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Species Construction and Distribution of Terrestrial Isopoda in Typical Zones of China

CHEN Guo-xiao
(Institute of Zoology, the Chinese Academy of Science, Beijing 100080, China)

Abstract: From an investigation and collection of specimens of terrestial isopoda in 20 sampling areas throughout 5 typical zones (i.e., tropical, subtropical, warm temperate, temperate and high frigid) in China, a total of 11 families, 29 genera and 72 species of terrestial isopoda were found. Due to the great zonal differences in the environmental surroundings, there are diversities in species distribution. Tropical and subtropical zones are mostly rich in number of species with a total of 38 and 47 species respectively, making up more than 80% in total. Only 9 species were found in temperate and warm temperate zones. In high frigrid region, due to the average temperature which is below zero degree celsius and which is unfavourable for the existance of terrestial isopoda, only 2 species were found.

Key words: typical zone; terrestrial isopoda; species construction; fauna distribution
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The terrestrial isopoda commonly known as damp worms are one group of common crustaceans belonging to Crustacea and Arthropoda in classification. They are numerous in species, distribute extensively and possess specified economic value, among which many species live in the soil of forests. They possess more comparatively important functions on energy transformation and circulation in soil ecosystem.

The international study on terrestrial isopoda had been started in the middle of nineteenth century (Buddle- Lund, 1885). So far, many researchers systematically studied on the taxonomy and biology of terrestrial isopoda (such as Arcangeli, 1921 to 1963; Budde- Lund, 1909, 1913; Dollfus, 1893 to 1898; Ferrara and Argano, 1989; Kwon, 1992, 1996; Nunommura, 1976 to 1991; Schmalfuss, 1972 to 1983; Taiti and Ferrara, 1983 to 1991; Vandell, 1945 to 1973; Verhoeff, 1926 to 1946). However, in China, few papers about the study of terrestrial isopoda have been reported and little has been done on systematic studying. Up till 1996, only part of Chinese terrestrial isopoda more concentrically were described by Arcangeli (1927, 1952), Kwon and Taiti (1993); especially the latter two researchers had totally studied and described 49 species of terrestrial isopoda in southern China including Hongkong and Macao and made simple analysis on their fauna distribution. Other researchers (Shen Jiarui, etc) only described a few species in several limited areas. It is vast in territory with diversification of geographical climatic zone and complexity of terrestial ecosystem in China. So, there is an urgent need to study terrestrial isopoda deeply and systematically. In 1993, a program supported by national natural science foundition of China for the study on soil animal in Chinese typical zone was developed in all regions of China, directed and cared of by academician YIN Wen-ying in Shanghai Institute of Entomology, A-

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Biography: CHEN Guo-xiao(1942-), male, was born in Beijing City, senior engineer and professor; bachelor, research area is invertebrate taxonomy and biology(main part: crustacean).

cademia Sinica, and five sample points of typical zone were selected for the study of soil animal. The author of this paper undertook luckily not only for the investigation on the point, Xiaolongmen in Beijing, in this subject, but also for the studying on terrestrial isopoda in every typical zone. The study included the classification, geographical distribution, fauna characteristics and biology of terrestrial isopoda in typical zone of China. In this paper, the fauna distribution of 72 species of identified terrestrial isopoda in typical zone of China was summarized essentially. The author has not only made systematic research on sample points in typical zone which were stated in the subject, but also complemented and investigated the point in temperate zone, Luya Mountain in Shanxi, and referenced with the specimen data collected from every place in past time. Meanwhile, species distribution data from Kwon and Taiti (1993), Kwon and Wang (1996) as well as Jeon and Kwon (1995) were also quoted for reflecting the full view of terrestrial isopoda fauna in China. But, in spite of that, for China with so vast territory and abundant resources which make its complex natural condition, only a preliminary view for terrestrial isopoda fauna in China is given in this paper. This research still needs deep and thorough developing study to make it perfect and to get even further progress in future.

1 Construction and Distribution of Species

The results of investigation (see table 1) showed that in typical zone of China there are totally 11 families, 29 genera and 72 species of terrestrial isopoda. Philosciidae is one of them with the richest kinds, totally 4 genera and 19 specis being discovered which made up 26.4% in total. Few species of them belonged to the dwell type on seaside, others lived in the fallen leaves layer of forest at tropical and subtropical zone. Specially, in genus *Burmoniscus*, 12 species were discovered, making up 16.7% in total, and so far it is a genus with the most kinds among terrestrial isopoda in China. Its 8 species are distributed on Jianfeng mountain in Hainan Province, in tropical rainy forest of Xishuangbanna in Yunna Province and Taiwan Province, and become a feature of rainy forest. Their *B. yunnanensis*, *B flavivertex* and *B. lobatus* in Yunnan Province are distributed only in China, other 5 species are also in tropical zone outside of China, such as *B. javanensis* in island Reunion island in Africa, New Guinea and Indonesia, Malaysia in Asia. In addition, it should be indicated for this genus that *B. mauritiensis* and *B. ocellatus* are distributed extensively and picked up at the most of sample points in tropical and subtropical zone, even dispersed to Hawaii, Japan and Korea peninsula. They are distributed so extensively and abundantly that they play very important role during energy transform in forest ecosystem.

