian.

The same basic TAB process that explains biostratigraphic differentiation also explains stratigraphically-progressive extinction with respect to the present biosphere. But before it is explained how it does let it first be noted that there is nothing intrinsically natural about the evolutionistic-uniformitarian explanation for progressive extinction. In fact, it is difficult for the evolutionist-uniformitarian to explain what causes extinctions! Benton[705] recently wrote: "Many hundreds of pages have been written about how the dinosaurs became extinct without our being any the wiser." Both concepts of gradual extinction of groups (such as by climatic change) and catastrophes within the context of geologic time (such as by a bolide impact at the end of the Cretaceous) encounter the difficulty of explaining how they could be sufficiently efficient and global in extent to totally obliterate taxa from off the earth. The Flood provides the best overall explanation for extinction becaues it is simultaneously global in extent and pervasive in effects (in contrast to the bolide impact whose effects on the biosphere would have been considerable but not as pervasive on a global scale). Moreover, the Diluvian interpretation is scientifically superior to a uniformitarian one because while the uniformitarian explanation must invoke multiple causes for extinctions throughout the geologic column, the Diluvian interpretation offers a single unified explanation. Occam's Razor thus favors it.

The initial understanding of how the Flood caused extinctions is the realization that the vast majority of organisms living at the time of the Flood were killed by it. The TAB process governed how many organisms of each antediluvian biogeographical zone (I, II, III, and IV) survived. The deeper the burial of a group of antediluvian organisms (irrespective of whether they were buried nearly *in situ* or transported significant distances) the less the probability that any organisms (or their eggs, larvae, seeds, spores, etc.) survived in the residual Floodwater and hence were available to repopulate the post-Diluvian earth. The sediment carried by the Floodwater not only acted as an entombing and filtering agent with respect to organisms, but also served to suffocate marine organisms. Where the burial was shallow, it meant that large amounts of sediment had not been suspended in the Floodwater and/or the period of deposition was not prolonged. In such a situation, it was more probable that some organisms had been spared from the entombing action of sediment or had not been filtered out of the Floodwater by descending sedimentary particles.

Figure 9 illustrates how depth of burial (and hence probability of survival, and thus ultimately the probability of not becoming extinct after the Flood) was controlled by the TAB process. Note that almost all of the representative stratigraphic sections (from all over the world) laid down in TAB I are thick, so this is indicative of very few organisms from that antediluvian biogeographic province having survived the Flood (this is shown in Figure 9 by the single line denoting minimal contribution to the postdiluvian biosphere). By contrast, the TAB IV sections are nearly all thin, so relatively many organisms from that biogeographic province survived the Flood (this is shown by the many lines fanning out from the TAB IV stratigraphic sections). This differential survival of TAB faunas and floras is the key to progressive extinctions relative to the contemporary biosphere. Note that the antediluvian biosphere (Figure 9, top right) had a considerable presence of all four biogeographic-province biotas (in terms of both population and low-taxon diversity). The center circle illustrates the effects of differential survival of TAB biotas: the organisms immediately surviving the Flood were numerically and taxonomically impoverished in TAB I and II constituents, and the largest share of survivors were from TAB IV.

As organisms began to repopulate the earth after the Flood, the lopsided representation of antediluvian biogeographic provinces became even more lopsided as organisms that had lived in separate biogeographic provinces before the Flood now coexisted and were now in direct competition. The organisms from the lower TAB's, being at a numerical disadvantage, were much more likely to be driven to extinction in the competition against the numerically-abundant higher-TAB biotas than this latter group. Numerical abundance was not the only extinction-biasing factor: the fact that the higher-TAB organisms were more taxonomically abundant gave them a reproductive advantage over lower-TAB organisms because the antediluvian ecological "webs" of higher TAB's were more likely to be nearly intact than was the case for lower TAB's. The end result is that the contemporary biosphere (Figure 9, lower right) is overwhelmingly dominated by TAB IV organisms: in biostratigraphic terms, the contemporary biosphere thus has much in common with Cenozoic but very little with Lower Paleozoic.

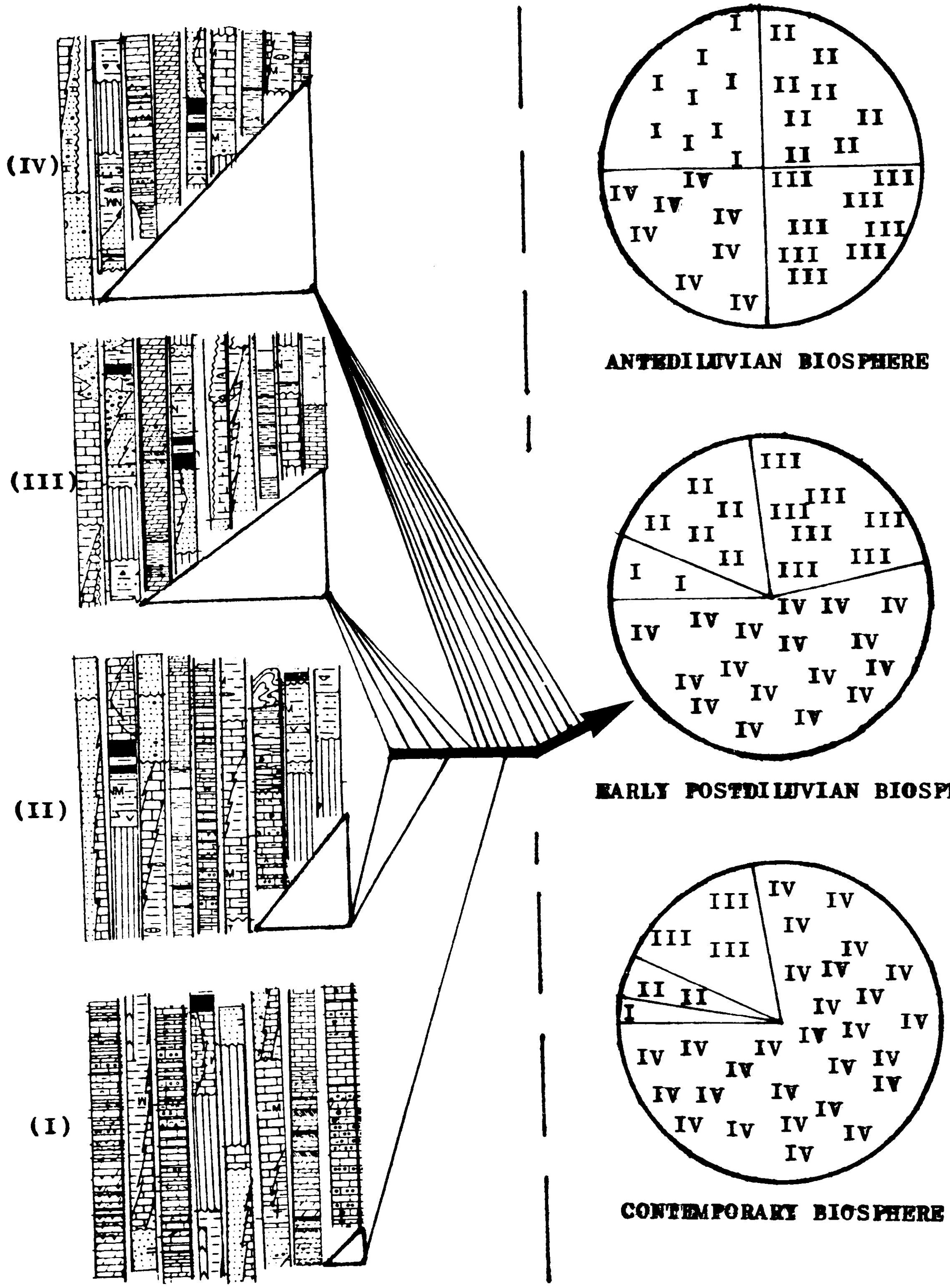
The discussion in the last few paragraphs was concerned with organisms that directly experienced the Flood; i.e., were not on the Ark. The present author follows Jones[706] in accepting ". . . (1) all birds, (2) all land-dwelling reptiles and mammals, (3) possibly some of the more terrestrial amphibia . . ." as having been the only animals on the Ark. Attention is now focused on the question of why the Ark-inhabiting organisms show the same progressive extinction with respect to the contemporary biosphere as do organisms that experienced the Flood. It has just been shown how the TAB process itself accounts for progressive extinction of organisms that went through the Flood. But the animals on the Ark were ecologically dependent on organisms that went through the Flood! One manifestation of this was the food chain. The Paleozoic reptiles ate TAB II vegetation, the dinosaurs primarily TAB III vegetation, and mammals were designed to subsist on TAB IV vegetation. Since vegetation, being outside the Ark, was subject to immediate differential extinction, the animals released from the Ark were subject to differential extinction which necessarily paralleled that of the vegetation they were dependent upon. Thus, the main reason why mammals survived at the expense of dinosaurs, "primitive" reptiles, etc., was because mammals had such a great reproductive advantage due to the overwhelming predominance of TAB IV vegetation soon after the Flood. The preferential relationship with humans of mammals probably was also a significant factor. It is concluded by reiterating that differential extinction was statistical, not absolute, which is why there are "living fossils" still extant (Table 1 shows measurable percentages of families from the Lower Paleozoic still extant) and why—conversely—many types of "advanced" mammals are extinct.

E. Causes for the (Near) Absence of Pre-Pleistocene Human Fossils

One major ramification of biostratigraphic differentiation is the (near) fact that humans do not appear until the very top of the geologic column. In a sense this should not be surprising to the Creationist-Diluvialist in view of the fact that man is totally different in capabilities and manner of life from all other organisms.

First of all, there are significant reports of pre-Pleistocene human remains pointed out by Creationists (for example, Jochmans[707]), and there are good reasons to suspect that there are many more that are not recognized — unintentionally and intentionally. Nonrecognition of human fossils is unintentional if fragmentary skeletal remains are erroneously ascribed to some other vertebrate. As far-fetched as this may appear, it actually frequently happens. Walker[708] said: "Sometimes mistakes occur and, since the specialist is usually unfamiliar with groups other than his own, he may not recognize the mistake. In this way crocodile femora have been described as hominoid clavicles (Le Gros Clark and Leakey 1951), lateral toes of *Hipparion* called *Australopithecus* clavicles (Bone 1955), crocodile naviculocuboids called *Palaeopropithecus* capitates (Sera 1935), and so on. It is no accident, perhaps, that mistakes occur most frequently in human and primate paleontology, because every scrap is seen as important and the anatomists are sometimes unfamiliar with other orders of mammals, let alone other classes of vertebrates. As a general rule, the smaller the fragment, the greater the chances of mistaken identity. The chances are especially high, it seems, if the bone to be examined is presented together with a set of similar bones . . . Apart from bones finding their way to the wrong specialist, it may also be true that a large number of unrecognized primate fossils still remain in museum collections. This is because the time involved in sorting through boxes of bone scraps and unidentified fragments is too long for most visiting scientists to expend." This process operates even more so down in the geologic column, where there is the widely-held evolutionary-uniformitarian belief that there are no human remains there. For example, a

Figure 9. A schematic illustration of the effect of TAB's on progressive extinction trends in the fossil record. The stratigraphic columns at left are representative of thicknesses that biotic members of TAB's are buried under; decreasing in trend going from I to IV. The width of each right triangle is directly proportional to the number of relatively thin stratigraphic sections. whereas the height is directly proportional to the thickness of such strata. The lines terminating at the arrow are units of biological survivors' representation—the organisms (primarily eggs, larvae, spores, seeds, etc.) which survived the straining action of sediments in Floodwater and were thus available to repopulate the postdiluvian world. The circles at right depict changes in the global biosphere since the Creation; the sections of the circle being proportional to the taxonomic diversity of each of the respective Biological Provinces with the amount of numeral figures proportional to the numbers of individuals extant. Explained in text.



specialist in Paleozoic tetrapods will have no training in human paleontology and will misidentify human skeletal fragments found in a Paleozoic bone assemblage as belonging to some vertebrate of that (alleged) time. The same holds true for Mesozoic, early Cenozoic, and Middle Cenozoic bone assemblages.

One must face the rather unpopular question of intentional nonrecognition of pre-Pleistocene human remains. Is one justified in suspecting that discoveries of human remains low in the geologic column are deliberately ignored or discounted? The likely answer can be found by considering the uniformitarian reaction to fossil finds that appear much earlier in the geologic column than had been previously accepted. Consider the "fact" that angiosperms do not appear until Late Cretaceous, and how a much earlier candidate was treated. Daghlian[709] wrote: "The Triassic age rather than morphological considerations appears to be the main obstacle to accepting *Sanmiguella* as a possible angiosperm." Evolutionary-uniformitarian preconceptions are vividly evident. In similar fashion is the example of belemnites, discussed in the author's work on cephalopods.[710] Reports of Devonian belemnites were admittedly "ignored or discounted" for nearly a century because of a widely-held preconception that there were no belemnites until the Triassic. If angiosperms and belemnites could be subject to such stratigraphic preconceptions, how many magnitudes more so would early Phanerozoic human remains! *If* such ancient human remains were ever recognized as valid by uniformitarians, they would probably be taken as evidence for, of all things, time travel! Lipps[711] wrote: "It is more likely that anomalies produced by time travel would be 'anachronisms' in historical or fossil records—for example, the fossilized remains of a modern human in Jurassic rock strata or descriptions of nuclear weapons in ancient literature. Should errata like these be found, they would constitute evidence that time travel is possible and will be developed."

Even having considered pre-Pleistocene human remains to be rare, one should note that such a situation is not unusual nor problematic when one considers it in the context of the whole fossil record. In other words, there are many extant organisms with a nonexistent (or poor) fossil record—not only organisms (for example, worms) lacking hard parts but also vertebrates. For instance, concerning certain modern amphibians, Carroll[712] wrote: "There are approximately 34 genera and 160 species of living Apoda. None has a fossil record. A single vertebra from the Upper Paleocene of Brazil is the only known fossil." Other examples include monotremes and marsupials: the latter has only 12 known Pre-Pleistocene fossil specimens.[713]

The clearest, least complex, and most probable single explanation for the near nonexistence of lower Phanerozoic human fossils is low antediluvian human population. Whitcomb and Morris[730] proposed a population of 1 billion, resulting from 6 surviving-reproducing offspring per generation. The population shrinks to 10 million if the number drops only slightly to 4.6.

The evidence derived from the extreme sinfulness of the antediluvians, as will now be shown, provides an independent basis for concluding that there were relatively few humans (perhaps only several million worldwide) as candidates for fossilization at the time of the Flood. It must be remembered, first of all, that plants and animals existed since Creation week as populations, whereas humans began with a single pair (Adam and Eve). The almost universal depravity of the antedeluvians guaranteed low fecundity. Anywhere from a large minority to a majority of the antediluvian population undoubtedly engaged in homosexual, zoophiliac, or pedophiliac contact. Even heterosexual contact was promiscuous, causing rampant venereal diseases and thereby damaging reproductive organs beyond use in childbearing and making it likely that any children born to parents whose organs had not been irreversibly damaged would themselves be born diseased and die shortly after birth. If a certain apocryphal tradition cited by von Wellnitz[714] is historically accurate, then low fecundity was also caused by the widespread use of contraceptives by women interested only in beauty.

The second major cause of low antediluvian population was the high murder rate (Genesis 6:11). A large fraction (perhaps majority) of babies and young children of every generation died through infanticide and child sacrifice to idols. Both children and adults were subject to the gross disrespect of life so characteristic of florid depravity. It would have mattered little that the longevity of antediluvians was measured in centuries if the vast majority of people were murdered long before that age. Lest it be considered that low fecundity and high murder rates discussed here are an exaggeration, let it be noted that the merciful God would have withheld the Flood had there been any significant percentage of people not totally depraved (just as He would have spared Sodom and Gomorrah if only 10 (relatively) righteous people were found—Genesis 18:32).

The net effect of the great evils of the antediluvians was a low population, and this caused a parallel situation with preservable implements. However, just because metal-work existed among the antediluvians (Genesis 4:22) does not mean that it was common among the populace. If there were sharp distinctions between antediluvian social classes, then probably only the upper classes had significant metal and ceramic implements.

Suppose that the antediluvian population totaled 10 million, and (for purpose of discussion) the number of preservable implements balanced out the number of skeletons that had not been preserved. According to Ronov,[699] there are 700 million cubic kilometers of Phanerozoic rock in the earth's crust. If randomly distributed, the antediluvian anthropogenic remains (bones and implements) would occur at a rate of one specimen per 70 cubic kilometers of rock. It takes little reflection to appreciate the vanishing probability of such remains ever being discovered. (If skeletons were disarticulated and the fragments scattered, this would increase the absolute number of individual remains. But this would be more than offset by the fact, known in studies of taphonomy,[715] that fragments are much more likely to go unnoticed than complete skeletons.) In reality, fossils are very inhomogeneously distributed in rock. However, the rarity of antediluvian anthropogenic remains overcomes any apparent increase in chance of discovery caused by exceptional concentration of remains. Suppose that the 10 million antediluvian anthropogenic remains, instead of being randomly scattered over the 700 million cubic kilometers of Phanerozoic rock, were concentrated in only 1 million cubic kilometers. Occurring at a rate (in the special rocks) of 10 specimens per cubic kilometer, the chances of discovery would still be quite small; and the chance that any cubic kilometer is one of the special ones would be only 1 in 700. It is thus improbable that the 1 million cubic kms. would simultaneously be those of many outcrops and in situations attracting particular investigative interest. In fact, paleontological interest is probably being inadvertently diverted away from any special humaniferous rocks. One of the sampling biases reviewed by Signor[716] is that of paleontologists' interest: paleontologists (and not to mention other professional—and amateur—collectors) tend to study rocks which are highly fossiliferous. But since humans were rare and humans probably did not live near regions of great animal population, then areas highly fossiliferous in these animal vertebrates (even more so those of concentrated marine invertebrates) are very negatively concentrated in human remains. This makes it all the more unlikely that the exemplary 1-in-700 million cubic kilometers has attracted any significant collectors' interest.

The present author believes that the smallness of the antediluvian human population is more than sufficient in itself as an explanation for the near absence of pre-Pleistocene human remains. Yet there are still other significant factors tending to greatly reduce the number of human fossils. Shotwell[717] wrote: "Forms which are nearly always rare or missing in fossil mammalian faunas, irrespective of their probable abundance in the area, are those with volant or arboreal habits. This characteristic has hindered the study of such groups as bats, primates, and flying squirrels. Their usual small size and fragility does not seem to be the important factor since insectivores and small rodents are not uncommon in quarries." Bishop[718] wrote: ". . . primates are normally 'shy' candidates for fossilization." Since humans lived away from regions of deposition (those first covered by the sediment of the Flood), their remains are more likely to have rotted away before having much chance to be buried. Figure 10 has been drafted to illustrate how antediluvian human communities were probably distributed—in a way that would have minimized the number of human bones eventually preserved. Every student of ancient history knows that most ancient civilizations were situated near rivers. This was probably even more so in the antediluvian world, because the dense forestation (and impenetrable grasslands) probably made rivers the only practical mode of long-distance transport and trade.

A very major clarification about the sedimentology of rivers is necessary in order to differentiate between rivers under ordinary (local flood) conditions and those at the time of the Flood. Rivers are normally areas of burial and preservation of vertebrates, under local flood conditions, because sediment is deposited on the floodplain or delta, entombing organisms. But in the global Flood situation, rivers were quickly elevated to flood stage from rain runoff and the runoff from subterranean springs. They were maintained at this flood stage at great intensity and for a prolonged period of time (relative to any local river flood), enabling the river and its adjacent floodplain to be entirely erosional along the entire length of the river. Under these conditions, humans living near the rivers were not entombed on the floodplains but were flushed out into the open ocean (Stage 2 of Figure 10). Since the rivers under these extremely erosional conditions did not become depositional until they entered the oceans, man-made implements and the human corpses that had sunk did not get deposited until they reached the mouths of the rivers. Any such remains were concentrated into small volumes of sediment (at the prodeltas) and—as discussed previously—overall few remains concentrated into small volumes of sediment means very low probability of discovery. Yet it is even plausible that the volumes of prodeltaic sediment were metamorphosed beyond recognition, obliterating all their anthropogenic remains. This is because there occur at the center of mountain ranges evidences of ancient oceanic crust (ophiolites): in plate-tectonics models, mountains are believed to be largely the result of ancient oceans that had been compressed into relatively small linear areas. Irrespective of whether or not there was continental drift during or after the Flood, narrow antediluvian oceans became compressed to form extant ophiolite-containing orogens. Any prodeltaic remains from antediluvian rivers (as shown in Figure 10) thus were probably metamorphosed as a result of being associated with oceanic crust.

