Journal of Environmental Science and Engineering B 11 (2022) 165-188
doi:10.17265/2162-5263/2022.05.002

Distribution Pattern and Geographical Division of Terrestrial Living Things in the World

Shen Xiaocheng[1,2], Lu Jiqi[2], Ren Yingdang[1], Shen Qi[3], You Zhixing[4], Liu Xintao[1], Zhang Shujie[2], Wang Guanghua[1] and Yang Linlin[1]

1. Institute of Plant Protection, Henan Academy of Agricultural Sciences, Zhengzhou 450002, China

2. College of Life Sciences, Zhengzhou University, Zhengzhou 450001, China

3. First Clinical College, Henan University of Chinese Medicine, Zhengzhou 450000, China

4. Academy of Mathematics and Systems Sciences, Chinese Academy of Sciences, Beijing 100049, China

Abstract: After summary of the distribution data of 180,661 genera of terrestrial animals, plants, fungi, bacteria and viruses in the world, according to the ecological conditions such as topography and climate, the world land is divided into 67 BGUs (Basic Geographic Units), which are analyzed by four quantitative methods: Single linkage method, Average group linkage method, Sum of squares method and MSCA (Multivariate Similarity Clustering Analysis) method. The MSCA has stronger data mining ability than the first three traditional clustering methods, and can obtain more, more detailed, more accurate and more stable clustering results. According to the clustering results, the first world biogeographical regionalization system was established. This system not only affirms and supports the reasonable scientific core of the mammalian and flowering plant geographical division plan formulated by the predecessors of scholars in the 19th century, but also revises some imbalances in the division criteria and boundary determination caused by their qualitative methods, unifying various global geographical division plans emerging since the 21st century.

Key words: Terrestrial organisms, animals, plants, fungi, bacteria, distribution, cluster analysis, geographical division.

1. Introduction

Biodiversity conservation has been the consensus of governments, scholars and people all over the world. There are more than 2 million kinds of creatures living on the earth's land. They are all over the world in different life forms. The drift of land blocks, the uplift of mountains, the change of climate, and the isolation of oceans affect the reproduction and diffusion of organisms, and organisms also build their own distribution patterns with their own evolution and adaptability. It is the research category of biogeography to analyze and summarize the distribution law and formation mechanism of organisms, and then divide the geographical distribution area. It is not only an important basic discipline for people to protect biodiversity, but also an effective tool to achieve rational, effective and sustainable use of natural resources [1-3].

Since the beginning of biogeography by the French naturalist G. Buffon in the middle of the 18th century [4], the British ornithologist P. Sclater has jointly laid the foundation of animal geography based on the distribution of birds, especially Passeriforms, and the British zoologist A. R. Wallace has proposed the animal geographical division scheme of 6 kingdoms and 24 subkingdoms, mainly based on the distribution of mammals [5, 6]. After German botanist A. von Humboldt [7] laid the foundation of plant geography in 1805, Swiss scholar A. de Candolle [8] and German scholar A. Engler [9] built the plant geography building according to the distribution of flowering plants. Later, people modified [10-13] to form a division system of 6

Corresponding author: Shen Xiaocheng, M.Sc., professor, research field: insectology, biogeography.

boundaries different from animals. Their interpretations of the 19th century are widely accepted and continue to be used [14].

Frankly speaking, people's universal acceptance and long-term use naturally show its reasonable core. These conclusions obtained by qualitative methods inevitably have imbalances in the determination of the criteria and boundaries. The exploration of biogeography has not stopped throughout the 20th century. On the one hand, people discussed the historical achievements and problems of early scholars [15-19], on the other hand, they actively tried to equip biogeography with quantitative analysis methods [20-29]. People have gradually come to a consensus that the intervention and support of mathematics should be an unavoidable or insurmountable way for the development of biogeography. Otherwise, it cannot be really mature [30].

Entering the 21st century, people's attention to biogeographical regionalization has risen rapidly [31-36], and different methods have been used to propose different geographic regionalization schemes for different biological groups [37-47]. C. B. Cox [41] proposed to remove the newly established Cape kingdom and Antarctic kingdom of phytogeography, and divide the paleotropical kingdom into the African kingdom and the Indo-Pacific kingdom. Wu Zhengyi [42] proposed to add the Tethys kingdom and Eastern Asiatic kingdom. S. Proches [43] conducted cluster analysis on the distribution of bats, divided the world into 10 geographical regions, and considered it suitable for animal geography and plant geography. H. Kreft [44] uses Simpson formula and UPGMA (Unweighted Pair Group Means Algorithm) method to group the world into seven kingdoms. Compared with Wallace scheme, except for the newly established Madagascar kingdom, the other boundaries have also changed. B. G. Holt [45] also used Simpson formula and UPGMA clustering method to analyze more than 20,000 species of terrestrial mammals, amphibians and non-marine birds, and divided the world into 11 kingdoms. And M. Rueda et al. [46] also analyzed these animals and believed that it was unnecessary to modify Wallace's scheme. E. J. Defriez and D. C. Reuman [47] jointly demonstrated the synchronization of land vegetation change in the world. In the face of such a controversial situation, it is no wonder that Professor J. J. Morrone [48] of Mexico sighed that geographical division is a spectre hindering the development of biogeography.

Compared with the highly discussed higher living things biogeography, the lower organisms are very cold. Although there are hundreds of documents involved in insect geography literature [49-51]. However, it was not until the last 20 years that individual groups of insects, such as Trichoptera, Siphonaptera, Symphyta, Staphylinidae, Aleurodidae, Cilicidae and Formicidae, were successively analyzed and their respective geographical division opinions were put forward [52-59]. However, no preliminary attempt has been made on microorganisms [60-69].

After trying and comparing various quantitative analysis methods, we put forward a new SGF (General Similarity Formula) [70] and its supporting MSCA (Multivariate Similarity Clustering Analysis) method [71, 72]. Through the analysis and verification of different geographical regions, different biological categories, different taxonomies, and different ecological groups, we can get results much faster, more accurate, and more reasonable than the traditional methods [73-97], and confirm the homogeneity of the distribution pattern of animals, plants, and microorganisms in China and the world [98, 99]. In view of the simplicity and rapidity of MSCA, based on the analysis of global insects [100], we analyzed the genus level of terrestrial living things around the world, and tried to establish the geographical division system of terrestrial living things around the world.

