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*Edited by the Director, Zoological Survey of India*

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# FAUNA OF RAJASTHAN, INDIA.

## PART I.—GENERAL INTRODUCTION, WITH A LIST OF COLLECTING LOCALITIES AND A BIBLIOGRAPHY OF RAJASTHAN ZOOLOGY

By

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(With 1 Text-figure, 9 Plates and 2 Appendices)

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### I—INTRODUCTION

#### (a) General

For a variety of reasons the fauna of Rajasthan has hitherto remained poorly studied, and the lacunae in our knowledge in this respect are especially marked in the case of the invertebrate fauna. In the later part of the nineteenth century and the early part of the twentieth some references to fauna, generally incidental, are to be found in the travel accounts of foreigners. Birds, however, received considerable attention by a number of authors (R. M. Adam, 1873-74 ; Butler 1875-76 ; and Hume, 1878). A. Adams (1899) gave a fairly comprehensive account of the more common mammals, birds, insects and helminths of the drier parts of western Rajasthan (Marwar\*, Sirohi and Jaisalmer). The account of the more common vertebrates as given in the various Imperial Gazetteers also deserves mention (*vide* "Imperial Gazetteers of India" 1908 ; Watson, 1904*a, b* ; and Erskine 1908*a-d* ; 1909).

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\*Marwar, the former princely State, corresponds to the present District of Jodhpur.

In more recent years a few accounts of the Rajasthan fauna, have appeared. While the total number of references on the zoology of Rajasthan may appear to be quite large (about 550 are listed in the Bibliography at the end, *vide* Appendix 2), the majority of these papers are short notes, though there are a few notable exceptions. A summary of the more important recent references on Rajasthan faunas arranged according to animal groups, is given below. A more exhaustive list will be found in the Subject Index at the end of the Bibliography in Appendix 2. It will be observed that comprehensive accounts of Rajasthan fauna are very few.

*Crustacea* :—*Living* : Tiwari (1951-59), Mathur & Sidhu (1957), Baid (1958), Krishna & Baid (1958) and Sidhu (1959). *Fossil* : Glaessner & Rao (1960), Prasad (1961) and Tiwari (1962a, b).

*Insecta* : Roonwal & Bose (1964).

*Fishes* : Mathur (1952), Hora & Mathur (1952), Krishna & Menon (1958) and Moona (1952).

*Birds* : Whistler (1938) and Biswas (1947).

*Mammals* : Krishna & Prakash (1955-60), Prakash (1956-63) and Sen & Sankhla (1959, 1962).

#### (b) *Material studied*

To obtain a more or less comprehensive information on the fauna of Rajasthan, and especially to fill in, as far as possible, the lacunae in our knowledge particularly regarding the invertebrates, the Zoological Survey of India initiated, in the year 1956, a programme of faunal explorations of Rajasthan especially the more arid portions, and a series of surveys were thus carried out during the years 1956-63 (part). In addition, the material of two surveys done earlier, during 1941 (by Drs. B. N. Chopra and M. L. Roonwal) and 1948 (by Shri K. S. Pradhan), were also studied. The material of the termite collection made by myself in 1952 was also made available through the courtesy of the Forest Research Institute, Dehra Dun.

The following is a list of the material studied, as collected mainly during 1941-63 ; for a list of the approximately 280 collecting localities in 23 out of the 26 districts of Rajasthan, see Table 1 in Appendix 1.

1. *A collection by Dr. B. N. Chopra and Dr. M. L. Roonwal (October-November, 1941).*—From the districts of Ajmer, Jodhpur, Udaipur and Dungarpur.
2. *A collection by Shri K. S. Pradhan (February-March, 1948).*—From the districts of Jodhpur, Sirohi and Udaipur.
3. *A collection of termites (Insecta : Isoptera) by Dr. M. L. Roonwal (July-September, 1952).*—From the districts of Ajmer, Bikaner, Bundi, Kotah, Jaipur, Jodhpur, Pali and Sawai Madhopur.
4. *A collection by Dr. B. Biswas and Shri T. G. Vazirani (November, 1956—February, 1957).*—From the districts of Jodhpur, Nagaur, Pali, Bikaner and Churu.
5. *A collection by Shri A. K. Mukherjee (April-May, 1957).*—From the districts of Jaipur (Sambhar Lake area), Nagaur and Ajmer.

