ACKNOWLEDGMENT

We are grateful for the technical assistance of Mr. S. Kollberg.

REFERENCES CITED


The Chromosomes of Nine Ant Species (Hymenoptera: Formicidae)
from Taiwan, Republic of China

A. CHANG-FU HUNG, HIROTAMI T. IMAI, and MASAO KUBOTA

ABSTRACT

Chromosomes of the following 9 species of ants from Taiwan are reported: Anicetus sp. near camposi Wheeler Chapman, n = 15; Tetragonaria allabrorata Walker, n = 16; Aphaenogaster titania Forel, 2n = 34; Oligomyrmex sistent Forel, n = 18; Xiphomyrmex sp., 2n = 20; Paratrechina longicornis (Latreille), 2n = 16; Pseudarticulatus sp., near energhi Forel, n = 14; Camponotus sp. (tyrannus complex), 2n = 20; Polyrhachis divers F. Smith, n = 21 (karyotype formula n = 1M + 8SM + 1ST + 3A + 8T).

The study of ant chromosomes was formerly a rather difficult task. However, with the improved techniques of Imai (1966) and Crozier (1968), ants have proven to be more suitable for cytological studies than most other groups of Hymenoptera. During summer of 1969 we studied the chromosomes of 20 species of ants in Taiwan. However, because of the hot summer weather and delays in photographing the squash preparations, preparations of 11 species were lost and some of the photographs were not clear.

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enough for karyotype analysis. The 9 species discussed hereinafter represent the 1st records of chromosomes for each species. In addition, 2 of the species represent 1st records for their subfamilies.

MATERIALS AND METHODS

Field-collected ants and their brood were held in the Entomology Laboratory of Chung Hsing University, Taichung, Taiwan, until the brood reached suitable stages. The organs used as sources of cytological material included the testes of male pupae at the "slight rouge" eye stage, the ovaries of female pupae at the "scarlet" eye stage, and the brains (cerebral ganglia) of all castes at the "transparent" preupal stage. The organs were dissected out in hypotonic solution with colchicine (0.45% sodium citrate 10 ml/0.1% colchicine 1 ml). After tracheae and fat bodies were removed, the organs were transferred to the same hypotonic solution for 10-15 min at room temperature. Fixing and staining were made in aceto-orcein (1% orcein in 50% glacial acetic acid) for 30 min. After this treatment, the organs were transferred to preclanmed slides with a small amount of aceto-orcein. Coverslips were placed over the organs, excess aceto-orcein was removed, and the material was squashed with the thumb between a piece of highly absorbent paper and a thick glass plate. Finally, the squash preparations were sealed with nail polish. Voucher specimens bearing collection numbers are deposited in the collections of Hung and Kubota.

RESULTS AND DISCUSSION

Dorylinae.—Aenictus sp., near campesi Wheeler & Chapman.—n = 15, 2 cells from testes of male pupae; 2n = 30, 4 cells from brain of worker prepupa. One colony (no. 11) taken at Fenchihu (1800 m alt.). Identified by W. L. Brown, Jr. This record is the first of chromosome number in this subfamily.

Pseudomyrmicinae.—Tetraponera allaborans Walker.—n = 16, 7 cells from testes of male pupae. One colony (no. 2) taken at Wufeng, Taichung. Identification confirmed by Dr. Brown. This record is also the first for the Pseudomyrmicinae.

Myrmicinae.—Aphaenogaster tipuna Forel.—2n = 34, 14 cells from brain of worker prepupa. One colony (no. 8) taken at Wushe (1500 m alt.) and another (no. 14) at Fenchihu. Identified by Dr. Brown. Hauschteck (1962) reported 2n = 22 for A. subterrana (Latreille) from Switzerland. The same number was found in A. shythies Forel from Japan (Imai 1971). Imai also reported haploid numbers of 16 and 17 for the other 2 Japanese species (A. osimensis Teranishi and famelica (F. Smith)) and suggested that the karyotype of famelica (n = 17) could be derived from that of osimensis (n = 16) by centric dissociation of the largest submetacentric chromosome. A karyotype variation of 16-18 was found in a North American species, A. radis (Emery), suggesting rapid karyotype change relative to phenotype change (Crozier 1970).

Oligomyrmex santari Forel.—n = 18, 11 cells from testes of male pupae. One colony (no. 12) taken at Fenchihu. The cytology of Oligomyrmex has not previously been studied. The other species in the subfamily Myrmicinae so far known to have n = 18 are Vollenhovia uncry Wheeler (Imai 1966) and A. rudis Emery (n = 16-18). The latter is in the tribe Pheidolini and according to Ettershank (1966) Vollenhovia is not a member of the Pheidoletonet genus group to which Oligomyrmex belongs.

Xiphomyrmex sp.—2n = 20, 11 cells from brain of worker prepupa. One colony (no. 19) taken at Fenchihu. Identified by Dr. Brown. The only other species of the tribe Tetramorini known cytologically are Strongynognathus huberi alpina Wheeler (Hauschteck 1962) and Tetramorium coccitum (L.) (Hauschteck 1961, Imai 1966). Each of the latter has n = 14.

