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## Microdistribution of the Cuckoo-wasp Population\*

*With 2 Text-figures*

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(Communicated by T. UCHIDA)

It is generally accepted without particular examination that such common animals having a great locomotive capacity as winged insects are distributed rather uniformly over a comparatively wide range of similar environmental conditions. This is usually true especially when the range is concerned with a limited area. According to experiences in collecting, however, it has been observed that the relative abundance between species of the cuckoo-wasp populations often markedly varies from one village to another, although the habitats lie rather closely to each other and there is no apparent difference of environmental conditions responsible for such a striking change in distribution. In order to grasp the phenomenon more accurately and to give explanation, if any, to such a curious state of the micro-distribution of the insects, the present study was undertaken.

## LOCALITIES AND THEIR TOPOGRAPHY

Depending in the main upon the previous experiences in collecting, ten villages at the foot of a small mount (Mt. Monju, 360 m high) lying between the cities of Fukui and Takefu were selected as stations (Fig. 1). The mount has comparative steep slopes and an intricate border at the foot. The stations are mostly situated in some inlet-like corners at the foot; hence they are surrounded more or less by little spurs. Stations 6,

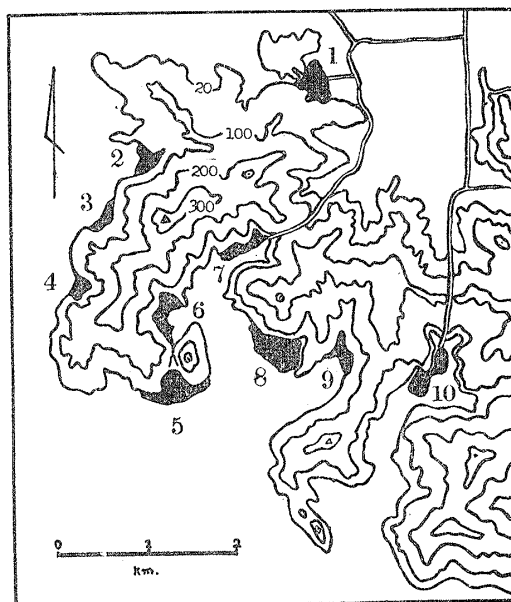


Fig. 1. Topography of the stations studied.

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7, 9 and 10 are especially deeply embraced by the offsets. These stations comprise from about 40 to 100 houses, involving 10-70 thatched roofs, the nesting-place of the hosts of the cuckoo-wasps.

#### SPECIES STUDIED AND METHOD OF SAMPLING

Out of the seven species of the genus *Chrysis* occurring in Fukui Pref., western M. Japan, five favourable species were selected as material (Table 1). They are

Table 1  
Species of the cuckoo-wasps studied and their hosts known so far in Japan

Species	Colour of abdomen	Host species
<i>Chrysis (Chrysis) ignita</i> L. ssp.	red	<i>Odynerus nigripes</i> Saussure <i>Odynerus</i> sp. <i>Symmorphus</i> sp. (?) <i>Rhygchium mikado</i> Kirsh
<i>C. (C.) komachi</i> Tsuneki	red and violet	unknown
<i>C. (C.) sarafschana rubripyga</i> Ts.	violet and red	<i>Odynerus shibuyai</i> Yasumatsu <i>Symmorphus captivus</i> Smith
<i>C. (C.) rubrifasciata</i> Tsuneki	blue violet with reddish bands	<i>Symmorphus</i> sp. <i>Symmorphus apiciornatus</i> Cam. (?)
<i>C. (Chrysogona) japonica</i> Cam.	blue green	<i>Symmorphus apiciornatus</i> Cam.

all parasitic on the nests of solitary diplopterous wasps that make their nests in thatches, reed-canes and hemp-stems of the roof, or in abandoned beetle burrows and other holes on posts and railings of houses.