6. *A collection by Dr. K. K. Tiwari and Shri S. Biswas (December, 1957—February, 1958).*—From the districts of Barmer, Jaisalmer and Jodhpur.
7. *A collection by Shri A. K. Mukherjee (November 1957—January, 1958).*—From the districts of Jaipur (Sambhar Lake area) and Nagaur.
8. *A small collection by Shri T. Vazirani (January-July, 1958).*—From the districts of Jaipur (Sambhar and vicinity) and Nagaur (Gudah, Jhapog, Koni and Lihorana).
9. *A small collection by Shri A. K. Mukherjee (July, 1958).*—From the district of Nagaur (Gudah on Sambhar Lake and vicinity).
10. *A small collection by Shri S. Biswas (August, 1958—January, 1959).*—From the district of Nagaur (Gudah on Sambhar Lake ; and vicinity).
11. *A small collection by Shri R. K. Bhatnagar (June-August, 1960).*—From the Jodhpur district (Jodhpur and surrounding areas, e.g., Mandor, Bishalpur and Khokra village).
12. *A collection by Dr. B. Biswas (August-November, 1960).*—From the districts of Bikaner, Jaisalmer, Nagaur, Sikar, Jhunjhunu and Ganganagar.
13. *A small collection by Shri R. N. Bhargava and Shri G. C. Saha (February-March, 1961).*—From the districts of Jaisalmer, Barmer, Udaipur, Jalore, Pali, Bundi and Kotah.
14. *Several small collections by Dr. A. K. Datta and Shri T. P. Bhargava (February, March, April and December, 1961).*—From the district of Jodhpur.
15. *Three small collections by Dr. A. K. Datta (July, November and December, 1961).*—From the districts of Pali and Udaipur.
16. *A small collection by Dr. A. K. Datta (January, 1962).*—From the district of Bharatpur.
17. *A small collection by Dr. K. K. Tiwari (January-February, 1962).*—From the district of Bharatpur.
18. *A collection by Shri K. K. Mahajan (February-April, 1962).*—From the districts of Jaipur (Sambhar area) and Jodhpur.
19. *Several small collections by Dr. A. K. Datta and Shri T. N. Bhargava (February-April, 1962).*—From the district of Jodhpur.
20. *Several small miscellaneous collections made by the staff of the Desert and Gangetic Plains Regional Stations of the Zoological Survey of India, Jodhpur, (during 1961-63).*—From Jodhpur and vicinity.
21. *A collection, mainly of fishes, made by Shri R. N. Bhargava and Shri N. Majumdar (June-July, 1963).*—From south and east Rajasthan (districts of Alwar, Jaipur, Sawai Madhopur, Jhalawar, Kotah and Jalore).

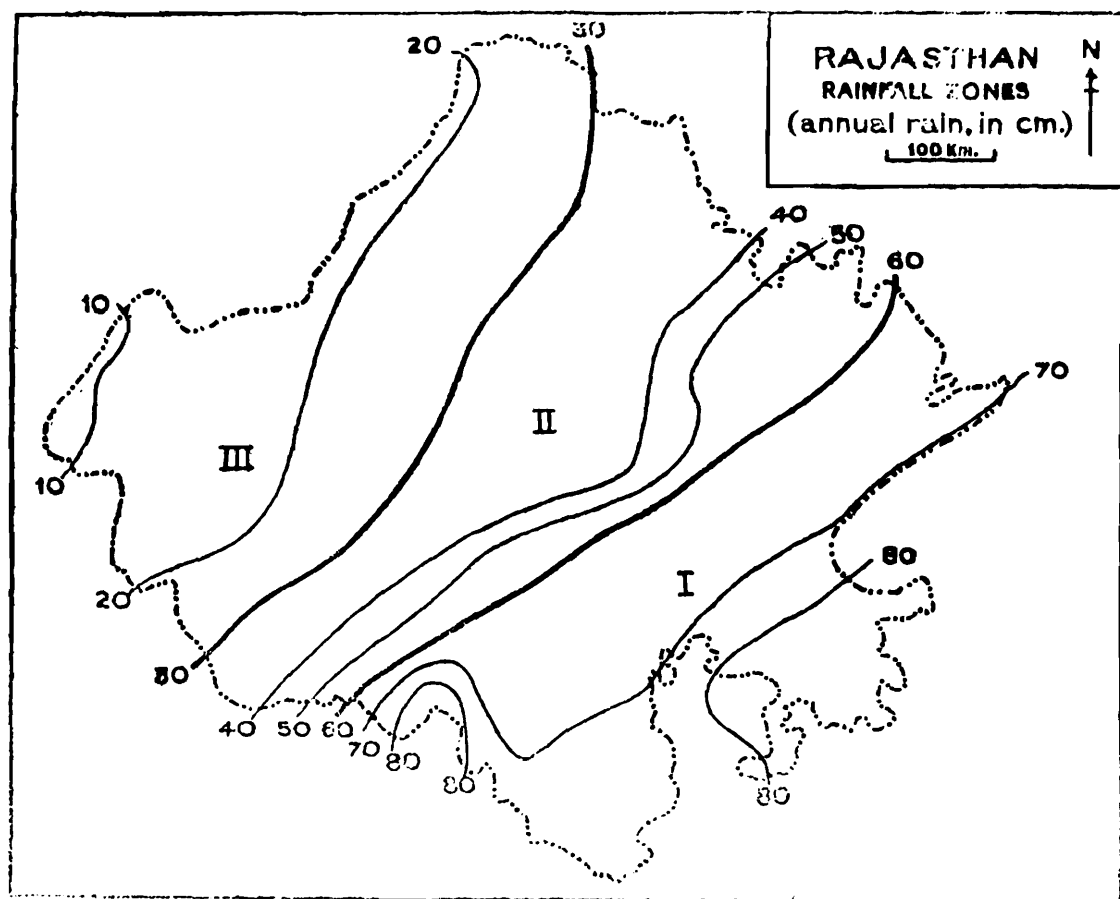
In addition to the recent survey material listed above, the identified material already present in the collections of the Zoological Survey of India has also been incorporated here. This material, though small in extent, has nevertheless served to fill in certain lacunae here and there.

