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Spatial Distribution Pattern of Hoplopleura affinis (Anoplura: Hoplopleuridae) on Its Rat Host Apodemus chevrieri in Yunnan, China*

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Abstract: **Objective** To determine the spatial pattern of Hoplopleura affinis among the individuals of its dominant rat host Apodemus chevrieri and to illustrate how the ectoparasitic sucking louse individuals distribute among their rat host individuals. **Methods** Iwao's linear regression method and a significance test of random deviation were used to analyze the spatial distribution pattern of Hoplopleura affinis among the individuals of Apodemus chevrieri. **Results** Hoplopleura affinis is a common sucking louse species on the body surface of Apodemus chevrieri, a common wild rat species in Yunan Province of China. In the light of Iwao's method, the equation for Hoplopleura affinis is $M^* = 3.10 + 6.69M$ ($r=0.67$, $P<0.05$). Both α and β in the equation ($\alpha = 3.10$, $\beta = 6.69$) are higher than 0 and 1, the border values for determining spatial pattern of populations. The F values is 8.77 ($F > F_{0.05(2,6)}$, $P<0.05$) in the significance test of random. The spatial pattern of Hoplopleura affinis among the individuals of its dominant host (Apodemus chevrieri) is of aggregated distribution. **Conclusions** The result suggests that the individuals of Hoplopleura affinis do not evenly distribute among its rat host individuals, but have a tendency to gather together and form different individual louse groups on the body surface of the rat host.

Key words: Anoplura; Hoplopleuridae; Sucking louse; Hoplopleura affinis; Rat host; Spatial distribution
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The research of the spatial distribution pattern of animal populations is not a new issue. With the development of ecology, some ecological techniques and methods have been introduced in the study of spatial distribution pattern with more and more reports appearing[1-4]. To some free-living insects, the spatial distribution pattern means how a certain insect population distributes their individuals in different sampling plots. To ectoparasites, however, a "sampling plot" usually means an individual of their hosts. The spatial distribution of ectoparasites on their hosts is actually the distribution among the different individuals of the hosts.

Hoplopleura affinis (Burmeister, 1839) is a common species of sucking lice on a common wild rat, Apodemus chevrieri Milne-Edwards 1868, in Yunnan Province of China. Sucking lice (a special group of insects) are the permanent ectoparasites on the body surface of mammals (especially rodents), which belong to order Anoplura in taxonomy. Though the medical significance of the parasitic sucking lice on rodents remains to be further proved, some researches imply that the sucking lice on rodents may play an important role in preserving the pathogens of some zoonoses such as murine typhus (endemic typhus), rabbit fever (tularemia) and even plague, etc[5-7].

Researches of the spatial pattern of populations are to determine the distributing styles of certain populations among the sampling units. This paper is an attempt to use Iwao's method and a significance test of random deviation to analyze the spatial distribution pattern of Hoplopleura affinis on its dominant rat host, Apodemus chevrieri, which is actually the spatial distribution among different individuals of the host. GUO XG once used Iwo's method and the significance test of deviation to study the spatial

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patterns of some gamasid mites and fleas and got a satisfied result[8,9].

1 MATERIALS AND METHODS

1.1 Field Investigation: Nine counties in Yunnan Province of China were chosen as the sites of field investigation in the study and the field investigation was carried out from January 2001 to November 2002. The nine investigated counties are Xianggelila, Gongshan, Jianchuan, Lijiang, Dali, Yuanjiang, Puer, Simao and Menghai. The studied louse species Hoplopleura affinis and its rat host Apodemus chevrieri were captured or collected from the sites of the field investigation. Each site (county) included two regions and four habitats. The two regions were flatland region and mountainous region and the four habitats were indoor habitat, outdoor habitat near dwelling (garden, plowland, bush area and some other habitat near the houses, etc.), outdoor cultivated habitat far from dwelling and forest habitat. Since there was no Apodemus chevrieri captured or the sampling numbers of the rat host were not enough for the spatial calculation in some counties and habitats, all the investigated sites (including nine counties, two regions and four habitats) were finally recombined as eight sampling units in the light of actual investigation data (See "Table 1" in "Results").