2. Materials and Methods

2.1 Global Terrestrial Species

According to the statistics of some scholars, there are 7 realms, 96 phyla, 352 classes, 1,466 orders and about 2.8 million species in the world [101]. Excluding deepsea species, fossil species, and subspecies classification, the biological groups involved in this study include 2,133,007 species of animals, plants and microorganisms of land, fresh water and shallow sea on the continental shelf, belonging to 8 kingdoms, 115 phyla, 356 classes, 1,352 orders, 8,714 families, 180,661 genera (Table 1). The species distribution information comes from the taxonomic monographs or catalogues compiled by biological taxonomists [102-207], and the database data compiled by biological professional websites [208-270], and some newly published new species and new distribution data are also supplemented at any time [271-326]. In order to improve the utilization rate of distribution data and the clarity of analysis results, this study uses the generic level as the BBU (Basic Biological Unit) for analysis [89, 97, 100].

2.2 Division of BGUs (Basic Geographic Units)

According to the ecological conditions such as topography and climate and the detailed degree of biological distribution data, the global land (except Antarctica) is divided into 67 BGUs (Fig. 1) [100]. Among them, there are 21 BGUs dominated by plains, 11 by hills, 12 by mountains, 11 by plateaus, 5 by deserts and 7 by islands. There are 27 BGUs in the tropics, 34 BGUs in the temperate zone and 6 BGUs in the cold zone.

2.3 Global Terrestrial Biological Distribution Database

Use Microsoft Access to build the database, with each BGU as a column and each BBU as a row. Convert the administrative regional records of each species' distribution within a genus into BGU records and summarize them into the genus distribution, and enter them into the database. If there is a distribution, it will be recorded as "1". If there is no distribution, it will not be recorded [100]. Totally, 180,661 genera of terrestrial organisms have 733,232 BDRs (Basic Distributive Records) in 67 BGUs, the AR (Average Richness) is 10,943.8 genera/BGU, and the ADT (Average Distributive Territory) is 4.06 BGUs/genera. These basic parameters of the database can provide basic estimates for the analysis results. If ADT is lower than 1.5, it will be difficult to obtain satisfactory results. Therefore, it should be considered to improve the biological order or reduce the number of BGUs. The number of biological genera of each BGU is shown in Table 2.

2.4 Clustering Method

Three commonly used hierarchical clustering methods and our new MSCA method are selected for analysis:

The single linkage method, also known as the nearest neighbor, uses Jackard (1901)'s similarity coefficient formula [20]: $SI=C/(A+B-C)$, which is the most basic clustering method;

Average group linkage method, also known as UPGMA (Unweighted pair group means algorithm) [25], uses the similarity coefficient formula of Szymkiewicz (1934) [22], also known as Simpson (1943) formula [23]: $SI=C/\min(A, B)$, which is a popular clustering method;

Table 1 Biodiversity of global terrestrial biota for this analysis.

Kingdom	No. of Phylum	No. of Classes	No. of Orders	No. of Families	No. of Genera	No. of Species
Animalia	20	63	373	4,631	141,814	1,334,834
Archaea	2	9	15	35	134	528
Bacteria	29	49	112	443	2,893	16,636
Chromista	13	68	291	1,280	5,577	79,122
Fungi	9	47	211	855	10,454	162,763
Plantae	15	41	215	1,006	17,526	527,776
Protozoa	11	43	80	295	831	4,809
Viruses	16	36	55	169	1,432	6,539
Total	115	356	1,352	8,714	180,661	2,133,007

Fig. 1 BGUs of the world.

01 Northern Europe, 02 Western Europe, 03 Central Europe, 04 Southern Europe, 05 Eastern Europe, 06 European Russia, 11 Middle East, 12 Saudi Arabia, 13 Yemen and Oman, 14 Plateau of Iran, 15 Central Asia, 16 Western Siberia, 17 Eastern Siberia, 18 Ussuri region, 19 Mongolia, 20 Plateau of Pamir, 21 Northeastern region of China, 22 Northwestern region of China, 23 Qinghai-Xizang region of China, 24 Southwestern region of China, 25 Southern region of China, 26 Centre-eastern China, 27 Taiwan region of China, 28 Korea Peninsula, 29 Japan, 31 Himalayan region, 32 Indian and Sri Lanka, 33 Myanmar, 34 Indochina Peninsula, 35 Philippines, 36 Indonesia, 37 New Guinea, 38 Islands of Pacific Ocean, 41 Northern Africa, 42 Western Africa, 43 Central Africa, 44 Reaches of Congo river, 45 Ethiopia region, 46 Tanzania region, 47 Angola region, 48 South Africa, 49 Madagascar, 51 Western Australia, 52 Northern Territory, 53 South Australia, 54 Queensland, 55 New South Wales, 56 Victoria, 57 Tasmania, 58 New Zealand, 61 Eastern Canada, 62 Western Canada, 63 Mts. Eastern US, 64 Plain Central US, 65 Hills Central US, 66 Mts. Western US, 67 Mexico, 68 Central America region, 69 Caribbean Islands, 71 Venezuela, 72 Plateau Guyana, 73 Northern Mt. Andes, 74 Amazon Plain, 75 Plateau Brazil, 76 Bolivia, 77 Argentina, 78 Southern Mt. Andes.

Sum of squares method, also known as Ward's method (1963) [26], uses the similarity coefficient formula [21] of Czekanowski (1913), also known as Sørensen (1948) formula [24]: $SI=2C/(A+B)$, which is a better method, but the calculation process is relatively complex. The three formulas used in these three methods are to calculate the similarity coefficient between the two regions. A and B are the number of species in the two regions respectively, and C is the number of common species in the two regions. The operation is completed by SPSS (Statistical Product Service Solutions).

The definition of the SGF proposed by us is that the similarity coefficient between multiple regions is the proportion of the average number of common species in each region participating in the analysis to the total species [70]. The formula of dissimilarity and its contribution rate is also proposed:

Similarity formula:

$$SI_n = \sum H_i/nS_n = \sum(S_i\text{-}T_i)/nS_n$$

Dissimilarity formula:

$$DI_n=1\text{-}SI_n=1\text{-}\sum(S_i\text{-}T_i)/nS_n=[nT+\sum(H\text{-}H_i)]/nS$$

Table 2 The distribution of global biota.