As a result of these surveys, a considerable amount of material, belonging to various groups has been accumulated. This is being studied by various specialists of the Zoological Survey of India as well as by others. In this series of papers, the results on the different groups will be published as they become ready and are made available by the specialists to whom, as well as to the collectors in the field, it is a pleasure to acknowledge our thanks.

(c) *Ecological zones of Rajasthan*

(Text-fig. 1)

Climatically in general, Rajasthan is, as discussed in the next section (Topography, etc.) divisible into two unequal halves by the diagonally (SW—NE) running, Aravalli Hills, viz., a wet south-eastern and a dry north-western area. Ecologically, however, it is possible to divide the State into three subequal diagonally (SW—NE) lying regions on the basis of rainfall and fauna, as follows (Sen & Sankhla, 1959, 1962) :—



TEXT-FIG. 1.—Map of Rajasthan, showing the rainfall clines (diagonal wavy lines) and the three rainfall cum ecological zones (I-III) demarcated by two thick cline lines. (Based on Sen & Sankhla, 1962.)

The figures at two ends of each rainfall cline represent the annual rainfall in centimetres. The three zones are :

Zone I.—Annual rainfall above 60 cm.

Zone II.—Annual rainfall 30-60 cms.

Zone III.—Annual rainfall under 30 cm.

**Zone I.**—Annual rainfall above 60 cm. This forms the south-eastern zone, and nearly corresponds to the zone separated by the Aravalli Hills. It extends from the Sirohi, Udaipur, Dungarpur and Banswara districts,

in the south to Tonk and Bharatpur districts in the north-east. The area supports good forests consisting of teak in some parts, and varying from pure *Anogeissus pendula* to mixtures of *Diospyros*, *Madhuca*, *Embllica*, *Cordia*, *Boehnia* and *Ficus* species. Grasses grow in open patches. Summers are relatively mild though still quite trying and the winters are mild and last for 2-3 months only. The larger fauna consists of several deer, antelopes and the gazelle. Both the tiger and the panther occur, but the former is either rare or absent in the southern portion of the zone. The hyaena occurs throughout the zone. Among the Primates, both the langur (*Semnopithecus entellus*) and the bandar (*Macaca mullata*) occur.

**Zone II.**—Annual rainfall 30-60 cms. This is the middle zone extending from the Jalore district in the south-west to Churu and Jhunjunu districts in the north-east. The forest is open scrub and thorny, consisting of *Anogeissus*, *Acacia*, *Zizyphus* and, in places, *Boswellia* species. Grasses grow all over. The summer is very hot and the scorching *loo* blows in May and June. There are few waterholes, and animal life is poor. Chinkaras and black buck are fairly common, and so are the nilgai and sambhar in places. The wild boar, the sloth bear, the jackal, the fox and the panther are found but the tiger is generally absent.