Formicinae.—Paratrechina longicornis (Latreille).—2n = 16, 7 cells from ovaries of female pupae. One colony (no. 3) taken at Taichung. This well known tropicopolitan species has been placed in the genus Prentoplis by some authors. Because Prentoplis impars Say is the only other species in the Lasini so far known to have 2n = 16 (Hauschteck 1962), a close relationship of longicornis to Prentoplis is evident. The other groups in this tribe the cytology of which has been examined are the genus Lasius with n = 14 or 15 (Crozier 1970, Hauschteck 1962, Hung 1969, Imai 1966) and Pseudolasius (see hereinafter).

Pseudolasius sp., near uncry Forel.—n = 14, from testes of 20 3 pupae. One colony (no. 10) taken at Lusan (1420 m alt.) near Wushe. This species has the same chromosome number as some species in Lasius. Although we lack data for the North American honey ant genus Myrmecocystis and the monotypic genus Andragnathus from Java, it now seems

Table 1.—Frequency of haploid and diploid cells observed in the testes, and of polyploid cells in male cerebral ganglia, of Pseudolasius.

<table>
<thead>
<tr>
<th>Individuals observed</th>
<th>n</th>
<th>2n</th>
<th>4n</th>
<th>8n</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Testes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>139</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>2</td>
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<td>349</td>
<td>0</td>
<td></td>
</tr>
<tr>
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<td></td>
<td>400</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>181</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>5*</td>
<td></td>
<td>0</td>
<td>53</td>
<td></td>
</tr>
<tr>
<td>6*</td>
<td></td>
<td>4</td>
<td>337</td>
<td></td>
</tr>
<tr>
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<td></td>
<td>0</td>
<td>276</td>
<td></td>
</tr>
<tr>
<td>8*</td>
<td></td>
<td>0</td>
<td>542</td>
<td></td>
</tr>
<tr>
<td><strong>Cerebral ganglia</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>33</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>85</td>
<td>42</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>29</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>4*</td>
<td></td>
<td>8</td>
<td>17</td>
<td>0</td>
</tr>
<tr>
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<td></td>
<td>75</td>
<td>16</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>29</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>38</td>
<td>9</td>
<td>4</td>
</tr>
</tbody>
</table>

* Exceptional males having diploid number which are conveniently named as diploid males.

**Diploid cells predominate over haploid cells, suggesting a diploid male occurred secondarily by polyploidization.
evident that the tribe Lasini is composed of 2 distinct groups as far as chromosome numbers are concerned: one with $n = 8$ and the other $n = 14–15$.

Polyploid cells have been observed in the larval somatic cells in ants (Smith and Peacock 1957, Haußbeck 1965). Imai and Yoshida (1965) also found diploid and tetraploid cells in the testes and tetraploids in the oogonial cells of A. osinensis. In our study we have found 7 diploid and 20 haploid males in this species with many diploid cells, especially in the testes (Table 1). However, no gross morphological differences were found between these haploid and diploid males. Further studies are needed to determine whether the diploid males produce functional sperm or not. This information may be a key point in knowing whether polyploidization has played an important role in the karyotype evolution in ants as suggested by Imai (1966, 1969, 1971) and Camponotus sp. (variegatus complex). $2n = 20$ cells from brains of worker pupae. One colony (no. 21) taken at Kenting Botanical Garden. Identified by Dr. Brown. C. compressus (F.) from India is the only other Camponotus known to have the same chromosome number (Kumbkarni 1965).

Polyrhachis dives F. Smith, $n = 21$ (Fig. 1), 20 cells from testes of male pupae. One colony (no. 19) taken on the campus of Chung Hsing University. This large Old World genus with ca. 500 nominal forms is poorly known cytologically. Besides P. dives, only 4 other species have been studied: Hippoponassa F. Smith with $n = 20$ and lamellidens F. Smith with $2n = 42$ (Imai 1966), simplex Mayr with $2n = 2$, $n = 21$ (Imai, unpublished) and rastellata (Latreille) with $n = 21$ (Crozier 1970). Morphologically, dives, hipponassa, and simplex are in the same subgenus, Myrmhopla, while rastellata belongs to the subgenus Cyrtomyrma and lamellidens is in the subgenus Polyrhachis. Furthermore, Myrmhopla is more closely related to Cyrtomyrma than to Polyrhachis (s. str.) (Hung 1967). As shown in Fig. 1, dives has a karyotype formula of $n = 1M + 8S + 1S + 3A + 8T = 21$. A karyotype formula of $n = 8S + 1S + 1T + 8T = 20$ was reported for hippocadens (Imai 1969) and according to Crozier (1970), rastellata has 4 metacentrics and 17 subacrocentrics $\approx$ subtelocentric acrocentric $\approx$ telocentric $\approx$ subcentric) chromosomes. We do not know the intronme positions of chromosomes in the other 2 species. However, it is interesting to note that within the subgenus Myrmhopla there are at least 2 different chromosome numbers with significantly different karyotype formulas.

ACKNOWLEDGMENT

We thank the Department of Entomology, Chung Hsing University, Taiwan for the use of space and laboratory facilities. We are indebted to Dr. W. L. Brown, Jr., Cornell University, Ithaca, N. Y., for the identification of certain species and to Dr. Masaki Kudo, Shiraume Junior College, Tokyo for assisting in obtaining materials. Thanks are also due Dr. R. H. Crozier, University of Georgia and Dr. P. B. Kannowski, University of North Dakota for their helpful criticisms of the manuscript.

This study was financed in part by Sigma Xi Grant-in-Aid of Research award to Hung. He is also deeply grateful to his wife, Hui-Mei, for her understanding and encouragement throughout the course of this work.

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