RE-SURVEY OF THE TERMITE FAUNA OF RAJASTHAN, INDIA, AND ITS ZOOGEOGRAPHY

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(With 4 Tables and 23 Text-figures)

INTRODUCTION

1. General

Rajasthan is the large westernmost State of India, covering 3,42,274 sq. km. (ca. 1,32,152 sq. miles). Two-thirds of it, lying W and NW of the diagonally running Aravalli Hills, is very arid and forms the bulk of the Great Indian Desert; the remaining one-third, lying S and SE of the Aravallis is relatively wet. It has 26 administrative districts (Text-fig. 1).

Until 1960, only 7 species of termites (Insecta : Isoptera) were known from Rajasthan. As a result of active exploration and study, Roonwal and Bose (1964) recorded 19 species and subspecies in their monograph. In the following 10 years (1964-73), we ourselves and parties from the Desert Regional Station, Zoological Survey of India have made intensive collections around Jodhpur and from several other districts of Rajasthan. As a result, one family (Kalotermitidae), one subfamily (Termitinae), 2 genera (Incisitermes and Angulitermes) and the following 14 species have been added to the Rajasthan fauna:—

1. Incisitermes didwanaensis Roonwal & Verma
2. Microcerotermes palestinensis Spaeth
3. M. sakesarensis Ahmad
4. Angulitermes jodhpurensis Roonwal & Verma
5. Odontotermes brunneus (Hagen)
6. O. dehraduni (Snyder)

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7. *O. distans* Holmgren & Holmgren
8. *O. feae* (Wasmann)
9. *O. giriensis* Roonwal & Chhotani
10. *O. gurdaspurensis* Holmgren & Holmgren
11. *O. latiguloides* Roonwal & Verma
12. *O. parvidens* Holmgren & Holmgren
13. *O. wallonensis* (Wasmann)
14. *Microtermes unicolor* Snyder

Text-fig. 1. Map of Rajasthan, showing the collecting localities for termites. (Inset: India, showing the area surveyed.) Large numerals (1—26): Administrative Districts: 1, Ajmer. 2, Alwar. 3, Banswara. 4, Barmer. 5, Bharatpur. 6, Bhilwara. 7, Bikaner. 8, Bundi. 9, Chittorgarh. 10, Churu. 11, Dungarpur. 12, Ganganagar. 13, Jaipur. 14, Jaisalmer. 15, Jalore. 16, Jhalawar. 17, Jhunjhunu. 18, Jodhpur. 19, Kota. 20, Nagaur. 21, Pali. 22, Sawai Madhopur. 23, Sikar. 24, Sirohi. 25, Tonk. 26, Udaipur. Small numerals (1—48, etc.): Collecting localities as listed in Table 1.

One species, *Trinervitermes heimi* (Wasmann), has been sunk as a junior synonym of *T. biformis* (Wasmann), and the following subspecies raised to full species rank:—

*Microcerotermes tenuignathus laxmi* Roonwal & Bose, raised to *M. laxmi* Roonwal & Bose.
Microcerotermes championi raja Roonwal & Bose, raised to M. raja Roonwal & Bose.

Microcerotermes tenuignathus tenuignathus Holmgren, now regarded simply as M. tenuignathus Holmgren, without any subspecies:

Odontotermes bellahunisensis guptai Roonwal & Bose, raised to O. guptai Roonwal & Bose.

Odontotermes brunneus kushwahai Roonwal & Bose, raised to O. kushwahai Roonwal & Bose.

The termite fauna of Rajasthan now comprises of 32 species spread over 4 families and 14 genera, as follows:

List of termites known from Rajasthan

Note: Species (or subspecies) from Rajasthan listed by Roonwal and Bose (1964) are marked with an asterisk (*); the rest are additional records.

Family I. Kalotermitidae
1. Incisitermes didwanaensis Roonwal & Verma

Family II. Hodotermitidae
2. Anacanthotermes macrocephalus* (Desneux)

Family III. Rhinotermitidae
Subfamily (i) Psammotermitinae
3. Psammotermes rajasthanicus* Roonwal & Bose
Subfamily (ii) Heterotermitinae
4. Heterotermes indicola* (Wasmann)
Subfamily (iii) Coptotermitinae
5. Coptotermes heimi* (Wasmann)

Family IV. Termitidae
Subfamily (i) Amitermitinae
6. Speculitermes cyclops cyclops* Wasmann
7. Amitermes belli* (Desneux)
8. Synhamitermes quadripect* (Wasmann)
9. Eremotermes neoparadoxalis* Ahmad
10. E. paradoxalis* Holmgren
11. Microcerotermes laxmi* Roonwal & Bose
   [M. tenuignathus laxmi R. & B.]
12. Microcerotermes palestinensis Spaeth
13. Microcerotermes raja* Roonwal & Bose
   [M. championi raja R. & B.]
14. *Microcerotermes sakesarensis* Ahmad
15. *Microcerotermes tenuignathus* Holmgren
   \[*M. t. tenuignathus* Holmgren.]

Subfamily (ii) Termitinae

16. *Angulitermes jodhpurensis* Roonwal & Verma

Subfamily (iii) Macrotermiteinae

17. *Odontotermes bruneus* (Hagen)
18. *O. dehraduni* (Snyder)
19. *O. distans* Holmgren & Holmgren
20. *O. feae* (Wasmann)
21. *O. giriensis* Roonwal & Chhotani
22. *O. guptai* Roonwal & Bose
   \[*O. bellahunisensis guptai* R. & B.]
23. *O. gurdaspurensis* Holmgren & Holmgren
24. *O. kushwahai* Roonwal & Bose
   \[*O. bruneus kushwahai* R. & B.]
25. *O. latiguloides* Roonwal & Verma
26. *O. obesus* (Rambur)
27. *O. parvidens* Holmgren & Holmgren
28. *O. wallonensis* (Wasmann)
29. *Microtermes mycophagus* (Desneux)
30. *M. obesi* Holmgren
   \[Syn. *M. anandi* Holmgren]
31. *M. unicolor* Snyder

Subfamily (iv) Nasutitermitinae

32. *Trinervitermes biformis* (Wasmann)
   \[Syns. *T. heimi* (Wasmann) and *T. longinotus* (Snyder)]

In the present paper, we have dealt with 29 species which constitute either new records from Rajasthan or are extensions of range in this area. Measurements (taken as defined in Roonwal, 1970a) and illustrations are provided only in those species for which they were not given in the earlier monograph (Roonwal and Bose, 1964). For a general account of the biology of several of the species, vide Roonwal (1970b). For distributional purposes, the records of Ahmad (1955) and Chaudhri and Ahmad (1972) for Pakistan and Bangla Desh were useful for comparison.

Ecological and zoogeographical importance of Rajasthan: A detailed faunistic study of so large an area as Rajasthan is in itself a desideratum. This need is further accentuated by the fact that the area is ecologically and zoogeographically of unusual interest. Ecologically, it is two-thirds arid and grades into semi-arid and wet areas, so that the ecological distri-
bution of the various species can be compared. Zoogeographically, the area forms a border zone between the western portion of the Palaearctic Region and the Oriental Region. For both these purposes, this taxonomic account, along with the earlier monograph of Roonwal and Bose (1964), provide the basic taxonomic framework. Zoogeography is discussed at the end.

2. Abbreviations used

Alt., Altitude, above mean sea-level.
Dist., District.
Ex., Exs., Out of; also example(s).
Im., Imago.
L., Length.
Pw., Pseudoworker.
S., Soldier.
Sev., Several.
Syn(s)., Synonym(s).
Type-loc., Type-locality.
W., Width.
Wk., Worker.

COLLECTIONS AND THE COLLECTING LOCALITIES
(Table 1 and Text-fig. 1)

<table>
<thead>
<tr>
<th>Collecting Stations</th>
<th>Approximate latitude (N)</th>
<th>Approximate longitude (E)</th>
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<tbody>
<tr>
<td>1</td>
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<tr>
<td>1. Ajmer District (No. 1 in Fig. 1)</td>
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<tr>
<td>2. Danpur village</td>
<td>23°50'</td>
<td>74°21'</td>
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<tr>
<td>3. Hill near Kuthumbi</td>
<td>23°30'</td>
<td>74°35'</td>
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4. Barmer District (No. 4 in Fig. 1)

6. Balotra | 25°50' | 72°15' |
7. Mevanagar (Nakhora), ca. 6 km. SW of Balotra | 25°45' | 72°10' |
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<tr>
<th>Collecting Stations</th>
<th>Approximate latitude (N)</th>
<th>Approximate longitude (E)</th>
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<tbody>
<tr>
<td>5. Bharatpur District (No. 5 in Fig. 1)</td>
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<tr>
<td>8. Noah village, <em>ca.</em> 7 km. E of Bharatpur</td>
<td>27°12'</td>
<td>77°35'</td>
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<td>6. Bhilwara District (No. 6 in Fig. 1)</td>
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<tr>
<td>9. Danta-ka-Khera</td>
<td>25°21'</td>
<td>74°32'</td>
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<td>10. Mandalgarh</td>
<td>25°10'</td>
<td>75°05'</td>
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<td>7. Dungarpur District (No. 11 in Fig. 1)</td>
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<tr>
<td>10A. Nallah, <em>ca.</em> 12 km. W of Bichwara</td>
<td>23°45'</td>
<td>73°26'</td>
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<tr>
<td>11. Sabella</td>
<td>23°50'</td>
<td>73°40'</td>
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<td>8. Jaipur District (No. 13 in Fig. 1)</td>
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<tr>
<td>12. Amber, <em>ca.</em> 10 km. N. of Jaipur</td>
<td>27°00'</td>
<td>75°50'</td>
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<td>13. Jaipur</td>
<td>26°55'</td>
<td>75°52'</td>
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<tr>
<td>14. Sambhar Lake</td>
<td>26°54'</td>
<td>75°13'</td>
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<td>9. Jhunjhunu District (No. 17 in Fig. 1)</td>
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<tr>
<td>15. Jhojhu village, <em>ca.</em> 62 km. SE of</td>
<td>28°30'</td>
<td>76°05'</td>
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<tr>
<td>16. Jhunjhunu</td>
<td>28°05'</td>
<td>75°24'</td>
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<tr>
<td>17. Khokund village, <em>ca.</em> 25 km. NE of Raghunathgarh</td>
<td>27°45'</td>
<td>75°35'</td>
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<tr>
<td>18. Moi village, <em>ca.</em> 46 km. SE of Jhunjhunu.</td>
<td>28°30'</td>
<td>75°55'</td>
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<tr>
<td>10. Jodhpur District (No. 18 in Fig. 1)</td>
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<tr>
<td>19. Agolai, <em>ca.</em> 45 km. W of Jodhpur</td>
<td>26°15'</td>
<td>72°35'</td>
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<td>20. Arnaji, <em>ca.</em> 33 km. S of Jodhpur</td>
<td>26°18'</td>
<td>73°04'</td>
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<td>21. Banar, <em>ca.</em> 15 km. NE of Jodhpur</td>
<td>26°15'</td>
<td>73°05'</td>
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<tr>
<td>22. Beriganga, <em>ca.</em> 20 km. N of Jodhpur</td>
<td>26°10'</td>
<td>73°04'</td>
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<tr>
<td>23. Bisalpur, <em>ca.</em> 30 km. W of Jodhpur</td>
<td>26°10'</td>
<td>73°15'</td>
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<tr>
<td>24. Borunda</td>
<td>26°25'</td>
<td>73°45'</td>
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<tr>
<td>25. Dipla village, <em>ca.</em> 58 km. W of Jodhpur</td>
<td>26°10'</td>
<td>72°35'</td>
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<tr>
<td>26. Jodhpur</td>
<td>26°18'</td>
<td>73°04'</td>
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<tr>
<td>27. Kalyanpur village, <em>ca.</em> 68 km. W of Jodhpur</td>
<td>26°00'</td>
<td>72°35'</td>
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<tr>
<td>28. Kaylana Lake ca. 10 km. W of Jodhpur</td>
<td>26°15'</td>
<td>72°55'</td>
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<tr>
<td>29. Khokaria village, <em>ca.</em> 11 km. N of Jodhpur</td>
<td>26°20'</td>
<td>73°05'</td>
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<tr>
<td>30. Mathania, <em>ca.</em> 30 km. NW of Jodhpur</td>
<td>26°32'</td>
<td>72°59'</td>
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<tr>
<td>31. Mandore, <em>ca.</em> 12 km. N of Jodhpur</td>
<td>26°20'</td>
<td>73°00'</td>
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<tr>
<td>Collecting Stations</td>
<td>Approximate latitude (N)</td>
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<tr>
<td>32. Mevalas village, ca. 10 km. W of</td>
<td>26°15'</td>
<td>72°50'</td>
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<tr>
<td>Jodhpur</td>
<td></td>
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<tr>
<td>33. Pratapsagar</td>
<td>26°20'</td>
<td>73°05'</td>
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<tr>
<td>34. Rohila village, ca. 8 km. W of Jodhpur</td>
<td>26°18'</td>
<td>73°00'</td>
</tr>
<tr>
<td>35. Salawas village, ca. 18 km. W of Jodhpur</td>
<td>26°05'</td>
<td>72°55'</td>
</tr>
<tr>
<td>36. Satlana village, ca. 56 km. SW of Jodhpur</td>
<td>25°55'</td>
<td>72°55'</td>
</tr>
</tbody>
</table>