Trachelipidae is the second big group of terrestrial isopoda in typical zone of China. It has 5 genera and 18 specis, and makes up 25% in total. *Nagurus* and *Lucasioides* are two of them with the most kinds, 5 species each, mainly distributed at each sample point in tropical and subtropical zone, and stay in grass of forest or under the rotten wood and broken stones. Among them, the distribution of *N. sundsicus* and. *N. annus* are very extensive. The formers are mainly picked up from the sample points of Yunnan (Xishuangbanna and Xishan in Kunming), Hongkong, Guangdong (Dinghu Mountain), Hubei (Luojia Mountain in Wuchang) and Jiangsu (Zijin Mountain in Nanjing), meanwhile they are in Indonesia, New Caledonia, etc, and the laters are in Hainan (Jianfeng Mountain) and south of Taiwan, Guangxi (Guilin), etc; meanwhile they are extensively distributed in tropical zone outside of China. But there are few reports saying that this species was discovered in greenhouse of Europe. Maybe this is due to the species moving there with plant- soil from tropical zone, not a phenomenon of natural distribution. On the other hand, only *L. gigliotost* in this genus is in temperate zone inside or outside of China, other 4 species are all distributed in temperate subtropical area in China, becoming a special species in these places. Most kinds of *Mongoloniscus* and *Agnora* are in tropical and subtropical zone, and become special species in China, such as *M. nigrogranulatus*, *A. ferrarai*, etc. So far only *M. sinensis* is discovered at Inner Mongolia North and North- east China, becoming a typical special species in temperate zone.

Table 1 The Distribution of Terrestrial Isopoda in Typical Zones of China

Species	A			B										C				D	E	
	1	2	3	1	2	3	4	5	6	7	8	9	10	1	2	3	4	1	1	2
Tylidae																				
Tylos minor Dollfus						+														
Tylos granuliferus Budde- Lund												+								
Ligiidae																				
Ligia exotica Roux	+					+								+						
Ligia occidentalis Dana														+						
* *Ligidium denticulatum* Shen		+																		
* *Ligidium (Nippoligidium) formosanum* Wang & Kwon								+												
* *Ligidium (Nippoligidium) acutitelson* Wang & Kwon								+												
Olibrinidae																				
Olibrinus truncatus Taiti & Ferrara						+														
Scyphacidae																				
Alloniscus pigmentatus Budde- Lund	+																			
Armadilloniscus ellipticus (Harger)						+														
* *Armadilloniscus lanyuensis* Kwon & Wang			+																	
* *Armadilloniscus hoonsooi* Kwon & Wang			+																	
Philosciidae																				
Littorophiloscia aldabrana Ferrara & Taiti						+														
Littorophiloscia amphindica Taiti & Ferrara			+																	
* *Littorophiloscia wangi* Kwon & Jeon								+												
* *Littorophiloscia formosana* Kwon & Jeon			+																	
Papuaphiloscia granulata Kwon & Taiti	+																			
Papuaphiloscia arcangelii Kwon & Taiti											+									
Pseudotyphiloscia alba (Dollfus)	+		+			+		+												
Burmoniscus javanensis (Richardson Searle)		+	+																	
Burmoniscus meeusei (Holthuis)			+																	
Burmoniscus xanthocephalus Taiti & Manicastri																				
Burmoniscus mauritiensis(Taiti & Ferrara)					+	+		+	+	+	+	+	+							
Burmoniscus okinawaensis (Nunomura)					+	+	+	+												
* *Burmoniscus yunnanensis* Kwon & Taiti		+																		
* *Burmoniscus flavivertex* Kwon & Taiti		+																		
* *Burmoniscus lobatus* Kwon & Taiti		+			+															
* *Burmoniscus purpura* Kwon & Taiti													+							
Burmoniscus ocellatus (Verhoeff)	+	+	+			+	+	+	+		+									
Burmoniscus wolffi (Vandel)			+								+									
* *Burmoniscus arcangelii* Kwon & Taiti								+												
Oniscidae																				
Exalloniscus cartii Arcangeli										+	+					+				
* *Exalloniscus rotundatus* Taiti & Ferrara						+														
* *Exalloniscus silvestrii* Kwon & Taiti				+																
Platyarthridae																				
* *Papuasoniscus lutaoensis* Jeon & Kwon			+																	
Trachelipidae																				
Nagurus sundaicus (Dollfus)		+		+		+	+			+		+								