1.2 Collection and Identification: The individuals of the rat host Apodemus chevrieri were randomly captured alive with mouse-cage-traps (10cm×12cm×18cm) while the individuals of the sucking louse (Hoplopleura affinis) on the body surface of every rat host were all collected and preserved in 70% of ethanol in the investigated field. Individual lice were digested in 10% of KOH slightly at first and then gradually dehydrated in 30%, 50%, 70%, 80%, 90%, 95% and 100% of ethanol. The dehydrated louse specimens were made transparent in the mixed solution (1:1) of pure ethanol and xylene (Xylol). After the dehydration and transparent process, the louse specimens were mounted on slides by using abienic balsam separately. Each individual louse specimen was finally identified species under a microscope. Each rat host was mainly identified at the investigated field according to its body size, shape and color, and the measured figures such as body length, ear length, the length of hind feet and so forth[5,6,9].

1.3 Calculation of Spatial Pattern: Iwao's method (a commonly used method in ecological practice) and a significance test of random deviation were used to analyze the spatial distribution pattern of Hoplopleura affinis on its dominant rat host Apodemus chevrieri. The first step in Iwao's method is to create a linear regression equation between mean (M) and Lloyd's mean crowding (M^*), $M^* = \alpha + \beta M$. Through the values of α and β in the equation and the significance test of random deviation based on Iwao's method, spatial distribution patterns of populations can be precisely identified as random or aggregated distributions[10,11].

Every individual of rat host (Apodemus chevrieri) was regarded as a sampling point in every sampling unit (actually the recombination of counties, regions and habitats) in the process of statistical calculation for the measurement of louse spatial distribution pattern. On the basis of counting louse individuals on every rat host individual (sampling point), the arithmetic mean of louse individuals (M_i) and the corresponding Lloyd's mean crowding (M_i^*) in every sampling unit was then calculated. Iwao's regression equation was finally established based on all the sampling units according to the following formulae[8-11]:

$$M_i = \frac{\sum_{j=1}^{N_i} M_{ij}}{N_i}; \qquad M_i^* = M_i + \left[\frac{\sigma_i^2}{M_i}\right] - 1;$$

$$M^* = \alpha + \beta M \quad \text{(Iwao's linear regression)}$$

Where M_{ij} stands for the louse individuals on rat host (Apodemus chevrieri) individual j (sampling point j) in sampling unit i, N_i the total number of rat host individuals in sampling unit i (the total number of the sampling points in sampling unit i), M_i and σ_i^2 the mean and variance of the louse individuals in sampling unit i and M_i^* the Lloyd mean's crowding in sampling unit i.

1.4 Significance Test of Deviation: The significance test of random deviation for both α and β in Iwao's linear regression equation was carried out according to the following formula[8,9,11,12]:

$$F = \frac{\frac{1}{2}\left[N\alpha^2 + 2\alpha(\beta-1)\sum_{i=1}^{N} M_i + (\beta-1)^2 \sum_{i=1}^{N} M_i^2\right]}{\frac{1}{N-2}\sum_{i=1}^{N}(M_i^* - \alpha - \beta M_i)^2}$$

Where N stands for the total numbers of sampling units used to establish Iwao's linear regression, and M_i, M_i^*, α and β the same as in the former formulae. When

$F < F_{0.05(2, N-2)}$ ($P > 0.05$), the spatial pattern is determined to be of a random distribution while the opposite situation ($F > F_{0.05(2, N-2)}$, $P < 0.05$) to be of an aggregated distribution.

2 RESULTS

2.1 Determination of Sampling Units: In the actual field investigation, no rat host (Apodemus chevrieri) or not enough rat hosts (sampling numbers) was captured in some counties and habitats. And therefore all the investigated sites (including nine counties, two regions and four habitats) were recombined as eight sampling units to meet the needs of Iwao's linear regression and the significance test of random deviation in the spatial pattern calculation (Table 1).

2.2 Collection of Lice and the Rat Hosts: The individuals of the rat host Apodemus chevrieri were randomly captured alive with mouse-cage-traps (or mouse traps). The individuals of sucking louse (Hoplopleura affinis) on the body surface of every rat host were all collected. The collected numbers of Apodemus chevrieri (rat host), together with the numbers of the louse (Hoplopleura affinis) on its body surface were listed in Table 1.