Humans flushed down the antediluvian rivers (Stage 2, Figure 10) usually did not even get deposited in the prodeltaic sediments at the mouths of these rivers, but instead tended to float on out into the ocean where they decomposed or else were devoured by predators or scavengers. This follows from the fact that both living mammals[719] and their corpses[720] tend to float on water (the latter buoyed up by the gases of decomposition). Since the antediluvian topography was probably low, only a relatively small water-level elevation of the antediluvian rivers was required to wash away the antediluvian human communities downstream. This has important ramifications. It took much less time for the antediluvian rivers to reach flash flood stage and wash out the human communities into the ocean (Stage 2, Figure 10) than it took for the ocean bottoms to be uplifted and the continental interiors to be submerged (Stage 3, Figure 10). Thus appreciable flooding of the continents, initiation of the TAB process, and actual burial of organisms found in the Phanerozoic fossil record (Stage 3) all did not begin until after humans had been flushed out into the oceans. The flatness of the topography meant that the antediluvian human communities could have been flooded in a matter of hours, denying the antediluvians time to flee their homes near the rivers.

Once human corpses were out at sea, they could have decomposed in a very few weeks—this fact based

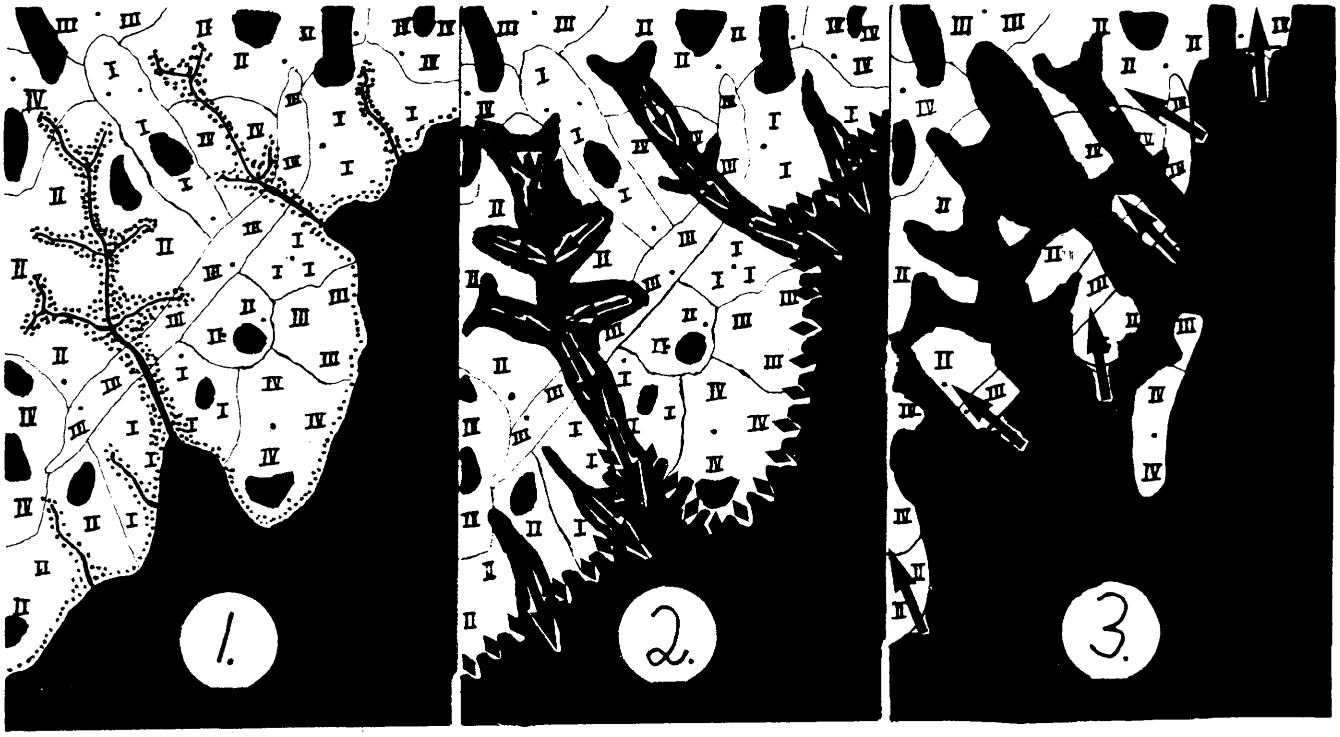


Figure 10. Antediluvian human communities and the near non-preservation of human remains in the pre-Pleistocene fossil record. Roman numerals and their enclosures depict TABs, dots indicate units of antediluvian human population, thick sinuous and dendritic lines denote rivers, the black denotes sea. No. 1 refers to geography before the Flood, No. 2 to the same area at the earliest part of the Flood (diamonds indicate tsunamis battering the coast, arrows indicate rivers swollen at flash flood stage), and No. 3 to Flood proper with its encroachment of seawater on continents (shown by arrows) and initiation of the TAB process. Explained in text.

on taphonomic studies[721] on floating mammal corpses. The skeleton could disarticulate before all the flesh was gone.[722] Flume experiments[723] have shown that complete crania are the easiest transported of all skeletal components by water currents. Thus the great preservability of teeth was offset by their tendency to be scattered; teeth gradually falling out of floating skulls as the alveoli decayed. (It should be pointed out that humans who had died before the Flood would not have much of a candidacy for fossilization because—as anthropological studies[724] have shown—perishable buried anthropogenic remains decay completely within 20 years at most.)

Another major factor limiting the number of fossil humans was diagenesis, but its exact role is not yet known. Behrensmeyer and Hill[725] wrote: "There are too many variables, too many unknowns, and a general lack of understanding of how bones become fossils." However, the selectivity of diagenetic conditions for preservation of buried bone is evident in the following statements of Hill:[726] "Not all environments will favour a bone's ultimate preservation, and in this many factors are involved . . . Many Miocene hominoid localities in East Africa are associated with carbonatitic volcanics. Analysis show that the chemical composition of such rocks is similar to that of bone, producing a stable environment for fossilization. Similar work is needed to determine what chemical conditions are necessary for fossilization, and which of the whole range of possible palaeoenvironments might have possessed them."

It is evident that if most antediluvian humans lived in areas whose diagenesis following Flood burial was not suitable for fossilization of even deeply buried bone, then this factor alone could account for the near absence of pre-Pleistocene humans. Organic acids help weather bone,[727] and modern taphonomy[728] suggests that alkaline conditions favor bone preservation. Still another important factor in diagenesis and fossilization is *e*H. Positive *e*H (oxidizing conditions) favors prompt decomposition of not only flesh but also bone.[729] Thus fluvial regions where antediluvians lived (Figure 10) may have generated sediment too oxidized for the final preservation of any human bones that had managed to get buried. By contrast, reducing conditions probably prevailed in the poorly-circulated, poorly-ventilated shallow antediluvian seas, facilitating the preservation of the endless number of Phanerozoic marine fossils once the seas were Flooded (Stage 3, Figure 10). Likewise, land areas away from rivers (where few humans lived—according to the model proposed in Figure 10) were water-logged and therefore reducing, thus facilitating the preservation of Phanerozoic land biotas. Yet it must be remembered that low antediluvian human population itself accounts for the paucity of pre-Pleistocene human remains.

References

AC — Academic Press, New York, London
AF — Palaeontologica Africana
AG — American Association of Petroleum Geologists Bulletin
AJ — American Journal of Science
AM — Geological Society of America Memoir
AP — Bulletin d'le Academie Polonnaise des Sciences
AS — Geology and Paleontology of Southeast Asia
AZ — Proceedings of the Geologists' Association
BB — Bibliography and Index of Geology

BF — Bulletin Societe Geologique de France
BI — Geobios
BM — BMR Journal of Australian Geology and Geophysics
BO — Palaeobotanist
BP — Bulletins of American Paleontology
BR — Bulletin of the British Museum (Natural History) Geology section
CA — Geological Association of Canada Special Paper
CB — Canada Geological Survey Bulletin
CE — Canadian Journal of Earth Sciences
CH — Alcheringa
CO — Scottish Journal of Geology
CP — Bulletin of Canadian Petroleum Geology
CR — Creation Research Society Quarterly
DE — Soviet Academy of Sciences Doklady: Earth Science Section (English-language Translations)
DO — Dowden, Hutchison, and Ross Publishing Co., Stroudsburg, Pennsylvania
EC — Ecology
EL — Elsevier Scientific Publishing Company, Amsterdam, London
FI — Fieldiana: Geology
FR — Memoir hors serie Societe geologique de France
FS — Fossils and Strata
GA — Geological Society of America Abstracts with Programs
GB — Geological Society of America Bulletin
GE — Geology
GL — Journal of the Geological Society of London
GM — Geological Magazine
GP — Geological Society of America Special Paper
GU — Journal of the Geological Society of Australia
HE — Eclogae Geologicae Helvetiae
HO — Journal of the Faculty of Science of the University of Hokkaido
IG — International Geology Review
IN — Journal of the Geological Society of India
JA — Neues Jahrbuch fur Geologie und Palaontologie
JJ — Japanese Journal of Geography and Geology
JP — Journal of Paleontology
JW — John Wiley and Sons, New York
KA — University of Kansas Paleontological Contribution
LE — Lethaia
LI — (Liverpool-Manchester) Geological Journal
ME — Ameghiniana
MM — Geological Society of America Memoir
NA — Nature
ND — Proceedings of the Indian Geologists' Association
NJ — Memoirs of Nanjing Institute of Geology and Palaeontology, Academia Sinica
NO — Norsk Geologisk Tiddskrift
OL — Palaeontologia Polonica
PA — Palaeontology
PB — Paleobiology
PE — Journal of Petroleum Geology
PH — Palaeontographica
PJ — Paleontological Journal (translation from Russian)
PL — Palaeontological Association of London Special Papers in Palaeontology
PO — Acta Palaeontologica Polonica
PP — Palaeogeography, Palaeoclimatology, Palaeoecology
PV — Palaeovertebrata
PZ — Palaeontologisch Zeitschrift
RB — Revista Brasileira de Geosciencas
RU — Geologisch Rundschau
SB — Akademiia Nauk CCCP Doklady, Sibirskoe Otdelenie
SC — Science
SB — Sedimentary Geology
SI — Acta Paleontologica Sinica
SJ — Palaeontological Society of Japan Special Paper
SL — Senckenbergaia Lethaia
SN — Scientia Sinica
SP — Springer-Verlag Publishing Company, Berlin, Heidelberg
SV — Soviet Geology and Geophysics (translations from Russian)
TE — Tectonophysics
TO — Journal of the Faculty of Science of the University of Tokyo
TP — Treatise on Invertebrate Paleontology
TR — Trudy Instituta Paleontologicheskovo Akademii Nauk CCCP
UB — United States Geological Survey Bulletin
US — University of Chicago Press, Chicago and London
UG — United States Geological Survey Professional Paper
UK — Akademiia Nauk CCCP Doklady: Seriya Geologicheskaya
UN — Gronlands Geologiske Undersogelse Rapport
VO — Voprosy Mikropaleontologii
WI — George Allen and Unwin Publishing Company, London
YG — Proceedings of the Yorkshire Geological Society
YO — University of Wyoming Contributions to Geology

1. Hallam A. (ed.). 1973. *Atlas of Palaeobiogeography.* EL
2. Murray G., Kaczor M. J., and R. E. McArthur. 1980. Indigenous Precambrian Petroleum Revisited. *AG* 64:1685
3. Halin G. and A. D. Pflug. 1980. Ein Neuer Medusen-Fund aus dem Jung-Prakambrium von Zentral Iran. *SL* 60:449
4. Paley, I. P. and Z. A. Zhuravleva. 1979. New data on the structure of the Kernlin sutural zone (Mongolia). *IG* 21: 709
5. Peel, J. S. and K. Sechen. 1979. A second fossil occurrence from the Precambrian Shield of southern west Greenland. *UN* 91: 99
6. Binder, P. L. and M. M. Bokhaii. 1979. Chitinozoan-like microfossil of a late Precambrian dolostone from Saudi Arabia. *GE* 8:70
7. Gunia, T. 1981. The First Discovery of Precambrian Microflora in Paragneisses of the Sowie Gory Mountains, Sudetes. *AP* XXIX(2)131
8. Horodyski, R. J. and J. A. Donaldson. 1980. Microfossils from the Middle Proterozoic Dismal Lakes Group, Arctic Canada. *RE* 11:126
9. Thi, P. T. 1978. Stratigraphy and Petrology of the Precambrian Formations of Vietnam. *SV* 19:31-37
10. Hofmann, H. J. 1981. First record of a Late Proterozoic faunal assemblage in the North American Cordillera. *LE* 14:303
11. Lindiao, C., Z. Huimm, X. Yasheng, and M. Gnogan. 1981. On the Upper Precambrian (Sinian Subratem) in China. *RE* 15:207-28
12. Schopf, J. W., *et al.* 1977. Six New Stromatolitic microbiotas from the Proterozoic of the Soviet Union. *RE* 4: 271-82
13. Shenfil, V. Yu. 1978. Algae in Precambrian Deposits of the Yenisey Ridge Region. *DE* 240:224
14. Nyberg, A. V. and J. W. Schopf. 1981. Precambrian Microbiota from the Min'yen Formation, Southern Ural Mountains, U.S.S.R. *Palynology* 5:221
15. Muir, M. D. 1978. Alcheringa news item. *CH* 2:310
16. Fedonkin, M. H. 1980. New Precambrian Coelenterata in the North of the Russian Platform. *PJ* 14:1
17. Mendelson, C. V. and J. W. Schopf. 1982. Proterozoic Microfossils from the Sukhuya Tunguska, Shorikha and Yudoma Formations of the Siberian Platform, USSR. *JP* 56:44
18. Martin, A., Nisbet, E. G. and M. J. Bickle. 1980. Archaean Stromatolites of the Belingwe Greenstone Belt, Zimbabwe (Rhodesia). *RE* 13:338
19. Ruiji, C. and Z. Uenjie. 1981. Sequence of Precambrian Stromatolite Assemblages in North China. *SI* 20:516
20. Yun, Z. 1981. Proterozoic Stromatolite Microfloras of the Gaoyuzhuang Formation (Early Sinian:Riphean) Hebei, China. *JP* 55:486
21. Shirmon, A. E. and A. Horowitz. 1972. Precambrian Organic Microfossils from Sinai. *Pollen et Spores* XIV(3)333
22. Lo, S. S. C. 1980. Microbial Fossils from the Lower Yudoma Suite, Earliest Phanerozoic, Eastern Siberia. *RE* 13:111
23. Zhongying, Z. 1981. A New Oscillatoria-like filament microfossil from the Sinian (late Precambrian) of western Hubei Province, China. *GM* 118:202
24. Cloud, P. E., *et al.* 1979. Earliest Phanerozoic or Latest Proterozoic Fossils from the Arabian Shield. *RE* 10:75
25. Shixing, Z. 1982. An Outline of Studies on the Precambrian Stromatolites of China. *RE* 18:369

26. Raher, P. K. and M. V. A. Sastry. 1982. Stromatolites and Precambrian Stratigraphy of India. *RE* :294
27. Cheng-Hua, D. 1982. Precambrian algal megafossils *Churaria* and *Tawuia* in some areas of eastern China. *CH* 6:58
28. Buck, F. 1980. Stromatolite and Ooid Deposits within the fluvial and Lacustrine Sediments of the Precambrian Ventersdorp Supergroup of South Africa. *RE* 12:312
29. Burrett, C. and R. Richardson. 1980. Trilobite Biogeography and Cambrian Tectonic Models. *TE* 63:163
30. Cowie, J. W. 1971. Lower Cambrian Faunal Provinces (in Middlemiss, F. A., Rawson, P. E., and G. Newall. 1971. *Faunal Provinces in Space and Time. LI* Special Issue, No. 4) p. 32-3
31. Wolfart, R. 1981. Lower Palaeozoic Rocks of the Middle East *(in* Holland, C. A., *ed.* 1981. *Lower Palaeozoic of the Middle East. Eastern and Southern Africa, and* Ant*arctica. JW.)* pp. 1-130
32. Klitzsch, E. 1981. Lower Palaeozoic Rocks of Libya, Egypt, and Sudan *(in* Holland. 1981. *ibid.)* pp. 131-63
33. Kabankov, V. Ya, Shasnurina, I. T., and N. A. Shishkin. 1973. New Data on the Lower Cambrian Stratigraphy of the Kolyma Uplift in the Northeastern USSR, DE 210:41
34. Piyasin, S. 1980. Tentative Correlation of the Lower Paleozoic Stratigraphy of Western Part of Southern Shan State, Burma and Northwestern Through Peninsular of Thailand. *AS* 21: 19-25
35. Dean, W. T. 1973. Cambrian and Ordovician correlation and trilobite distribution in Turkey. *FS* 4:355
36. Theokritoff, G. 1979. Early Cambrian provincialism and biogeographic boundaries in the North Atlantic Region. *LE* 12:282
37. Ke-xing, Y. and Z. Sen-gui. 1981. Lower Cambrian Archaeocyathid Assemblages of Central and Southwestern China *(in* Teichert, C., Lu, L., and C. Pei-ji. 1981. *Paleontoldgy in China, 1979. GP* 187) P. 41
38. Kobayashi, T. 1967. Stratigraphy of the Chosen Group in Korea and South Manchuria, *TO* 16:431, 472, 499
39. Palmer, A. R. 1969. Cambrian Trilobite Distributions in North America and their bearing on Cambrian Palaeogeography of Newfoundland *(in* Kay, M. 1969. *North Atlantic-Geology and Continental Drift. AG* Memoir 12) p. 141
40. Wentang, Z. and Y. Jin-liang. 1981. Trilobites from the Hsuchuang Formation (Lower Middle Cambrian) in western marginal parts of the North China Platform (in Teichert *et al.* 1981. *op. cit.)* p. 161-9
41. Zhao-ding, Z. and J. Li-Fu. 1981. An Early Cambrian trilobite faunule from Yeshan Luhe District, Jiangus *(in* Teichert *et al.* 1981. *op. cit.)* p. 154
42. Palmer, A. R. 1971. The Cambrian of the Great Basin and Adjacent Areas, Western United States *(in* Holland, C. H. 1971. *Cambrian of the New World.* JW), p. 4
43. Korobov. M. N. and T. V Yarkauskus 1980. First Trilobite Find In the Middle Cambrian of the Baltic Region (Lithuania). *DE* 253:138
44. Palmer, A. R. 1972. Problems in Cambrian Biogeography. 24th *CO*, Sec. 7, pp. 312-4.
45. Palmer, A. R. 1973. Cambrian Trilobites *(in* Hallam. 1973. op. cit.) p. 4
46. Palmer, A. R. 1977. Biostratigraphy of the Cambrian System—A Progress Report. *RV* 5:14
47. Palmer, A. R. 1982. Fossils of Dresbachian and Franconian (Cambrian) Age from the Subsurface of West-Central Indiana. *Indiana Geological Survey Special Report* 29, 12 p.
48. Palmer, A. R. and J. S. Peel. 1979. New Cambrian faunas from Peary Land. eastern North Greenland. *UN* 91:30
49. Henningsmoen, G. 1956. The Cambrian of Norway, 20th *CO,* p. 46
50. Taylor, M. E. 1976. Indigenous and Redeposited Trilobites from Late Cambrian Basinal Environments of Central Nevada. *JP* 50:670-6
51. Shah, S. K., Raina, B. K., and M. L. Razdan. 1980. Redlichid Fauna from the Cambrian of Kashmir. *IN* 21:511
52. Jell, P. A. 1975. Australian Middle Cambrian Eodiscoids with a Review of the Superfamily. *PH* A150:1-97.
53. Tai-Xiang, A. 1981. Recent progress in Cambrian and Ordovician conodont biostratigraphy of China *(in* Teichert *et al.* 1981. *op. cit.)* p. 210
54. Taylor, M. E. 1977. Late Cambrian of Western North America: Trilobite Biofacies, Environmental Significance, and Biostratigraphic Implications *(in* Kauffman, E. G. and J. E. Hazel. 1977. *Concepts and Methods of Biostratigraphy. DO).* p. 402
55. Fortey, R. A. and W. A. Rushton. 1976. *Chelidonocephalus* Trilobite Fauna From the Cambrian of Iran. *BR* 27 (4)322
56. Bell, W. C., Feniak, O. W., and V. E. Kurtz. 1952. Trilobites of the Franconia Formation. Southeast Minnesota. *JP 26:178*
57. Ahlberg, P. 1981. Ptychopariid Trilobites in the Lower Cambrian of Scandinavia *(in* Taylor, M. E. 1981. *Short Papers for the Second International Symposium on the Cambrian System.* US Geological Survey Open-File Report 81-743), p. 6
58. Korobob, M. H. 1973. Trilobity Semiestva Concoryphidae i ich znacheniye dlya stratigrafii Kembriiskich otlozhenii. UK 211 (transactions), p. 119 (in Russian)
59. Rozanov. A. Yu and F. Debrenne. 1974. Age of Archaeocyathid Assemblages. *AJ* 274: 834
60. Hill. D. 1972. Archaeocyatha. *TP* E40-E41
61. Holland, C. H. and B. H. Sturt. 1970. On the Occurrence of Archaeocyathids in the Caledonian Metamorphic Rocks of Soroy and their Stratigraphic Significance *NO* 50:343
62. Shengzhe, G. 1981. Lower Cambrian Archaeocyathids from the Central Part of Da Hinggan Ling. *SI* 20:63
63. Kobluk, D. R. 1982. First record of *Labyrinthies soranfi* Kobluk from the southern Appalachians, Lower Cambrian Shady Dolomite, Virginia. *CE* 19:1094
64. Zhantkov, T. M. and N. V. Polyanskiy. 1972. Stratigraphy of the Basal Part of the Sequence in the Chingiz-Tarbagatay Maganticlinorium. *DE* 204:26
65. Nitecki, M. H. 1967. Bibliographical Index of North American Archaeocyathids. *FI* 17(2)111
66. Kruse, P. D. and P. W. West, 1980. Archaeocyatha of the Amadeus and Georgina Basins. *BM* 5:166
67. Zhambyn, B. 1971. The Wendian and Lower Cambrian of Northern Mongolia. *IG* 13:916
68. Ke-Xing, Y. and Z. Sen-giu. 1980. Lower Cambrian archaeocyatha of Central and Southwestern China. *SI* 19 (5)391
69. Palmer, A. R. and A. Yu. Rozanov. 1976. Archaeocyatha from New Jersey: Evidence for an intra-Cambrian unconformity in the north-central Appalachians. *GE* 14:714
70. James, N. P. and F. Debrenne. 1980. First regular archaeocyaths from northern Appalachians, Forteau Formation, western Newfoundland. *CE* 17:1609-10
71. Whittington, H. B. 1956. Presidential Address: Phylogeny and Distribution of Ordovician Trilobites. *JP* 40: 703, 8
72. Whittington, H. B. and C. P. Hughes. 1972. Ordovician Geography and Faunal Provinces Deduced from Trilobite Distribution. *Royal Society* of *London Philosophical Transactions,* Ser. B, p. 247
73. Whittington. H. B. 1973. Ordovician Trilobites *(in* Hallan. 1973. *op. cit.)* pp. 14-15
74. Ross, R. J. 1975. Early Paleozoic trilobites, sedimentary facies, lithospheric plates, and ocean currents. *FS* 4:312
75. Apollonov, S. K. 1974. *Ashgillskie Trilobity Kazakhstana.* Nauka. Moskva. P. 4 (in Russian)
76. Anderston, R., Bridges, P. H., Leeder, M. R., and B. W. Sellwood. 1979. *A Dynamic Stratigraphy of the British Isles WI,* p. 34
77. Tian-rong, Z. 1981. New Materials of Early Tremadocian Trilobites from Sandu and Pu'an, Guizhou. SI 20:246
78. Shaw, F. C. and R. A. Fortey. 1977. Middle Ordovician facies and trilobite faunas in North America. *GM* 114(6) 441
79. Ludvigsen, R. 1976. New cheirurinid trilobites from the lower Whittaker Formation (Ordovician), southern McKenzie Mountains. *CE* 13:948
80. Fortey, R. A. 1973. Early Ordovician trilobite communities. *FS* 4:331
81. Wilson, J. L. 1957. Geography of Olenid Trilobite Distribution and Its Influence on Cambro-Ordovician Correlation. *AJ* 255:321-40
82. Hong-jun, G. and D. Ji-ye. 1979. Cambrian and Early Ordovician Trilobites from Northeast Hebei and West Liaoning. *SI* 17(4)458
83. Winder, C. G. 1960. Paleoecological Interpretation of Middle Ordovician Stratigraphy in Southern Ontario, Can-