BGU	No. of genera	BGU	No. of genera	BGU	No. of genera	BGU	No. of genera
01	18,085	23	4,828	44	7,429	65	13,440
02	20,530	24	9,449	45	5,252	66	19,893
03	17,750	25	14,344	46	9,065	67	20,542
04	22,030	26	18,512	47	9,560	68	19,064
05	7,598	27	13,508	48	13,129	69	10,205
06	7,267	28	5,915	49	9,092	71	10,433
11	9,700	29	15,311	51	11,835	72	7,457
12	4,274	31	6,969	52	7,740	73	17,071
13	3,881	32	13,978	53	7,411	74	13,092
14	6,577	33	7,662	54	16,798	75	14,826
15	5,261	34	11,947	55	16,353	76	7,842
16	3,562	35	8,662	56	11,613	77	10,738
17	8,027	36	16,764	57	8,658	78	8,519
18	4,879	37	9,516	58	12,175	BDR	733,232
19	2,543	38	11,547	61	12,416	BBU	180,661
20	3,419	41	10,232	62	13,740	BGU	67
21	7,229	42	10,264	63	21,132	AR	10,943.8
22	3,570	43	5,178	64	15,944	ADT	4.06

RCS (Rate of Contribution of Similarity) formula:

$$RCS_i=H_i/\sum H_i$$

RCD (Rate of Contribution of Difference) formula:

$$RCD_i=(nT_i+H-H_i)/(nS-\sum H_i)$$

in which, SI_n is the similarity coefficient of n geographical units, S_i, H_i and T_i are respectively the number of species, common species and unique species of i geographical units, and meet $H_i = S_i-T_i$. S_n is the total number of species of n geographical units. Each numerical value required for calculation can be easily obtained from the query page of the database. Both manual calculation and computer software analysis are very convenient and fast.

The MSCA used with SGF is that the similarity coefficients of any group can be calculated directly, regardless of the clustering order, and even the total similarity coefficients of 67 BGUs can be calculated first. Finally, the cluster diagram is arranged according to the size of similarity coefficient [71, 72]. The total similarity coefficient, the total dissimilarity coefficient, the similarity contribution rate and the dissimilarity contribution rate of each BGU are all concepts and indicators that cannot be calculated by traditional analysis methods.

3. Results

3.1 MSCA Results of Global Terrestrial Organisms

3.1.1 Clustering Results

The MSCA analysis results of world organisms are shown in Fig. 2. The total similarity coefficient of 67 BGUs is 0.091, and the total dissimilarity coefficient is 0.909. When the horizontal line of similarity is 0.330, 20 SUCs (Small Unit Crowds) are clustered into a~t; At 0.210, they were clustered into 7 LUC (Large Unit Crowds) from A to G. Check that the constituent units of each group are adjacent to each other and conform to geographical principles; Each large group is basically a relatively independent continental block, and each small group has a relatively unique ecological environment within the large group, which conforms to the ecological principles; The degree of similarity within each group is higher than that between groups, which conforms to the principle of statistics; Each LUC