to be continued

Continued

Species	A			B										C				D	E	
	1	2	3	1	2	3	4	5	6	7	8	9	10	1	2	3	4	1	1	2
Nagurus nanas (Budde- Lund)	+		+		+			+												
* *Nagurus cristatus* (Dollfus)	+					+														
Nagurus pallidipennis (Dollfus)	+	+																		
* *Nagurus verhoeffi* (Arcangeli)	+			+																
Prothacheoniscus major (Dollfus)															+	+				
Lucasioides gigliotosi (Arcangeli)		+											+	+						
* *Lucasioides zavattarii* (Arcangeli)						+														
* *Lucasioides issedi* (Arcangeli)								+		+										
* *Lucasioides pedimaculatus* Kwon & Taiti				+																
* *Lucasioides cavernicolus* Kwon & Taiti				+																
* *Mongoloniscus sinensis* (Dollfus)															+	+	+	+		
* *Mongoloniscus vannamei* (Arangeli)										+										
Mongoloniscus nipponicus (Arrcangeli)										+	+									
* *Mongoloniscus nigrorgranulatus* Kwon & Taiti					+					+	+									
Agnara madagascariensis Budde- Lund	+		+																	
* *Agnara ferrarai* Jeon & Kwon			+																	
* *Agnara delvecchioi* Verhoeff								+												
Porcellionidae																				
Agabiformius lentus (Budde- Lund)	+	+		+					+											
* *Leptotrichus sinensis* (Arcongeli)											+									
Porcellio laevis Latreille	+	+		+	+		+		+	+	+	+	+	+	+	+	+	+	+	+
Porcellio guadriseriatus Verhoeff												+	+							
Porcellio scaber Latreille												+	+							
Porcellionides pruinosus (Brandt)	+	+		+	+		+		+	+	+	+	+	+	+	+	+	+	+	+
Armadillidiidae																				
Armadillidium vulgare (Latreille)	+	+		+	+			+			+	+	+	+	+	+	+	+		
Armadillidium nasatum Budde- Lund													+							
* *Armadillidium triangule* Tang													+							
Armadillidae																				
Cubaris murina Brandt	+	+		+		+	+													
* *Troglodillo rotundatus* Kwon & Taiti					+															
* *Sinodillo troglophilus* Kwon & Taiti		+																		
* *Sinodillo ferrarai* Kwon & Taiti		+																		
* *Sinodillo schmafussi* Kwon & Taiti		+																		
Dryadillo maculates (Arcangeli)	+		+			+														
Spherillo rffaelei (Arcangeli)		+		+	+	+	+		+											
* *Spherillo orientalis* Kwon & Taiti				+																
* *Venezillo parvus* (Budde- Lund)	+	+				+														
* *Porakermania maculata* Kwon & Taiti	+																			

Note　* express species special for China.

A　tropical zone. 1　the Jianfengling of Hainan and its neighborhood; 2　the southeast of Xishuangbanna, Yunnan; 3　the southeast of Taiwan.

B　subtropical zone. 1　Xishan of Kunming, Yunnan; 2　Guilin, Guangxi; 3　Hongkong; 4　Dinghushan, Guangdong and its neighborhood; 5　the middle and north of Taiwan; 6　Gushan, Fujian; 7　Yuelushan, Hunan; 8　Loujiashan, Wuchang, Hubei; 9　Tianmushan of Zhejiang and its neioghborhood; 10　Zijinshan of Nanjing and its neighborhood.

C　warm temperate zone. 1　Laoshan of Shandong and its neighborhood; 2　Luyashan of Shanxi; 3　Xiaolongmen of Beijing; 4　Chifeng of Innermogolia.

D　temperate zone. 1　Changbaishan of Jilin and its neighborhood.

E　high frigid zone. 1　Xining, Qinghai; 2　Changdu of Xizang.

Armadillidae, a typical group in tropical and subtropical zone is the third group of terrestrial isopoda in China typical zone, with 7 genera and 10 species, making up 13.9% in total. Almost all of them are discovered only at few points there, and most of their kinds are special species for China, such as *Troglodillo rotundatus*, *Sinodillo troglophilus*, *S. ferrarai*, *S. schmalfussi*, *Spherillo orientalis*, *Venezillo porvus* and *Parakermania maculate*, etc. But the distributions of *Cubaris murina*, *Dryadillo maculates* and *Spherillo raffaelei* are rather extensive. Except dispersed in much more sample points of China, they are also found in foreign tropical zone, for example, the former in South America and Africa (Arabia), and the later two kinds in Vietnam neighboring with China. Because this group mainly live in fallen leaves layer of forest, they also take part in energy circle of forest ecosystem, specially in playing important role during soil decomposition.