ada. 21st *CO*, pt. 7, pp. 18-27

84. Nakhorosheva, L. D. 1976. Ordovician Bryozoa of the Soviet Arctic (*in* Bassett, M. G., *ed.* 1976. *The Ordovician System.* University of Wales Press), p. 576
85. Whittington, H. B. 1968. *Cryptolithus* (Trilobita): Specific Characters and Occurrence in Ordovician of Eastern North America. *JP* 42:704
86. Kobayashi, T. and T. Hamada. 1970. A Cyclopygid-bearing Ordovician Faunule discovered in Malaya with a Note on the *Cyclopykidae.* *AS* 8:8
87. Landing, E. and C. R. Barnes. 1981. Conodonts from the Cape Clay Formation (Lower Ordovician), southern Devon Island, Arctic Archipelago. *CE* 18:1609-10
88. Ross, R. J. 1957. Ordovician Fossils from Wells in Williston Basin, Eastern Montana. *UB* 1021-M, p. 440
89. Ludvigsen, R. 1978. Middle Ordovician Trilobite Biofacies, Southern Mackenzie Mountains (*in* Stelck, C. R., and B. D. E. Chatterton. 1978. Western and Arctic Canadian Biostratigraphy. *CA* 18), p. 3
90. Taylor, M. E. 1973. Biogeographic Significance of Some Cambrian and Ordovician Trilobites from Eastern New York State. *GA* 5:226-7
91. Fortey, R. A. 1976. Correlation of Shelly and Graptolitic Early Ordovician Successions Based on the Sequence in Spitzbergen (*in* Bassett. 1976. *op. cit.*), p. 268
92. Berry, W. B. N. 1972. Early Ordovician bathyurid province lithofacies, their relationship to a proto-Atlantic Ocean and correlations. *LE* 5:73
93. Ross, R. J. and J. K. Ingham. 1970. Distribution of the Toquima-Table Head (Middle Ordovician Whiterock) Faunal Realm, Northern Hemisphere. *GB* 81:394, 8
94. Ormiston, A. R. and R. J. Ross. 1979. *Monorakos* in the Ordovician of Alaska and its Zoogeographic Significance (*in* Boucot, A. J. and J. Gray. 1979. *Historical Biogeography, Plate Tectonics, and the Changing Environment.* Oregon State University Press), p. 53
95. Ross, R. J. 1958. Trilobites in a Pillow-Lava of the Ordovician Valmy Formation, Nevada. *JP* 32:570
96. Ross, R. J. 1970. Ordovician Brachiopods, Trilobites, and Stratigraphy of Eastern and Central Nevada. *UG* 639: 2-40
97. Kobayashi, T. and R. Hamada. 1978. Upper Ordovician Trilobites from the Langkawi Islands, Malaysia. *AS* 19: 1-29
98. Cocks, L. R. M. and R. A. Fortey. 1982. Faunal evidence for oceanic separation in the Palaeozoic of Britain. *GL* 139:469-73
99. Koren', T. N., *et al.* 1979. New Evidence on Graptolite Successions Across the Ordovician-Silurian Boundary in the Asian Part of the USSR. *PO* 24(1)126
100. Walters, M., Lesperance, P. J., and C. Hubert. 1982. The biostratigraphy of the Nicolet River Formation in Quebec and intra-North American correlations in Middle and Upper Ordovician strata. *CE* 19:571-88
101. Romano, M. 1982. The Ordovician biostratigraphy of Portugal—A Review with new data and re-appraisal. *LI* 17:89-110
102. Nikitin, I. F. 1972. *Ordovik Kazakhstana.* Chast' 1: Stratigrafiia. Izdatelstov Nauka, Kazahskoye SSR, Alma Ata. 239 p. (in Russian)
103. Obut, A. M. 1977. Stratigrafiya i Fauna Ordovika i Silura Chukotskovo Polyostrova. *SB* 351, 222 p. (in Russian)
104. Cooper, B. J. 1981. Early Ordovician Conodonts from the Horn Valley Siltstone, Central Australia. *PA* 24:148
105. Sheng, S. F. 1980. *The Ordovician System in China.* International Union of Geological Sciences Pub. 1, 7 p., charts.
106. Rozman, Kh. S. and Ch. Minzin. 1980. Stratigraphy of the Ordovician Ashgillian Stage of Western Mongolia. *IG* 22:578
107. Kobayashi, T. 1960. The Ordovician of Korea and its Relation to the other Ordovician Territories. 21st *CO*, sec. 7, pp.34-44
108. Sokolov, B. S., *et al.* 1960. Stratigraphy, Correlation and Paleogeography of the Ordovician Deposits of the USSR. 21st *CO*, sec. 7, pp. 4-58
109. Jaanusson, V. 1979. Ordovician. *TP* A139-A155
110. Antsygin, N. YA., Varganov, V. G., and V. A. Nasedkina. 1970. Upper Cambrian and Lower Ordovician of the Orsk District of the Urals. *DE* 193:27-8
111. Severzina, L. G. 1978. Fauna i Biostratigrafiia Verkhnovo Ordovika i Silura Altae-Sayanskoi Oblasti. *SB* 405, p. 4 (in Russian)
112. Kanizin, A. B. 1977. Razrez Ordovika i Silura Reki Moyero. *SB* 303, p. 14 (in Russian)
113. Nikiforova, O. I. 1968. *A Guide to the Geological Excursion on Silurian and Lower Devonian Deposits of Pedolia (Middle Dniestr River).* Leningrad. pp 8-9
114. Melnikova, L. M. 1976. Late Ordovician Ostracods of the Bolshaya Nirunda River. *PJ* 10:459
115. Rozman, Kh. S. 1967. Ordovician Biostratigraphy of the Sette Daban Range (South Verkhoyansk Region). *DE* 184:33
116. Bialy, B. I. Biostratigrafiia Pogranichiyh Otlozhenii Nizhnego i Srednovo Ordovika Na Yugo Sibirskoi Platformy. *SB* 372, p. 64 (in Russian)
117. Nikolskii, F. V. and A. A. Podvesko 1980. Characteristics of the Formation of Deposits of the Krivolutskii Formation of the Middle Ordovician in the Lena-Tunguska Interfluvial Area. *SV* 21:33-4
118. Lofgren, A. 1978. Arenigian and Llandvernian conodonts from Jamtland, northern Sweden. *FS* 13:6
119. Roomusoks, A. 1960. Stratigraphy and Paleogeography of the Ordovician in Estonia. 21st *CO*, sec. 7, p. 60
120. Apollonov, M. K. 1975. Ordovician trilobite assemblages of Kazakhstan. *FS* 4:375-80
121. Owens, R. M. 1973. Ordovician Proetidate from Scandinavia. *NO* 53:150, 175
122. Volkova, K. A., Latpov Yu., i K. R. Wuiznikova. 1978. Or dovik i Silur Yuzhnovo Verkhoyana. SB 381 (in Russian)
123. Nazorov, B. B. 1977. A New Radiolarian Family from the Ordovician of Kazakhstan. *PJ* 11:166
124. Kanygin, A. V., Moskalenko, T. A., and A. G. Yadrenkina. 1980. On the Lower to Middle Ordovician Boundary Deposits of the Siberian Platforms. *SV* 21:11
125. Stock, C. W. 1981. *Cliefdenella alaskaensis* N.S.P. (Stromatoporoidea) from the Middle/Upper Ordovician of Central Alaska. *JP* 55:998
126. Stouge, S. and J. S. Peel. 1979. Ordovician conodonts from the Precambrian Shield of southern West Greenland. *UN* 91:106
127. Robison, R. A. and J. Pantoja-Alos. 1968. Tremadocian Trilobites from the Nochixtlan region, Oaxaca, Mexico. *JP* 42:768-9
128. Melnikova. 1979. Some Early Ordovician Ostracodes of the Southern Urals. *PJ* 13:71
129. Flower, R. H. 1979. A New raedemannocerid cephalopod from the Ordovician of western North Greenland. *UN* 91:93
130. Ermikov, V. D., *et al.* 1979. The Tremadocian of Northern Gornyi Altai. *SV* 20:15-25
131. Li-wen, X. and L. Cai-gen. 1981. The Cambrian-Ordovician Boundary in China (*in* Taylor, M. E., *ed.* 1981. *op. cit.*), p. 242-3
132. Acenolaza, F. G. 1976. The Ordovician System in Argentina and Bolivia (*in* Bassett. 1976. *op. cit.*), p. 481
133. Chugaeva, M. N. 1976. Ordovician in the North-Eastern USSR (in Bassett. 1976. *op. cit.*), p. 286-7
134. Benedetto, J. L. 1977. Una Nueva Fauna De Trilobites Tremadocianos de La Provincia De Jujuy (Sierra de Cajas), Argentina. *ME* 14:186
135. Koroleva, M. N. 1978. New Ordovician Harpidae (Trilobita) of North Kazakhstan. *PJ* 12:215
136. Baldis, B. A. and G. Blasco. 1974. Trilobites Ordovicos de la Comarca de Jachal Precordillera Argentino. *ME* 11:71
137. Bulman, O. M. B. 1964. Lower Palaeozoic plankton. *GL* 120:470-3
138. Bulman, O. M. B. 1971. Graptolite faunal distribution (*in* Middlemiss, *et al.* 1971. *op. cit.*), pp. 49-56
139. Nelson, S. 1963. Ordovician Paleontology of the Northern Hudson Bay Lowland. *AM* 90, pp. 63-80
140. Pomerol, Ch. and C. I. Babin. 1977. *Stratigraphie et Paleogeographie Precambrian et Paleozoique.* DOIN Editeiurs, Paris, pp. 201-410
141. Kilpatrick, D. J. and P. D. Fleming. 1980. Lower Ordovician sediments in the Wagga Trough: discovery of early Bendigonian graptolites near Eskdale, north Victoria. *GU*
142. Twenhofel, W. H. *ed.* 1954. Correlation of the Ordovician Formations of North America. *GB* 65:247-98
143. Bergstrom, S. M. and R. A. Cooper. 1973. *Didymograptus bifidus* and the trans-Atlantic correlation. *LE* 6:331

144. Jiantino, Yu. and F. Yiting. 1981. *Arienigraptus*, A New Graptolite Genus from the Ningkuo Formation (Lower Ordovician) of South China. *SI* 20:32
145. Jackson, D. E. 1969. Ordovician Graptolites in Lands Bordering North Atlantic and Arctic Oceans *(in* Kay, M. 1969. *op. cit.),* p. 505
146. Acenolaza, F. G., Gorustovich, S., and J. Solis. 1976. El Ordovicio Del Rio La Alumbierra, Departmento Tinogasta, Provincia de Catamarca. *ME* 13:269
147. Oradovaskaya, M. M. 1970. Ordovician and Silurian Stratigraphy of the Chukotska Peninsula. *DE* 191:36
148. Rosen, R. N. 1979. Permo-Triassic Boundary of Fars-Persian Gulf area of Iran. *JP* 53:92
149. Shiding, J. 1981. Some New Graptolites from the Ningkuo Formation (Lower Ordovician) of Zhejiang. *SI* 20:69
150. Skevington, D. 1974. Controls Influencing the Composition and Distribution of Ordovician Faunal Provinces (in Rickards, R. B., Jackson, D. E., and C. P. Hughes. 1974. *Graptolite Studies in Honour* of *O. M. B. Bulman. PL* 13), p. 62
151. Moskalenko, T. A. 1972. Conodonts from Llandoverian Deposits of the Siberian Platform. *DE* 204:236
152. Peterson, M. S., Rigby, J. K., and L. F. Hintze. 1980. *Historical geology* of *North America,* 2nd edition. Brown Publ. Co., Dubuque, Iowa, p. 57
153. Jinding, L., *et al.* 1980. Discovery of Ordovician Graptolites from Wufeng of Yougan, Fujian Province. *SI* 19 (6)512
154. Yao-kun. L. 1980. *Ordosogravtus* — A New Graptolite Genus and Its Affinities. *SI* 19(6)479
155. Riva. J. 1974. Late Ordovician Spinose Climacograptids from the Pacific and Atlantic Faunal Provinces *(in* Rickards, *et al.* 1974. *op. cit.),* p. 109
156. Miller, H. 1979. Das Gundegebirge der Anden im Choros-Archipel, Region Aisen, Chile. *RU* 68:449
157. Sobolevaskaya, R. F. 1971. New Ordovician Graptolites of the Omulev Mountains. *PJ* 5:76-9
158. Kobayashi, T. 1968. Stratigraphy of the Chosen Group in Korea and South Manchuria. TO, sec. 2, Vol. 17:260
159. Gang, W. 1981. On the Discovery of New Graptolites from the Tungtze Formation (Lower Ordovician) in Gulin of Sichuan. *SI* 20:351
160. Alikhova. T. N. 1976. Principal problems of the stratigraphy of the Ordovician system. *IG* 18:896-9
161. Degarden, J. M. 1979. Decouverte du genre *Phyllograptus* (Graptolites) dans l' Ordovicien des Pyrenees Atlantiques Consequences Stratigraphiques. *BI* 12(2)321
162. Jackson, D. E. 1966. Graptolitic Facies of the Canadian Cordillera and Arctic Archipelago: A Review. *CP* 14:470
163. Jaanusson. V. 1973. Ordovician Articulate Brachiopods. *(in* Hallah. 1973. *op. cit.),* pp. 20-25
164. Williams, A. 1973. Distribution of Brachiopod Assemblages in Relation to Ordovician Palaeogeography *(in* Hughes, N. F. 1973. *Organisms and Continents Through Time. PL* 12), p. 178. 182
165. Potter, A. W. and A. J. Boucot. 1971. Ashgillian Late Ordovician Brachiopods from the Eastern Klamath Mountains of Northern California. *GA* 3:180-1
166. Rozman, Kh. S., *et al.* 1970. Biostratigrafiia Vyerkhnovo Ordovika Severo-Vostoka CCCP. *UK* 205:246-7
167. Hill, D., Playford, G., and J. T. Woods. 1969. *Ordovician and Silurian of Queensland.* Queensland Palaeontographical Society, Brisbane, p. 2
168. Biernat, G. 1973. Ordovician Inarticulate Brachiopods from Poland and Estonia. *OL* 28:16
169. Barnes, C. R., Rexroad, C. B., and J. F. Miller. 1972. Lower Paleozoic Conodont Provincialism. *GP* 141: 167-73
170. Bergstrom, S. M. 1973. Ordovician Conodonts *(in* Hallam. 1973. *op. cit.),* p. 50-4
171. Lindstrom, M. 1976. Conodont Palaeogeography of the Ordovician *(in* Bassett, M. G. *ed.* 1976. *op. cit.),* pp. 503-17
172. Votaw, R. 1979. Upper Ordovician conodonts from the Upper Peninsula of Michigan. *GA* 11(5)259
173. Bergstrom, S. M. 1977. Early Paleozoic Conodont Biostratigraphy in the Atlantic Borderlands (in F. M. Swain. 1977. *Stratigraphic Micropaleontology of Atlantic Basin and Borderlands. EL),* p. 89
174. Bergstrom, S. M. 1981. Personal Communication.
175. Bellini, F. and D. Massa. 1980. A Stratigraphic Contribution to the Palaeozoic of the Southern Basins of Libya *(in* Salem, M J. and M. T. Busreevil. 1980. *The Geology of Libya.* Academic Press, London, NY), p.3-on.
176. Abaimova, G. P. 1971. New Early Ordovician Conodonts from the Southeastern Part of the Siberian Platform. *PJ* 5:486-90
177. Gastil, R. G. and R. H. Miller. 1981. Lower Palaeozoic strata on the Pacific Plate of North America. *NA* 292:828
178. Gerasimova, N. A., Dubinina, S. V., and N. I. Zardrashvile. 1977. Age of the Siliceous Elastic Complex of the Atasu Anticlinorium, Central Kazakhstan. *DE* 235:39-41
179. Kurtz, V. F. and J. F. Miller. 1981. Early Ordovician Conodont Faunas from Central East Greenland. *GA* 13 (6)285
180. ________ 1978. *The Geology* of *New Zealand. New* Zealand Geological Survey. Vol. I, p. 66
181. Gnoli, M. and E. Serpagli. 1980. The Problematic Micro-organisms *Nivia* in the Lower Ordovician of Precordilleran Argentina and its Paleogeographic Significance. *JP* 54: 1246
182. Talent, J. A. 1981. Palaeontology and Stratigraphy in India: Retrospect and Prospects. *IN* 22:454
183. Moskalenko, T. A. 1976. Evironmental Effects on the Distribution of Ordovician conodonts of the western Siberian Platform *(in* Barnes, *C.* R. 1976. *Conodont Paleo-*ecology. CA 15), p. 60
184. Tipnis, R. S., Chatterton, B. D. E., and R. Ludvigsen. 1978. Ordovician Conodont Biostratigraphy of the Southern District of Mackenzie, Canada *(in* Stelck and Chatterton. 1978. *op. cit.),* p. 41
185. Moskalenko, T. A. 1976. Unique Conodontophorid Finds in the Ordovician Deposits of the Irkutsk Amphitheater. *DE* 229:232
186. Abaimova, G. P. and E. P. Markov. 1977. Pyerviye Nahodki Conodontov Nizhneordoviskich zony *Kordylodus* na yuge Sibirskoi Platformy. *SB* 372:87 (in Russian)
187. Novikova, M. Z., Ryazantsev, A. V.. and S. V. Dubinina. 1978. Age of the Akdym Series of the Yerementau-Niyaz Anticlinorium, Central Kazakhstan. *DE* 241:57
188. Nasedkina, V. A. and V. N. Puchkov. 1972. Srednoordovikskie Konodonty Severa Urala i ikh stratigraficheskoe Znacheniye. *UK (Uralskiy tsentr.),* vip. 145:5-34 (in Russian)
189. Kushnareva, T. I. and N. B. Rasskazowa. 1978. The Ordovician of the Pechora syneclise. *IG* 20:700-1
190. Crick. R. E. 1978. *Ordovician Nautiloid Biogeography: A Probabalistic Multivariate Analysis.* Unpublished Ph.D. Thesis, University of Rochester, p. 12
191. Crick, R. E. 1980. Integration of paleobiogeography and Paleogeography: Evidence from Arenigian Nautiloid Biogeography. *JP* 54:1224
192. Dun-lin, Q. 1980. Ordovician Cephalopods from Wuwei of Anhui and their Stratigraphical Significance. *SI* 18 (4)260
193. Ross, R. J. 1965. Early Ordovician trilobites from the Seward Peninsula, Alaska. *JP* 39
194. Xi-ping. 1981. Early Ordovician Nautiloids from Quingshuihe, Nei Monggol (Inner Mongolia) and Pianguan, Shanxi Province. *SI* 20(4)361
195. Stait, B. 1980. *Gouldoceras* N. Gin (Cephalopoda, Nautiloidea) and a Revision of *Hecatoceras,* Teichert and Glenister, from the Ordovician of Tasmania, Australia. *JP* 54: 1114
196. Zhong-fa, L. 1981. Ordovician Cephalopods from Hunjiang Region of Jilin and Northern Neimongol. *SI* 20 (5)398
197. Miller, A. K., Youngquist, W., and C. Collinson. 1954. Ordovician Cephalopod Fauna of Baffin Island. *AM* 62: 4-16
198. Crick, R. E. 1981. Diversity and evolutionary rates of Cambro-Ordivician nautiloids. *PB* 7:225
199. Flower, R. H. 1976. Ordovician Cephalopod Faunas and their Role in Correlation *(in* Bassett. 1976. *op. cit.),* pp. 529-42
200. Antze, Mu., *et al.* 1973. Stratigraphy of the Mount Jolmo Lungma Region in Southern Tibet, China. *SN* 16(1) 96-on.
201. Zhuravleva, F. A. 1978. Some Mongolian Early and Middle Paleozoic Cephalopods. *PJ* 12:485
202. Flower, R. H. 1963. New Ordovician Ascocerida. JP 37:69-82
203. Sheehan, P. M. 1979. Swedish Late Ordovician Marine