**11. Nagaur District (No. 20 in Fig. 1)**

| 37. Didwana                          | 27°20'                   | 74°30'                    |
| 38. Nagaur                           | 27°11'                   | 73°41'                    |
| 38A. Panchota village, ca. 12 km. from Maroth | 27°03'                   | 75°05'                    |
| 38B. Solayana village, ca. 4 km. S of Maroth | 27°08'                   | 75°10'                    |
| 39. Soyala village, ca. 20 km. SW of Nagaur | 26°55'                   | 73°20'                    |

**12. Pali District (No. 21 in Fig. 1)**

| 40. Hemawas Dam, near Pali           | 25°40'                   | 73°20'                    |
| 40A. Sardarsamand                    | 25°54'                   | 73°25'                    |

**13. Sikar District (No. 23 in Fig. 1)**

| 41. Badalas village, ca. 20 km. SW of Sikar | 27°25'                   | 75°00'                    |
| 42. Harshnath, ca. 25 km. NW of Sikar     | 27°30'                   | 75°18'                    |
| 42A. Lachmangarh, ca. 25 km. NW of Sikar  | 27°45'                   | 75°00'                    |
| 42B. Palsana, ca. 20 km. SE of Sikar     | 27°25'                   | 75°20'                    |
| 42C. Pipardi village, ca. 10 km. NE of Sikar | 27°40'                   | 75°20'                    |
| 42D. Purohiton-ka-Bas, ca. 5 km. NE of Sikar | 27°38'                   | 75°18'                    |

**14. Sirohi District (No. 24 in Fig. 1)**

| 43. Mount Abu                         | 24°25'                   | 72°45'                    |
| 44. Oria village, near Mt. Abu        | 24°30'                   | 72°45'                    |

**15. Tonk District (No. 25 in Fig. 1)**

| 45. Banasthali, ca. 56 km. SE of Jaipur | 26°27'                   | 75°55'                    |
| 46. Newai village, ca. 60 km. SE of Jaipur | 26°25'                   | 75°55'                    |

**16. Udaipur District (No. 26 in Fig. 1)**

| 47. Amet, ca. 50 km. NE of Udaipur    | 25°15'                   | 73°55'                    |
| 48. Olna-khera, near Amet             | 25°10'                   | 74°00'                    |

**TOTAL: 60 Stations**
Termites studied for the present account comprised about 187 vials collected mostly during the 10-year period (1964-73), and were obtained from 60 stations in 16 districts (Table 1 and Text-fig. 1) situated mostly in the central, eastern and southern Rajasthan, largely leaving out the western and north-western desert area except the eastern fringe (Jodhpur, etc.). Of these 16 districts, 9 were repeats from those mentioned in the earlier monograph (Roonwal and Bose, 1964) and 7 were districts not covered earlier. In this way, between the present and the earlier accounts, 24 out of the total of 26 districts of Rajasthan have been covered as follows, only two relatively small districts viz., Chittorgarh and Jhalawar, thus remaining unsurveyed:—

**Districts of Rajasthan indicating where termite surveys have been carried out**

**Notes**: * Districts covered in the earlier monograph (Roonwal and Bose, 1964).
+ Districts covered in the present account.

1. Ajmer
2. Alwar
3. Banswara
4. Barmer
5. Bharatpur
6. Bhilwara
7. Bikaner
8. Bundi
9. Chittorgarh
10. Churu
11. Dungarpur
12. Ganganagar
13. Jaipur
14. Jaisalmer
15. Jalore
16. Jhalawar
17. Jhunjhunu
18. Jodhpur
19. Kota
20. Nagaur
21. Pali
22. Sawai Madhopur
23. Sikar
24. Sirohi
25. Tonk
26. Udaipur

**Systematic Account**

**Family 1. Kalotermitidae**

1. *Incisitermes didwanaensis* Roonwal & Verma 1973

(Text-fig. 2)


*Castes known.*— Im. (dealate ♂), S., Pw.

*Material.*—A dealate ♀ imago, and several soldiers and pseudoworkers;

*Measurements.*—For details, see Roonwal and Verma, 1973c.

*Distribution.*—Didwana (Nagaur Dist., Rajasthan).
Remarks.—The above (Roonwal and Verma, 1973c) is the third record of the genus from the orient and the first one from India. The other two oriental species are from the Philippines (I. mcgregori Light and I. taylori Light).

Family II. Hodotermitidae

2. Anacanthotermes macrocephalus (Desneux)

Hodotermes macrocephalus Desneux, 1906, p. 344.

Castes known.—Im., S., Wk.

Material.—35 vials, 1964-73, mostly S. and Wk., and a few Im., from Rajasthan thus: (i) Barmer Dist.: Balotra and Mevanagar (Nakhora). (ii) Jodhpur Dist.: Agolai, Arnaji, Beriganga, Bisalpur, Jodhpur, Kalyanpur, Kaylana, Mathania, Megalasia, Rohila, Salawas and Satlana.

Distribution.—From E. Afghanistan, via Pakistan (Baluchistan, Sind, Punjab) to western Rajasthan in India. The present records add a few more localities in western Rajasthan. The species does not seem to go much further east beyond Jodhpur.

Remarks.—Swarming in Jodhpur occurs in August. This is an arid zone species. For its distribution in Rajasthan in relation to vegetation and soil, vide Roonwal and Bose (1973). Sex ratios, body-weight in dealates and sexual dimorphism in external body-parts of imagoes have been discussed by Roonwal and Rathore (1972).
Family III. RHINOTERMITIDAE
Subfamily (i) HETEROTERMITINAE

3. Heterotermes indicola (Wasmann) 1902

(Text-fig. 3)


Castes known.—Im., S., Wk.

Material.—5 vials, 1972-73, Im., S., Wk., Jodhpur city; imagoes from swarms and soldiers and workers from wood-work in houses.

Measurements (mm.), etc.

Imago (1 ex., Jodhpur)

1. Total length with wings 10.0
2. Total length without wings 5.0
3. Head-length to tip of labrum 1.26
4. Head-length to mandible-base 0.84
5. Max. width of head, with eyes 0.89
6. Max. height of head 0.58
7. Labrum (Median L × W) 0.14 × 0.30
8. Eyes (L × W) 0.23 × 0.18
9. Min. eye-antennal distance 0.027
10. Pronotum (L × W) 0.37 × 0.68
11. No. of antennal segments 17

Text-fig. 3. Heterotermes indicola (Wasmann). Imago. Jodhpur (Rajasthan) : (A) Head and pronotum, dorsal view. (B) Ditto, side view. (C), (D) Left and right mandibles, respectively.

ap., apical teeth; m1-m3, marginal teeth 1-3 respectively.
For measurements of soldiers from Rajasthan, vide Roonwal and Bose (1964).

**Distribution.** — Widely distributed in Pakistan and North India south to about 20°N latitude.

**Remarks.** — The present is the first breeding record, as indicated by the presence of imagoes, from Rajasthan. Swarming occurs in Jodhpur in July and August in the early part of the night (8—8.30 P.M.). The species was found to seriously damage wood-work in houses in Jodhpur city.

Subfamily (ii) **Coptotermitinae**

4. **Coptotermes heimi** (Wasmann)

(Text-fig. 4)


*Coptotermes heimi* (Wasm.), 1962b, Roonwal & Chhotani, p. 38.

**Castes known.** — Im., S., Wk.

**Material.** — 5 vials, 1973, Im., S., Wk., from Rajasthan, thus: (i) Jodhpur Dist.: Jodhpur. (ii) Sikar Dist.: Pipardi village and Purohitonka-Bas.

For measurements of imagoes see Roonwal and Chhotani (1962 b) and for soldiers, Roonwal and Bose (1964).

![Text-fig. 4. Coptotermes heimi (Wasmann). Imago (alate ♀). Jodhpur (Rajasthan). (A) Head and pronotum, dorsal view. (B) Ditto, side view. (C), (D), Left and right mandibles respectively.

*ap.*, apical teeth; *m1—m3*, marginal teeth 1-3 respectively.]
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**Distribution.**—Widely distributed almost all over India and Pakistan. First recorded from Rajasthan by Roonwal and Bose (1964) from the districts of Jaisalmer, Jodhpur, Pali, Nagaur and Jaipur; the present records from the Sikar district are new.

**Remarks.**—Breeding, as indicated by the presence of imagoes, from Rajasthan is here recorded for the first time. Swarming in Jodhpur occurs from end-May to early August (31 May to 3 August) at night (ca. 8 to 9 P.M.).