**Zone III.**—Annual rainfall below 30 cm. This is the westernmost zone and extends from the Barmer and Jaisalmer districts in the south-west to Bikaner and Ganganagar districts in the north-east. Rainfall is scanty and fails completely in some years, leading to extreme draught and famine. The land is largely open and covered by sand dunes or open rocky areas with low bushes and very few trees (mostly *Acacia* *Prosopis* and *Zizyphus* species) as well as *Cactus* and *Capparis*. The summers are very hot and the *loo* blows in May and June, the temperature going up to 49°C or more. Winters are cold, frost is common and temperatures go down to -2°C. The low rainfall and deep water-table make agriculture difficult. Among the herbivores, the Chinkara and the black buck are found in herds, and the nilgai may be seen near a few cultivated areas. The principal carnivore is the wolf which hunts in packs and is so serious a menace to sheep and goat that owners of flocks organise wolf-eradicating campaigns. Most other carnivores e.g., the jackal, fox and jungle cat, are nocturnal. The tiger is absent and the panther rare. The gerbils (*Meriones hurrianae* and *Tatera indica*) are found in enormous numbers and live in underground tunnels.

#### (d) *Abbreviations used*

Except where otherwise stated, the following abbreviations have been used in this series :—

*Alt.*, Altitude above mean sea-level.

*Coll.*, collected by ; collection.

*Coll. Sta.*, Collecting Station.

*Det.*, determined (identified) by.

*Dist.*, district.

*Ex.*, from.

*F.R.I.*, Forest Research Institute, Dehra Dun.

*Lat.*, latitude.

*Long.*, longitude.

*No.*, number.

*Syn.*, synonym.

*Z.S.I.*, Zoological Survey of India, Calcutta.

### (e) Acknowledgements

In the preparation of this introductory part of the series, it is a pleasure to acknowledge the assistance which I have received from several members of the staff of the Zoological Survey of India, specially Dr. K. K. Tiwari, Dr. B. Biswas, Shri Ramakrishna, Shri O. B. Chhotani, Shri P. K. Maiti and Shri D. P. Bhattacharya of the Headquarters and Dr. A. K. Datta, Dr. R. S. Pillai, Shri R. C. Sharma and Shri R. N. Bhargava of the Desert and Gangetic Plains Regional Station, Jodhpur. The photographs given here, and which illustrate the ecological habitats of the desert and the relatively green areas of Rajasthan, were taken by the various field parties and the photographers of the Survey, and the sources are acknowledged in the Plates.

## II—TOPOGRAPHY, PHYSICAL FEATURES AND ADMINISTRATIVE DISTRICTS OF RAJASTHAN.

(Text-fig. 1 ; and Plates 9 to 17)

### (a) *Topography, physical features, etc.*

*Topography, etc.*—Rajasthan (formerly called Rajpootana or Rajputana) is the second largest and the westernmost State of India, and lies approximately between latitudes  $23^{\circ} 10'$  and  $30^{\circ} 30'$  north and longitudes  $69^{\circ} 50'$  and  $78^{\circ} 25'$  east. It has a land-area of about 1,32,077 square miles and a population of about 1,59,70,774 ; it is, thus thinly populated.

*Geography.*—Rajasthan is cut into two unequal and climatically different halves by the Aravalli Hills (highest peak : Guru Shikhar near Mt. Abu, *ca.* 1981 metres or 6,500 ft. above mean sea-level) which cut across it diagonally south-west to north-east. The large north-western tract, which forms about three-fifths of the State, is flat, ill-watered and with little rain, and is largely sandy and unproductive—it forms a part of the Great Indian Desert. The smaller, south-eastern tract is rocky, is better served by rivers and gets more rain ; its hills and plains are covered with green, deciduous forest and the land is well cultivated. In the north-western tract the only river of importance is the Luni which rises near Ajmer and falls into the Rann of Cutch. In the south-eastern tract there are two principal rivers, the Chambal and the Banganga, which drain north-east into the R. Jamna. There are no natural fresh-water lakes except the shallow Sambhar Basin which holds brackish

water, but a number of large and small artificial lakes and tanks are to be found all over Rajasthan. There is a large Ganga Canal in the Ganganagar District in the north, and a number of new canals both large and small, etc., are either already functioning or under active construction, and will be ready in the next few years—among the larger ones are the Ghaggar and the Rajasthan Canals and the Kotah Barrage. This change is bound to affect the distribution of the fauna of the State. For further information on geography, see Blanford (1876) and the gazetteers (Imperial Gazetteer, 1908 ; Watson, 1904 ; and Erskine, 1908, 1909).