Benthic Assemblages and Their Bearing on Brachiopod Zoogeography (*in* Boucot and Gray. 1979. *op. cit.*), pp. 61-75

204. Paul, C. R. C. 1976. Palaeogeography of Primitive Echinoderms in the Ordovician (*in* Bassett. 1976. *op. cit.*), pp. 564-71
205. Derstler, K. 1979. Biogeography of the Stylophoran Carpoids (Echinodermata) (*in* Boucot and Gray. 1979. *op. cit.*), pp. 100-2
206. Rozhkov. C. V. 1981. Morskiye Lilii Nadsemeistva Pisocrinacea. *TR* 192:47 (in Russian)
207. Jobson, L. and C. R. C. Peel. 1979. *Compagiginus fenestratus*, a new Lower Ordovician inadunate crinoid from North Greenland. *UN* 91:72
208. Witzke, B. J., Frest, T. J., and H. L. Strimple. 1979. Biogeography of the Silurian-Lower Devonian Echinoderms (*in* Boucot and Gray. 1979. *op. cit.*), pp. 125-6
209. Berry, W. B. N. and A. J. Boucot. 1973. Correlation of the African Silurian Rocks. *GP* 147 all pages, maps.
210. Berry, W. B. N. and A. J. Boucot. 1972. Correlation of the South American Silurian Rocks. *GP* 133, 59 p., maps.
211. Berry, W. B. N. and A. J. Boucot. 1970 Correlation of the North American Silurian Rocks. *GP* 102, 289 p., maps.
212. Rust, F. C. 1981. Lower Palaeozoic Rocks of Southern Africa (*in* Holland. 1981. *op. cit.*), p. 181
213. Ziegler, A. M., *et al.* 1977. Silurian Continental Distributions, Paleogeography, Climatology, and Biogeography. *TE* 40:39
214. Ivanovskii, A. B. and N. P. Kul'kov. 1975. Biogeographic Zoning of Silurian Deposits. *SV* 17:36-9
215. Yu, W.,Jia-yu, R., and Y. Xue-chang. 1980. The Genus *Atrypoidea* (Brachiopoda) of Southwest China and Its Stratigraphical Significance. *SI* 19(2)103
216. Cocks, L. R. M. and W. S. McKerrow. 1973. Brachiopod Distributions and Faunal Provinces in the Silurian and Lower Devonian (*in* Hughes. 1973. *op. cit.*), 295-9
217. Minato, M. and M. Kato. 1965. Waagenophyllidate. *HO* 12:31
218. Wang, Yu., *et al.* 1981. Stratigraphic distribution of brachiopoda in China (*in* Teichert, *et al.* 1981. *op. cit.*), p. 99
219. Baoyu, L. 1980. *The Silurian System of China.* Institute of Geology—Chinese Academy of Geological Science, Peking, pp. 2-5
220. Ziegler, A. M., Rickards, R. B., and W. S. McKerrow. 1974. Correlation of the Silurian Rocks of the British Isles. GP 154:9-13
221. Berry, W. B. N. and A. J. Boucot. 1972. Correlation of the Southeast Asian and Near Eastern Silurian Rocks. *GP* 137:14-61, maps.
222. Copper, P. 1977. The late Silurian brachiopod genus *Atrypoidea. Geologiska Foreningens i Stockholm Forhandlingar,* 99:11
223. Zhengsu, Y. 1981. On the Geological and Geographic Distribution of *Tuvaella* with Reference to its Habitat. *SI* 20(6)570-1
224. Jia-yu, R. and Z. Zi-xin. 1982. A Southward extension of the Silurian Tuvaella brachiopod fauna. *LE* 15:142
225. Cocks, L. R. M. 1972. The Origin of the Silurian *Clarkeia* Shelly Fauna of South America and its Extension to West Africa. *PA* 15:625
226. Shevchenko, V. I., *et al.* 1977. New Data on Silurian sediments of the Volga Region near Volgograd. *DE* 233:125
227. Lanbacher, G., Boucot, A. J., and J. Gray. 1982. Additions to Silurian Stratigraphy, Lithofacies, Biogeography, and Paleontology of Bolivia and Southern Peru. *JP* 56:1138-70
228. Kaljo, D. L. 1978. On the Bathymetric Distribution of Graptolites. *PO* 23(4)524
229. Berry, W. B. N. 1973. Silurian-Early Devonian Graptolites (*in* Hallam. 1973. *op. cit.*), p. 83
230. Bordet, P., Colchen, M., and L. Fort. 1972. Some Features of the Geology of the Anapuina Range, Nepal Himalaya (in Jhingran, A. G. and K. S. Paldiya. 1973. *Himalayan Geology,* Delhi)
231. Lenz, A. C. 1979. Llandoverian Graptolite Zonation in the Northern Canadian Cordillera. *PO* 24:139
232. Furon, R. 1972. *Elements de Paleoclimatologie.* Librairie Vuibert, Paris, p. 92
233. Koren', T. N. 1973. The Silurian and Lower Devonian Graptolite-bearing strata in the USSR (a review). *GM* 110:3
234. Berry, W. B. N. and V. J. Gupta. 1966. Monograptids from the Kashmir Himalayas. *JP* 40:1339
235. Jaeger, H. 1979. Devonian Graptolithina (*in* House, M. R., Scruton, C. T., and M. G. Bassett. 1979. *The Devonian System. PL* 23), p. 337
236. Amatov, V. A., *et al.* 1970. *Basic Features of the Paleozoic Stratigraphy and tectonics of the Mongolian Peoples Republic.* Peoples Republic Translation, Vol. 1, p. 31-2
237. Tarlo, L. B. H. 1964. Psammosteiformes (agnatha)—A Review with descriptions of New Material From the Lower Devonian of Poland. *OL* 13:10
238. Halstead, L. B. and S. Turner. 1973. Silurian and Devonian Ostracoderms (*in* Hallam. 1973. *op. cit.*), pp. 68-75
239. Turner, S., Jones, P. J., and J. J. Draper. 1981. Early Devonian thelodonts (agnatha) from the Toko Syncline, western Queensland, and a review of other Australian Discoveries. *BM* 6:52
240. Tankard, A. J., *et al.* 1982. *Crustal Evolution of Southern Africa. SP,* pp. 353-6
241. Koemmelbein, K. 1968. Devonian of the Amazonas Basin, (*in* Oswald, D. H. 1968. *International Symposium on the Devonian System,* Calgary) Vol. 2, p. 201-8
242. Cross, W. 1973. Kleinschuppen, Flossenstacheln, und Zaline om Fischen Aus Europaischen und Nordamerik aurscer Bonebeds Des Devons. *PH* A142:51-155
243. Gupta, V. J. and Ph. Janvier. 1979. Late Devonian Vertebrate Remains from Western Himalayas (Himachal Pradesh, India). *ND* 12:161
244. Gupta, V. J. and P. Janvier. 1981. Remarks on an Osteolipid Fish from the Devonian of Zanskar, Ladakh. *ND* 14:80
245. Blieck, A. 1982. Les Grandes Signes De La Biographie des Heterostraces du Silurien Superieur-Devonien Inferieur dans le domane nord-Atlantique. *PP* 38:286
246. Kiang, P. 1981. Devonian Antiarch Biostratigraphy of China. *GM* 118:70
247. Guscherkov, V. A. 1968. A Find of Placoderms in the Northern Tien Shan. *DE* 179:53-4
248. Denison, R. H. 1968. Early Devonian Lungfishes from Wyoming, Utah, and Idaho. *FI* 17(4)353-413
249. Janvier, P. 1977. Descriptions des Restes D'Elasmobrances (Pisces) Du Devonien Moyen de Bolivia. *PV* 7-IV, pp. 127-32
250. Gupta, V. J. and S. Turner. 1973. Oldest Indian Fish. *GM* 110:483
251. Gupta, V. J. and R. A. Denison. 1966. Devonian Fishes from Kashmir, India. *NA* 211:177
252. Tikhiy, V. N. and M. S. Stanichkova. 1973. Age of the Kazanla Suite and the beginning of Devonian Sedimentation on the Russian Platform. *DE* 210:94
253. Blieck, H., *et al.* 1980. A New Vertebrate locality in the Eifelian of the Khush-Yeilagh Formation, Eastern Alborz, Iran. *PV* 9-V:1-4
254. Bernacsek, G. M. 1977. A Lungfish Cranium from the Middle Devonian of the Yukon Territory, Canada. *PH* A157:176
255. Gaikusha, M. P., Yengoyoan, M. A., Oganesyan, D. Va., and S. S. Sakrasyan. 1971 A Find of Fish Remains in the Upper Devonian of Armenia *DE* 196:77
256. Janvier, P. 1980. Osteolipid Remains from the Middle East (*in* Panchen, A. L. 1980. *The Terrestrial Environment and The Origin of Land Vertebrates. AC*), p. 224
257. Schrank, E. 1977. Zur Palaeobiogeographie silurischer Trilobiten. *JA* 155(1)110-23
258. Chlupac, I. 1975. The distribution of phacopid trilobites in space and time. *FS* 4:400-5
259. Eldredge, N. and A. R. Ormiston. 1979. Biogeography of Silurian and Devonian Trilobites of the Malvinokaffric Realm (*in* Boucot and Gray. 1979. *op. cit.*), pp. 147-69
260. Baldis, B. A., *et al.* 1976. Trilobites Silurico-Devonicos de la Sierra De Zapla (Nordeste de Argentina). *ME* 13:185
261. Talent, J. A., *et al.* 1975. Correlation of the Silurian Rocks of Australia, New Zealand, and New Guinea. *GP* 150, 108 p.
262. Li-wen, X. 1981. Some Late Devonian trilobites of China (*in* Teichert. 1981. *op. cit.*), p. 183
263. Ormiston, A. R. 1967. Lower and Middle Devonian Trilobites of the Canadian Arctic Island. *CB* 153:8

264. Kobayashi, T. and T. Hamada. 1974. Silurian Trilobites of Japan and Adjacent Regions. *PJ* 18, 155 p.
265. Kobayashi, T. and T. Hamada. 1977. Devonian Trilobites of Japan and Adjacent Regions. *PJ* 20, 202 p.
266. Ormiston, A. R. 1975. Siegenian trilobite zoogeography in Arctic North America. *FS* 4:391
267. Alberti, G. K. B. von. 1969. Trilobiten des jungeren Siluriums sowie des Unter und Mitteldevons. *Abhandlungen der senckenbergischen Naturforschenden Gesselschaft* 520:34
268. Lane, P. D. and A. J. Thomas. 1978. Silurian trilobites from Northeast Queensland and the classification of effaced trilobites. GM 115:351
269. Ormiston, A. R. 1977. Trilobites and the Silurian-Devonian Boundary (*in* Martinsson, A. 1977. *The Silurian-Devonian Boundary*. E. Schwiezerbeutsche Verlagsbuchhandblung, Stuttgart), p. 324
270. Menner, Vl. V., Krylova, A. K., Kolodeznikov, K. Ye., and G. S. Fradkin. 1970 Correlation of the Middle Devonian of the Siberian Platform *DE* 193:106-9
271. Anderson, M. M., Boucot, A. J., and J. G. Johnson. 1969. Eifelian Brachiopods from Padaukpin, northern Shan States, Burma. *BR* 18(4)109
272. Shih-pu, Y., Kiang, P., and H. Hung-fei. 1981. The Devonian System in China. *GM* 118:113-38
273. Talent, J. A. 1972. Provincialism and Early Devonian Faunas. *GU* 19:88
274. Durkoop, A., Mensink, H., and G. Plodowski. 1968. Devonian of Central and Western Afghanistan and Southern Iran (*in* Oswald. 1968. *op. cit.*), V1, pp. 540-3
275. Alberti, G. K. B. von. 1981. Zur Biostratigraphie und Fauna (Tentaculiten, Trilobiten, Graptolithen) des Unter-, und Mittel-Devons von Benzueg (Becken von Bechar, SW-Algerien) *JA Monatschefte* 1981(11)643
276. Edwards, D. 1973. Devonian Floras (*in* Hallam. 1973. *op. cit.*), pp. 106-10
277. Chaloner, W. G., Mensah, M. K., and M. D. Crane. 1974. Non-Vascular Land Plants from the Devonian of Ghana. *PA* 17:933
278. Alvarez, R. C. 1981. Devonian Plants from Hornachos (Badajoz), Spain. *BO* 28:15
279. Zdebska, D. 1982. A New Zosterophyll from the Lower Devonian of Poland. *PA* 25:247-63
280. Chaloner, W. G. and Z. Sheerin. 1979. Devonian Macrofloras (*in* House, *et al.* 1979. *op. cit.*), p. 159
281. Lejal-Nicol. 1975. Sur Une Nouvelle Flora A Lycophytes De Devonien Inferieur de la Libye. *PH* B151:53
282. Hueber, F. M. 1971. Early Devonian Land Plants from Bathurst Island, District of Franklin. *Kansas Geological Survey Paper* 17-28, p. 1
283. Irwina, A. et. Y. Lemoigne. 1979. Sur la Presence du *Callixylon newberryi* (Dawson) Elkins et. Wieland 1814 en Kazakhstan (URSS) au Devonien Superieur. *PH* 170B:1
284. Andrews, H. N., Gensel, P. G., and W. H. Forbes. 1974. An Apparently Heterosporous Plant from the Middle Devonian of New Brunswick. *PA* 17:338
285. Lacey, W. S. 1975. Some Problems of "Mixed" Floras in the Permian of Gondwanaland (*in* Campbell, K. S. W. 1975. *Gondwana Geology*, Canberra), p. 129
286. Churkin, M., Jr., *et al.* 1969. Lower Devonian Land Plants from Graptolitic Shale in South-Eastern Alaska. *PA* 12:560
287. Zahkarova, T. V. 1981. On the Systematic Position of the Species "Psilophyton" goldschmidti from the Lower Devonian of Eurasia. *PJ* 15(3)109-on.
288. Grierson, J. D. 1976. Sedersia Complexa (Lycopsida, Middle Devonian) Its Anatomy, and the Interpretation of Pyrite Petrifactions. *American Journal of Botany* 63:1187
289. Cornet, B., Phillips, T. L., and H. N. Andrews. 1976. The Morphology and Variation in *Rhacophyton Ceratangium* from the Upper Devonian and Its Bearing on Frond Evolution. PH 158B:107-21
290. House, M. R. 1973. Devonian Goniatites (*in* Hallam. 1973. *op. cit.*), p. 101-2
291. House, M. R. 1980. Early Ammonoids in Space and Time (*in* House, M. R. and J. R. Senior. 1980. *The Ammonoids. AC*), p. 365
292. House, M. R. 1982. Written Communication.
293. Bogoslovsky, B. I. 1980. Early Devonian Ammonoids of the Zeravshan Range. *PJ* 14:54
294. Ameta, S. S. and K. Gaur. 1980. New Fossil Find from the Muth Quartzite, Pen Valley, Lahaul and Spiti District, Himachal, India. *ND* 13(1)73
295. House, M. R. 1978. Devonian ammonoids from the Appalachians and their bearing on International zonation and Correlation (*in* House. 1978. *op. cit.*), p. 30
296. House, M. R. and R. B. Blodgett 1982 The Devonian goniatite genera *Pinacites* and *Foodites* from Alaska. *CE* 19:1873
297. Yuen, Weng C. and W. Zigler. 1981. Middle Devonian conodonts from Xequitu Q1., Inner Mongolia Autonomous Region, China. *SL* 62:127
298. Oliver, W. A. 1976. Presidential Address: Biogeography of Devonian Rugose Corals. *JP* 50(3)369-71
299. Oliver, W. A. 1977. Biogeography of Late Silurian and Devonian Rugose Corals. *PP* 22:85-135
300. Chang-Ming, Y. and K. Guo-dun. 1980. Rugose Corals from Devonian Ertang Formation of Central Guangxi. *SI* 19(3)180
301. Hill, D. 1957. Presidential Address: The Sequence and Distribution of Upper Palaeozoic Coral Faunas. *Australian Journal of Science* 119(3A)42-61
302. Sharkova, T. T. 1980. Rifogennie Postroiki Rannevo Devona Yuzhnoi Mongolii (*in* Sokolov, B. C. 1980. *Koraly i Rifi Fanerozoi CCCP*, Nauka, Moskva), p. 93 (in Russian)
303. Pedder, A. E. H. 1982. *Chostophyllum*, A New Genus of Charactophyllid Corals from the Middle Devonian of Western Canada. *JP* 56:579-80
304. Flugel, E. 1975. Fossile Hydrozoen-Kenntnisstand und Probleme. *PZ* 49(4)385-9
305. Minato, M., *et al.* 1965. *The Geologic Development of Japanese Islands*, pp. 39-84
306. Oliver, W. A. 1980. Corals in the Malvinokaffric Realm. *Munsterche Forschungen Zur Geologie und Palaeontologie*, Heft 52:17
307. Boucot, A. J., Johnson, J. G., and J. A. Talent. 1969. Early Devonian Brachiopod Zoogeography. *GP* 119, pp. 14-23
308. Boucot, A. J., Johnson, J. G., and W. Struve. 1966. *Stringocephalus*, Ontogeny and Distribution. *JP* 40:1358
309. Hamada, T. 1971. Early Devonian Brachiopods from the Lesser Khingan District of Northeast China. *SJ* 15:4
310. Sartenaer, P. 1969. Late Upper Devonian (Famenian) Rhynchonellid Brachiopods from Western Canada. *CB* 169:12
311. Tyazheva, A. P. and P. A. Zhavoronkove. 1972. *Korali i Brakiopody Pogranichnich Otlozhenii Siluria i Nizhnevo Devona Zapadnovo Sklona Yuzhnovo Urala.* Nauka, Moskva, p. 3 (in Russian)
312. Walmsley, V. G. and A. J. Boucot. 1975. The Phylogeny, Taxonomy, and Biogeography of Silurian to Mid Devonian Isorthinae (Brachiopoda). *PH* 148A:49
313. Thanh, T. D. 1980. The Stratigraphy of the Devonian Deposits in Vietnam. *SV* 21:34-5
314. Yan, Z. 1981. Early Devonian Brachiopods from Zhusilghairhan Reg. Western Neumongol. *SI* 20(5)391
315. Boucot, A. J., Isaacson, P. E., and G. Leubacher. 1980. An Early Devonian Eastern Americas Realm Faunule From the Coast of Southern Peru. *JP* 54:361
316. Gatsianova, P. T. 1975. Brakiopody Rannevo i Srednovo Devona Altae-Sayanskoi Oblasti. *SB* 248:6 (in Russian)
317. Brice, D. 1977. Biostratigraphie du Devonien d'Afghanistan. *FR* 8:267-76
318. Garcia-Alcalde, J. L. and P. R. Racheboeuf. 1975. Donnes paleobiologiques Strophochonetinae de Devonien et palaeobiogeographiques sur quelques d'Espagne et du Massif Armorican. *LE* 8(4)337
319. Hodson, F. and W. H. C. Ramsbottom. 1973. The Distribution of Lower Carboniferous Goniatite Faunas in Relation to Suggested Continental Reconstructions for the Period (*in* Hughes. 1973. *op. cit.*), p. 323
320. Rocha-Campos, A. C., De Carvalho, R. G., and A. J. Amos. 1977. A Carboniferous (Gondwana) Fauna from Subandean Bolivia. *RB* 7:291
321. Closs, D. 1967. Orthocone Cephalopods from the Upper Carboniferous of Argentina and Uruguay. *ME* 5(3)123-on.
322. Ruzina, L. F. 1980. Sayoorskiye Ammonoidei. *TR* 181, Ris. 1 (in Russian)