Family IV. TERMITIDAE

Subfamily (i) AMITERMITINAE

5. *Speculitermes cyclops cyclops* Wasmann

*(Text-fig. 5)*


**Castes known.**—Im. (not Rajasthan); Wk.


**Measurements (mm.), etc.**

**Workers** (1 ex., Dungarpur Dist.)

1. Total length 6.8
2. Head-length to mandible-base 1.16
3. Max. width of head 1.32
4. Mid-dorsal spot (L × W) 0.21 × 0.21
5. Pronotum (L × W) 0.47 × 0.79
6. No. of antennal segments 15

**Distribution.**—Found in the relatively moist areas of North India (eastern and southern Rajasthan, Uttar Pradesh, Madhya Pradesh) and Maharashtra; and Pakistan. Records from Burma are doubtful.

Text-fig. 5. *Speculitermes cyclops cyclops* (Wasmann). Worker. Bichiwara (Dungarpur Dist., Rajasthan). (A) Basal segments of a 15-segmented antenna, showing the subdivision of segment 3 (of a 14-segmented antenna) into two segments (3 and 4). (B) Mid-dorsal spot on head.
Remarks.—From Rajasthan it was hitherto known only from the Kota district; the present record from the Dungarpur district extends the range further south. In Rajasthan it occurs only in the wet zone (open or dense forests). The number of worker antennal segments, normally 14, is here often 15 (by the subdivision of segment 9). The soldier caste is mostly wanting in the genus (*vide* Roonwal and Chhotani, 1960).

6. Amitermes belli (Desneux) 1906

*Termes belli* Desneux, 1906, p. 352.

_Castes known._—Im., S., Wk.


For measurements of imagoes and soldiers from Rajasthan, _vide_ Roonwal and Bose (1964).

_Distribution._—Pakistan (Baluchistan, N.W.F.P., Sind, Punjab) and western India (Rajasthan).

Remarks.—It is an arid to wet zone species; for its distribution in Rajasthan in relation to soil and vegetation, _vide_ Roonwal and Bose (1973).

7. Eremotermes neoparadoxalis Ahmad 1955

Ahmad, 1955, p. 252.

_Castes known._—S., Wk.

_Material._—5 vials, 1964-72, S., Wk., Jodhpur Dist. (Agolai, Beringanga, Jodhpur and Satlana).

_Distribution._—Pakistan (Sind, Baluchistan, N.W.F.P.) and western India (Rajasthan and Delhi). In Rajasthan known from the districts of Jodhpur (present record), Bikaner and Jaipur.

Remarks.—It is an arid zone species.

8. Eremotermes paradoxalis Holmgren 1913

(Text-fig. 6)


_Castes known._—Im., S., Wk.

_Material._—5 vials, 1969-73, Im., S., Wk., Jodhpur (Jodhpur Dist.).

_Measurements (mm.) etc._

_Imagoes_ (8 exs., Jodhpur)
1. Total length with wings 8.9—10.3
2. Total length without wings 5.1—5.7
3. Head-length to tip of labrum 1.00—1.05
4. Head length to mandible-base 0.52—0.74
5. Max. width of head with eyes 0.70—0.89
6. Max. height of head 0.40—0.53
7. Labrum (Median L × W) 0.08—0.16 × 0.27—0.37
8. Eyes (L × W) 0.18—0.22 × 0.15—0.19
9. Ocelli (L × W) 0.10—0.11 × 0.08—0.09
10. Min. eye-ocellus distance 0.027—0.036
11. Min. eye-antennal distance 0.027—0.045
12. Pronotum (L × W) 0.32—0.47 × 0.52—0.68
13. No. of antennal segments 15

A) Head and pronotum, dorsal view. (B) Ditto, side view. (C), (D), Left and right
mandibles respectively.
ap., apical teeth; m1—m2, marginal teeth 1 and 2 respectively.

For measurements of soldiers from Rajasthan, *vide* Roonwal and Bose (1964).

*Distribution.*— Widely distributed in India (Rajasthan, Punjab, Delhi, and Peninsular India down to Kerala); and Pakistan (Punjab, N.W.F.P.).

*Remarks.*—In Rajasthan it was hitherto known from the districts of Nagaur, Jaipur and Kota; the present is the first record from the Jodhpur district. The present is also the first record of breeding in Rajasthan. Swarming occurs at Jodhpur during June and August in the afternoons and evenings (ca. 4.45 to 7.30 P.M.). It is a semi-arid zone species.
9. Microcerotermes palestinensis Spaeth 1962

(Text-fig. 7)

(Nec Emerson of authors, vide discussion in Roonwal, 1974.)

Castes known.—Im. (not Rajasthan), S., Wk.


Measurements (mm.), etc.

Soldiers (3 exs., Mathania and Amet, Rajasthan)

1. Total length with mandibles
5.0—5.3
2. Head-length with mandibles
2.21—2.26
3. Head-length to mandible-base
1.26
4. Max. width of head
0.95
5. Max. height of head
0.68—0.74
6. Length of mandibles (left; right)
1.0; 1.0
7. Postmentum (Median L x W)
0.58 × 0.32
8. Pronotum (L x W)
0.32—0.37 × 0.63—0.68
9. Mandible-Head Index (Left Mandible-length/Head-length to mandible-base)
0.79
10. No. of antennal segments
13

Distribution.—India (western and southern Rajasthan, e.g., Jodhpur and Udaipur Dists.), and West Asia (Israel).

Text-fig. 7. Microcerotermes palestinensis Spaeth. Soldier. Amet (Udaipur Dist., Rajasthan). (A) Head and pronotum, dorsal view. (B) Postmentum, in situ.
Remarks.—This is the first record from India. The species was originally described from Israel (an arid area) and this widely separated discontinuous distribution is of interest. In India it has been found both in the semi-arid areas as well as in relatively wet forested zones. The shape and distribution of micrasters on its wing-membranes have been described by Roonwal, Verma and Rathore (1974).

10. Microcerotermes raja Roonwal and Bose 1964

(Text-fig. 8)


Castes known.—Im., S., Wk.

Text-fig. 8. Microcerotermes raja Roonwal & Bose (M. championi raja R. & B.). Imago. Jodhpur (Rajasthan). (A) Head and pronotum, dorsal view. (B) Ditto, side view. (C), (D), Left and right mandibles respectively.
ap., apical teeth; m1-m2, marginal teeth 1 and 2 respectively.

Material.—8 vials, Im., S., Wk., 1969-73, districts of Jodhpur (Jodhpur and vicinity) and Nagaur (Solayana village, ca. 4 km. S of Maroth).

Measurements (mm.), etc.

Imago (4 exs., Jodhpur)

1. Total length with wings 8.0—9.8 (48 exs.)
2. Total length without wings 3.2—6.2 (54 exs.)
3. Head-length to mandible-base 0.95—1.00
4. Max. head-width with eyes 0.72—1.42 (54 exs.)
5. Labrum (Median L × W) 0.11—0.15 × 0.39
6. Eyes (max. × min. diameter) 0.18 × 0.16
7. Ocellus (max. × min. diameter) 0.072 × 0.045
8. Min. eye-oellus distance 0.07—0.08
9. Pronotum (L × W) 0.47 × 0.74—0.79
10. No. of antennal segments 14
Distribution.—Rajasthan: Jodhpur and Nagaur Dists., as above.

Remarks.—It is a semi-arid zone species. The imago has been described by Roonwal, Verma and Rathore (1973) who have also made observations on gallery-system, swarming, etc. Swarming at Jodhpur occurs in the day (about 11 A.M. — 3 P.M.) during the monsoon for a period of about six weeks (end-June to second week of August). The shape and distribution of microasters on wing-membrane have been described by Roonwal, Verma and Rathore (1974), and sex ratios and sexual dimorphism in external body-parts discussed by Roonwal and Verma (1973). Roonwal and Rathore (in press, c) have discussed its swarming and egg-laying.

11. Microcerotermes sakesarensis Ahmad 1955

(Text-fig. 9)

Ahmad, 1955, p. 247.

Castes known.—S., Wk.


Text-fig. 9. Microcerotermes sakesarensis Ahmad. Soldier. Sambhar Lake (Jaipur Dist., Rajasthan). (A) Head and pronotum, dorsal view. (B) Postmentum, in situ.
Measurements (mm.), etc.

**Soldiers** (2 exs., Sambhar Lake)

1. Total length with mandibles 5.3
2. Head-length with mandibles 2.47—2.58
3. Head-length to mandible-base 1.63—1.74
4. Max. width of head 0.95
5. Length of mandibles (left; right) 0.89; 0.89
6. Pronotum ($L \times W$) $0.37 \times 0.63$
7. No. of antennal segments 13

**Distribution.**—India (Sambhar Lake, Jaipur Dist., Rajasthan); and Pakistan (Punjab, N.W.F.P.).

**Remarks.**—This is the first record from India. It is evidently an arid zone species.

12. **Microcerotermes tenuignathus** Holmgren


**Castes known.**—S., Wk.


**Distribution.**—Western India (Gujarat and Rajasthan); and Pakistan (Baluchistan, N.W.F.P., Punjab; Sind). In Rajasthan it is known from the districts of Barmer, Jaisalmer, Jodhpur, Jaipur and Kota. The present is the first record from Jodhpur proper.

Subfamily (ii) **TERMITINAE**


(Text-fig. 10)


**Castes known.**—Im., S., Wk.

**Material.**—2 vials, 1972-73, Im., S., Wk., Jodhpur.

**Measurements (mm.), etc.**

**Imagoes** (5 exs., Jodhpur)

1. Total length with wings 10.0—11.0
2. Total length without wings 6.0—7.0
3. Head-length with mandibles 1.00—1.11
4. Head-length to mandible-base 0.68—0.84
5. Max. width of head with eyes 0.95—1.00
6. Max. height of head 0.53
7. Labrum (Median $L \times W$) $0.09 \times 0.36$
8. Eyes (max. × min. diameter) $0.23—0.25 \times 0.20—0.22$
9. Pronotum ($L \times W$) $0.47—0.53 \times 0.89—0.95$
10. No. of antennal segments 15
**Soldiers** (5 exs., Jodhpur)

1. Total length with mandibles 3.7—4.7
2. Head-length with mandibles 2.42—2.74
3. Head-length to mandible-base 1.11—1.32
4. Head-length with frontal projection 1.32
5. Max. width of head 0.95—1.00
6. Max. height of head 0.58
7. Max. length of mandibles (left; right) 1.32—1.42; 1.32—1.42
8. Labrum (Median L × W) 0.25 × 0.210
9. Postmentum (Median L × W) 0.32—0.27
10. Pronotum (L × W) 0.21 × 0.58—0.63
11. No. of antennal segments 14

**Distribution.**—India : Jodhpur (Rajasthan).


**Remarks.**—Swarming occurs in August in the afternoon (for fuller details of breeding, vide Roonwal and Verma, 1974). The shape and distribution of micrasters on wing-membranes have been described by Roonwal, Verma and Rathore (1974). The shape and the width/
length ratio of eggs have been discussed by Roonwal (1973b). Egg-laying, hatching, etc. have been described by Roonwal and Rathore (in press, c).