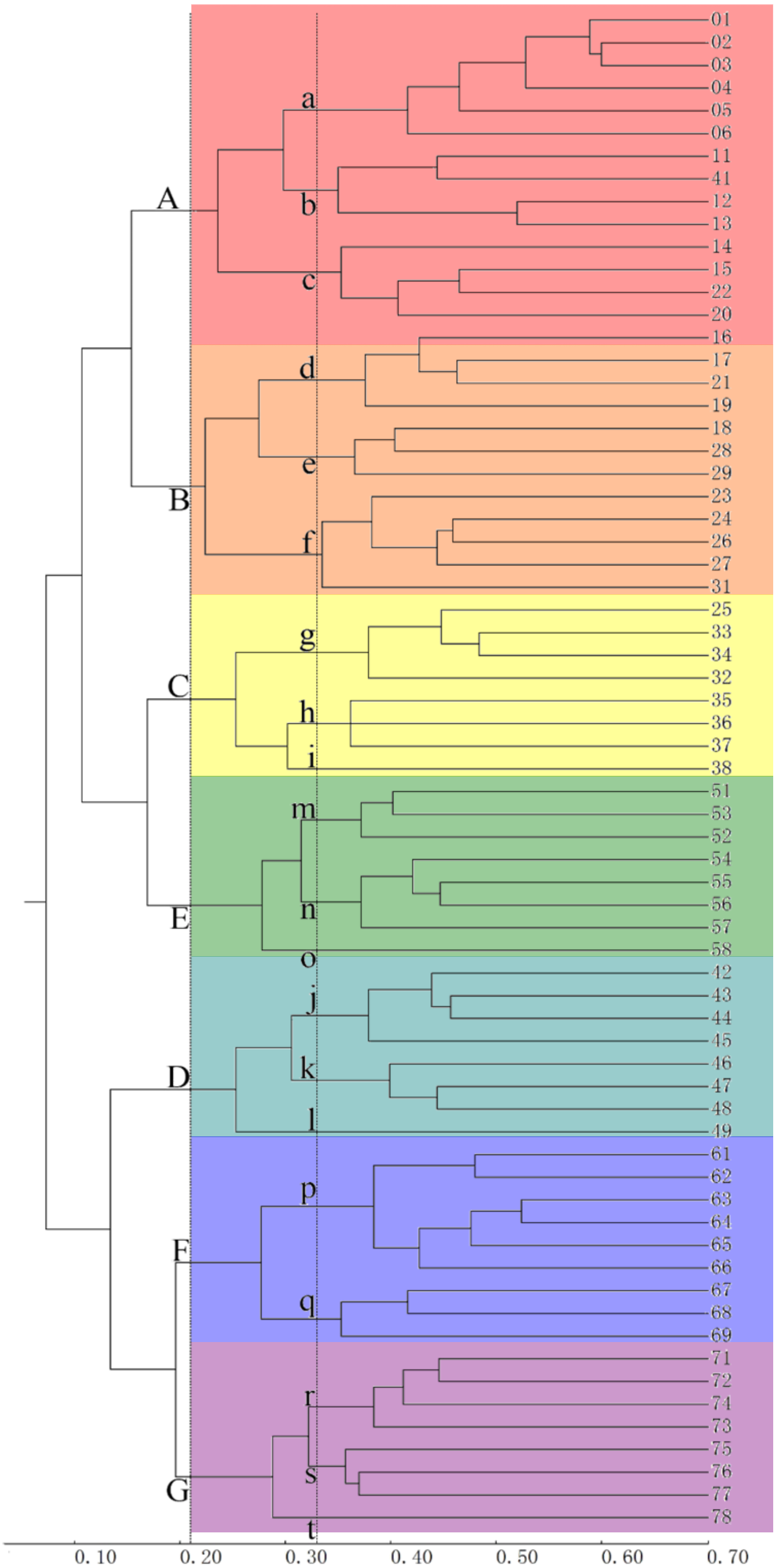

Fig. 2 Clustering tree of global biota by MSCA.

or SUC has all own endemic species, which conforms to the biological principles.

3.1.2 Similarity Contribution Rate and Dissimilarity Contribution Rate of Each BGU

In cluster analysis, each BGU plays an unequal role in similarity and dissimilarity (Table 3). Each large group has its own core area in its composition. It forms a group with more common species to exert its attraction, and it also spreads its distance from other groups with more unique species. Where the attraction of the two core regions is equal, it is the boundary of the two groups. The BGU at the boundary often swings from side to side due to the slight difference in the attraction of the two sides. The cohesion and independence of the core area is the mechanism of the formation of biological distribution area. Obviously, the sum of the two contribution rates of BGU No. 02, 04, 26, 36, 48, 54, 66, 67, 68, 73 and 75 is more than 4%, and they play a backbone role in clustering.

Similarly, the role of each biological group in quantitative analysis is not equal. Table 4 lists the contribution rates of several representative biological groups. This is also the reason why we emphasize full participation, no selection and no weighting in the MSCA method.

Table 3 The rate of contribution of similarity and difference of every BGU.

LUC	SUC	BGU	No. of genus	Among them		RCS (%)	Dissimilarity nT_i+H-H_i	RCD (%)
				Common	Endemic			
A	a	01	18,086	17,619	467	2.53	91,499	1.31
		02	20,531	19,732	799	2.83	111,630	1.60
		03	17,751	17,266	485	2.48	93,058	1.33
		04	22,030	20,744	1286	2.98	143,247	2.05
		05	7,593	7,534	59	1.08	74,248	1.06
		06	7,271	7,217	54	1.04	74,230	1.06
	b	11	9,703	9,429	274	1.35	86,758	1.24
		41	10,235	9,858	377	1.42	93,260	1.33
		12	4,281	4,234	47	0.61	76,744	1.10
		13	3,884	3,805	79	0.55	79,317	1.14
	c	14	6,583	6,353	230	0.91	86,886	1.24
		15	5,261	5,095	166	0.73	83,856	1.20
		20	3,421	3,361	60	0.48	78,488	1.12
		22	3,573	3,510	63	0.50	78,540	1.12
B	d	16	3,566	3,551	15	0.51	75,283	1.08
		17	8,029	7,942	87	1.14	7,576	1.08
		19	2,188	2,165	23	0.31	77,205	1.11
		21	7,228	7,107	121	1.02	78,829	1.13
	e	18	4,884	4,726	158	0.68	83,689	1.20
		28	5,916	5,866	50	0.84	75,313	1.08
		29	15,314	14,542	772	2.09	115,011	1.65
	f	23	4,832	4,750	82	0.68	78,573	1.12
		24	9,452	9,240	212	1.33	82,793	1.18
		26	18,512	17,548	994	2.52	126,879	1.82
		27	13,509	12,573	936	1.81	127,968	1.83
		31	6,976	6,771	205	0.97	84,793	1.21

Table 3 to be continued

C	g	25	14,342	13,868	474	1.99	95,719	1.37
		32	13,980	12,931	1,049	1.86	135,181	1.93
		33	7,662	7,527	135	1.08	79,347	1.14
		34	11,947	11,471	467	1.65	97,647	1.40
	h	35	8,664	8,237	427	1.18	98,201	1.41
		36	16,765	15,131	1,634	2.17	172,176	2.46
		37	9,519	8,675	844	1.25	125,702	1.80
	i	38	11,550	10,530	1,020	1.51	135,639	1.94
D	j	42	10,272	9,829	443	1.41	97,681	1.40
		43	5,179	4,986	193	0.72	85,774	1.23
		44	7,431	6,907	524	0.99	106,030	1.52
		45	5,256	5,078	178	0.73	84,677	1.21
	k	46	9,069	8,256	813	1.19	124,044	1.78
		47	9,563	9,091	472	1.31	100,362	1.44
		48	13,119	11,680	1,439	1.68	1,625,622	2.33
	l	49	9,094	7,228	1,866	1.04	195,623	2.80
E	m	51	11,837	11,194	643	1.61	109,716	1.57
		52	7,743	7,602	141	1.09	79,674	1.14
		53	7,415	7,307	108	1.05	77,758	1.11
	n	54	16,801	15,481	1,320	2.22	150,788	2.16
		55	16,356	15,616	740	2.24	111,793	1.60
		56	11,614	11,267	347	1.62	89,811	1.29
	o	57	8,661	8,369	292	1.20	89,024	1.27
		58	12,174	10,981	1,193	1.58	146,779	2.10
F	p	61	12,409	12,255	154	1.76	75,892	1.09
		62	13,736	13,478	258	1.94	81,637	1.17
		63	21,098	20,359	739	2.92	106,983	1.53
		64	15,897	15,627	270	2.24	80,292	1.15
		65	13,427	13,218	209	1.90	78,614	1.13
	q	66	19,868	18,662	1206	2.68	139,969	2.00
		67	20,547	19,272	1,275	2.77	143,982	2.06
		68	19,067	17,180	1,887	2.47	187,078	2.68
		69	10,204	9,584	620	1.38	109,785	1.57
G	r	71	10,435	10,172	263	1.46	85,278	1.22
		72	7,461	7,235	226	1.04	85,736	1.23
		73	17,074	15,731	1,343	2.26	152,079	2.18
		74	13,092	12,374	718	1.78	113,561	1.63
	s	75	14,822	13,448	1,374	1.93	156,439	2.24
		76	7,845	7,724	121	1.11	78,212	1.12
		77	10,745	10,281	464	1.48	98,636	1.41
	t	78	8,521	7,665	856	1.10	127,516	1.83
Total			733,231	696,385	36,846	100.00	6,986,840	100.00
Global			180,661	143,815	36,846			

Table 4 The rate of contribution of similarity and difference of some living things.