323. Wang, M. 1981. Carboniferous Ammonoids from Eastern Xinjiang. *SI* 20(5)480
324. Gandin, V. G. 1971. The First Continuous Upper Paleozoic Sequence Found in the Northeastern USSR. *DE* 200:35
325. Amos, A. J. 1979. *Guia Paleontologica Argentina,* Buenos Aires, p. 13-on.
326. Gless, M. J. M., *et al.* 1980. Pre-Permian Depositional Environments around the Brabant Massif in Belgium, the Netherlands, and Germany. *SG* 27(1)69
327. Ruzhencev, Ye. 1974. Late Carboniferous of the Russian platform and Cisuralia. *PJ* 8(3)313-22
328. Higgins, A. C. and C. H. T. Wagner-Gentries. 1982. Conodonts, Goniatites, and the Biostratigraphy of the earlier Carboniferous from the Cantabrian Mountains, Spain. *PA* 25:313-50
329. Kuzina, L. F. 1971. New and Little Known Early Visean (Silurian) Ammonoids. *PJ* 5:34-8
330. Thomas, D. H. 1928. An Upper Carboniferous fauna from the Amotape Mountains, north western Peru. *GM* 65:146-52
331. Ruzhentsev, V. Ye. and M. F. Gogoslovskaya. 1975. The Family Reticuloceratidae and Related Taxa. *PJ* 9(1)49-58
332. Sturgeon, M. T., Windle, D. L., Mapes, R. H., and R. D. Hoare. 1982. New and Revised Taxa of Pennsylvanian Cephalopods in Ohio and West Virginia. *JP* 56:1453-79
333. Nassichuk, W. W. 1975. Carboniferous Ammonoids and Stratigraphy of the Canadian Arctic Archipelago. *CB* 237:3
334. Semichatova, S. V., *et al.* 1979. The Bashkirian Stage as a Global Stratigraphic Unit (*in* Wagner, R. H., Higgins, A. C., and S. V. Meyen. 1979. The *Carboniferous of the USSR.* YG Occasional Publication 4), p. 106
335. Martin, H., Walliser, O. H., and N. Wilczewski. 1970. A Goniatite from the Glaciomarine Dwyka Beds near Schlip, South West Africa (in ————. 1970. *2nd Gondwana Symposium Proceedings*), p. 625
336. Riccardi, A. C. and N. Sabattini. 1975. Cephalopoda from the Carboniferous of Argentina. *PA* 18:119
337. Ruzhentsev, B. E. and M. F. Bogushevski. 1978. Namyoorski Etap i Evolutsyi Ammonoidey. *TR* 167:22-6 (*in* Russian)
338. Brown, D. A., K. S. W. Campbell, and J. Roberts. 1964. A Visean Cephalopod Fauna from New South Wales. *PA* 7:682-3
339. Solonina, R. V. and A. A. Gieke. 1977. New Data on the Upper Carboniferous in the Northern Kharaulakh Area Soviet Arctic Maritime Region). *SV* 18:11-on.
340. Miller, A. K. and H. F. Garner. 1953. Upper Carboniferous Goniatites from Argentina. *JP* 27:823
341. Runnegar, B. 1979 Marine Fossil Invertebrates of Gondwanaland: Palaeogeographic Implications (*in* ————. 1979. *IV International Gondwana Symposium,* 1977, Calcutta, India), pp. 155-6
342. Ross, C. A. 1973. Carboniferous Foraminiferida (*in* Hallam. 973. *op. cit.*), p. 127
343. Sando, W. J., Mamet, B. L., and J T Dutro 1969. Carboniferous Megafaunal and Microfaunal Zonation in the Northern Cordillera of the United States. UG 613E, p. E2
344. Ozawa, T. 1976. Late Visean *Eostafella* (Fusulininean Foram) from West Malaysia. *AS* 17:120
345. Li, Land, G. Feng. 1980. Late Carboniferous brachiopods from Yanji of Jilin, Northeast China. *SI* 17(6)490
346. Metcalfe, I. 1980. Palaeontology and Age of the Panching Limestone, Pahang, West Malaysia. *AS* 21:13
347. Rogozov, Yu. G., *et al.* 1971. Moscovian Stage of North-Central Chukotka. *DE* 197:56
348. Thompson, M. L. 1967. American Fusulinacean Faunas Containing Elements from other Continents (*in* Teichert, C. and E. L. Yochelson. 1967. *Essays in Paleontology and Stratigraphy.* University of Kansas Press.), p. 107
349. Ross, A. 1967. Development of Fusulinid (Foraminiferida) Faunal Realms. *JP* 41(6)1342-3
350. Douglas, R. C. 1977. The Development of Fusulinid Biostratigraphy. (*in* Kauffman and Hazel. 1977. *op. cit.*), p. 473
351. Meyen, S. V. 1970. On the Origin and Relationship of the Main Carboniferous and Permian Floras (*in* ————. 1970. *op. cit.*), p. 553
352. Chaloner, W. G. and S. V. Meyen. 1973 Carboniferous and Permian Floras of the Northern Continents (*in* Hallam 1973. *op. cit.*), pp. 170-8
353. Plumstead, E. P. 1973. The Late Palaeozoic Glossopteris Flora (*in* Hallam. 1973. *op. cit.*), p. 192
354. Ageev, K. S., *et al.* 1981. Permian Deposits in Severnaya Zemlya *SV* 22(3)135-8
355. Ziegler, A. M., *et al.* 1981. Paleozoic Biogeography and Climatology (*in* Niklas, K. J. 1981. *Paleobotany, Palaeocology, and Evolution.* Praeger Publishers, NY); Vol. 2, pp. 236-59
356. Asama, K. 1976. *Gigantopteris* flora in Southeast Asia and its Phytopaleogeographic Significance. *AS* 17:204
357. Jennings, J. R. 1980. Fossil Plants from the Fountain Formation (Pennsylvanian) of Colorado. *JP* 54:149
358. El-Khayal, A. A., Chaloner, W. G., and C. R. Hill. 1980. Palaeozoic Plants from Saudi Arabia. *NA* 285:33
359. Lele, K. M. 1974. Late Palaeozoic and Triassic Floras of India and Their Relation to the Floras of Northern and Southern Hemispheres. *BO* 23(2)106
360. Gorelova, S. G. 1978. The Flora and Stratigraphy of the Coal-Bearing Carboniferous of Middle Siberia. *PH* 165B: 54
361. Pfefferkorn, A. W. and W. H. Gillespie. 1980. Biostratigraphy and Biogeography of Plant Compression Fossils in the Pennsylvanian of North America (*in* Dilcher, D. L. and T. N. Taylor. 1980. *Biostratigraphy of Fossil Plants.* DO), p. 95
362. Phillips, T. L. 1980. Stratigraphic and Geographic Occurrences of Permineralized Coal—Swamp Plants—Upper Carboniferous of North America and Europe (*in* Dilcher and Taylor. 1980. *ibid.*), pp. 32.3
363. Hsu, J. 1976. On the Palaeobotanical Evidence for Continental Drift and Himalayan Uplift. *BO* 25:135
364. Meyerhoff, A. A. 1978. Petroleum in Tibet and the India-Asia Suture(?) Zone. *PE* 1:110
365. Ting-Yang, H. Ya. 1954. Climate and Relative Positions of the Continents During the Lower Carboniferous. *Acta Geologica Taiwanica* 6:5-8
366. Hill, D. 1948. The Distribution and Sequence of Carboniferous Coral Faunas. *GM* LXXXV(3)126-7
367. Hill, D. 1973. Lower Carboniferous Corals (*in* Hallam. 1973. *op. cit.*), p. 135
368. Sayutina, T. A. 1973. Nizhnekammyenougulniye Koraly Severnevo Urala. *TR* 140:9
369. Nelson, S. J. 1982. New Pennsylvanian syringoporid coral from Kamloops area, British Columbia. *CE* 19:376-7
370. Sando, W. J. 1980. The Paleoecology of Mississippian Corals in the Western Conterminous United States. *PO* 25:620
371. Scruton, C. T. 1973. Palaeozoic Coral Faunas from Venezuela. II. Devonian and Carboniferous Corals from the Sierra De Perija. *BR* 23(4)225
372. Khoa, N. D. 1977. Carboniferous Rugosa and Heterocorallia from boreholes in the Lublin Region (Poland). *PO* 22(4)301-3
373. Minato and Kato. 1965. *op. cit.* (ref. 217), pp. 40-54
374. Rowett, C. L. 1975 Stratigraphic Distribution of Permian Corals in Alaska. UG 823D, pp. D64-D72
375. Hoover, P. R. 1981. Paleontology, Taphonomy, and Paleoecology of the Palmanto Formation (Permian of Venezuela). *BP* 80(313)7-10
376. Wilson, E. C. 1974. Bibliographic Index of North American Permian Rugose and Tabulate Coral Species. *JP* 48: 598-604
377. Rowett, C. L. 1972. Paleogeography of Early Permian Waagenophyllid and Durhaminid Corals. *Pacific Geology*
378. Gobbett, D. J. 1967. Palaeozoogeography of the Verbeekinidae (Permian Foraminiferida) (*in* Adams, C. G. and D. Ager. 1967. *Aspects of Tethyan Biogeography.* Systematicists Association (of London) Publication No. 7, p. 79
379. Gobbett, D. J. 1973. Permian Fusulinacea (*in* Hallam. 1973. *op. cit.*), pp. 153-6
380. Ross, C. A. 1979. Evolution of Fusulinacea (Protozoa) in Late Palaeozoic Space and Time (*in* Boucot and Gray. 1979. *op. cit.*), p. 225
381. Bostwick, D. A. and M. K. Nestell. 1967 Permian Tethyan Fusulinid Faunas of the Northwestern United States (in Adams and Ager 1967. *op. cit.*), p. 95
382. Yancey, T. E. 1975. Permian Marine Biotic Provinces in North America. *JP* 49:763

383. Kalmikova, M. A. 1975. Znachenie Fuzulinid v. Rasshifrovkie Paleografii Asselskovo Vyeka Rannei Permi. *VO* 18:126 (in Russian)
384. Toriyama, R. 1973. Upper Permian Fusulininan Zones (in Logan, A. and L. V. Hills. 1973. *The Permian and Triassic Systems and Their Mutual Boundary. CP Memoir* 2), pp. 498-9
385. Stow, D, A. V. 1975. New Fusulinid Evidence for the Permian Age of the Palaeozoic rocks of Hydra, Greece. *GM* 112:72
386. Waterhouse, *J.* B. 1976. *World Correlations for Permian Marine Faunas*. University of Queensland Paper of Department of Geology 7(2)167
387. Stehli, F. G. 1957. Possible Permian Climatic Zonation and Its Implications. *AI* 255:611-14
388. Termier, H. W., Termier, G. et. D. Vachard. 1977. Monographie Paleontologique des Affleurements Permiens De Djebel Tebaga (Sud Tunisien) *PH* 156A:16
389. Nakamura, K. 1979. Additional Occurrences of Urushtenoidea (Brachiopoda) from the Permian of Asia. *HO,* Ser. IV 18:224
390. Waterhouse, J. B. and G. B. Bonham-Carter. 1972. Permian Paleolatitudes Judged from Brachiopod Diversities. 24th *CO,* Sec. 7, pp. 354-9
391. Stehli, F. G. 1973. Permian Brachiopods (in Hallam. 1973. *op. cit.),* pp. 145-6
392. Nakamura, N. and F. Golshani. 1981. Notes on the Permian Brachiopod Genus *Crytospirifer. HO,* Ser. IV 20:69
393. Archbold, N. W., *et al.* 1982. Indonesian Permian brachiopod fauna and Gondwana-South East Asia relationships. *NA* 296:
394. Glenister, B. F. 1981. Written Communication.
395. Waterhouse, J. B. and V. J. Gupta 1977 Permian Faunal Zones and Correlations of the Himalayas *ND* 10(2)1-19
396. Waterhouse, J. B. 1972. The evolution, correlation, significance of the Permian ammonoid family Cyclolobidae. *LE* 5:268
397. Spinosa C., Furnish, W. M. and B. F. Glenister. 1975. The Xenodiscidate, Permian Ceratitoid Ammonoids. JP 49:240
398. Leven, E. Ya. 1982. The Permian Yakhtashian Stage: its basis, characteristics, and correlation. *IG* 24(8)945-54
399. Xi-lou. 1981. Early Permian Cephalopods from Northwest Gansu and Western Nei Monggol. *SI* 21(6)499
400. Valdiya, K. S. and V. J. Gupta. 1972. A Contribution to the Geology of Northeastern Kumuan. with Special Reference to the Hercynian Gap in Tethys Himalaya (in Jhingran and Valdiya. 1972. *op. cit.),* 1-34
401. Vachard D. and C. Montenat. 1981. Biostratigraphie, Micropaleontologie, et Paleogeographie du Permian de la Region de Tezak (Montagnes Centrales D'Afghanistan). *PH* 178B:4-5
402. Yegorov. A. Yu. and V. S. Andreyev. 1982. Structure of Permian' deposits of Northern Verkhoyansk. *IG* 24(8) 979-87
403. Teichert. C. and M. Rilett. 1974. Revision of Permian Ecca Series Cephalopods, Natal, South Africa. *KA* 68:l
404. Frest. T. J., Glenister. B. F. and W. M. Furnish. 1981. Pennsylvanian-Permian Chedoceratacean Ammonoid Families Maumitidae and Pseudonaloritidae. *JP (Supplement)* for Vol. 55. pp. 31-45
405. Glenister, B. F. and W. M. Furnish. 1961. The Permian Ammonoids of Australia. *JP* 35:676-7
406. Kamen, Kaye M. 1978. Permian to Teritary Faunas and Paleogeography: Somalia, Kenya, Tanzania, Mozambique, Madagascar, South Africa. *PE* 1:82, 95
407. Ruzhencev, V. Ye. 1976. Late Permian Ammonoids from the Soviet Far East. *PJ* 10:279
408. McClure. 1980. Permo-Carboniferous glaciation in the Arabian Pennisula. *GB* 91:708-9
409. Kulikov, M. V., Pavlov A. M., and V. N. Rostovtsev. 1973. A Find of Goniatites in the Lower Kazanian in the Northern Part of the Russian Platform. *DE* 211:112
410. Glenister, B. F., Nassichuk, W. W., and W. W. Furnish. 1979. Essay Review: Ammonoid Successions in the Permian of China. *GM* 116:232-8
411. Ross. J. R. P. 1979. Permian Ectoprocts in Space and Time (in Boucot and Gray. 1979. *op. cit.),* p. 265
412. Ross, J. R. P. 1981. Written Communication.
413. Ross, J. R. P. 1978. Biogeography of Permian Ectoproct Bryozoa *PA* 21:341-on.
414. Sakagami, S. 1976. Paleobiogeography of Permian Bryozoa on the Basis of the Thai-Malayan District. *AS* 17:157
415. Charig, A. J. 1971. Faunal Provinces on Land: evidence based on the distribution of fossil tetrapods with especial reference to the reptiles of the Permian-and Mesozoic *(in* Middlemiss, *et al.* 1971. *op. cit.),* p. 118
416. Anderson. J. M. and A. R. T. Cruickshank. 1978. The Biostratigraphy of the Permian and the Triassic. Part 5. A Review of the Classification and Distribution of Permo-Triassic Tetrapods. *AF* 21:23, charts.
417. Olson, E. C. 1957. Catalogue of Localities of Permian and Triassic Terrestrial Vertebrates of the Territories of the USSR. *JG* 65:212-25
418. Cox, C. B. and D. G. Smith, 1973. Triassic Vertebrate faunas of Svalbard. *GM* 110:408
419. Ingavat, R. and P. Janvier. 1981. *Cyclotosaurus Posthumus* Fraas (Capitosauridae, Stereospondyli) from the Huai Hih Lat Formation (Upper Triassic) Northeastern Thailand. *BI* 14:712
420. Olsen, E. P., McCune, A. R., and K. S. Thomson. 1982. Correlation of the early Mesozoic Newark Supergroup by vertebrates, principally fishes *AJ* 282:35-9
421. Cox, C. B. 1973. Triassic Tetrapods *(in* Hallam. 1973. *op. cit.).* p. 217
422. Brown, D. A. 1967. Some Problems of Distribution of Late Palaeozoic and Triassic Terrestrial Vertebrates. *40th* ANZAAZ. *Australian National University: Geology Department Publication* No. 105A, pp. 28-37
423. Leonardi, *G.* 1980. *Isochnothium* sp. Pista de un Gigantesco Teconte na Formacao antenor Navarro (Triassico). Sousa, Paraiba, Brasil. *RB* 10(3)186.
424. Ai-lin, S. and H. Lian-hai. 1981. *Hazhenia,* a New Genus of Scalaposauria. *SI* 20(4)310
425. Cei, R. I. and J. Gargiula. 1977. Icnites de Tetrapodos Permicos Del Sin De Mondozo. *ME* 14:127
426. Barbarera, M. C.. Correia. N. D. R.. and J. J. Aumond. 1980. Contribiucao a Estrata e Bioestratigrafia do Grupa Passa Dois Na Serra Do Cadead o (Nordeste do Parana, Brasil). *RB* 10(3)268
427. Reeside, J. B., *et al.* 1957. Correlation of the Triassic Formations of North America Exclusive of Canada. *GB* 68:1451-1514
428. Haubold, H. Die Tetrapodenfahrten des Buntsandsteins in der Deutsche Demokratischen Republik und in West deutschland und ihie Equivalente in der gesanten Trias. *Palaontologische Abhandlungen* A IV(3)409
429. Stehli, F. G. 1964. Permian Zoogeography and Its Bearing on Climate *(in* Cloud, P. 1970. *Adventures in Earth History.* W. H. Freeman and Sons, San Francisco), p. 828
430. Kitching, J. W. 1977. *The Distribution* of *the Karroo Vertebrate Fauna.* University of Witwatersrand, Johannesburg, enclosed map.
431. Chudinov, P. K. 1965. New Facts about the Fauna of the Upper Permian of the USSR. *JG* 73:118
432. Ai-lin, S. 1973. Permo-Triassic of Sinkiang. *SN* 16(1) 152-3
433. Harris, J. M. and R. L. Carroll. 1977. *Kenyasaurus,* A New Eosuchian Reptile from the Early Triassic of Kenya *JP* 51:139
434. Bonaparte, *J.* F. 1978. *El Mesozoico de America Del Sur* y Sus *Pterapodos.* Tucaman, Argentina, pp. 176-95
435. Sigogneair-Russel. D. and A. L. Sun. 1981. A Brief Review of Chinese Synapsids. *BI* 14(2)276-7
436. Panchen, A. L. 1970. *Handbuch de Palaoherpetologie* Teil 5a., p. 70
437. Anderson, H. M. and J. M. Anderson. 1979. A Preliminary Review of the Uppermost Permian, Triassic, and Lowermost Jurassic of Gondwanaland. *AF* 13:9-22, enclosures.
438. Techter, D. 1972. Introduction *(in* Glut, D. F. 1972. *The Dinosaur Dictionary* Citadel Press, New Jersey), p. 6
439. Schaeffer, B. 1970. Mesozoic Fishes and Climate *(in* Yochelson, E. L. 1970. *Proceedings* of *the North American Paleontological Convention.* Vol. I). pp. 378-83
440. Minikh, A. V. 1981. *Saurichthys* Species from the Triassic of the USSR. *PJ* 1981(1)81-on.
441. Kobayashi, T. 1975. Upper Triassic Estherids in Thailand and the Conchostracan Development in Asia in the Mesozoic. *AS* 16:57-60
442. Miska, R. C., Sahni, A., and N. Chhabra. 1973. Triassic Conodonts and Fish Remains from Niti Pass, Kumuan