The cuckoo-wasps, especially the males, have a peculiar habit of flying to wooden poles in the bright sunshine. Moreover, in their activities there can be observed a marked rhythm. They come most abundantly to the pole three times a day, once in the forenoon, once about noon and once in the afternoon, the exact time of the morning and afternoon flights being somewhat varied according to the period of the season. Besides, remarkable oscillations can be observed at each height of the rhythm of their activities. When they come, they come continuously one swarm after the other. Probably the strong musky scent given off, characteristic of the species, plays an important part in such a gregarious activity. When they stop coming, a short vacant time elapses before they come streaming again. Generally, however, such rhythmic activities are not marked at the beginning of the season, but become gradually prominent as time passes on. This is also more or less different from species to species. It is most striking in the red species (*C. ignita* ssp.) and somewhat less so in the blue ones (*C. rubrifasciata* and *japonica*) (Table 2). Moreover, in the latter group, the median peak is not distinctly apparent in the lowland region. On rainy or overcast days the cuckoo-wasps do not make their appearance.

In gathering material, therefore, particular care was taken to catch one at least during such climaxes of rhythm in their activities. The stations were visited on fine days from two to five times during the period, May 3-17, 1955, and

Table 2

Rhythmic activities of the cuckoo-wasps (represented by the number captured), recorded at St. 5 and at St. 9 (within parenthesis).

Time	8:30—9:30—10:30—11:30—12:30—13:30—14:30—15:30—16:30—17:30									
Temperature	17.0—20.0—22.0—24.2—25.3—26.5—28.0—27.2—26.5—23.7 (18.0)–(19.7)–(20.5)–(24.3)–(25.0)–(26.2)–(27.8)–(28.5)–(27.5)–(26.3)									
<i>ignita</i>	45(1)	33(0)	8(0)	34(0)	10(1)	4(3)	9(1)	21(1)	4(1)	
<i>komachi</i>	2(3)	2(5)	1(4)	0(0)	1(1)	0(1)	0(1)	0(5)	0(1)	
<i>s. rubripyga</i>	0(1)	1(0)	0(0)	1(0)	0(0)	0(2)	1(1)	2(0)	2(0)	
<i>rubrifasciata</i>	10(15)	6(27)	2(18)	5(4)	2(5)	6(13)	4(7)	4(19)	3(8)	
<i>japonica</i>	3(6)	3(8)	1(6)	1(0)	0(1)	2(2)	0(0)	0(4)	1(1)	

as many cuckoo-wasps were collected as possible. The insects obtained were grouped per hour and labelled. It is rather a difficult matter to capture the ruby-tailed wasps quickly crawling or flying along the rounded surface of an electric pole. With a special technique, however, over 80% were captured every time.

## RESULTS

Total number of each species of the cuckoo-wasps collected at each station and the time spent in doing it were set out in Table 3 and the relative abundance

Table 3

Total number of the cuckoo-wasps collected at each station

Station No.	1	2	3	4	5	6	7	8	9	10	Total
Time spent	3:00	2:00	2:00	3:30	11:20	2:50	3:00	2:30	9:00	5:30	44:40
<i>ignita</i>	22	14	16	9	180	15	5	24	11	5	301
<i>komachi</i>	7	4	2	1	10	3	1	6	26	12	72
<i>s. rubripyga</i>	9	14	14	7	13	1	1	10	3	6	78
<i>rubrifasciata</i>	22	22	14	9	63	45	54	32	114	55	430
<i>japonica</i>	1	8	2	3	14	9	30	12	33	12	124
Total	61	62	48	29	280	73	91	84	187	90	955

(percentage) between the species at each station was shown in Figure 2. At first glance it is quite obvious that the pattern of the constitution of the cuckoo wasp populations markedly differ from station to station, although they are situated within a narrow area and at about the same level. At Station 5, *C. ignita* represents the dominant species. The same but less striking relationship can be perceived at Station 1. On the other hand, at Stations 6, 7, 9 and 10, *ignita* is completely replaced in dominancy by *rubrifasciata*, the chief of the blue species. At Stations 2, 3, 4 and 8, the relation is intermediate, though strictly the dominancy is barely retained at Station 3, equally divided at 4 and reversed at 2 and 8.