Living things	No. of genera	Distribution No. of BGU	RCS (%)	RCD (%)
Anurosporidium	1	0	0	0
Dendrocacalia	1	1	0	0.00096
Calonemertes	1	2	0.0003	0.00093
Protubera	1	10	0.0014	0.00081
Lachnocladium	1	30	0.0043	0.00053
Polyomavirus	1	67	0.0096	0
Noctuidae	3,331	13,865	1.7911	2.97928
Colleoptera	38,537	72,821	9.3091	17.38131
Mamalia	1,374	7,794	1.0728	1.13778
Ascomycota	7,551	44,951	6.2003	5.14427
Plantae	17,526	163,944	23.0223	14.02180

3.1.3 Consistency of Analysis Results of Main Groups

In order to avoid accidents, we also carried out more than 70 item analysis on animal, plant, microorganism and subordinate main phyla, class, order and other classification groups, and obtained consistent clustering results. The overall results of 37,470 genera of animals excluding insects are consistent with those of 141,814 genera of animals, which proves that they are not affected by the wide variety and large proportion of insects. Not only are the clustering results between the higher order elements of bound and gate highly homogeneous. There is also no significant difference between class, order and other middle order elements [99].

3.2 Analysis Results of Traditional Clustering Methods

The result of the single linkage method (Fig. 3) is chaotic and cannot be divided into different levels, and there are quite a number of units that cannot be grouped together, becoming the “noise” called by industry insiders. It is difficult to find unit groups similar to D, E, F and G, but also cannot be at the same level.

The results of the average group linkage method (Fig. 4) are improved compared with the single linkage method, and the sense of hierarchy is significantly improved. When the distance is about 0.650, it is clustered into 5 unit groups, of which 4 are similar to the large groups of C, D, E and G, and the large groups composed of the remaining 31 BGUs are difficult to distinguish with geographical significance.

The result of the sum of squares method (Fig. 5) is better than that of the average group linkage method. When the distance is 1.30, it can be grouped into 8 unit groups, which are equivalent to 5 large groups B, C, D, E, G and 3 small groups a, b, p respectively, compared with Fig. 2. In Group E, BGUs 58 and 78 are clustered together, which is difficult to meet the requirements in terms of geography or ecology.

The comparison results show that MSCA has stronger data mining ability than traditional methods, and can obtain more, more detailed, more accurate and more stable clustering information.

3.3 Geographical Division of Terrestrial Organisms in the World

According to the above analysis results, a unified geographical division scheme of world living things is established below (Fig. 6, Table 5), with kingdom and sub-kingdom as the names of the two divisions stratums.

3.3.1 West Palaearctic Kingdom

It is composed of 14 BGUs (01~06, 11~15, 20, 22, 41), including Europe, North Africa, Arabian Peninsula, Central Asia, Pamirs Plateau, Northwest China, etc., which is equivalent to the western half of the Palaearctic region of animal division. The total area is about 28.87 million square kilometers. There are 31 phyla, 87 classes,

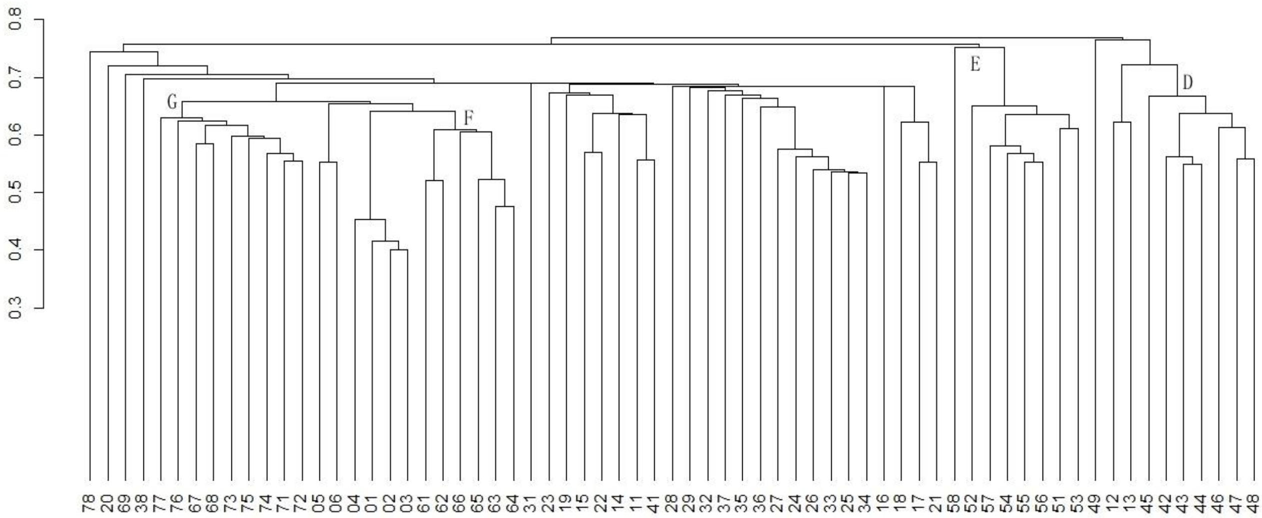

Fig. 3 Clustering tree of global biota by single linkage method.