Himalaya (*in* Jhingran and Paldiya. 1973. *op. cit.*), p. 148

443. Vorobyeva, E. I. 1973. Age of the Fish Fauna of the Vilyuy Syneclise. *DE* 213:212
444. Cosgrif, J. 1974. Lower Triassic Temnospondyli of Tasmania. *GP* 149:129
445. Lovovskiy, V. R. and M. H. 1974. The first discovery of labyrinthodont in Lower Triassic sediments in Mangyshlack. *IG* 16:611
446. Schaeffer, B. and M. Mangus. 1976. An Early Triassic Fish Assemblage from British Columbia. *American Museum of Natural History Bulletin* 156:519-63
447. Forey, P. and B. G. Gardiner. 1973. A New Dictyopygid from the Cave Sandstone of Lesotho, Southern Africa. *AF* 15:29-31
448. Lu yi, J. 1981. Late Triassic Lamellibranchs from Datong of Qinghai, Northwest China. *SI* 20(6)584
449. Hutchinson, P. 1975. Two Triassic Fish from South Africa and Australia, with comments on the Evolution of the Chondrostei. *PA* 18(3)613
450. Uppal, S., Sahni, A. and V. J. Gupta. 1981. New Fish Locality from the Permian of Northern Pirpanjal Flank, Kashmir. *ND* 14(2)155
451. Kummel, B. Lower Triassic (Scythian) Molluscs (*in* Hallam. 1973. *op. cit.*), pp. 228-9
452. Wiedmann, J. 1973. Upper Triassic Heteromorph Ammonites (*in* Hallam. 1973. *op. cit.*), p. 244
453. Ishibashi, T. 1975. Triassic Ammonites from Indonesia Malaysia. *AS* 16:46-7
454. Brookfield, M. E. and G. E. G. Westermann. 1982. Mesozoic Ammonites from the Spong Valley, Zanskar, Northwest India. *IN* 23:1
455. Loughman, D. L. and A. Hallam. 1982. A Facies Analysis of the Pucara Group (Norianto Toanaan Carbonates, Organic-Rich Shale and Phosphate) of Central and North Peru. *SG* 32:163
456. Buriy, I. V. and N. K. Zharnikova. 1981. Ammonoids from the *Triolites* Zone in the Southern Primorye Region. *PJ* 15(3)58
457. Qing-ge, H. 1980. Discovery of the Late Anisian *Peraceratites Trinodosus* Fauna (Ammonoidea) from Doilung deqen, Tibet and Its Significance. SI 19(5)345
458. Bychkov, Yu. M. and A. D. Chekhov. 1979. Find of Tethys Ammonoids of Triassic Age in the Koryak Mountains. *DE* 245:55
459. Vavilov, M. N. 1978. Some Anisian Ammonoids of Northern Siberia. *PJ* 12:331
460. Zonenshayn, L. P., Kiparosova, L. D., and T. M. Okuneva. 1971. First Find of Marine Triassic Sediments in Mongolia. *DE* 199:32
461. Barnard, P. D. W. 1973. Mesozoic Floras (*in* Hughes. 1973. *op. cit.*), p. 178.182
462. Xing-xue, L. 1981. Thirty Years of Paleobotany in China (*in* Teichert. 1981. *op. cit.*), pp. 22-3
463. Wesley, A. 1973. Jurassic Plants (*in* Hallam. 1973. *op. cit.*), p 329
464. Ash, S. 1982. Occurrence of the Controversial Plant Fossil *Sanmiguella CF. S. Lewisi* Brown in the Upper Triassic of Utah. JP 56:752
465. Ash, S. R. 1980. Upper Triassic Floral Zones of North America (in Dilcher and Taylor. 1980. *op. cit.*)
466. Krassilov, V. A. 1981. Changes of Mesozoic Vegetation and the Extinction of Dinosaurs. *PP* 34:213
467. Ge, S. 1981. Discovery of Dipteridaceae from the Upper Triassic of Eastern Jilin. *SI* 20(5)467
468. Kobayashi, T. and T. Hamada. 1974. Non-marine Mesozoic Formations and Fossils in Thailand and Malaysia. *AS* 15:209
469. Vachrameev, V. A. 1972. Mesozoic Floras of the Southern Hemisphere and Their Relationship to the Floras of the Northern Continents. *PJ* 6:412
470. Buriy, I. V. and N. K. Zharikova. 1981. Plant-bearing Strata of the Ladinian Stage (Middle Triassic) in South Primorye. *IG* 23:32
471. Vigran, J. O. 1970. Fragments of a Middle Jurassic Flora from Northern Tronddag, Norway. *NO* 50(3)193
472. Stevens, C. R. 1963. Faunal Realms in Jurassic and Cretaceous Belemnites. *GM* 100:484
473. Frebold, H. 1975. The Jurassic Faunas of the Canadian Arctic. *CB* 243:1-5
474. Yun-zhu. 1980. Studies on Lower Jurassic Ammonites from Kaiping-Enping Area, Guangdong. *SI* 19(2)76
475. Sato, T. 1975. Marine Jurassic Formations and Faunas in Southeast Asia and New Guinea. *AS* 15:156
476. Stevens, G. R. 1973. Jurassic Belemnites (*in* Hallam. 1973. *op. cit.*), pp. 261-4
477. Howarth, M. K. 1973. Lower Jurassic (Pliensbachian and Toarcian) Ammonites (*in* Hallam. 1973. *op. cit.*), pp. 277-80
478. Dietl, G. 1973. Middle Jurassic (Dogger) Heteromorph Ammonites (*in* Hallam. 1973. *op. cit.*), p. 284
479. Cariou, E. 1973. Ammonites of the Callovian and Oxfordian (*in* Hallam. 1973. *op. cit.*), p. 292-3
480. Wiedmann, J. 1973. Ancyloceratina (Ammonoidea) at the Jurassic/Cretaceous Boundary (*in* Hallam. 1973. *op. cit.*), p. 310
481. Aliev, M. M. 1980. Stratigraphic position and geographic range of *Inoceramus azerbaid janensis.* *IG* 22:806
482. Maryanska, T. 1977. Ankylosauridae (Dinosauria) from Mongolia (*in* Kielan-Jaworska, Z. 1977. Results of the Polish-Mongolian Palaeontological Expeditions—Part VII. *OL* No. 37), p. 87
483. Monteillet, J., Lanparient, J. R., et e. P. Taquet. 1982. Un Pterosaurien geant dans le Cretace superiare de Paki. *Comptus Rendus des Sciences de L'Academie des Sciences.* Serie II, Tome 295, p. 409
484. Sochava, A. V. 1969. Dinosaur Eggs from the Upper Cretaceous of the Gobi Desert. *PJ* 3:518
485. Reyment, R. A. 1981. Colombia (*in* Reyment, R. A. and P. Bengston. 1981. *Aspects of Mid-Cretaceous Regional Geology. AC*), pp. 186-9
486. Charig, A. J. 1973. Jurassic and Cretaceous Dinosaurs (*in* Hallam. 1973. *op. cit.*), p. 486
487. ________. 1982. *Britannica Science and Future Library. VI*, p. 176 (Map by Ralph Stobart)
488. Morris, W. J. 1981. A New Species of hadrosaurian dinosaur from the Upper Cretaceous of Baja California—*Lambeosaurus laticaudus. JP* 55:453
489. Buffetaut, E. 1981. A plesiosaur vertebra from the Chichali Formation (Late Jurassic to Early Cretaceous) of Pakistan. *JA Monatschefte* 1981, heft 6, p. 334
490. ________. 1977. Dinosaurs found in Tibet. *New Scientist* 73(1038)329
491. Galton, P. M. and J. A. Jensen. 1975. *Hypsilon* and *Iguanodon* from the Lower Cretaceous of North America. *NA* 257:668
492. Dodson, P. and A. K. Behrensmayer. 1980. Taphonomy and paleoecology of the dinosaur beds of the Jurassic Morrison Formation. *PB* 6:209
493. Horner, J. R. 1979. Upper Cretaceous Dinosaurs from the Bearpaw Shale (Marine) of South-Central Montana with a checklist of Upper Cretaceous Dinosaur remains from Marine Sediments in North America. *JP* 53:514-5
494. Carpenter, K. 1982. Baby dinosaurs from the Late Cretaceous Lance and Hell Creek Formations and a description of a new species of Theropod. *YO* 20:125
495. Galton, P. M. and J. A. Jensen. 1978. Remains of Ornithopod Dinosaurs from the Lower Cretaceous of North America. *Brigham Young University Studies in Geology* 25(3)1-10
496. Taquet, P. 1977. Les Decouvertes recentes et Dinosaures du Jurassique et du Cretace en Afrique au Roche et Moyen-Orient et en Inde. *FR* No. 8, pp. 327-8
497. Molnar, R. E., Flannery, T. F., and T. A. V. Rich. 1981. An Allosaurid Theropod dinosaur from the Early Cretaceous of Victoria, Australia *CH* 5:141-2
498. Thulborn, R. A. and A. Warren. 1980. Early Jurassic plesiosaurs from Australia. *NA* 285:224
499. Buffetaut, E. 1981. Elements pour une historie paleobiographique du Sud-Est Asiatique: l'apport des Vertebres Fossiles Continentaux. *BF* 23(6)589
500. Molnar, R. E. and R. A. Thulborn. 1980. First Pterosaur from Australia. *NA* 288:362
501. Matsumoto, T. 1973. Late Cretaceous Ammonoidea (*in* Hallam. 1973. *op. cit.*), pp. 422-7
502. Stevens, G. R. 1973. Cretaceous Belemnites (*in* Hallam. 1973 *op. cit.*), 387-90
503. Pergament, M. A. 1981. Pacific Region of the USSR (*in* Reyment and Bengston. 1981. *op. cit.*), pp. 69-102
504. Kennedy, W. J. and W. A. Cobban 1977 The Role of Ammonites in Biostratigraphy *PL* 316-20

505. Kurten, B. 1973. Early Tertiary Land Mammals *(in* Hallam. 1973. *op. cit.),* pp. 438-40
506. Ming-zhen, Z. 1981. Vertebrate paleontology in China, 1949-1979. (in Teichert. 1981. *op. cit.),* pp. 17-8
507. Macfadden, B. J. 1980. The Miocene Horse *Hipparion* from North America and from the Type Locality in Southern France *PA* 23(3)631
508. Woodburne, M. O. and R. L. Bernor. 1980. On Superspecific Groups of Some Old World Hipparionine Horses. *JP* 54:1320
509. Davies. M. 1975 (Updated Edition). *Tertiary Faunas.* WI, pp. 375-8
510. Patterson, B. and Pascual. 1972. The Fossil Mammal Fauna of South America *(in* Keast, A., Erk, F. C., and B. Glass. 1972. *Evolution, Mammals, and Southern Continents.* State University of New York Press, Albany), pp. 250-2
511. Keast, A. 1972. Australian Mammals: Zoogeography and Evolution *(in* Keast, *et al.* 1972. *ibid),* p. 225
512. Cooke, H. B. S. 1972. The Fossil Mammal Fauna of Africa *(in* Keast, *et al.* 1972. *ibid.),* p. 97
513. Min-chen, C. and Z. Jia-Jian. 1980. The Mammal-Bearing Early Tertiary Horizons of China. *Museum of Paleontology (University of California; Berkeley)* 32
514. Sahni, A., *et* al. 1981. Vertebrates from the Subeth formation and comments on the biogeography of Indian subcontinent during the early Paleogene. *BF* (1981)(7) 23(6)690
515. Savage, R. J. G. 1967. Early Miocene Mammal Faunas of the Tethyan Region *(in* Adams and Ager. 1967. *op. cit.),* p. 273
516. Cooke, H. B. S. 1978. Africa: The Physical Setting *(in* Haglio, V. J. and H. B. *S.* Cooke 1978 *Evolution of African Mammals,* Harvard University Press, Cambridge), p. 24
517. Storer, J. E. 1978. Tertiary Sands and Gravels in Saskatchewan and Alberta: Correlation of Mammalian Faunas (in Stelck and Chatterton. 1978. *op. cit.),* p. 97
518. Archer. M. and A. Bartholomai. 1978. Tertiary Mammals of Australia: A Synoptic Review *CH* 2(1)3
519. Dashzeveg, D. 1980. New Pantodonts from the Eocene of Mongolia. *PJ* 14(2)97
520. Kennedy, *G.* E. 1980. *Paleoanthrolopogy.* McGraw Hill, p. 138
521. Goldsmith, N. F., *et al.* 1982. Ctenodactid rodents in the Miocene Negev fauna of Israel. *NA* 296:645
522. Lytshev. G. F. 1978. A New Early Oligocene Beaver of the Genus *Agnatocastor* from Kazakhstan, *PJ* 12:542
523. Brandy, L. D. 1981. Rongeues Muroides Du Neogene Superieur D'Afghanistan. Evolution, Biogeography, Correlations. *PV* 11(4)136
524. Dashzeveg. D. and M. C. McKenna. 1977. Tarsoid Primate from the Early Tertiary of the Mongolian People's Republic. *PO* 22:122
525. Tang, X. and Z. Ming-zhen. 1965. The Vertebrate-Bearing Early Tertiary of South China: A Review. *IG* 7:1349
526. Belyaeva, E. I. 1968. USSR (Tertiary) Faunas *(in* Orlov, *Yu.* A. 1968. *Fundamentals of Paleontology.* Vol. 13), p. 54
527. Barry, J. C., Lindsay, E. H., and L. L. Jacobs. 1982. A Biostratigraphic Zonation of the Middle and Upper Siwaliks of the Potwar Pleateau of Northern Pakistan *PP* 37:99
528. Yongsheng, T. 1982. Chinese Dintatheres and the Evolution of the Dinocerata. *JP* (Abstracts, North American Paleontological Convention III), Supplement for 1982.
529. Hottinger. L. 1973. Selected Paleogene Larger Foraminiferida (in Hallam. 1973. *op. cit.),* pp. 448-51
530. Adams, C. G. 1973. Some Tertiary Foraminiferida *(in* Hallam. 1973. *ibid.),* pp. 456-66
531. Rau. W. W. 1981. Pacific Northwest Tertiary benthic Foraminiferal biostratigraphic framework—An Overview. *GP* 184:69
532. Samanta, B. K. 1982. *Fabiania* Silvestii (Foraminiferida) from India, with notes on its global distribution. *GM* 119:260
533. Serova, M. Ya. 1978. Planktonoviye Foraminifery Paleogena i Neogena Severniy Chasti tikookeanskoi Provincii. *VO* 21:172-5
534. Henderson, G., Rosenkrantz, A., and E. J. Schiener. 1976. Cretaceous-Tertiary sedimentary rocks of West Greenland *(in* Escher. A. and W. S. Watt. 1976. *Geology of Greenland,* Copenhagen), p. 341
535. Poore, R. Z. 1980. Age and Correlation of California Paleogene Benthic Foraminiferal Stages. *UG* 1162-C, p. CR
536. Chang-Min, Y. and W. Hui-ji. 1981. Some Tube-like Fossils from the Early Tertiary of Northern Jiangsu. *SI* 20 (5)415
537. Turner, D. L. 1970. Pacific Coast Miocene Foraminiferal Stages (in Bandy, O. L. *ed.* 1970. Radiometric Dating and Paleontological Zonation. *GP* 124:94-5
538. Yi-chun, H. and Z. Xue-lu. 1980. Early Tertiary Foraminiferida from the Kaslu Basin of Xinjiang. *SI* 19(2)167
539. Saperson, E. and M. Jahal. 1980. Biostratigraphy of the Anomalinidate and Cibicidate in the Soviet Tethyan Paleogene. *Micropaleontology* 26(4)393
540. Siesser, W. G. 1982. Cretaceous Calcareous Nannoplankton in South Africa. *JP* 56:335-50
541. Yu-lin, L. and L. Cai-hua. 1981. A New Echinoid with Sexual Dimorphism from Late Tertiary Deposits of Beibuwan, Guangxi. *SI* 20(5)484
542. Chaprioniere, G. C. H. 1981. Influence of Plate Tectonics on the distribution of Late Palaeogene to Early Neogene larger foraminiferids in the Australasian region. *PP* 31: 306-9
543. Zinsmeister, W. J. 1981. Middle to Late Eocene Invertebrate Fauna from the San Julian Formation at Punta Casamayor, Santa Cruz Province, Southern Argentina. *JP 55:* 1090
544. Varhatova, N. N., *et al.* 1979. Paleobiografiya i Paleotemperatura Eotsenskih Morei Yevrazii Ustanovleniye po Nummulitidam. *VO* 22:76, 93
545. Yi-chun, H. 1981. Thirty years of micropaleontological research in China *(in* Teichert. *et al.* 1981). pp. 12-14
546. Yan-hao, *et al.* 1981. Invertebrate paleontology in China (1949-79). *(in* Teichert. *et al.* 1981. *op. cit.).* pp 6
547. Stainforth, R. M. and J. L. Lamb. 1981. An Evaluation of Planktonic Foraminiferal Zonation of the Oligocene. *KA Paper* 104, p. 3
548. Shi-lan, Z. 1982. Neogene Calcareous Nannofossils from the Huanglui Formation of the Yinggehai Basin, South China Sea. *SI* 21(2)200
549. Amard, B. 1983. Decouverte de microfossiles dans le Proterozoique metamorphique de l'adrardes Iforas (Mali). *CR Academic des Sciences Paris* Serie II, Tome 296(1)85
550. Bekker, Yu. R. 1980. A New Locality with Fossil Fauna of the Ediacara type in the Urals. *DE* 254:236
551. Cheng-Hua, D. 1982. Late Precambrian algal megafossils *Chuaria* and *Tawaia* in some areas of eastern China. *CH* 6:58
552. Andrawis, S. F., *et al.* 1983. Lower Paleozoic Trilobites from subsurface rocks of the Western Desert, Egypt. *JA Monatschefte* 1983(2)65-6
553. Zhenhun, S. 1982. Late Lower Cambrian Trilobites from Southern Dahongshan Region, Hubei. *SI* 21(3)307
554. Zhi-yi, Z. and Z. Zhi-qiang. 1982. An Ashgillian (Rawtheyan) Trilobite Faunule from Ejin Qi, Nei Monggol (Inner Mongolia). *SI* 21:669
555. Matthews, S. C. and V. V. Missarzhevsky. 1975. Small shelly fossils of late Pre and early Cambrian age: a review of recent work. *GL* 131:290
556. Maithy, P. K. and S. Gupta. 1981. Archaeocyatha from the Vindhyan Supergroup of India. *BB* 46(11)2802
557. Krylov, *et al.* 1981. Middle Reaches of the Aldan River (in Raaben, M. E. 1981. *The Tommotian Stage and the Cambrian Lower Boundary Problem.* National Science Foundation), p. 17
558. Jordan, M. 1979. The Stratigraphic Significance of Graptolites in Romania. *PO* 24:122
559. Kobayashi, T. and H. Igo. 1965. On the Occurrence of Graptolitic Shales in North Thailand. *JJ* 36:37
560. Ji-jin, L. 1982. Graptolites from the Jeanling Formation (M. Ordovician) of Yaxian, Hainan Island. *SI* 21(2)205
561. Tsai,. D. T. 1982. The Graptolitic Zonal Scale of the Pacific Ocean Province. *SV* 23(4)9
562. Wang, C. Y. and W. Zeigler. 1983. Conodonten aus Tibet. *JA Monatscheft* 1983(2) p. 70
563. Ulrich, E. O., *et al.* 1944. Ozarkian and Canadian Cephalopods, *GP* 58
564. Flower, R. and C. Teichert. 1957. The Cephalopod Order Discosorida. *KA Article* 6, p. 33