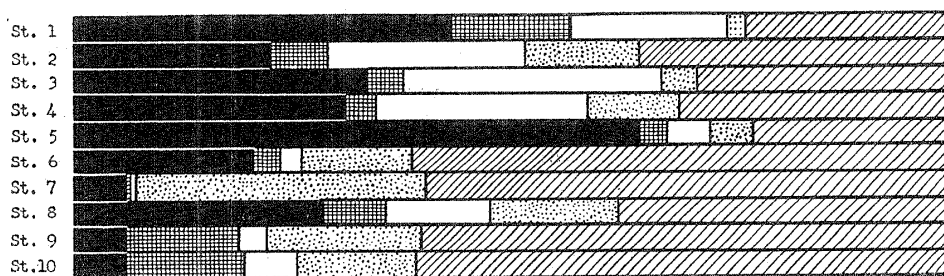


Fig. 2. Relative abundance (percentage) between species of the cuckoo-wasp population at each station. Black area, *ignita*; meshed area, *komachi*; white area, *s. rubripyga*; dotted area, *japonica*; hatched area, *rubrifasciata*.

Relative abundance of *japonica* is roughly in parallel with that of *rubrifasciata*.

Moreover, in order to make the climatic conditions as far as similar, a collection on the same day at each station when the rhythmic activities of the insects were not as yet striking was carried out. The result showed the same general tendency as given above. All these results well agree with the collecting records of the previous years. Therefore, it by no means follows that the results represent only a particular state of microdistribution of the cuckoo-wasps in the district.

#### DISCUSSION

In the first place the results clearly indicate that the cuckoo-wasps, despite their comparatively great locomotive capacity, do not move about so freely from village to village as might be expected. This is doubtlessly an important factor to retain the actual state of the distribution. In the second place, it can be perceived that they have nothing to do with the relative situations of the stations set up against the mount. In the third place, however, the results are apparently closely related to the topography of the localities. In the villages deeply surrounded by the spurs of the mount, the blue species are relatively abundant, while in those where the valley is suddenly and widely opened, the percentage occupied by the red species is by far the larger. This is a tendency generally observed heretofore in the collecting of the cuckoo wasps in various localities at medium height in middle Japan. But it is uncertain from the results only whether the topography is directly connected with the distribution of the insects, or indirectly related through the intervention of the host species, since the prosperity of the parasitic forms depends chiefly upon the number of the host animals. On this account, the investigation was conducted upon the species constitution of the Eumenidae populations including both the known and the supposed host species of the cuckoo-wasps at each station. But no marked change not only in their species constitution, but also in their relative abundance corresponding to the change in the parasite population constitution could be confirmed between them. Possibly in this case, the host-parasite relationship does not play any important rôle in determining the difference in the parasite distribution. As for the mutual relation between species of the cuckoo-wasps, intraspecific cannibalism in the larval stage due to hyperparasitism is more severe than the interspecific depredation and inter-

specific interference between adult insects is very slight. Both have no connection with topography. Thus the problem comes to be focused upon the effect of topography on the distribution of the cuckoo-wasps.

In the villages deeply embraced by the spurs, hours of sunshine are shorter, day-degrees are lower accordingly and the temperature fluctuation within a day is somewhat larger as compared with the open localities. These factors must contribute to bring a longer period of cooler hours to the places and this condition the blue species seems to adjust themselves more favourably. Indeed, *C. rubrifasciata* and *japonica*, each has a greater preference for cooler climate as compared with *C. ignita*. The former commonly occur throughout the highlands and the mountain regions while the race of *ignita* dealt with here comes to be rarer as go higher in the mountain. Even in the flat lands the blue species usually emerge much earlier in spring than the red ones; they begin to fly about earlier in the morning and they tend to lack the mid-day peak in activities. Moreover, when attention is taken as to the more detailed distribution of these cuckoo-wasps within a village at a delta of a brook (like most of the stations studied), it is found that the blue species is comparatively abundant in the upper and narrow area, while the red one is rather numerous in the lower and more open part of the delta. These data seem to indicate how sensitively they can react to the temperature difference of a locality. We can probably attribute that strange microdistribution of the cuckoo-wasps which I have now taken up to this delicate difference in temperature preference between them tied up with the slight change in climatic conditions between the villages caused chiefly by the topography.

#### SUMMARY

Relative abundance between species in the cuckoo-wasp population is sometimes markedly different between adjacent villages. In this case, the factor affecting such a distribution is not the host-parasite relationship, nor the interaction between species, but probably the topography of the place that acts through a climatic factor upon the different temperature preference of each species.

#### LITERATURE

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