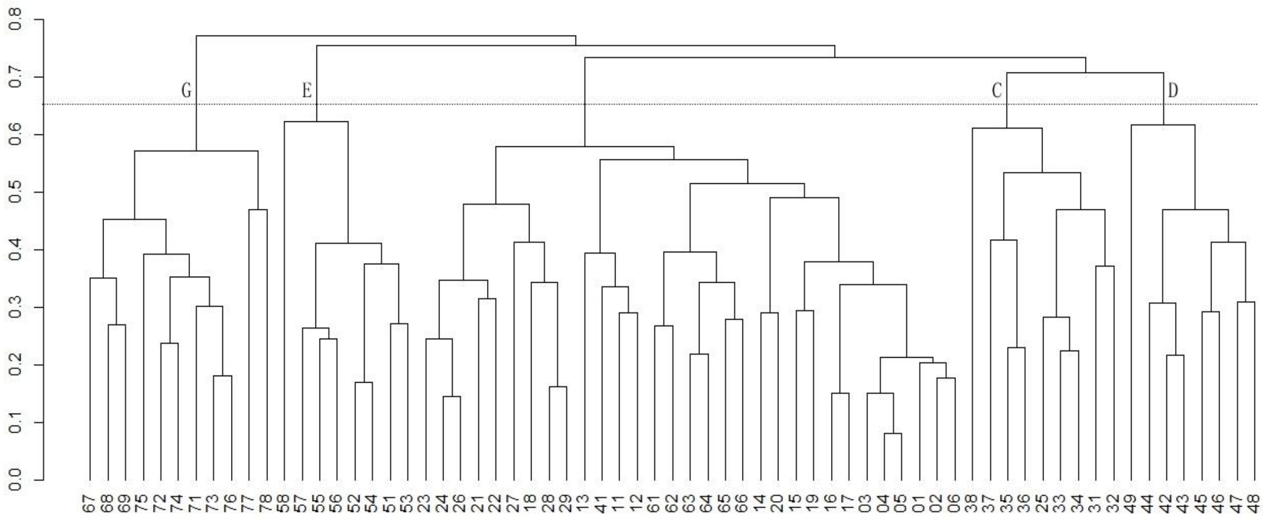

Fig. 4 Clustering tree of global biota by average group linkage method.

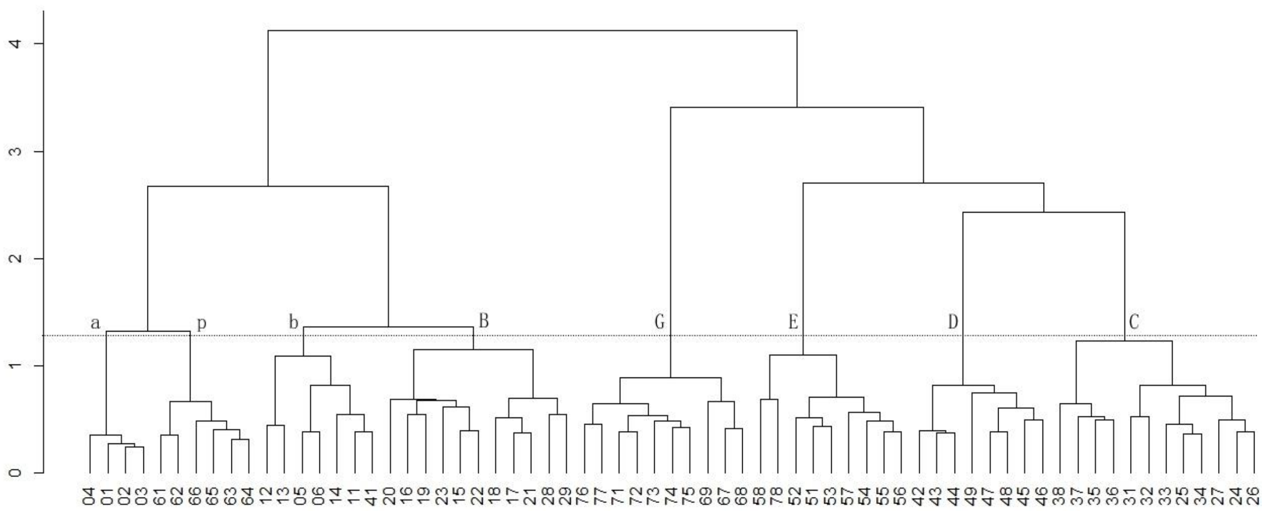

Fig. 5 Clustering tree of global biota by sum of squares method.