565. Ingavat, R., Maunlek, S., and C. Vdomratin. 1975. On the Discoveries of Permian fusulinids and Ordovician Cephalopods of Ben Rai, West Thailand. *BB* 43(1)785
566. Kaplan, A. A. 1917. Silurian-Devonian Boundary Beds of Central Kazakhstan. *DE* 199(1-6)45-7
567. Xue-chang, Y. and R. Jia-yu. 1982. Brachiopods from the Upper Xiushan Formation (Silurian) in the Sichuan-Guishou-Hunan-Hubei Border Region. *SI* 21(4)432, 419
568. Yu-nan, N., *et al.* 1982. The Silurian Rocks of West Yunnan. *SI* 21:119
569. ________. 1982. Silur Sibirskoi Platformy. *SB* 508 (in Russian)
570. Hagen, D. and E. Kemper. 1976. Geology of the Thong Pha Plurm Area (Kancharaburi Province, West Thailand). *Geologisches Jahrbuch* B21, pp. 53-91
571. Benton, M. J. 1982. Dictyodora and associated trace fossils from the Palaeozoic of Thuringia. *LE* 15:115-32
572. Draper, J. J. 1980. Rusophycus (Early Ordovician ichnofossil) from the Mithaka Formation, Georgina Basin. *BM* 5:57-61
573. Barcellos, M. T. 1979. Scales and Teeth of fish of the Budo facies, Itarare Subgroup, Rio Grande de Sul. *BB* 43(4)1458.
574. Babin, *et al.* 1976. The Schistes de Porsiguen Formation (Upper Devonian) of Brest Roads, Armorican Massif. *BB* 46(2)383
575. Shitao, W., *et al.* 1980. The discovery of Silurian agnathans and Pisces from Chaoxian County, Anhui Province and its stratigraphic significance. *BB* 46(7)
576. Young, G. C. 1982. Devonian Sharks from South-Eastern Australia and Antarctica. *PA* 25(4)818
577. Vicente, J. C. 1975. Essai d'organisation palaeogeographique et structural du Paleozoique des Andes Meridionales. *RU* 64(2)358
578. Isaacson, P. E. 1974. First South American Occurrence of *Globithyris* Its Ecological and Age significance in the Malvinokaffric Realm. *JP* 48:779
579. Tian-rui, L. 1982. Trilobite Fauna from the Fentou Formation (Middle Silurian) of Nanjing and its Geologic Age. *SI* 21(4)455
580. Kobayashi, T. and T. Hamada. 1960. A New Proetid from Perlis, Malaysia. *JJ* 37:89
581. Chibukova, Ye. V. 1974. Floral Assemblages of Devonian-Carboniferous Boundary Beds and the age of the Solonchatka Creek Flora. *DE* 215:68
582. Xing-xue, L. and W. Hong-feng. 1982 On the Occurrence of Late Devonian Plants from Mt. Longmenshan, North Sichuan. *SI* 21(1)94
583. Tripathi, C. 1980. Note on the Report of diamiotite and plant remains from Salari area, Kaming district, Arunachal Pradesh. *BB* 47(1)170
584. Cai, C. and H-J. Schweitzer. 1983. Uber *Zosterophyllum yunnanicum* Hsu Aus dem Unterdevon Sud Chinas. *PH* B185:2
585. Yochelson, E. 1983. A Devonian aptychas (Cephalopoda) from Alabama. *JP* 59:124
586. Suarez-Riglos, M. 1979. Review of the Bolivian Devonian based on a new goniatite from Huamampampa Formation in Campo Redendo, Chuquisaca. *BB* 45:2991
587. Yiping, R. 1981. Devonian and Earliest Carboniferous Ammonoids from Guangxi and Guizhou. *NJ* 15:139
588. Luo-zhao, L. 1982. *Gansuceras*, a New Devonian Cephalopoda from Gansu. *SI* 21(3)342
589. Yong-yi, C. 1982. Some Tabulate Corals from Late Middle Devonian in Baijinksham District of Dahinganling. *SI* 21(4)479
590. Boucot, A. J., Brunton, C. H. C., and J. N. Theron. 1983. Implications for the age of the South African Devonian rocks in which *Tropidoleptus* (Brachiopoda) has been found. *GM* 120(1)51-3
591. Zheng-xiang, T. 1982. Earliest Devonian Brachiopod Fauna from Ruergai, Sichuan and Diebu, Gansu. *SI* 21 (3)337
592. Johnson, J. G. 1970. Great Basin Lower Devonian Brachiopoda. *MM* 121, p. 4-9
593. Cooper, G. A. and J. T. Dutro. 1982. Devonian Brachiopods of New Mexico. *BP* 82, 83, no. 315, p. 6
594. Isaacson, P. E. and D. G. Perry. 1977. Biogeography of *Tropidoleptus* (Brachiopoda, Orthida during the Devonian, and Morphological Considerations. *JP* 51:1109
595. Yiping, R. 1981. Carboniferous Ammonoid faunas from Qixu in Nandan of Guangxi. *NJ* 15:226
596. Kochanssky-Devide, V., *et al.* 1980. Carboniferous of Northwest Yugoslavia. *BB* 44(4)1406
597. Young, J. A. 1942. Pennsylvanian Scaphopoda and Cephalopoda from New Mexico. *16*:121-5
598. Wilson, R. M. 1980. A goniatite from the Mill Hill Maine Band, Lower Limestone Group of East Fife. SG 16:33
599. Ming-qian, W. 1981. Carboniferous Ammonoids from Eastern Xinjiang. *SI* 20(5)480
600. Wang-shi, W. and Z. Cai-lin. 1982. Early Carboniferous Corals in the Ammonoid Facies from Barkol, Xinjiang. *SI* 21(2)151
601. De-you, W. 1982. Some Marine Pelecypods from the Middle Carboniferous in Gushi of Henan. *SI* 21(4)46
602. Mapes, R. H. 1979. Carboniferous and Permian Bactritoidea (Cephalopoda) in North America. *KA Article* 4:3-4
603. Miller, A. K. and W. Yongquist. 1942. American Permian Nautiloids. *MM* 41
604. Vdorenko, M. V. 1975. Zoogeograficheskoe Rannemraronirovaniye Evraziiskoi Oblasti Karbonie (Vizeiski Vyek) po danym Foraminifer. *VO* 18:22-5 (in Russian)
605. Lipina, O. A. 1973. Zonalnaya Stratigrafiya i Paleobiogeografiya turne po Foraminiferam. *VO* 16:11-25 (in Russian)
606. Dumont, J. F. and M. Lys. 1973. Description of an autochthonous Carboniferous Sequence, Coller Bolgesi, Egrider. *BB* 42(1)545
607. Hamadat. 1964. Two Carboniferous Brachiopods from Loeiy, Thailand. *JJ* 35(1)6
608. Konovalova, M. V. 1975. Nekatoriye Paleobiogeograficheskoe i Paleoecologicheskoe ossobenosti postdnekammenougolnich i Rannepermskich Foraminifer Timano-Cechorskoi oblasti. *VO* 18:148 (in Russian)
609. Jiang-xiu, H. 1982. Middle and Upper Carboniferous Fusulinids from the Nadanhada Range, Heilongjiang Province. *SI* 21(3)
610. Marfenkova, M. M. 1975. Paleogeografiya i Foraminifery Rannevo Karbona Chu-Betrak-Dalinskovo Baseina (Yuzhniy Kazahstan). *VO* 18:63 (in Russian)
611. Ivanovskiy, A. B. and G. S. Kropacheva. 1980. A Discovery of *Pseudofavosites* (tabulata) in the Permian rocks of the Soviet Far East. *DE* 252:189
612. Barthvon, W. 1972. Das Permokarbon Bie Zudiniz (Bolivia) und eine Ubersedt des Jung palaezoikums in Zentral Teil der Andem. *RU* 61:249-65
613. Sokratov, B. G. 1983. Oldest Triassic strata and the Permian-Triassic boundary in the Caucasus and Middle East. *IG* 25(4)488
614. Xi-luo, L. 1982. Some Early Permian Ammonoids from Jilin and Nei Monggol. *SI* 21(6)5
615. Furnish, W. M., *et al.* 1973. Permian Ammonoid *Cyclolobus* from the Zerwan Formation, Guryul Ravine, Kashmir. *SC* 180:188
616. Zhuo-quan and M. Jun-wen. 1982. Early Lower Permian Ammonoids from Yichuan, Jiangxi. *SI* 21(3)288
617. Miller, A. K. and S. G. Unklesbay. 1974. Permian Nautiloids from Western United States. *JP* 16:111-17
618. Dowson, D. T. 1978. A Permian aulocerid from Saraburi, central Thailand. *BB* 43(1)446
619. Chung-duen, Y. 1979. A nothosaur from Lu-hsi County, Yunnan Province. *BB* 43(4)1521
620. Demathieu, G. et M. Wiedram. 1982. Les empreiutes de pas de reptiles dans le Trias du Vieux Emossen (Finhaur, Valais, Suisse). *HE* 75(3)722
621. Bermudo, Melendez D. 1980. Discovery of a "protoavian" reptile from the Triassic of the Prudes Mountain Range, Taragona. *BB* 44(4)1868.
622. Zhong-jian, Y. 1980. A New Late Permian fauna from Jiyuan County, Henan Province. *BB* 44(4)1869.
623. Beltan, L., *et al.* 1979. A new marine fish and placodont reptile fauna of Ladinian age from Southwestern Turkey. *JA Monatschefte* 1979(5)258
624. Selozneva, H. A. 1982. Triassic Fish Finds in the Franz Jozef Land Archipelago. *PJ* 16(2)131
625. Martin, M. 1980. Diptheronotus Gibbosus (Actinopterygi, Chondrostie) Nouveu Colobodortide du Trias Superieur Continental Marocain. *BI* 13(3)445
626. Stipanicic, P. N. 1980. The Triassic of the Rio de Los Patos Valley, San Juan. *BB* 44:1781

627. Russell, D. and D. Russel. 1977. Preliminary Results of paleontologic exploration in the Triassic of Algarve, Portugal. *BB* 45(2)2660
628. Vollrath, A. 1977. A discovery of *Semionotus* (Pisces, Ganoidea) in the Stuben Sandstone near Winnenden. *BB* 42(2)2109
629. Johnson, G. D. 1980. *Xenacanhtodii* (Chondrichthees) from the Tecovas Formation (Late Triassic) of West Texas. *JP* 54(5)925
630. Nairn, A. E. M. 1978. Northern and Eastern Africa (*in* Moullade M. and A. E. M. Nairn. 1978. *The Phanerozoic Geology of the World.* A. Mesozoic) El., p. 356-8
631. ________. 1982. Bio-i Lithostratigrafiya Triasa Sibiri. *SB* 462 (in Russian)
632. Podstolski, R. 1980. Cephalopods from the Gorazde Beds (lower Muschelkalk) quarried at Gorazde near Opole. *BB* 45(2)2446
633. Turculet, I. 1980. Norian fauna of the Ciungi Klippe, Rarau Bucovine, eastern Romanian Carpathians. *BB* 47 (2)377
634. Shilin, P. V. and Yu. V. Suslov. 1982. A Hadrosaur from the Northeastern Aral Region. *PJ* 16(1)132
635. Sanz, J. L. 1982. A Sauropod Dinosaur from the Lower Cretaceous of Galve (Province of Teruel, Spain). *BI* 15(6)944
636. Zeng, D. and Z. Jin-jian. 1980. Fossil Dinosaur eggs from the eastern part of the Dongting Basin, Hunan Province. *BB* 44(2)2667
637. Zhao, Z. 1979. The discovery and significance of a new type of dinosaur eggs and a dinosaur footprint from Neixiang County, Henan Province. *BB* 45(2)3448
638. Smith, P. L. 1983. The Pliensbachian ammonite *Dayiceras dayiceroides* and Early Jurassic paleogeography. *CE* 20(1)89
639. Hirano, H. 1982. Cretaceous biostratigraphy and ammonites in Hokkaido. *Proceedings of the Geologists' Association* 93(2)213
640. Shotwell, J. A. 1961. Late Tertiary Biogeography of Horses in the Northern Great Basin. JP 35:205-8
641. West, M. R. M. 1979. Apparent prolonged evolutionary stasis in the Middle Eocene hoofed mammal *Hyopsodus*. *PB* 5(3)253
642. Olson, S. L. and Y. Hasegawa. 1979. Fossil Counterparts of Giant Penguins from the North Pacific. *SC* 206:688-9
643. Whitcomb, J. C. and H. M. Morris. 1961. *The Genesis Flood.* Presbyterian and Reformed Pub. Co., pp. 273-5
644. Price, G. M. 1923. *The New Geology.* Pacific Press, California
645. Clark, H. W. 1968. *Fossils, Flood, and Fire.* Outdoor Pictures, California
646. Burdick, C. L. 1976. What about the zonation theory? *CR* 13(1)37-8
647. Morris, H. M. and G. E. Parker. 1982. *What is Creation Science?* Creation-Life Pub., San Diego, p. 212
648. McLaren, D. J. 1977. The Silurian-Devonian Boundary Committee: A Final Report (*in* Martinson, A. 1977. *The Silurian-Devonian Boundary.* E. Schweizerbutsche, Stuttgart) 27-8
649. ________. 1982. Response by Phillip Gingerich. *JP* 56:831
650. Watson, J. V. 1982. Single-system geology after Arkell. *NA* 295:268
651. McKerrow, W. S. 1971. Palaeontological prospects—the use of fossils in stratigraphy. *GL* 127:455-6
652. Cowie, J. W., *et al.* 1972. A Correlation of Cambrian rocks in the British Isles. *GL Special Report No. 2*, p. 40
653. Woodmorappe, J. 1978. The Cephalopods in the Creation and the Universal Deluge. *CR* 15(2)100-3
654. Stanley, S. M., Andicott, W. O., and K. Chinzie. 1980. Lyellian curves in paleontology; Possibilities and Limitations. *GE* 8:424
655. Chaloner, W. G. and W. S. Lacey. 1973. The Distribution of Late Palaeozoic Floras (*in* Hughes. 1973. *op. cit.*), p. 274
656. Bartenstein, H. and H. M. Bolli. 1977. The Foraminifera in the Lower Cretaceous of Trinidad, West Indies. *HE* 70(2)552
657. Windle, T. M. F. 1979. Reworked Carboniferous Spores: An Example from the Lower Jurassic of Northeast Scotland. *Review of Paleobotany and palynology* 27:174-on. Chapter under "Unrecognized Reworking."
658. Ethington, R. L. and D. Schumacher. 1969. Conodonts of the Copenhagen Formation (Middle Ordovician) in Central Nevada. *JP* 43:478
659. Harland, W. B. (ed.). 1967. *The Fossil Record: a symposium with documentation*, Geological Society of London/Palaeontological Association, 827 p.
660. Raup, D. M. 1978. Cohort analysis of generic survivorship. *PB* 4:3-13
661. Cutbill, J. L. and B. M. Funnel. 1967. Numerical Analysis of *The Fossil Record* (*in* Harland. 1967. *op. cit.*), p. 793-4
662. Koch, C. F. 1978. Bias in the published fossil record. *PB* 4(3)367
663. Sepkoski, J. J. 1979. A kinetic model of Phanerozoic taxonomic diversity A. Early Phanerozoic families and multiple equilibria. *PB* 5(3)230
664. Kielan-Jaworska, Z. 1975. Late Cretaceous Mammals and Dinosaurs from the Gobi Desert. *American Scientist* 3:150
665. Lubenow, M. L. 1980. Significant fossil discoveries since 1958: Creationism Confirmed. *CR* 17(3)148-60
666. Woodmorappe, J. 1980. An Anthology of Matters Significant to Creationism and Diluviology: Report 1. *CR* 16:11-2
667. Woodmorappe, J. 1982. An Anthology of Matters Significant to Creationism and Diluviology: Report 2. *CR* 18:219 (stratigraphic-range extensions) and 209-16 (alleged reworking)
668. Shu, O. 1982. Upper Permian and Lower Triassic palynomorphs from eastern Yunnan, China. *CE* 19:79
669. Bengston, S. 1981. *Atractosella*, a Silurian alcyonacean Octocoral. *JP* 55:281
670. Collins, D. and A. M. Rudkin. 1981. *Priscansermarinus Bernetti*, a Probable Lepadomorph Barnacle from the Middle Cambrian Burgess Shale of British Columbia. *JP* 55:1014
671. Raup, D. M. 1976. Species diversity in the Phanerozoic: a tabulation. *PB* 2:288
672. Simpson, G. G. 1980. *Why and How: Some Problems and Methods of Historical Biology.* Pergamon Press, Oxford, New York, p. 6
673. Maheshwari, H. K. 1972. Permian Wood from Antarctica and Revision of Some Lower Gondwana Wood Taxa. *PH* B138:5
674. Karamlov, V. B. 1967. Discoveries of Ancient Onealites and Catagraphs in Paleozoic Sediments of the Shanton Islands. *DE* 175:85-7
675. Krasnov, Ye. V. and V. O. Savitskiy. 1973. Upper Jurassic Coral Reefs of Sakhalin and the Hypothesis of Drift of the Japanese Islands. *DE* 209:53
676. Harper, C. W. 1981. Inferring Succession of Fossils in Time: The Need for a Quantitative and Statistical Approach. *JP* 55:442
677. Stubblefield, C. J. 1956. Cambrian Palaeogeography in Britain. *20th CO*, vi, p. 6
678. Brand, P. J. 1965. New Lower Cambrian Fossil Localities in Northwest Scotland. *SG* 1:285-6
679. Cowie, *et al.* 1971. op. cit., entire volume.
680. Sheehan, P. M. 1980. Paleogeography and Marine Communities of the Silurian Carbonate Shelf in Utah and Nevada (*in* Fouch, T D., *et al.* 1980. *Paleozoic Paleogeography of the West-Central United States.* SEPM Rocky Mt. Section) p. 20
681. Gutschick, R. C., *et al.* 1980. Mississippian Shelf Margin and Carbonate Platform from Montana to Nevada. (*In* Fouch. 1980. *op. cit.*)
682. Mudds, J. R. 1981. Discovery of the Carboniferous Coral *Dorlodotia* in Northern England. YG 43:331-40
683. Stanley, K. O. 1971. Tectonic and Sedimentologic History of Lower Jurassic Sunrise and Dunlop Formations, West-Central Nevada. *AG* 55(3)455
684. Cope, J. C. W., *et al.* 1980. A Correlation of Jurassic Rocks in the British Isles. *GL Special Paper 15*, both volumes.
685. Imlay, R. W. 1980. Jurassic Paleobiogeography of the Conterminous United States in Its Continental Setting. *UG* 1062:43
686. Howarth, M. K. 1980. The Toarcian Age of the Upper Part of the Marlstone Rock Bed of England. *PA* 23:638
687. Raup, D. M. and R. E. Crick. 1979. Measurement of Faunal Similarity in Paleontology. *JB* 53:1213
688. Potapenko, Yu. Ya. and G. A. Stukalina. 1971. First Find