Porcellionidae, Armadillidiidae and Oniscidae are main groups of terrestrial isopoda in typical zone of China. Porcellionidae includes 4 genera and 6 species. Armadillidiidae and Onisidae with 1 genus and 3 species each, occupy 8.3% and 4.1% in total. Its *Porcellio leavis*, *Porcellionides pruinosus* and *Armadillidium vulgare* are cosmopolitan species. They are very rich in quantity. They can be found anywhere in China and can live everywhere, such as in all of residential areas and their neighboring parks, under the stone in farmland, brick and rubble, haystack and rubbish and so on. These several kinds of terrestrial isopoda can be used as medical animal to cure diseases such as menopause and dropsy, excepting their digestion soil. Other kinds can be found occasionally on very few locations. But, some kinds are widely distributed. For example, *Porcellio scaber* only exist actually in south of Europe in the past time, however due to mankind s movement they moved extensively to America, Europe, Africa, Australia, Asia, etc. In Oniscidae, excepting *Exalloniscus carcii* is distributed in tropical and subtropical zone of China, Korea and Japan, other two kinds are in few points of forest zone in subtropical zone of China with only few in quantity.

The kinds of other terrestrial isopoda family are rather few altogether with 13 species, making up 18.1% in total. Among them, except *Papausoniscus lutaoensis*, *Ligidium denticulatum*, *L. formosanum* and *L. acutitelson* which live in forests of tropical and subtropical zone, other nine kinds almost live in tropical and subtropical zones under the littoral sand and stone, which cannot move and permeate into inland. Only two kinds of Ligiidae can live in littoral temperate zone. Specially, *Ligia exotica* has strong adaptability and becomes a cosmopolitan distributed species, and it can be found distributed nearly in every littoral province of China.

2 Key Envirenmental Factor Affecting Species Distribution

To sum up the above statement, there are 72 kinds of terrestrial isopoda in China typical zone. Most of them live in tropical and subtropical zones, with 38 and 47 species respectively, 9 kinds in warm temperate zone (including temperate zone) and only 2 in high- frigid zone. After thorough analysis, the reasons making the zonal difference of species are not only self origination and living custom, but also closely related with the environmental conditions including climate, soil and plant vegetation. As the annual average temperature in tropical and subtropical zones is generally up to 18 , the types of soil mainly are forest laterites, yellow and yellow- brown soils, and their vegetation is in all type and high diversity of plant species, specially, broadleaf forests with mass of branches and leaves that make up damp environment suitable to terrestrial isopoda inhabiting. So, the kinds of terrestrial isopoda are very abundant. Most of their distributions are in tropical rainy forests. For example, in both points of, Hainan Island and Xishuangbanna, the kinds of terrestrial isopoda are more to 28, suming up totally to 1/3 species.

The annual average temperature of warm temperate zone and temperate zone is 8~ 14 . The types of soil there are mainly forest brown and dark brown soils. Although there the vegetations are in all type, the plant species are few, and the degree of moisture is not so good for growth of terrestrial isopoda. So, the kinds of terrestrial isopoda there obviously have been in a decrease, and only 9 kinds were found. When the annual average temperatures in high- cool zone are under 0 , the most types of soil are high mountain grassy marshland, the types of vegetation are very single, mainly of short small bush and grassy plant, and its enviroment is very exposed and dry. So, only a few wide spread species

with high adaptability can live there, till now 2 kinds were found. They mainly stay in heap of grasses and woods near the residential area or under the brick and rubble.

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中国典型地带陆生等足类的种类组成和分布

陈国孝

(中国科学院动物研究所, 北京　100080)

摘　要: 通过对中国 5 个典型地带(热带、亚热带、暖温带、温带、高寒带) 20 个样点进行陆生足类的调查采集, 共发现陆生等足类 11 科、29 属、72 种. 其中以喜湿虫科(Philosciidae)的种类最为丰富, 共计 4 属、19 种, 约占总数的 26.4%; 气肢虫科(Tachelipidae)为第 2 大类群, 计有 5 属、18 种, 约占总数的 25%; 卷壳虫科(Armadillidae)共有 7 属、10 种, 为第 3 大类群, 约占总种数的 13.9%; 鼠妇科(Porcellionidae)、卷甲虫科(Armadillidiidae)及潮虫科(Oniscidae)也是陆生等足类的主要类群, 这 3 科共占总种数的 16.5%; 其它 5 科的陆生等足类种类较少, 合计 13 种. 由于各地带自然环境明显不同, 造成了物种分布上的差异. 其中热带和亚热带地区种类最多, 分别为 38 种和 47 种, 共占总种数的 80%以上; 暖温带和温带地区仅发现 9 种; 而高寒带由于平均气温在 0　以下, 不利于陆生等足类的生存, 故迄今仅发现 2 种.

关键词: 典型地带; 陆生等足类; 种类组成; 区系分布

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