Table 1 Numbers of the louse (Hoplopleura affinis) and its rat host (Apodemus chevrieri) in different sampling units

Sampling units				No of rat host (Apodemus chevrieri)	No of louse (Hoplopleura affinis)
Codes	Corresponding counties (sites)	Corresponding regions	Corresponding habitats*		
1	Dali	Mountainous region	OC	57	72
2	Dali	Mountainous region	FH	118	262
3	Xianggelila	Mountainous region	FH	112	392
4	Gongshan	Mountainous region	OC+FH	92	62
5	Jianchuan	Flatland region	OC	40	34
6	Jianchuan	Mountainous region	OH+OC+FH	79	141
7	Lijiang	Mountainous region	OC	40	57
8	Lijiang	Mountainous region	FH	66	314
	Total			604	1334

* Annotation: OC, FH and OH stand for "outdoor cultivated habitat far from dwelling", "Forest habitat" and "outdoor habitat near dwelling" respectively. No rats (Apodemus chevrieri) were captured from indoor habitat.

2.3 Result of Spatial Pattern Calculation: The arithmetic mean (M), variance (σ^2) and Lloyd's mean crowding (M^*) of the studied louse Hoplopleura affinis in every sampling unit were calculated and summarized at first, and then some other parameters in the significance test of random deviation are also calculated and listed out (Table 2).

In the light of the M and M^* in Table 2, a specific Iwao's linear regression equation between M and M^* for Hoplopleura affinis was established and the equation was $M^* = 3.10 + 6.69M$ ($r = 0.67$, $P < 0.05$). Both α and β in the equation ($\alpha = 3.10$, $\beta = 6.69$) were higher than 0 and 1, the border values for determining spatial pattern of populations. The F value was 8.77 ($F > F_{0.05(2,6)}$, $P < 0.05$) in the significance test of random deviation ($F_{0.05(2,6)} = 5.14$, $F_{0.01(2,6)} = 10.92$; $N-2 = 8-2 = 6$).

Table 2 Some calculated parameters in the establishment of Iwao's linear regression equation and the significance test of random deviation for Hoplopleura affinis

Codes of sampling units	M_i	σ_i^2	M_i^*	$(M_i^* - \alpha - \beta M_i)^2$
1	1.26	8.77	7.21	18.67
2	2.22	92.32	42.8	617.48
3	3.50	78.14	24.82	2.86
4	0.67	4.62	6.53	1.11
5	0.85	6.44	7.42	1.87
6	1.78	8.97	5.81	84.61
7	1.43	13.69	10.03	6.96
8	4.76	126.59	30.36	20.95

* Annotation: (1) Iwao's linear regression equation: $M^* = 3.10 + 6.69M$ ($\alpha = 3.10$; $\beta = 6.69$; $r = 0.67$, $P < 0.05$). (2) Significance test of random deviation: $F = 8.77$, ($F > F_{0.05(2,6)}$, $P < 0.05$)

The spatial pattern of Hoplopleura affinis among the individuals of its dominant host (Apodemus chevrieri) was then determined to be of an aggregated distribution.

3 DISCUSSION

Spatial distribution pattern is to illustrate how a certain animal population distributes their individuals in every sampling plot which is an important theoretical issue in the field of ecology. There are a lot of methods to calculate and determine the spatial distribution pattern of animal populations. Iwao's linear regression ($M^* = \alpha + \beta M$) has long been used to analyze the spatial patterns of various animal populations in the ecological practice. According to the original definition of Iwao's method, the spatial pattern of a certain population could be directly determined through the values of α and β. When $\alpha > 0$, $\beta > 1$, the spatial pattern of the population would be determined as an aggregated distribution and when $\alpha = 0$, $\beta = 1$, a random distribution. In this way of determination, $\alpha = 0$ and $\beta = 1$ is to be considered as a border parameter for differentiating a random distribution from an aggregated one. This is very simple and easy to be adopted in ecological applications but not always the case. The fact is that the possibility of exact 0 or 1 is very low and there is some deviation in the practical use[8, 9, 11]. The significance test of random deviation used in this paper has been regarded as a better way to solve the above problem, which is firstly deduced by HONG W[11].