of Fossils in the Metamorphic Complex of the Main Caucasus Range. *DE* 198:134

689. Yochelson, E. L. and E. Stump. 1977. Discovery of early Cambrian Fossils at Taylor Nunatak, Antarctica. *JP* 51: 873
690. Skehan, J. W., Murray, D. P., and A. R. Palmer. 1972. p. 694
691. Collier, K. O. 1981. An Empirical Estimate of Preservation Bias in Paleobiogeography. GA 13(7)429
692. Woodmorappe. 1978. (ref. 653; *op. cit.*), pp. 104-9
693. Nelson, S. J. 1981 Stratigraphic Position of Ordovician Oil Shales, Southhampton Island, Northwest Territories, Canada *AG* 65:1174
694. Sheehan, D. M. 1982. The Dichotomy of Mid-Paleozoic Community Evolution-Epicontinental Seas vs. Open Seas. *GA* 5(14)288
695. Taylor, M. E. and R. M. Forester. 1979. Distributional model for marine isopod crustaceans and its bearing on early Paleozoic paleozoogeography and continental drift. *GB* 90:405-13
696. Crick, R. E. 1980. Integration of Paleobiogeography and Paleogeography: Evidence from Arenigian Nautiloid Biogeography. *JP* 54:1220-1
697. Parker, R. B. and H. Toots. 1980. Trace Elements in Bones are Paleobiological Indicators (*in* Behrensmeyer, A. K. and A. P. Hill. 1980. *Fossils in the Making. UC*, p. 206
698. Ronov, A. B. 1982 The Earth's sedimentary shell (quantitative patterns of its structure, compositions, and evolution. *IG* 24(12)1381 (Part II)
699. Ronov, A. B. 1982. The Earth's sedimentary shell (quantitative patterns of its structure, compositions, and evolution. *IG* 24(11)1321-39 (Part I)
700. Hobson, G. D. and E. N. Tiratsov. 1981. *Introduction to Petroleum Geology*, 2nd Edition. Gulf Pub. Co. Houston, Texas, p. 271
701. Stokes, W. L. 1983. Diastrophy—a Word Whose Time Has Come. *Journal of Geological Education.* 31:35
702. Dott, R. H. 1982. The Challenge of Scientific Creationism. *JP* 56:268
703. Woodmorappe, J. 1981. The Essential Nonexistence of the Evolutionary-Uniformitarian Geologic Column: A Quantitative Assessment. *CR* 18(1)58-67
704. Milne, D. H. 1981. How to Debate with Creationists—and "Win." *American Biology Teacher.* 43(5)238, his figure 1b
705. Benton, M. J. 1983. Large-scale replacements in the history of life. *NA* 302(3)17
706. Jones, A. J. 1973. How Many Animals in The Ark? *CR* 10:102-8
707. Jochmans, J. R. 1978. *Strange Relics from the Depths of Earth.* Bible-Science Organisation.
708. Walker, A. C. 1980. Functional Anatomy and Taphonomy (*in* Behrensmeyer and Hill. 1980. *op. cit.* Ref. 197), p. 182-3
709. Daghlian, C. P. 1981. A Review of the Fossil Record of Monocotyledons. *Botanical Review* 47(4)523
710. Woodmorappe. 1978. *op. cit.* (Ref. 653), p. 101
711. Lipps. 1983. (Letter) *Science Digest*, February 1983, p 9
712. Carrol, R. L. 1977. Patterns of Amphibian Evolution: an extended Example of the incompleteness of the Fossil Record (*in* Hallam, A. 1977. *Patterns of Evolution in the Fossil Record. EL*), p. 422
713. Simpson. 1980. *op. cit.*, (Ref. 672), p. 252-5
714. von Wellnitz, M. 1979. Noah and the Flood: The Apocryphal Traditions. *CR* 16(1)44
715. Behrensmeyer, A. and R. E. D. Boaz. 1980. The Recent Bones of Amboseli Park, Kenya, in Relation to East African Paleoecology (*in* Behrensmeyer and Hill. 1980. *op. cit.*, Ref. 697), p. 80
716. Signor, P. W. III. 1982. Species richness in the Phanerozoic: Compensating for sampling bias. GE 10:626
717. Shotwell, J. A. 1955. An Approach to the Paleoecology of Mammals. *EC* 36:328
718. Bishop, W. W. 1980. Paleogeomorphology and Continental Taphonomy (*in* Behrensmeyer and Hill. 1980. *op. cit.*), p. 32
719. Wall, W. P. 1983. The Correlation Between High Limb-Bone Density and Aquatic Habits in Recent Mammals. *JP* 57:197
720. Schafer, W. 1972 (translated). *Ecology and Palaeoecology of Marine Environments. UC*, p. 20
721. Hill, A. P. 1980. Early Postmortem Damage to the Remains of Some Contemporary East African Mammals (*in* Behrensmeyer and Hill. 1980. *op. cit.*), p. 134
722. Hill, A. 1979. Disarticulation and scattering of mammal Skeletons. *PB* 5(3)262
723. Boaz, N. T. and A. K. Behrensmeyer. 1976. Hominid Taphonomy: Transport of Human Skeletal Parts in an Artificial Fluviatile Environment. *American Journal of Physical Anthropology* 45:59
724. Gifford, D. P. and A. K. Behrensmeyer. 1977. Observed Formation and Burial of a Recent Human Occupation Site in Kenya. *Quaternary Research* 8:245-66
725. Behrensmeyer, A. K. and A. P. Hill. 1980. Introduction (*in* Behrensmeyer and Hill. 1980. *op. cit.* Ref. 697), p. 1
726. Hill, A. 1978. Taphonomical background to fossil man-problems in palaeoecology (*in* Bishop, W. W. 1978. *Geological Background to Fossil Man.* Scottish Academic Press), p. 98
727. Behrensmeyer, A. K. 1978. Taphonomic and ecologic information from bone weathering. PB 4(2)150-62
728. Behrensmeyer, A. K., *et al.* 1979. New perspectives in vertebrate paleoecology from a recent bone assemblage. *PB* 5(1)14
729. Rolfe, W. D. I. and D. W. Brett. 1969. Fossilization Processes (*in* Eglinton G. and M. T J Murphy. 1969. *Organic Geochemistry. SP*), p. 226
730. Whitcomb & Morris. 1961. *op. cit.* p. 26
731. Cooper, *et al.* 1982. Late Precambrian and Cambrian Fossils from Northern Victoria Land and their Stratigraphic Implications (*in* Craddock, C. 1982. *Antarctic Geoscience.* University of Wisconsin Press), p. 630
732. Clarkson, P. D., Hughes, C. P., and M. R. A. Thomson. 1979. Geological Significance of a Middle Cambrian fauna from Antarctica *NA* 279:791
733. Dalziel, I. W. D. 1982. The Early (Pre-Middle Jurassic) History of Scotia Arc Region: A Review and Progress Report (*in* Craddock. 1982. *op. cit.*), pp. 114-5
734. Ke-xing, Y. and Z. Sen-gui. 1983. Discovery of the *Tommotia* Fauna in Southwest China *SI* 22(1)40
735. Stumm, E. C. 1956. Upper Cambrian Trilobites from Michigan. *Contributions of the Museum of Paleontology, University of Michigan.* XIII(4)95
736. Oosthuizen, R. D. 1981. An Attempt to Determine the Provenance of the Southern Dwyka from Palaeontological Evidence. *AF* 24:27-8
737. Sen-Gui, Z. 1983. Early Cambrian Archoeocyathids from Kuruktag, Xinjiang. *SI* 22(1)18
738. Yen-hao, L. 1976. Ordovician Biostratigraphy and Palaeogeography of China. *NJ* 7, p. 23
739. Alexander, R. R. 1975. Phenotypic Lability of the Brachiopod *Rafinesquina Alternata* (Ordovician) and Its Correlation with the Sedimentological Regime. *JP* 49:608
740. Sheehan, P. M. 1975. Lower Devonian Brachiopods from the Solis Limestone, Chihuahua, Mexico. *JP* 49:445
741. Bassi, U. K., Chopra S. and B. M. Datta. 1983. A New Phanerozoic Basin in Kinnaur, Himachal Himalayo. *IN* 24:281-90
742. Crick, R. E. and C. Teichert. 1983. Ordovician endocerid genus *Anthocerass* its occurrence and morphology. *CH* 7(2)155
743. Cai-gen, L. 1982. Ordovician Cephalopods from Xainza, Xizang (Tibert). *SI* 21(5)558
744. Karatajute-Talimaa, V. N. 1978. Silurskiye i Devonskiye Telodonty CCCP i shpitzbergena. Mosklas, Vilnius, 334 p. (in Russian)
745. Blieck, A., *et al.* 1982. Vertebres du Devonien superieur d'Afghanistan. *Bull du Museum National d'Historie Naturell* 4e serie T, p. 5
746. Boucot, A. J., Doumani, G. A., and G. F. Webers. 1967. Devonian of Antarctica (*in* Oswald, D. H 1967 *op. cit.*), p. 640-1
747. Young, G. G. and J. D. Gorter. 1981. A new fish fauna of Middle Devonian age from the Taemas/Wee Jasper region of New South Wales. *Australia, Bureau of Geology and Mineral Resources*, p. 86
748. Carozzi, A. V. 1979. Petroleum Geology in the Paleozoic Clastics of the Middle Amazon Basin, Brazil. *PE* 2(1) 66-7

749. Denison, R. H. 1966. *Cardipeltis* An Early Devonian Agnathan of the Order Heterostraci. *FI* 16(4)89-92

750. Long, T. A. 1983. New Bothriolepid Fish from the Late Devonian of Victoria, Australia. *PA* 26:296

751. Stumm, E. C. 1953. Lower Middle Devonian Proetid Trilobites from Michigan, Southwestern Ontario, and Northern Ohio, *Contributions of the Museum of Paleontology, University* of *Michigan* XI(2)15

752. Carls, P. and R. Lages. 1983. Givetium und Ober-Devon in der Ostlichen Iberischen Ketten (Spanien). *Zietschrift der Deutchen Geologischen Gesselschaft* 134(1)120-3

753. Rzhonsnitskaya, M. A. 1978. *Yarusnoye Raschlenenie Nizhnevo Devona Tiho'okeanskoi oblasti na Teritorii CCCP.* Moskva, Hedra, p. 10 (in Russian)

754. Plumstead, E. P. 1964. Palaeobotany of Antarctica (in Adie, R. J. 1964. *Antarctic Geology. JW),* p. 638

755. Jing-zhi, *et al.* 1979. *Advances in the Carboniferous Biostratigraphy of China.* Academia Sinica, Nanjing China, p. 4

756. Tanner, W. R. 1983. A New Species of *Gosslingia* (Zosterophyllophyton) from the Lower Devonian Beartooth Butte Fm. of Northern Wyoming *(in* Mamet, B. and M. J. Copeland. 1983. *Third North American Paleontological Convention Proceedings)* V. 1, p. 541

757. Singh, G., Maithy, P. K., and M. N. Bose. 1982. Upper Palaeozoic Flora of Kashmir Himalaya. *BO* 30(2)194

758. Grindley, G. W., *et al.* 1980. A Mid-Late Devonian Flora from the Rupert Coast, Marie Byrd Land, West Antarctica. *Journal* of *the Royal Society* of *New Zealand* 10(3)271-2

759. Bogoslovskiy, B. I., Poslavskaya, I. A., and O. Ye. Belyayev. 1982. Frasnian ammonoids from Central Kazakstan. *PJ* 16(3)32

760. Gupta, V. J. and H. K. Erben. 1983. A Late Devonian ammonoid faunule from Himachal Pradesh, India. *PZ* 57(1/2), p. 93

761. Anderson, T., *et al.* 1974. Geology of a Late Devonian Fossil Locality in the Sierra Buttes Fm., Dugan Pond, Sierra City Quadrangle, California. *GA* 6(3)139

762. Petersen, M. S. and W. L. Stokes. 1983. A clymenid ammonoid from the Pinyon Peak Limestone of Utah. *JP* 57:717

763. Yan, Z. and R. Yiping. 1983. Discovery of a Devonian ammonoid Species from Ejin Banner of Western Inner Mongolia. *SI* 22

764. Boucot, A. J., Massa, D., and D. G. Perry. 1983. Stratigraphy, Biogeography, and Taxonomy of Some Lower and Middle Devonian Brachiopod-Bearing Beds of Libya and Northern Niger. *PH* 180A, p. 95

765. Kropachev, A. P., *et al.* 1982. The Fammenian Deposits in the North of the Sette-Daban Range. *SV* 23(5)117

766. Miller, H. 1982. Geologic Comparison between the Antarctic Peninsula and Southern South America *(in* Craddock. 1982. *op. cit.),* p. 127

767. Yin, T. H. 1935. *Upper Palaeozoic Ammonoids* of China. Peiping, pp. 1-6

768. Yi-ping, R. 1979. *On the Occurrence and Stratigraphical Significance of the Carboniferous Ammonoid Faunas* in *Nandan* of *Guangxi.* Academia Sinica, Nanjing, China, pp. 3-7

769. Campbell, K. S. W., Brown, D. A., and A. R. Coleman. 1983. Ammonoids and the correlation of the Lower Carboniferous rocks of eastern Australia. *CH* 7(2)76

770. Lin, R. 1983. Fusulinacean Fauna from the Quanwangtou Limestone (Early Upper Carboniferous) in Jiawang Coal Field, Northern Jiangsu. *SI* 22(2)179

771. Chandra, A. and A. K. Srivastava. 1982. Plant Fossils from the Talchir and Coal-Bearing Formations of South Rewa Gondwana Basin, India and their Biostratigraphical Significance. *BO* 30(2)143-67

772. Benita, M. and D. L. Jones. 1983. Tectonic and Paleobiologic Significance of Permian Radiolarian Distribution in Circum-Pacific Region. *AG* 67(3)522

773. Archbold. N. W. 1983. Permian Marine invertebrate provinces' of the Gondwanan Realm. *CH* 7(1)61-70

774. Nassichuk, W. W. 1970. Permian ammonoids from Devon and Melville Islands, Canadian Arctic Archipelago. *JP* 41:77

775. Kobayashi, I., *et al.* 1982. Discovery of Carboniferous-Permian bryozoans at Ikadomari in Sado Island. *BB* 47 (7)1792

776. Olson, E. C. 1967. Early Permian Vertebrates. *Oklahoma Geological Survey* Circular 74

777. Clemens, W. A., *et al.* 1979. Where, When, and What *(in* Lillegraven, J. A., *et al.* 1979 *Mesozoic Mammals.* University of California Press), p. 14

778. Hammer, W. R. and J. W. Cosgriff. 1981. *Myosaurus Gracilis,* an Anomodont Reptile from the Lower Triassic of Antarctica and South Africa. *JP* 55:411

779. Colbert, E. H. 1982. Mesozoic Vertebrates of Antarctica *(in* Cradock. 1982. *op. cit.),* p. 620-1

780. Monod, O., *et al.* 1983. Decouverte de Dipneustes Triasianes (Ceratodontiformes, Dipnoi) dans la Formation de Cenger ("Arkoses Rouges") da Touras Lycien (Turquie Occidentale) *BI* :167

781. Banks, M. R. 1978. Correlation Chart for the Triassic System of Australia. *Australia: Bureau of Mineral Resources, Geology, and Geophysics* Bulletin 156C

782. Dziewa. T. J. 1980. Note on a Dipnoan Fish from the Triassic of Antarctica. *JP* 54:488-9

783. Thulborn, R. A. 1983. A Mammal-like reptile from Australia. NA 303:330

784. Pie-xia. G. 1982. On the Occurrence of Late Lower Triassic Ammonoids from Anhui and Jiangsu. *SI* 21(5)567

785. Yi-gang, W. 1983. Ammonoids from Falang Formation (Ladinian-E. Carnian) of Southeast Guizhou, China. *SI* 22(2)160

786. Mahashwari, H. K. 1982. Mesozoic Plant Fossils from the Himalayas-A Critique. *BO* 30(3)243

787. Bose, M. N., *et al.* 1982. *Pachypteris Haburensis* N.S.P. and Other Plant Fossils from the Pariwar Formation. *BO* 30(1)1-2

788. Ballance, P. F. and W. A. Watters. 1971. The Mawson Diamictite and the Carapace Nunatak, Victoria Land, Antarctica. *New Zealand Journal* of *Geology and Geophysics* 14 (3) 521

789. Askin, R. H. and D. H. Elliot. 1982. Geologic Implication of recycled Permian and Triassic palynomorph in Tertiary rocks of Seymour Island, Antarctic Peninsula. *GE* 10:547-51

790. Behrendt, J. and T. S. Laudon. 1964. Cretaceous Fossils Collected at Johnson Nunatak. Antarctica. SC 143:353-4

791. Quilty, P. G. 1970. Jurassic Ammonites from Ellsworth Land, Antarctica. *JP* 44:110

792. ———— 1982. Atlas Bespozvonochnikh Pozdnemyelovih Morei Prikaspiiskoi Upadini. *TR* 187:4, 193-228

793. Davoudzadeh. M. and K. Schmidt. 1983. Contribution to the Paleogeography and Tectonics of the Middle and Upper Jurassic of Irah. JAAbh. 166(3)331

794. Thomson, M. R. A. 1980. Late Jurassic ammonite faunas from the Latady Formation, Orville Coast. *Antarctic Journal of the United States* 15(5)28-30

795. Thomson' M. R. A. 1982. A comparison of the ammonite faunas of' the Antarctic Peninsula. *GL* 139:763-70

796. Carpenter, K. 1982. The Oldest Late Cretaceous Dinosaurs in North America? *Mississippi Geology* 3(2)13

797. Bose, M. N., Kutty, T. S., and H. K. Mahashwari. 1982. Plant Fossils from the Gangapur Formation *BO* 30(2)122

798. Pei-ji, C. 1983. A Survey of the non-marine Cretaceous in China, *Cretaceous Research* 4:128

799. Wellenhofer, P., *et al.* 1983. A Pterosaurian from the Lower Cretaceous of Brazil. *PZ* 57(l/2) 149

800. Birkenmayer. K.. *et al.* 1983. Cretaceous and Tertiary fossils in glaciomarine strata at Cape Melville, Antarctica. NA 303:56

801. Zaborski, P. M. 1982. Campanian and Maastrichtean sphenodiscid ammonites from southern Nigeria. *BR* 36(4)304

802. Farquharson, G. W. 1982. Late Mesozoic sedimentation in the Northern Antarctic Peninsula and its relationship to the southern Andes. GL 139:721-2

803. Dong-li. S. and Z. Bing-gao. 1983. Aspects of the Marine Cretaceous of China. *Cretaceous Research* 4:147

804. Lillegraven, J. A. and A. R. Tabrum. 1983. A new species of Centetodon (Mammalia, Insectivora, Geolabididae) from southwestern Montana. *University* of *Wyoming Contributions to Geology.* 22(1)58

805. Savage, D. E. and D. E. Russell. 1983. *Mammalian Paleofaunas* of *the World.* Addison-Wesley Pub. Co., 432 p.

806. Woodburne, M. O. and W. J. Zinsmeister. 1982. Fossil Land Mammal from Antarctica. SC 218:284

807. Zinsmeister, W. J. and H. H. Camacho. 1982. Late Eocene Molluscan Fauna of LaMeseta Formation of Seymour Island, Antarctic Peninsula. *(in* Craddock. 1982. *op.* cit.), p. 300-1