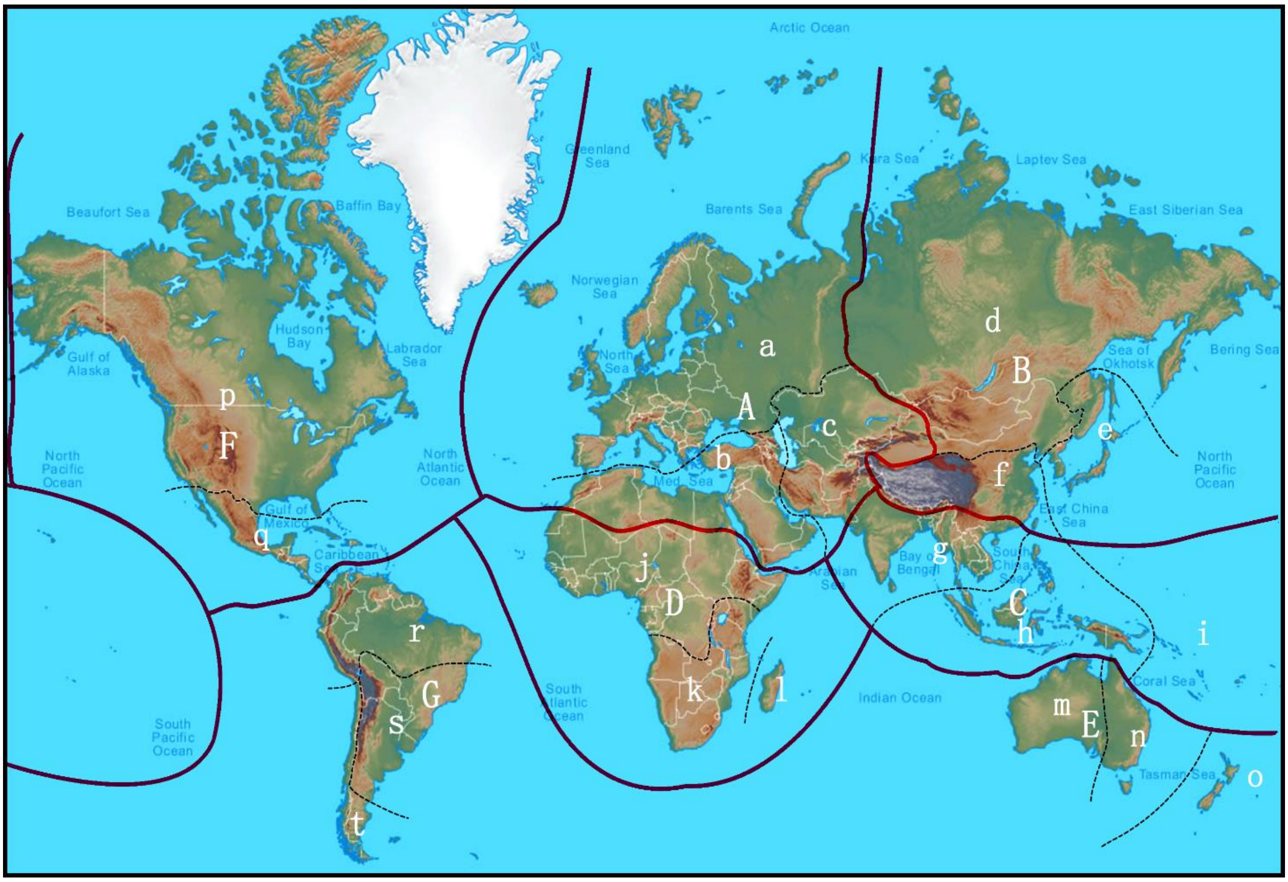

Fig. 6 The biogeographical division scheme of global terrestrial biota.

A. West Palaearctic Kingdom, B. East Palaearctic Kingdom, C. Indo-Pacific Kingdom, D. Afrotropical Kingdom, E. Australian Kingdom, F. Nearctic Kingdom, G. Neotropical Kingdom.

a. European Subkingdom, b. Mediterranean Subkingdom, c. Centre Asian Subkingdom, d. Siberian Subkingdom, e. Northeast Asian Subkingdom, f. Chinese Subkingdom, g. South Asian Subkingdom, h. Indonesian Subkingdom, i. Pacific Subkingdom, j. Centre African Subkingdom, k. Southern African Subkingdom, l. Madagascan Subkingdom, m. Western Australian Subkingdom, n. Eastern Australian Subkingdom, o. New Zealander Subkingdom, p. North American Subkingdom, q. Centre American Subkingdom, r. Amazonian Subkingdom, s. Argentine Subkingdom, t. Chilean Subkingdom.

452 orders, 2,834 families, 25,042 genera (Table 5). Compared with other kingdoms, the biological richness is medium and the endemism is low. It has jurisdiction over European Subkingdom, Mediterranean Subkingdom and Central Asian Subkingdom. The European Subkingdom is rich, and its core region is Southern Europe.

3.3.2 East Palaearctic Kingdom

It is composed of 12 BGUs from 16 to 19, 21, 23, 24, 26 to 29 and 31. It is adjacent to the Western Palaearctic Kingdom along the eastern edge of the Ob River and Pamir Plateau, including North Asia, Northeast Asia, East Asia, etc., which is roughly equivalent to the eastern half of the Palaearctic Region. The total area is 23.12 million square kilometers. There are 29 phyla, 75 classes, 373 orders, 2,150 families, 23,893 genera of various organisms. The richness of this area is medium and the specificity is the lowest. It is closely related to the Western Palaearctic and Indo-Pacific Kingdom, and moderately related to the Nearctic Kingdom. It has jurisdiction over Siberian Subkingdom, Northeast Asian Subkingdom and Chinese Subkingdom. Among them, the richness of the Chinese Subkingdom is the highest. Its core region is the Middle East of China.

Table 5 The diversity and endemic of terrestrial biota in every kingdom and subkingdom.

Division scheme	Area (10^4 km^2)	Diversity					Endemic			
		Phy.	Cla.	Ord.	Family	Genus	Fam.	%	Genus	%
A. West Palaearctic	2,887	31	87	452	2,834	25,042	160	5.65	6,691	26.72
a. European	1,016	31	87	441	2,673	20,811	130	4.86	3,912	18.80
b. Mediterranean	1,004	24	62	327	1,556	9,570	8	0.51	789	8.24
c. Centre Asian	867	24	56	253	1,157	7,458	3	0.26	600	8.05
B. East Palaearctic	2,312	29	75	373	2,150	23,893	37	1.72	4,959	20.76
d. Siberian	1,644	24	61	267	1,152	7,953	1	0.09	242	3.04
e. N-E Asian	80	24	64	308	1,536	9,378	14	0.91	791	8.64
f. Chinese	568	27	70	324	1,796	20,076	17	0.95	3,052	15.20
C. Indo-Pacific	925	30	76	406	2,447	27,014	72	2.94	8,393	31.07
g. South Asian	568	28	70	352	1,931	18,100	26	1.35	2,346	12.96
h. Indonesian	302	29	71	336	1,791	15,097	20	1.12	3,530	23.38
i. Pacific	55	27	63	289	1,306	6,829	7	0.54	912	13.35
D. Afrotropical	2,470	30	72	375	2,159	20,826	97	4.49	9,861	47.35
j. Centre African	1,637	28	61	304	1,457	11,307	19	1.30	2,097	18.55
k. South African	770	29	67	330	1,754	13,609	29	1.65	3,459	25.43
l. Madagascan	63	22	53	239	1,038	6,341	30	2.89	1,879	29.62
E. Australian	795	32	85	428	2,553	20,959	130	5.05	8,541	40.75
m. West Australian	460	31	77	347	1,656	9,784	14	0.85	1,054	10.77
n. East Australian	308	31	80	392	2,272	17,071	74	3.26	3,991	23.38
o. New Zealander	27	32	77	341	1,373	5,589	25	1.82	994	17.78
F. Nearctic	2,423	32	92	475	3,229	33,407	242	7.49	10,646	31.87
p. North American	2,152	31	89	459	2,824	22,131	122	4.32	3,771	17.04
q. Centre American	271	31	80	399	2,454	22,710	70	2.85	4,663	20.53
G. Neotropical	1,797	32	84	422	2,410	24,551	96	3.98	9,229	37.59
r. Amazonian	860	29	77	384	2,008	18,219	30	1.49	3,517	19.30
s. Argentine	783	31	76	379	1,896	15,335	9	0.47	2,250	14.67
t. Chilean	154	24	63	282	1,171	4,837	13	1.11	759	15.69