Subfamily (iii) MACROTERMITINAE

14. Odontotermes brunneus (Hagen)

(Text-fig. 11)

Termes brunneus Hagen, 1858, Linn. Entom., Berlin, 12, p. 133 Im., S.


Castes known.—Im. (not Rajasthan), S., Wk.


Measurements (mm.), etc.

Soldier (1 ex., Banasthai, Tonk Dist.)

1. Total length with mandibles 5.0
2. Head-length with mandibles 2.31
3. Head-length to mandible-base 1.32
4. Max. width of head 1.21
5. Length of mandibles (left; right) 1.0; 1.0
6. Distance of tooth from apex in left mandible 0.32
7. Left Mandibular Index (Tooth distance/Mandible-length) 0.32
8. Pronotum (L × W) 0.47 × 1.05
9. No. of antennal segments 16
Distribution.—Widely distributed in India. (Sri Lanka records given by some authors are doubtful.) This is the first record from Rajasthan.

Remarks.—The structure of its dome-shaped earthen mounds has been described by Roonwal (1973a) from Gujarat.

15. Odontotermes dehraduni (Snyder) 1934

(Text-fig. 12)


Text-fig. 12. Odontotermes dehraduni (Snyder). Imago. Jodhpur (Rajasthan). (A) Head and pronotum, dorsal view. (B) Ditto, side view. (C), (D), Left and right mandibles, respectively.
ap., apical teeth; m1—m3, marginal teeth 1-3 respectively.

Castes known.—Im. only.


Measurements (mm.), etc.

Imago (2 exs., Jodhpur)

1. Total length with wings
2. Total length without wings
3. Head-length to tip of labrum
4. Head-length to mandible-base
5. Max. width of head with eyes
6. Labrum (Median L × W)
7. Eyes (L × W)
8. Ocelli (L × W)
9. Min. eye-ocellus distance
10. Pronotum (L × W)
11. No. of antennal segments

27.5—27.9
13.4
2.79—2.89
1.84
2.58—2.63
0.58 × 0.79
0.74 × 0.63
0.32 × 0.42
0.11
1.05—1.16 × 2.05—2.21
19
Distribution.—North India (Dehra Dun, Uttar Pradesh; Delhi; and Jodhpur, Rajasthan); and Pakistan (Jhelum Dist.; Lahore and Rawalpindi).

Remarks.—This is the first record from Rajasthan. Only imagoes (at swarms) have so far been obtained. Swarming occurs at Jodhpur in early July at night; at other places, from end-June to early September. In Delhi, Vishnoi (1957b) reported sporadic swarming in small numbers in early monsoon (end-June and July) at night.

16. Odontotermes distans Holmgren & Holmgren 1917
(Text-fig. 13)


*Castes known.*—Im. (Rajasthan); S., Wk. elsewhere.


*Measurements (mm.), etc.*

*Imagoes (2 exs., Jodhpur)*

1. Total length with wings 27.0—28.0
2. Total length without wings 14.0—15.0
3. Head-length to tip of labrum 3.26—3.31
4. Head-length to mandible-base 1.74—1.84
5. Max. width of head with eyes 2.63—2.74
6. Labrum (Median L × W) 0.58—0.68 × 1.0
7. Eyes (L × W) 0.63 × 0.53—0.58
8. Ocelli (L × W) 0.26 × 0.16
9. Min. eye-ocellus distance 0.26
10. Pronotum (L × W) 1.16 — 1.32 × 2.47—2.53
11. No. of antennal segments 19

Distribution.—Widely distributed in India (Uttar Pradesh, especially the northern hilly areas; Rajasthan; West Bengal; Assam; Tamil Nadu); going up to ca. 2100 metres.

Remarks.—This is the first record from Rajasthan. Swarming occurred on 16 July, in the evening (6.30 P. M.).

17. Odontotermes feae (Wasmann)
(Text-fig. 14)


*Castes known.*—Im. (not Rajasthan), S., Wk.
**Material.**—2 vials, 1972, S., Wk., Mt. Abu and Oria village (near Mt. Abu), Sirohi Dist.

Text-fig. 13. *Odontotermes distans* Holmgren & Holmgren. Imago (alate ♂). Khokharia village (Jodhpur Dist., Rajasthan). (A) Head and pronotum, dorsal view (B) Ditto, side view. (C), (D) Left and right mandibles, respectively.

ap., apical teeth; m1—m3, marginal teeth 1-3 respectively.

Measurements (mm.) etc.

Soldiers (3 exs., Mt. Abu)

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Total length with mandibles</td>
<td>7.6—9.6</td>
</tr>
<tr>
<td>2. Head-length with mandibles</td>
<td>4.16—4.21</td>
</tr>
<tr>
<td>3. Head-length to mandible-base</td>
<td>2.58—2.63</td>
</tr>
<tr>
<td>4. Max. width of head</td>
<td>2.21—2.26</td>
</tr>
<tr>
<td>5. Labrum (Median L x W)</td>
<td>0.37 x 0.53</td>
</tr>
<tr>
<td>6. Length of mandibles (left; right)</td>
<td>1.53; 1.53</td>
</tr>
<tr>
<td>7. Distance of tooth from apex, in left mandible</td>
<td>0.74—0.79</td>
</tr>
<tr>
<td>8. Postmentum (Median L x W)</td>
<td>1.74 x 0.84</td>
</tr>
<tr>
<td>9. Pronotum (L x W)</td>
<td>0.89—0.94 x 1.63—1.68</td>
</tr>
<tr>
<td>10. No. of antennal segments</td>
<td>17</td>
</tr>
</tbody>
</table>

Distribution.—Widespread in India, Sri Lanka and farther east (Bangla Desh, Burma, Thailand).

Remarks.—This is the first record from Rajasthan.

18. Odontotermes giriensis Roonwal & Chhotani 1962

(Text-fig. 15)


Castes known.—S., Wk.


Measurements (mm.), etc.

*Soldiers* (2 exs., Didwana, Nagaur Dist.)

1. Total length with mandibles 4.2—4.5
2. Head-length with mandibles 1.89—1.95
3. Head-length to mandible-base 1.16—1.21
4. Max. width of head 1.11
5. Max. height of head 0.63—0.68
6. Labrum (Median $L \times W$) $0.26 \times 0.21—0.26$
7. Length of mandibles (left; right) 0.74; 0.74
8. Postmentum (Median $L \times W$) $0.79 \times 0.53$
9. Pronotum ($L \times W$) $0.53 \times 0.84$
10. No. of antennal segments 15

**Distribution.**—Eastern India: Meghalaya and Arunachal Pradesh [N.E.F.A.] and Western India (Rajasthan: Nagaur and Sikar Dists.); and Bangla Desh.

**Remarks.**—This is the first record from Rajasthan. The widely discontinuous distribution (the eastern area in the wet forest zone and the western in the semi-dry zone) is of interest. Examples from the two areas are exactly alike and cannot be separated.


**Castes known.**—S., Wk.


**Distribution.**—Western India (widely distributed in Rajasthan in both dry and wet districts, viz., Sikar, Jhunjhunu, Bikaner, Nagaur, Ajmer and Udaipur); and Pakistan.

**Remarks.**—This is the first record from the Ajmer district.

20. *Odontotermes guardaspurensis* Holmgren & Holmgren 1917

(Text-fig. 16)


**Castes known.**—Im. (not Rajasthan), S., Wk.

**Material.**—9 vials, S., Wk., 1972-73, from Rajasthan, thus: Jodhpur, Nagaur, Ajmer, Bharatpur and Banswara Districts.

Z. S...29
Text-fig. 16. *Odontotermes gurdaspurensis* Holmgren Holmgren. & Soldier. Danpur village (Banswara Dist., Rajasthan). (A) Head and pronotum, dorsal view. (B) Postmentum, in situ.

**Measurements (mm.), etc.**

**Soldiers** (3 exs., Banswara Dist.)

1. Total length with mandibles  
2. Head-length with mandibles  
3. Head-length to mandibles-base  
4. Max. width of head  
5. Max. height of head  
6. Length of mandibles (left; right)  
7. Distance of tooth from apex, in left mandible  
8. Labrum (Median L × W)  
9. Postmentum (Median L × W)  
10. Pronotum (L × W)  
11. No of antenal segments

**Distribution.**—Widely distributed in western and northern India (Punjab, Haryana, Rajasthan, and Muzaffarabad Dist., Kashmir); and Pakistan (Punjab, N.W.F.P., Baluchistan).
Remarks.—This is the first record from Rajasthan where it occurs in the wet to semi-arid zones, west up to Jodhpur District and south up to Banswara District, but seems to be absent from the very arid western districts. In the wet area (Banswara District) it was taken from a mound.

21. Odontotermes kushwahai Roonwal & Bose 1964

*Odontotermes brunneus kushwahai* Roonwal and Bose, 1964, p. 33.

Castes known.—S., Wk.


Distribution.—Western India (Rajasthan : Udaipur Dist.; and Gujarat : Kaira Dist.); and South India (Tamil Nadu : Salem Dist.).

Remarks.—The present lot is also from the Udaipur District where the type came from. Its discontinuous distribution is noteworthy.

22. Odontotermes latiguloides Roonwal & Verma

*(Text-fig. 17)*


Castes known.—S., Wk.

Material.—12 vials, 1964-73, S., Wk., from 8 wet and semi-arid districts of Rajasthan (except the western arid zone), as follows: Jhunjhunu, Sikar, Jaipur, Jodhpur, Bhilwara, Sirohi, Banswara and Dungarpur.

Measurements (mm.), etc.

Soldiers (14 exs., Rajasthan)

1. Total length with mandibles 3.8—5.1
2. Head-length with mandibles 1.79—2.16
3. Head-length to mandible-base 1.00—1.26
4. Max. width of head 1.00—1.21
5. Max. height of head 0.53—0.74
6. Max. length of mandibles 0.79—0.89
7. Distance of tooth from apex, in left mandible 0.26—0.34
8. Labrum (Median L × W) 0.26—0.37 × 0.26—0.32
9. Postmentum (Median L × W) 0.53 × 0.47
10. Postmentum Index (W/Median L) 0.92
11. Pronotum (L × W) 0.47—0.58 × 0.79—0.95
12. No. of antennal segments 17

Distribution.—Widespread in Rajasthan; recorded from 8 districts as given above; up to ca. 1200 m. altitude (Mt. Abu).Apparently confined to moist forests or gardens and areas where the vegetation is rich due to large quantities of subsoil water (e.g., Borunda). Absent in the very arid western areas of Rajasthan.

23. **Odontotermes obesus** (Rambur)


*Castes known.*—Im., S., Wk.

*Material.*—26 vials, 1971-73, Im. (5 vials), and mostly S. and Wk. from the following districts of Rajasthan: Ajmer, Bhilwara, Jaipur, Jhunjhunu, Jodhpur, Nagaur, Pali, Sikar and Udaipur.