Hoplopleura affinis is a common species of sucking louse on the body surface of Apodemus chevrieri (a very common wild rat in Yunnan Province of China). This paper describes how the louse individuals (Hoplopleura affinis) distribute among different individuals of its rat host. The spatial pattern of Hoplopleura affinis in this study is actually the distribution pattern of the louse individuals among the different individuals of rat host Apodemus chevrieri.

The result concludes that the spatial pattern of Hoplopleura affinis among the different individuals of its dominant rat host is of aggregated distribution. This suggests that every individual within the population of Hoplopleura affinis does not exist independently. The existence of one individual louse would have more or less influences on the distribution of the others in the same population. As a result, the louse individuals in the same population would have a tendency to form various aggregated groups. The aggregated distribution pattern reveals that the louse individuals do not evenly distribute among the host individuals but gather as different sizes of groups on the body surface of some rat individuals.

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云南省齐氏姬鼠体表相关甲胁虱(虱目:甲胁虱科)的空间分布格局(摘要)

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摘要:目的 判定相关甲胁虱在齐氏姬鼠不同个体间的空间分布格局,揭示体表寄生吸虱在其鼠类宿主不同个体间的分布状况。**方法** 本文应用 Iwao直线回归方法及其随机偏离度检验对相关甲胁虱在齐氏姬鼠不同个体间的空间分布格局进行了研究。**结果** 相关甲胁虱是云南省境内齐氏姬鼠体表的主要寄生吸虱之一,分布比较广泛。按照 Iwao方法所建立的回归方程为 $M^* = 3.10 + 6.69M$($r = 0.67$, $P < 0.05$),所得到的 α与 β值($\alpha = 3.10$; $\beta = 6.69$)均明显高于判定界线值 0和 1。对 α与 β值进行随机偏离度检验,F值为 8.77($F > F_{0.05(2,6)}$, $P < 0.05$),由此判定相关甲胁虱在齐氏姬鼠不同个体间的空间分布格局为聚集型分布。**结论** 相关甲胁虱在齐氏姬鼠的寄生是不均匀的,而存在聚集现象,有形成大小不一吸虱个体群的趋势。

关键词:虱目;甲胁虱科;吸虱;相关甲胁虱;鼠类宿主;空间分布
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1998年新疆塔什库尔干县学龄儿童甲状腺肿大调查*

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关键词:地方性甲状腺肿;学龄儿童;监测
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新疆塔什库尔干县位于帕米尔高原东部、喀喇昆仑山和兴都库什山北部、塔里木盆地西面,是与多国邻接的高原山区边境县,平均海拔 4 000 m,属独特的高原干燥气候。由于当地土盐资源丰富、牧民的生活习俗及经济条件给推广普及加碘盐造成一定困难。为了解当地牧区儿童碘缺乏病现状,我们于 1998年 7月对 2个乡的 6所小学 546名 7～14岁儿童进行了甲状腺肿调查。

1 对象与方法

1.1 对象:本县库克西力克乡和大同乡的 6所小学 546名 7～14岁儿童。

1.2 方法:按照《全国碘缺乏病防治监测方案》的标准进行甲状腺触诊检查。

2 结果

共调查儿童 546名,查出甲状腺肿大 137人,肿大率为 25.1%。其中 I°127人,II°10人。

3 讨论

通过调查表明,位于塔什库尔干县境内叶尔羌河流域两侧的库科西力克乡、大同乡儿童甲状腺肿大率较高,充分说明我县儿童 IDD病情的严重性。此外调查结果还表明大同乡的碘缺乏病患病率高于库科西力乡。碘缺乏病患病率高的主要原因是当地地层中碘元素缺乏,以及生活在这里的塔吉克族牧民经济条件差、文化素质低,特别是至今仍基本上食用土盐有关。因此,为达到消除碘缺乏病的目标,各级领导和有关部门要高度重视并有力的协调各有关部门加强此项工作,必须加强防治 IDD的宣传教育,使本地居民养成食用加碘盐的习惯,对孕妇和儿童应采用强化补碘、碘化油注射、加碘器补碘等方法,并结合当地经济条件广泛推广使用,有效地防治碘缺乏病,以达到 IDD的防治目标。

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