3.3.3 Indo-Pacific Kingdom

It is composed of 25, 32~38 BGUs in total. It is adjacent to the Eastern Palaearctic Kingdom along the southern edge of the Himalaya region, the southern edge of the Yunnan Guizhou Plateau, and the northern edge of the Nanling Mountains. It is adjacent to the western edge of the Indian Desert and the Western Palaearctic Kingdom, including South Asia, Southeast Asia, New Guinea, Pacific islands, etc., which is equivalent to the newly established Indo-Pacific boundary in the plant geographical division. The total area is 9.25 million square kilometers. There are 30 phyla, 76 classes, 406 orders, 2,447 families and 27,014 genera of various organisms. This area has high abundance and medium specificity. The floristic similarity is closely related to the Eastern Palaearctic and Australian kingdoms. It has jurisdiction over South Asian Subkingdom, Indonesia Subkingdom and Pacific Subkingdom. The richness is higher in South Asia and the specificity is higher in Indonesia Subkingdom. Its core region is Indonesia.

3.3.4 Afrotropical Kingdom

It is composed of 42-49 BGUs in total, including African continent and islands except North Africa. It is adjacent to the Western Palaearctic Kingdom along the northern edge of the Sahara Desert, which is basically the same as Afrotropical Realm in the animal geographical division and the newly established African Kingdom in the plant geographical division. The total area is 24.7 million square kilometers. There are 30 phyla, 72 classes, 375 orders, 2,159 families, 20,826 genera of various organisms. The species richness is the lowest, the endemic is high, and the endemic proportion is the highest. It has jurisdiction over the Central African Subkingdom, the South African Subkingdom and the Madagascar Subkingdom. The richness is high in the South African Subkingdom, and the endemic proportion is high in the Madagascar Subkingdom. Its core region is South Africa.

3.3.5 Australian Kingdom

It is composed of 51~58 BGUs, including the mainland of Australia, Tasmania Island, New Zealand and nearby islands. There is no land connection with other Kingdoms, and it is smaller than the Australian Raelm of animal division, which is equivalent to the Australian Kingdom after the new adjustment of plant division, with a total area of 7.95 million square kilometers. There are 32 phyla, 85 classes, 428 orders, 2,553 families, 20,959 genera of various organisms. The species richness is low, but the specificity is outstanding. It has jurisdiction over West Australian Subkingdom, East Australian Subkingdom and New Zealand Subkingdom. Abundance and endemism are higher in the East Australia. Its core area is Queensland.

3.3.6 Nearctic Kingdom

It is composed of 9 BGUs from 61 to 69, including North America, Central America, Caribbean islands, etc. It is equivalent to North America. The total area is 24.23 million square kilometers. There are 32 phyla, 92 classes, 475 orders, 3,229 families, 33,407 genera of various organisms. The richness of this area is the highest, and the proportion of endemism is medium. Its relations with South America are far closer than those with Eurasia. It governs North American Subkingdom and Centre American Subkingdom. Their richness is relatively rich. Its core area is the Rocky Mountains.

3.3.7 Neotropical Kingdom

It is composed of 71-78 BGUs, equivalent to South America. The total area is 17.97 million square kilometers. There are 32 phyla, 84 classes, 422 orders, 2,410 families, 24,551 genera of various organisms. Both richness and endemism are moderate. It governs Amazonian Subkingdom, Argentina Subkingdom and Chilean Subkingdom. Its core area is the northern part of the Andes Mountains.

Acknowledgements

We thank scholars from all over the world, such as Professor C. Barry Cox of King’s College London, Professor Holger Kreft of the University of Gertingen in Germany, Professor John C. Morse of the University of Clemson in the United States, Professor Daniel R. Gustafsson of the University of Utah in the United States, Professor Peter Vrsansky of the Institute of Geography of the Slovak Academy of Sciences, Professor Jean Claude Beaucournu of the French Medical School, Professor Robert J. Whittaker of the University of Oxford in the United Kingdom, Professor Thomas Najer of the Czech Veterinary and Pharmaceutical University, Professor Maram Caesar of the University of Paris in France, Professor Michel P. Valim of the University of Sao Paulo in Brazil, Professor Miklos D. F. Udvardy of California State University in the United States, Professor Nikki H. A. Dagamac of Grifswald University in Germany, Professor Leho Tedesoo of Tartu University in Estonia, Professor Jennifer A. Rudgers of the University of New Mexico in the United States, Professor Jane Fröhlich-Nowoisky of John Gutenberg University in Germany, Professor Kathleen K. Treseder of California State University, Irvine, USA, Professor Antoine Guisan of the University of Lausanne in Switzerland, Professor Kevin C. Rowe of the Victoria Museum in Australia, Professor Daosavanh Sanamxay of the National University of Laos, Professor Pipat Soisok of Prince Songka University in Thailand, Professor M. V. Cianciaruso of the Federal University of Goyas in

Brazil, Professor Gabor Csorba of the Hungarian Museum of Natural History, Professor Anderson Feijo of the Federal University of Paraiba in Brazil, Dr. Tania Escalante of the National University of Mexico, Professor Cibele R. Bonvicino of the National Cancer Institute of Brazil, Professor Daniel González-Acuñad of the University of Concepcion in Chile, etc., domestic scholars such as Professor Yang Xingke of the Institute of Zoology of the Chinese Academy of Sciences, Professor Zhang Rongzu and Zhang Yili of the Institute of Geography of the Chinese Academy of Sciences, Professor Cai Wanzhi and Yang Ding of the Chinese Agricultural University, Professor Li Houhun and Bu Wenjun of Nankai University, Professor Wei Meicai of Jiangxi Normal University, Professor Jiang Haisheng of South China Normal University, etc. They have enthusiastically encouraged, or presented literature, or modified manuscripts, or discussed in depth, or put forward suggestions, which effectively promoted and improved the research work.

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