*Distribution.*—Common all over India, Pakistan and Bangla Desh. Occurs all over Rajasthan in both wet and dry areas.

*Remarks.*—The present record is new for the Rajasthan districts, of Bhilwara and Jhunjhunu. Very common and highly variable as regards size of soldiers and workers. Imagoes were obtained at Jodhpur from swarms on 16 August (light swarm) and 18 August (very heavy swarm) in the early part of the night (*ca.* 8-9 P.M.).

24. **Odontotermes parvidens** Holmgren & Holmgren 1917

(Text-fig. 18)

Text-fig. 18. Odontotermes parvidens Holmgren & Holmgren. Soldier. Khokund village (ca. 25 km. NE of Raghunathgarh, Jhunjhunu Dist., Rajasthan). (A) Head and pronotum, dorsal view. (B) Postmentum, in situ.

Castes known.—S. only from Rajasthan; S., Im., Wk. from other parts of India.

Material.—A vial, 2 S., Khokund village, ca. 25 km. NE from Raghunathgarh (Jhunjhunu Dist.), Y P. Sinha & Party coll., 27.ix.1973, ex cowdung. (Mixed with O. obesus.)

Measurements (mm.), etc.

Soldiers (2 exs., Jhunjhunu Dist.)

1. Total length with mandibles 6.1
2. Head-length with mandibles 2.89—2.95
3. Head-length to mandible-base 1.84—1.89
4. Max. width of head 1.47
5. Max. length of mandibles (left; right) 1.05; 1.05
6. Distance of tooth from apex, in left-mandible 0.63
7. Left Mandibular Index (Tooth distance/Mandible-length) 0.60
8. Postmentum (Median L × W) 1.16×0.58
9. Pronotum (L × W) 0.63—0.68 × 1.05
10. No. of antennal segments 16—17
**Distribution.**—Widely distributed in Pakistan (up to ca. 1525 m. alt., N.W.F.P.), India, Bangla Desh and Burma.

**Remarks.**—This is the first record from Rajasthan.

25. *Odontotermes wallonensis* (Wasmann) 1902

(Text-figs. 19 and 20)


**Castes known.**—Im., S., Wk.

**Material.**—2 vials, Bar (Ajmer Dist.), one with sev. Im., 9.viii.1973, at light; the other with sev. S., ex under stone.

**Measurements (mm.), etc.**

**Imago** (1 ex., Bar, Ajmer Dist.)

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Total length with wings</td>
<td>30.0</td>
</tr>
<tr>
<td>2. Total length without wings</td>
<td>15.0</td>
</tr>
<tr>
<td>3. Head-length to tip of labrum</td>
<td>3.26</td>
</tr>
<tr>
<td>4. Head-length to mandible-base</td>
<td>2.0</td>
</tr>
<tr>
<td>5. Max. width of head with eyes</td>
<td>3.10</td>
</tr>
<tr>
<td>6. Max. height of head</td>
<td>1.32</td>
</tr>
<tr>
<td>7. Labrum (Median L × W)</td>
<td>0.68 × 1.0</td>
</tr>
<tr>
<td>8. Eyes (L × W)</td>
<td>0.95 × 0.79</td>
</tr>
<tr>
<td>9. Ocelli (L × W)</td>
<td>0.42 × 0.32</td>
</tr>
<tr>
<td>10. Min. eye-oellus distance</td>
<td>0.11</td>
</tr>
<tr>
<td>11. Pronotum (L × W)</td>
<td>1.42 × 2.79</td>
</tr>
<tr>
<td>12. No. of antennal segments</td>
<td>19</td>
</tr>
</tbody>
</table>

![Text-fig. 19. *Odontotermes wallonensis* (Wasmann). Imago ♀. Forest plantation, ca. 3 km. E of Bar village (Ajmer Dist., Rajasthan). (A) Head and pronotum, dorsal view. (B) Ditto, side view. (C), (D) Left and right mandibles respectively.](image)

*ap* apical tooth; *m1-m3*, marginal teeth 1-3 respectively.
**Soldier (1 ex. Bar, Ajmer Dist.)**

1. Total length with mandibles 5.3
2. Head-length with mandibles 2.84
3. Head-length to mandible-base 1.68
4. Max. width of head 1.42
5. Labrum (Median L × W) 0.42 × 0.37
6. Length of mandibles (left; right) 1.16; 1.16
7. Distance of tooth from apex, in left mandible 0.47
8. Postmentum (Median L × W) 0.89 × 0.58
9. Pronotum (L × W) 0.63 × 1.05
10. No. of antennal segments 16

**Distribution.**—Widespread in India from central Rajasthan (Bar, Ajmer Dist.), Gujarat and Delhi in the west to Orissa in the east; and the whole of Peninsular India.

**Remarks.**—This is the first record from Rajasthan. Swarming was noted at Bar (Ajmer Dist.) on 9 August.

26. *Microtermes mycophagus* (Desneux) 1906

*Termes mycophagus* Desneux, 1906, p. 348.

**Castes known.**—Im., S., Wk.

**Material.**—27 vials, 1972-73, Im., S., Wk., from following districts in Rajasthan: Jaipur (Sambhar Lake), Nagaur (Didwana); and Jodhpur (mostly imagoes from swarms) and Sikar (Palsana).

**Distribution.**—India (western and northern Rajasthan, east to Sikar and Alwar Dists.; and Delhi); and Pakistan (Sind, Punjab, N.W.F.P., Baluchistan).

**Remarks.**—Common in arid and semi-arid areas. Swarming occurred at Jodhpur from 26 June to 22 August at night (8 to 9 P.M.). It is an arid zone species (for its distribution in Rajasthan in relation to soil and vegetation, vide Roonwal and Bose, 1973).

27. *Microtermes obesi* Holmgren 1913

(Text-fig. 21)

*(Synonym: M. anandi* Holmgren)*


**Castes known.**—Im., S., Wk.

Text-fig. 21. *Microtermes obesi* Holmgren (synonym *M. anandi* (Holmgren). Imago, Jodhpur. (Rajasthan). (A) Head and pronotum, dorsal view. (B) Ditto, side view. (C), (D) Left and right mandibles, respectively. *ap.*, apical teeth; *m1-m3*, marginal teeth 1-3 respectively.

**Material.**—12 vials, 1965-72, Im., S., Wk., from the following districts in Rajasthan: Jodhpur, Nagaur, Jaipur and Udaipur.
Measurements (mm.), etc.

**Imagoes (4 exs., Jodhpur)**

<table>
<thead>
<tr>
<th>Measurement Description</th>
<th>Measurements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Total length with wings</td>
<td>14.1—14.8</td>
</tr>
<tr>
<td>2. Total length without wings</td>
<td>9.4—10.2</td>
</tr>
<tr>
<td>3. Head-length to mandible-base</td>
<td>1.53—1.83</td>
</tr>
<tr>
<td>4. Max. width of head with eyes</td>
<td>1.58—1.79</td>
</tr>
<tr>
<td>5. Labrum (Median $L \times W$)</td>
<td>0.26—0.39 $\times$ 0.68</td>
</tr>
<tr>
<td>6. Eyes (max. $\times$ min. diameter)</td>
<td>0.38—0.39 $\times$ 0.31—0.33</td>
</tr>
<tr>
<td>7. Min. eye-ocellus distance</td>
<td>0.05</td>
</tr>
<tr>
<td>8. Pronotum ($L \times W$)</td>
<td>0.95—1.05 $\times$ 1.37—1.58</td>
</tr>
<tr>
<td>9. No. of antennal segments</td>
<td>15</td>
</tr>
</tbody>
</table>

For measurements of soldiers, vide Roonwal and Bose (1964).

**Distribution.**—Widespread in India (including Rajasthan), Pakistan and Bangla Desh; also reported from Sri Lanka.

**Remarks.**—The present records from the Rajasthan districts of Nagaur and Udaipur are new. The species seems to occur in both dry and wet areas. Swarming occurred at Jodhpur from 14 June to 17 August during the day (about 11 A.M. to 1.30 P.M.). For further details of swarming, post-swarming behaviour, egg-laying and hatching, vide Roonwal and Rathore (in press, b).

28. *Microtermes unicolor* Snyder

*(Text-fig. 22)*


**Castes known.**—Im. (Rajasthan), S. and Wk. (Uttar Pradesh).

**Material.**—3 vials, Im., 1965-72, Jodhpur Dist. (Mandore, Banar, Jodhpur).

Measurements (mm.), etc.

**Imagoes (5 exs., Jodhpur Dist.)**

<table>
<thead>
<tr>
<th>Measurement Description</th>
<th>Measurements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Total length with wings</td>
<td>17.3—18.7</td>
</tr>
<tr>
<td>2. Total length without wings</td>
<td>9.4—10.8</td>
</tr>
<tr>
<td>3. Head-length to tip of labrum</td>
<td>1.63—1.84</td>
</tr>
<tr>
<td>4. Head-length of mandible-base</td>
<td>1.05—1.16</td>
</tr>
<tr>
<td>5. Max. width of head with eyes</td>
<td>1.58—1.68</td>
</tr>
<tr>
<td>6. Max. height of head</td>
<td>0.58—0.68</td>
</tr>
<tr>
<td>7. Labrum ($Median L \times W$)</td>
<td>0.26 $\times$ 0.42—0.53</td>
</tr>
<tr>
<td>8. Eyes ($L \times W$)</td>
<td>0.41—0.47 $\times$ 0.36—0.42</td>
</tr>
<tr>
<td>9. Lateral ocelli ($L \times W$)</td>
<td>0.18—0.23 $\times$ 0.14—0.18</td>
</tr>
<tr>
<td>10. Min. eye-antennae distance</td>
<td>0.045—0.063</td>
</tr>
<tr>
<td>11. Pronotum ($L \times W$)</td>
<td>0.84—0.95 $\times$ 1.42—1.53</td>
</tr>
<tr>
<td>12. No. of antennal segments</td>
<td>15</td>
</tr>
</tbody>
</table>
Distribution.—Pakistan (Punjab, N.W.F.P., Sind), western and north-western India, e.g., Rajasthan (Jodhpur Dist.) and Uttar Pradesh (Dehra Dun); and Bangla Desh.

Text-fig. 22. Microtermes unicolor Snyder. Imago. Jodhpur (Rajasthan). (A) Head and pronotum, dorsal view. (B) Ditto, side view. (C), (D) Left and right mandibles respectively.

*ap.*, apical teeth; *m1*-m3, marginal teeth 1-3 respectively.

Remarks.—This is the first record from Rajasthan. Swarming occurred at Jodhpur and vicinity during 5 July to 20 August at night (about 8.45 P.M.). (Also vide Roonwal and Rathore, *in press*, b, for further observations on swarming.)

Subfamily (iv) NASUTITERMITINAE

29. Trinervitermes biformis (Wasmann)

[ Synonyms: *T. heimi* (Wasmann) and *T. longinotus* (Synder) ]


Castes known.—Im., S. (dimorphic), Wk.

Material.—7 vials, 1964-73, S., Wk., from the following districts of Rajasthan: Ajmer, Bhilwara, Jodhpur, Pali and Udaipur.

Distribution.—Widely distributed in western and southern India (Rajasthan, Madhya Pradesh, Maharashtra, Karnataka and Tamil Nadu); and Sri Lanka; also Pakistan (Punjab).
Remarks.—Roonwal and Bose (1964) had first recorded it from Rajasthan (districts of Jaipur, Kota, Nagaur and Udaipur); the present are new records from the districts of Ajmer, Bhilwara, Jodhpur and Pali, thus considerably extending its range, especially to the western, semi-arid areas of Jodhpur and Nagaur.

Zoogeography and Ecology

1. General

Rajasthan, the westernmost State of India, lies close to, almost adjoining, the traditional eastern border of the Western Palaeartic Zone whose eastern limit is the River Indus, so that it is not surprising that the area is, like Pakistan east of the Indus, in some respects transitional and not sharply defined. This is specially so for the Vertebrates (vide infra, Discussion), but is less marked for other groups of animals. In the Isoptera, for example, only a small part shows Palaeartic facies, the bulk being Oriental but of Ethiopian origin).

Sclater's (1855) zoogeographical divisions based on birds, amplified further on the basis of other major groups of animals, are accepted today virtually without substantial change (vide Beaufort, 1951, for the world; and Roonwal and Ali, 1965, for the Indian fauna). These regions, which have also been widely adopted by termitologists for faunistic and zoogeographical purposes (Snyder, 1949; Emerson, 1955), are as follows: Nearctic, Neotropical, Palaeartic, Ethiopian, Malagasy, Oriental (Indo-Malayan of some authors), Australian and Papuan.

2. Generic and Specific Analyses

(Table 2)

For the zoogeographical status of the genera, the earlier analysis of Emerson (1955) and the general evolutionary trends of the order Isoptera as summarised by Weidner (1966, 1970) have been of considerable help.

For generic endemism, Emerson's (1955) definition is: "Endemic genera are those genera found only in a single major zoogeographical region." For the present purpose "endemism" has been evaluated only in terms of Rajasthan which is a vast enough extent of landmass (3,42,274 sq. km.) to justify a more restricted approach. In this limited sense, no genus is endemic in Rajasthan, but a few species are.

Family Kalotermitidae

1. Genus Incisitermes Krishna

This is a widespread genus with some 25 species occurring in the Papuan region (Fiji, Hawaii, etc.), Asia (the Philippines, India), North
Table 2.—Zoogeographical distribution of the termite species of Rajasthan (Western India).

*Abreviations:* + Present; — absent; Eth., Ethiopian; Nt., Neotropical; Or., Oriental; Pal., Palaearctic.

<table>
<thead>
<tr>
<th>Species</th>
<th>INDIA</th>
<th>Pakistan</th>
<th>Rest of</th>
<th>Afghanistan</th>
<th>Rest of</th>
<th>Elsewhere</th>
<th>Zoogeographical status</th>
<th>Endemism</th>
<th>Origins</th>
</tr>
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<tbody>
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<td></td>
<td>INDIA</td>
<td>Pakistan</td>
<td>Rest of</td>
<td>Afghanistan</td>
<td>Rest of</td>
<td>Elsewhere</td>
<td>Zoogeographical status</td>
<td>Endemism</td>
<td>Origins</td>
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<tr>
<td></td>
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<td>North India down to lat. 20°N</td>
<td>India below lat. 20°N</td>
<td>(upto Mediterranean)</td>
<td>elsewhere</td>
<td>geographical status</td>
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<td>FAMILY I</td>
<td>Kalotermitidae</td>
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<td>Roonwal &amp; Verma</td>
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<td>Rhinotermitidae</td>
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<td>(Roonwal and Bose)</td>
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<td>Or. — ?</td>
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<tr>
<td></td>
<td>(Wasmann)</td>
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<td>(Wasmann)</td>
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<tr>
<td>Table 2 — Cond.</td>
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<tr>
<td>6. Speculitermes cyclops Wasmann</td>
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<td>+</td>
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<td>+</td>
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<td>Or.</td>
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<tr>
<td>7. Anitermes belli (Desneux)</td>
<td>+</td>
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<td>Or.</td>
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<tr>
<td>8. Synhamitermes quadriceps (Wasmann)</td>
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<td>+</td>
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<td>+</td>
<td>+</td>
<td>+</td>
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<td>—</td>
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<tr>
<td>10. Eremotermes paradoxaolisis Holmgren</td>
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<td>+</td>
<td>+</td>
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<td>Or.</td>
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<tr>
<td>15. Microcerotermes tenuignathus Holmgren (Rajasthan, Gujarat)</td>
<td>—</td>
<td>+</td>
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<td>+</td>
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<td>17. Odontotermes brunneus (Hagen) (Sri Lanka)</td>
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<td>Or.</td>
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<tr>
<td>18. O. dehraduni (Snyder)</td>
<td>—</td>
<td>+</td>
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<td>Or.</td>
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<tr>
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<td>Odontotermes feae (Wasmann)</td>
<td>Odontotermes giriensis * Roonwal &amp; Chhotani</td>
<td>Odontotermes guptai * Roonwal &amp; Bose</td>
<td>Odontotermes gurdaspurensis * (Holmgren &amp; Holmgren)</td>
<td>Odontotermes kushwahai * Roonwal &amp; Bose</td>
<td>Odontotermes latiguloides * Roonwal &amp; Verma</td>
<td>Odontotermes parvidens * Holmgren &amp; Holmgren</td>
<td>Odontotermes wallonensis (Wasmann)</td>
<td>Microtermes mycophagus * (Desneux)</td>
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<tr>
<td>30</td>
<td>Microtermes unicolor Snyder</td>
<td></td>
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<td>+</td>
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<td>+</td>
<td>+</td>
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<tr>
<td>31</td>
<td>Microtermes obesi Holmgren</td>
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<td>32</td>
<td>Trinervitermes biforum (Wasmann) [syn. T. heimi (Wasmann)]</td>
<td></td>
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</table>
**ROONWAL & VERMA : Termite Fauna of Rajasthan**

**America**, Mexico, Central and South America and the West Indies. Three species are found in the Oriental region, viz., two in the Philippines (*megregori Light* and *taylori Light*) and one in Rajasthan, India (*didwanaensis Roonwal & Verma*). The origin of the genus is difficult to establish. Almost half the number of known species are from the Neotropical region (southern U.S.A., Mexico, Central America and the West Indies), and it is probable that the genus originated there (*vide* also Krishna, 1961, p. 387). Thence it may have spread to Oceania (the Papuan region) and the Orient in the early Mesozoic age before the continents drifted apart in the sense of Wegener (1922), but the route is by no means clear. If the eastward migrations occurred through North Africa, the genus is to-day absent there, possibly by extinction. *I. didwanaensis* might represent a remnant on the route farther east, leading to the Philippines and the islands of the Papuan region. If this line of argument is correct, *I. didwanaensis*, while being restricted to Rajasthan and thus endemic and Oriental, must be regarded against the background of the probable distant Neotropical origin of the genus.

**Family Hodotermitidae**

2. **Genus Anacanthotermes** Jacobson

This is a small subtropical genus of large harvester or grass-cutting desert termites, with some 10 species which occur from West and Central Asia to Western India (Rajasthan east up to Jodhpur), with one species, *A. viarum* (Konig), going down to the drier regions of South India.

According to Emerson (1955, p. 482), the genus probably arose "in the Southern Palearctic steppes and deserts and dispersed eastwards to tropical Indomalaya." This event must have occurred early enough (Miocene or Pliocene) to allow time for the genus to reach South India and evolve a second species.

The sole Rajasthan species, *A. macrocephalus* (Desneux), occurs from Eastern Afghanistan via Pakistan (Baluchistan, Sind, Punjab) to Western India (western Rajasthan : Districts of Bikaner, Barmer and Jodhpur, its easternmost limit being Jodhpur and vicinity, i.e., up to the eastern edge of the Indian Desert). Like most other members of the genus, *A. macrocephalus* should be regarded as a Palearctic species derived from its other Palearctic fellow species, though Harris (1970) excludes it from his Palearctic list.

Ecologically, *A. macrocephalus*, though an arid zone species (*cf. Psammothermes*, below), occurs in soils which have a little clay or loam or gravel and on which some natural vegetation can subsist in the presence of irrigation or natural water and where the land is capable of being cultivated.
Records of the Zoological Survey of India

Family RHINOTERMITIDAE

Subfamily (i) PSAMMOTERMITINAE

3. Genus Psammotermes Desneux

This is a small genus of arid zone or sand termites occurring from North Africa across West Asia to Western India, including the drier western parts of the Indian Desert. Its 8 known species largely occur in the Ethiopian region, with one species going north to the fringe of North African temperate desert (Mediterranean belt of the Palaearctic) and one to the dry steppe zone in Madagascar. Thus, the genus is essentially Ethiopian and desertic, and Emerson (1955, pp. 483, 484) had concluded that this situation “indicates a dispersion from Africa at least by Eocene times.”

The single Rajasthan species, P. rajasthanicus Roonwal & Bose, is essentially a desertic and sand species, occurring in Western Rajasthan (Barmer, Jaisalmer and Bikaner districts) and the adjoining parts of Pakistan (Sind, coastal Baluchistan, Punjab). Its soldiers are trimorphic.

It is Oriental in distribution but is not endemic to Rajasthan. Essentially, it is an extension of the Ethiopian element, as already suggested by Roonwal and Bose (1960, 1962, 1964) and Roonwal, Chhotani and Bose (1962), into the Palaearctic-Oriental border area. West of it is found P. hybostoma Desneux, from Southern Arabia (Muscat) to the Sahara in North Africa (Desneux, 1904, p. 25).

Subfamily (ii) HETEROTERMITINAE

4. Genus Heterotermes Froggatt

This genus, with numerous species, is cosmopolitan, occurring throughout the tropical and subtropical termite belt, and its species, are present in the Nearctic, Neotropical, Ethiopian (poor), Oriental and Australian regions. Its phylogenetic and geographical origins are not clear. It is a rather primitive genus among the Rhinotermitidae, and is, according to Emerson (1955, pp. 483, 499), “presumed to have arisen in the tropics before the Cretaceous separation of Australia from Indomalaya”, but its exclusion from the greater portion of the Ethiopian region is puzzling, and odd representatives there, and elsewhere, are probably later introductions.

The sole Rajasthan species, H. indicola (Wasmann), is widespread (Afghanistan, Pakistan, North India and Bangladesh.) It is not endemic to Rajasthan but is broadly Oriental and belongs to the group of four oriental species which occur in the Indian Subregion, viz., ceylonicus Holmgren (Sri Lanka); gretridae Roonwal (the western sub-Himalayas), indicola (Wasmann) (supra) and malabaricus Snyder (South India).
Subfamily (iii) Coptotermitinae

5. Genus Coptotermes Wasmann

Like Heterotermes, this genus too is widespread. Some 54 living species are known and are distributed in the Papuan, Australian, Oriental, Ethiopian and Neotropical regions, and introduced in some others. About half the number of known species are Oriental, and that region is generally regarded as its place of origin, from which it has spread elsewhere (Emerson, 1955, p. 484).

Of the 24 Oriental species, 8 are found in the Indian Sub-region (Roonwal and Chhotani, 1962b). The sole species occurring in Rajasthan viz., C. helmii (Wasmann) (synonym C. parvulus Holmgren) is widespread in Pakistan, India and Bangla Desh and should be regarded as broadly Oriental.

Family Termitidae

Subfamily (i) Amitermitinae

6. Genus Speculitermes Wasmann

This genus, which is characterised among other things by the extreme rarity of the soldier caste (formerly believed to be altogether absent), is closely allied to the mainly Neotropical Anoplotermes (a soldierless genus) with which it forms a close complex. Speculitermes occurs in South America (4 species) and the Oriental region (10 species) and may, on the basis of the richness of the species, be regarded as Oriental, though the Anoplotermes-Speculitermes Complex as a whole probably arose in the Neotropics, and thence got dispersed in the early Mesozoic, or somewhat later, to the Orient before the three southern continents drifted apart in Wegener's (1922) sense (as already suggested by Roonwal, Chhotani and Bose, 1962; and Roonwal and Chhotani, 1966), though its absence in Africa remains a puzzle.

S. cyclops cyclops Wasmann occurs in the whole of India (except Assam where S. c. rongrensis Roonwal & Chhotani is found) and Pakistan (submontaneous parts of the Punjab). Its Burmese records need confirmation. It is Oriental and is restricted to the Indian Sub-region; it is not endemic to Rajasthan. Ecologically it occurs in moderately moist forests, with or without gravelly or stony soil, and where there is some decaying vegetable matter on which it feeds; it avoids open, arid areas.

7. Genus Amitermes Silvestri

This large genus, with some 115 species, is widespread, occurring in the following regions: Australian (56), Oriental (6), Ethiopian (32), Palearctic (6), Nearctic (8) and Neotropical (7). Its two principal
centres, viz., Australia and Tropical Africa, are wide apart, and the intervening Oriental Region is poor. Emerson (1955, p. 472) considered it “mainly tropical”, but he was not then aware of the exceptional richness of the Australian fauna (vide Gay, 1968).

The origin of *Amitermes* is not clear. Its primitive relatives are Oriental, and this feature, viewed in conjunction with its present areas of abundance, would suggest an Oriental-Australian origin on the one hand and an almost equally feasible Oriental-Ethiopian origin on the other.

Ecologically, the genus seems to be versatile, equally at home in tropical forests and more open habitats and even in hot deserts. This feature is well illustrated by the six Oriental species half of which occur in tropical forests (Malaya, Thailand, Sumatra) and the other half in deserts (Pakistan and western Rajasthan). The sole Rajasthan species, *A. belli* (Desneux), occurs in both arid and wet habitats in Rajasthan and adjoining Pakistan. Zoogeographically, it is Oriental but not endemic to Rajasthan.

8. Genus *Synhamitermes* Holmgren

This small, fairly advanced amitermitine genus contains only four species and has a discontinuous distribution—in the Neotropics (South America, one species) and the Orient (India, Bangla Desh and Sri Lanka, 3 species), a discontinuity which can best be explained, as in so many other cases, on the basis of Wegener’s (1922) Continental Drift Theory. The genus probably arose in the Oriental region where it is best represented today. The sole Rajasthan species, *S. quadriceps* (Wasmann), is widespread in India (Maharashtra, Rajasthan and Bangla Desh), and is found in moist forested areas. It is Oriental but not endemic to Rajasthan.

9. Genus *Eremotermes* Silvestri

This small genus, with only 10 species, occurs from North and Central Africa via West Asia to Pakistan and India. The zoogeographical distribution is: Palaearctic 3, Ethiopian 1, and Oriental (Pakistan and India) 6. It is a genus of small, whitish desert termites which live a subterranean life in small colonies. It probably arose in the Oriental region where its greatest concentration lies, and thence migrated west to Africa. The two Rajasthan species are distributed as follows:—

(i) *E. neoparadoxalis* Ahmad: Pakistan (Sind, Baluchitan, N.W.F.P.) and Western India (western Rajasthan and Delhi). It is a dry and semi-dry zone species.

(ii) *E. paradoxalis* Holmgren: Widely distributed in India (Western India, e.g., Rajasthan including both dry and moist districts east up
to Kota; Delhi; east up to Bihar; Madhya Pradesh; and Peninsular India down to Kerala); and Pakistan (Sind, Punjab, N.W.F.P.). It is ecologically more versatile and is found both in arid, desertic areas as well as in the more moist forest belts.

Both species are Oriental, but not endemic to Rajasthan.

10. Genus Microcerotermes Silvestri

This large genus, with some 117 species, is widespread, occurring in all the major zoogeographical regions except the Neotropical, but the majority of the species (73%) are concentrated almost equally in the Oriental and the Ethiopian regions. The distribution is briefly as follows: Papuan (5 species), Australian (11), Oriental (40), Ethiopian (45), Malagasy (5), Palaeartic (6), and Neotropical (5). The genus probably originated in tropical Africa in the Mesozoic period before it separated from South Asia by Continental Drift, and thence spread to other areas, both moist and dry, and today an appreciable number of species are found in both arid and semi-arid areas too.

The five Rajasthan species have the following distribution; ecologically, they occur largely in arid and semi-arid areas, but some also in moist zones:—

(i) *M. laxmi* Roonwal & Bose: Western India (Bikaner District, Rajasthan). (ii) *M. palestinensis* Spaeth: Western India (Rajasthan: Jodhpur and Udaipur districts) and West Asia (Israel). (iii) *M. raja* Roonwal & Bose: Western India (Rajasthan: Jaipur District) and Pakistan (Punjab, N.W.F.P.). (iv) *M. sakesarensis* Ahmad: Western India (Rajasthan: Jaipur District) and Pakistan (Punjab, N.W.F.P.). (v) *M. tenuignathus* Holmgren: Western India (Gujarat and Rajasthan) in both semi-dry and moist areas) and Pakistan (all over).

Thus, all the five are Oriental and only two of them, *M. laxmi* and *M. raja*, are endemic to Rajasthan.

Subfamily (ii) Termitinae

11. Genus Angulitermes Sjöstedt

This small genus, formerly regarded as mainly Ethiopian, has now been found to be abundant in the Orient, especially in the Indian Sub-region, and the zoogeographical distribution of its 20 known species is as follows:— Ethiopian 5; Palaeartic (Israel) 1 and Oriental (Pakistan, India, Bangla Desh, Burma) 14. According to Emerson (1955, pp. 480, 485), the subfamily Termitinae, where *Angulitermes* belongs, probably arose in the Ethiopian region (where it is best represented) in the early Mesozoic period, before the Cretaceous, and thence spread elsewhere. *Angulitermes*, however, is a medium-specialised
genus, and is much better represented in the Oriental than in the
Ethiopian region, and its origin in the Oriental region is more feasible.
Ecologically, the genus is wholly subterranean, occurring in dry as
well as moist areas.

The sole Rajasthan species, *A. jodhpurensis* Roonwal & Verma,
has hitherto been found only in Jodhpur, situated on the eastern fringe
of the Indian Desert. It is Oriental, and is endemic to Rajasthan.

Subfamily (iii) MACROTERMITINAE

12. Genus *Odontotermes* Holmgren

This is a large and specialised genus, with some 169 species, confined
to the Ethiopian (90 species) and the Oriental (79) regions, one of the
latter ones also extending to the Papuan. Its members cultivate fungi
and several of them build conspicuous earthen mounds. Ecologically,
the genus is versatile and its representatives occur in both tropical rain
forests as well in open grasslands and even semi-deserts; in very arid
areas, e.g., western Rajasthan, the mound-building species do not as
a rule construct mounds.

According to Emerson (1955, p. 486), “the fungus-growing termites
or Macrotermiteae are clearly of Ethiopian origin from some extinct
group that shared the primitive characters of both the Macrotermiteae
and the Nasutitermiteae and possibly derived from the
primitive Amitermiteae. All ten genera of the Macrotermiteae are
Ethiopian.”

*Odontotermes*, the majority of whose species are Ethiopian,
may thus well be regarded as having originated in tropical
Africa, and thence spread to the Orient relatively late (Miocene or
Pliocene?) through some ecologically suitable corridor. At present
the Oriental species occur throughout South and South-east Asia from
Pakistan *via* India, Nepal and Bangla Desh to South China, Indonesia
and the Philippines.

The 12 Rajasthan species are distributed as follows:—

(i) *O. brunneus* (Hagen) : Widely distributed in India and Sri Lanka.
(ii) *O. dehraudni* (Snyder) : North India (Uttar Pradesh, Delhi, Rajasthan)
and Pakistan. (iii) *O. distans* Holmgren & Holmgren : Widely distributed all over India. (iv) *O. feae* (Wasmann) : Widely distributed in India and further east: (Nepal, Bangla Desh, Burma, Thailand). (v) *O. giriensis* Roonwal & Chhotani : India (western part, e.g., Rajasthan; and eastern part, e.g., Meghalaya and Arunachal Pradesh); and Bangla Desh. (vi) *O. guptai* Roonwal & Bose : Rajasthan, in
both dry and moist districts. Endemic to Rajasthan. (vii) *O. gurda-


**Genus Microtermes Wasmann**

This genus contains some 58 species which are confined to the Ethiopian (40 species), Malagasy (5) and Oriental (13) regions. Its representatives share many of the ecological characteristics of *Odontotermes* and often live in the mounds of, or in close association with, the latter; and they also grow fungi. Like *Odontotermes*, this specialised genus also probably had an Ethiopian origin and thence spread to India rather late (Miocene of Pliocene ?) through some ecologically suitable corridor.

The three Rajasthan species are distributed as follows:—

(i) *M. mycophagus* (Desneux) : Western India (Rajasthan and Delhi); and Pakistan. (ii) *M. obesi* Holmgren : South Asia (Pakistan, all India, Bangla Desh, Sri Lanka). (iii) *M. unicolor* Snyder : Pakistan, western and north-western India (Rajasthan and Uttar Pradesh); and Bangla Desh. All the three species are Oriental, and none is endemic to Rajasthan.

**Subfamily (iv) Nasutitermitinae**

**Genus Trinervitermes Holmgren**

This medium-sized genus with nasute soldiers, which are often dimorphic or even trimorphic, is mainly Ethiopian and contains some 63 species as follows:— 56 Ethiopian, 1 Palaeartic (Arabia), and 6 Oriental. As suggested by Emerson (1955, p. 481), it probably arose in the “Ethiopian region when a tropical savanna was established in the Miocene...” and “invaded India from Africa in the Miocene, or more probably, in the Pliocene, through a tropical savanna or steppe corridor.” The sole Rajasthan species, *T. biforis* (Wasmann), is widespread in India (western and Peninsular India) and also occurs in Pakistan and Sri Lanka. It is Oriental, but not endemic to Rajasthan.

4. **Discussion**

(a) **Zoogeographical composition :**

From the analyses given above (also Table 2), it will be seen that the 32 Rajasthan termites are composed of two zoogeographical elements,
viz., an overwhelmingly Oriental element (31 species, or 97%) alone with a tiny Palaeartic one (one species, or 3%). The following six species (19%) are endemic:

**Kalotermitidae:**

*Incisitermes didwanaensis*

**Termitidae:**

**Amitermitinae:** *Microcerotermes laxmi* and *M. raja.*

**Termitinae:** *Angulitermes jodhpurensis.*

**Macrotermiteinae:** *Odontotermes guptai* and *O. latiguloides.*

The phylogenetic distribution of the 32 species is as follows:

<table>
<thead>
<tr>
<th>Family</th>
<th>Species</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kalotermitidae</td>
<td>1</td>
<td>3.1%</td>
</tr>
<tr>
<td>Hodotermitidae</td>
<td>1</td>
<td>3.1%</td>
</tr>
<tr>
<td>Rhinotermitidae</td>
<td>3</td>
<td>9.4%</td>
</tr>
<tr>
<td>Psammotermitinae</td>
<td>1</td>
<td>3.1%</td>
</tr>
<tr>
<td>Heterotermitinae</td>
<td>1</td>
<td>3.1%</td>
</tr>
<tr>
<td>Coptotermitinae</td>
<td>1</td>
<td>3.1%</td>
</tr>
<tr>
<td>Termitidae</td>
<td>27</td>
<td>84.4%</td>
</tr>
<tr>
<td>Amitermitinae</td>
<td>10</td>
<td>31.3%</td>
</tr>
<tr>
<td>Termitinae</td>
<td>1</td>
<td>3.1%</td>
</tr>
<tr>
<td>Macrotermiteinae</td>
<td>15</td>
<td>46.9%</td>
</tr>
<tr>
<td>Nasutitermitinae</td>
<td>1</td>
<td>3.1%</td>
</tr>
</tbody>
</table>

The primitive families (the first three) are poorly represented (15.6%), the higher one, the Termitidae, constituting the remaining 84.4%. Among the Termitidae itself, the more primitive subfamilies, the Amitermitinae and the Termitinae, constitute 34.4%, and the other two 50%. This distribution would suggest that the bulk of the fauna is probably of more recent origin (Miocene or Pliocene?), and since these subfamilies are probably of Ethiopian origin, this part is probably an immigrant from Africa relatively late.

Among the primitive families, a single species, *I. didwanaensis*, is endemic, the remaining five endemics being from the higher groups.

(b) Origins (Tables 2 and 3)

It will be seen from the above analyses that the Rajasthan termite fauna (which is today overwhelmingly Oriental in its facies) is, in origin largely Ethiopian (68%), and to a much lesser extent Oriental (15.6%); it has tiny fractions which are Palaeartic (1 species, *Anacanthotermes macrocephalus*) and distantly Neotropical* (1 species, *Speculitermes cyclops*), and a small proportion (9.4%) of doubtful origin (Table 3).

* In distant origin (the *Anoplotermes-Speculitermes* complex).
The present-day geographical situations of termite genera and species depend upon numerous factors of origin operating through long geological periods—such as land configurations (emergences and submergences), climates, ecological changes, adaptations, migrations, rates of evolution, etc. For Rajasthan termites we have material to discuss only some of these factors, especially migrations (dispersals), local evolution (endemism) and ecological adaptations.

(c) Paucity of geological evidence

The origin of termites from blattoid type ancestors is widely accepted on the basis of morphological similarities in blattids and primitive termites (such as the Mastotermitidae) and the degenerative reduction in the imagos and workers of the higher termites of such primitive characters as the anal lobe of the hindwing, the number of antennal segments, the Y-suture of the head, the two lateral ocelli, the styli, the external genitalia, etc.; and on the development of social organisation.

Fossil evidence from geological history is not helpful since the earliest known termites are from periods as late as the early Tertiary or the late Cretaceous and such fossils are indistinguishable from modern Isoptera genera (Imms, 1937; Weidner, 1966, 1970). The Problattodea (long extinct), which are regarded as the distant ancestors of both the Blattodea and the Isoptera, arose in the late Carboniferous or early Devonian.

A portion of western Rajasthan was, in pre-Mesozoic times (from the Permian onward) under the sea which withdrew by the Pliocene so that some termites might have invaded the dried up land in more recent times. No termite fossils have been found in Rajasthan, and geological evidence thus provides little guidance in zoogeographical matters. It may be presumed (vide Roonwal, Chhotani and Bose, 1962) that the primitive elements which were evolved earlier (e.g., Anoploter- mes-Speculitermes complex), came from South America before the southern continents separated from one another in terms of the Continental Drift Theory of Wegener (1922). Those higher ones (Termitidae) which came from Africa, and were evolved later, probably also came...
later (Miocene or Pliocene?) through some ecologically suitable corridor between Africa and South Asia; that was also the time when the sea receded from western Rajasthan.

(d) Ecological considerations and migrations

The present-day ecological characteristic of Rajasthan—its desiccation—is a recent feature, less than 10,000 years old. Before that event the land was well forested and verdant and presumably sustained a richer, more varied and a more tropical fauna than today. Desiccation probably resulted in (i) the early elimination of the inadaptable species; and (ii) the intrusion, mainly from the western desertic and savanna regions on the west, e.g., Iran, West Asia and even the Sahara, of such arid zone species, or allies, as Eremotermes neoparadoxalis, Microcoterms pales"inensis, M. sakesarensis and M. teniiognathus. This was a second series of intrusions, the first ones having occurred in geological times mainly from Africa (for the Ethiopian elements) and from South India-Malaya area (for the Oriental elements). The sole Palaearctic element, Anacanthotermes, probably came from the Iran-Central Asian region quite early (Miocene or Pliocene?) so as to allow it enough time to reach South India where it has evolved into a second species, A. viarum; the other species stopped short at the eastern border of the Indian Desert.

(e) Endemism (Table 4)

Six endemic species are presumed to have evolved locally. None of the genera concerned is endemic—some have an Ethiopian origin (Microcoterms, Odontoterms), one an Oriental origin (Angulitermes), while for the primitive genus Incisitermes the origin is uncertain. Termite endemism in Rajasthan, a dry area, is only 19%. This is in contrast to some of the tropical rain-forest areas in India where high endemism (58.8%) occurs (Table 4).

<table>
<thead>
<tr>
<th>Area</th>
<th>Percentage of endemism</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rajasthan (mostly arid)</td>
<td>16 %</td>
<td>Present account</td>
</tr>
<tr>
<td>Assam region (tropical rain-forest)</td>
<td>58.8 %</td>
<td>Roonwal &amp; Chhotani (1962, 1965)</td>
</tr>
<tr>
<td>Andaman &amp; Nicobar Islands (tropical rain-forest)</td>
<td>58.8 %</td>
<td>Roonwal &amp; Bose (1970)</td>
</tr>
</tbody>
</table>

TABLE 4.—Degree of endemism in the termite fauna in some arid and rain-forest areas in Indian Region.
(f) Comparison with other animals

No information is available on the zoogeographical status of the Rajasthan fauna of other groups of insects or indeed other animal groups except mammals. According to Prakash (1963, 1973), in origin the Rajasthan mammals are 49% Palaearctic, 51% Oriental and 2.6% endemic. Earlier writers (e.g., Blandord, 1901) also stated the presence of a substantial Palaearctic element in the Indian Desert. According to Prakash, the Palaearctic element varies with the group, from zero (Primates, etc.) to 44 (Rodentia) and 100 (Insectivora). Prakash postulates a wide source of immigration of the western (Palaearctic) elements from the Sahara, Iran, Central Asia and even farther west, and for the eastern (Oriental) elements from Peninsular India and South-east Asia (Text-fig. 23). In the absence of detailed analyses, it is difficult to say to what extent this postulate of widespread intrusion is justified.

Text-fig. 23. Postulated immigration routes of the intrusive mammals in the Indian Desert. (After Prakash, 1973.)

Acknowledgements

We are indebted to the Officer-in-Charge, Desert Regional Station, Zoological Survey of India, Jodhpur, for kindly placing the Station's termite collections at our disposal. Our thanks are also due to Mr. N. S. Rathore for general help in various ways; and to the Council of Scientific and Industrial Research, New Delhi, for financial assistance.
SUMMARY

1. The taxonomic portion of account is based on an extensive collections (some 187 vials), made during the years 1964-73 from 60 localities in 16 districts of Rajasthan (6 never covered before), and forms a supplement to the earlier monograph of Roonwal and Bose (1964).

2. Several new additions of species and extensions of distributional range have been made to the termite fauna of Rajasthan. The additions are: One family (Kalotermitidae), one subfamily (Termitinae), 2 genera (Incisitermes and Angulitermes) and the following 14 species:—

1. Incisitermes didwanaensis Roonwal & Verma
2. Microcerotermes palestinensis Spaeth
3. M. sakesarensis Ahmad
4. Angulitermes jodhpurensis Roonwal & Verma
5. Odontotermes bruneus (Hagen)
6. O. dehraduni (Snyder)
7. O. distans Holmgren & Holmgren
8. O. feae (Wasmann)
9. O. giriensis Roonwal & Chhotani
10. O. gurdaspurensis Holmgren & Holmgren
11. O. latiguloides Roonwal & Verma
12. O. parvidens Holmgren & Holmgren
13. O. wallonensis (Wasmann)
14. Microtermes unicolor Snyder

3. The total number of species from Rajasthan has now risen from 19 in the earlier monograph (Roonwal and Bose, 1964) to 32. (Of the two species of Trinervitermes mentioned in the earlier account, T. heimi is now regarded as a junior synonym of T. biformis.)

4. In many species, new distributional records are given.

5. Measurements and illustrations are given for those species and castes which were not covered in the earlier monograph of Roonwal and Bose.

6. A phylogenetic analysis shows that the primitive families (Kalotermitidae, Hodotermitidae and Rhinotermitidae) are poorly represented (with 15.6 %, 3.1 % and 9.4 % representation respectively). The specialised family, Termitidae, accounts for the remainder (84.4 %).

7. A zoogeographical analysis shows that the present-day composition is overwhelmingly Oriental (97%), with only a small Palaearctic element (1 species, 3 %). Six species (19 %) are endemic to Rajasthan.

8. In origin, the fauna is largely Ethiopian (68.8 %), to a much lesser extent Oriental (15.6 %), and there are tiny fractions of the Palaearctic and Neotropical elements (1 species each), while 3 species (9.4 %) are of doubtful origin.
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