*Geology.*—The Aravalli Range is pre-Cambrian and is the most ancient mountain range in India. Overlying it is another ancient or Archaean rock formation, the Raialo Series, chiefly marbles. At Pokran there are dark sandstones, presumably Permo-Carboniferous. Jurassic and Tertiary rocks occur in the Bikaner and Jaisalmer districts, while the Cretaceous rocks of the Barmer district are probably of marine origin. There is some evidence to show that in Jurassic times western Rajasthan was under the sea. The dessication of Rajasthan is a recent (post-glacial) phenomenon (Wadia, 1960). For further information on geology, see Blanford (1876), La Touche (1902), Fermor (1930), Fox (1931), Heron (1935, 1938) and Krishnan (1952); and the Gazetteers. For soils see Krishnaswami & Gupta (1952) and Bharucha (1960).

*Climate.*—The climate in the plains is extreme—very hot and dry (with hot winds or *loo*) in summer (May-June) and very cold and dry in winter (December-February). The Mean Monthly Minimum temperatures are 46.9°—85.0°F. at Bikaner and 43.1°—80.3°F. at Jaisalmer, the corresponding Mean Monthly Maximum temperatures being 71.7°—107.1°F. and 74.8°—109.1°F. respectively. The hilly regions, particularly the Aravalli Hills and the areas south-east of it, have a more moderate and wetter climate. The annual rainfall is scanty in the north-western area (*ca.* 15—30 cm. in the Barmer, Jaisalmer, Bikaner and Jodhpur districts), but rapidly increases on, and east of, the Aravalli Hills (Udaipur and Jaipur *ca.* 60; Kotah 75; Jhalawar 90; and Mt. Abu 150 cm.). The bulk of the rainfall is received during the summer monsoon (July-September) and a small amount during the winter (January-February). For further information on climate see Pramanik & Hariharan (1952) and the Gazetteers.

*Vegetation.*—The western desert area of Rajasthan is characterised by open scrub forest, with low bushes and stunted trees, and wide stretches of little else but sand dunes. The slopes and heights of the Aravallis are well-wooded, with tall, broad-leaved trees of many species. The total area covered by forests in the State is about 15,000 sq. miles, the bulk of it lying either on the Aravallis or south and east of it. For further information on vegetation, see King (1879), Adams (1899), Blatter & Halberg (1918-21), Rao (1941) and the Gazetteers.

*General.*—A brief general account of the arid lands of the world, including Rajasthan, has been given by White (1960). Among other things, he also discusses the “conditions of animal life”.

*(b) Administrative districts*

Before India's Independence (1947), Rajasthan was largely composed of the so-called "Princely States". Today, it is divided into 5 Divisions, 26 Districts, 82 Subdivisions and 212 Tehsils. The 5 Divisions and 26 Districts are :

**I—BIKANER DIVISION**

1. Bikaner Dist. (10,150 sq. miles).
2. Churu Dist. (6,581 sq. miles).
3. Ganganagar Dist. (5,159 sq. miles).

**II—AJMER DIVISION**

4. Ajmer Dist. (2,439 sq. miles).
5. Alwar Dist. (3,126 sq. miles).
6. Bharatpur Dist. (3,121 sq. miles).
7. Jaipur Dist. (6,554 sq. miles).
8. Jhunjhunu Dist. (2,322 sq. miles).
9. Sawai Madhopur Dist. (4,057 sq. miles).
10. Sikar Dist. (3,021 sq. miles).
11. Tonk Dist. (2,685 sq. miles).

**III—JODHPUR DIVISION**

12. Barmer Dist. (9,734 sq. miles).
13. Jaisalmer Dist. (16,062 sq. miles).
14. Jalore Dist. (4,730 sq. miles).
15. Jodhpur Dist. (9,024 sq. miles).
16. Nagaur Dist. (6,767 sq. miles).
17. Pali Dist. (4,673 sq. miles).
18. Sirohi Dist. (1,705 sq. miles).

**IV—KOTAH DIVISION**

19. Bundi Dist. (2,173 sq. miles).
20. Jhalawar Dist. (2,143 sq. miles).
21. Kotah Dist. (5,707 sq. miles).

**V—UDAIPUR DIVISION**

22. Banswara Dist. (2,266 sq. miles).
23. Bhilwara Dist. (3,758 sq. miles).
24. Chittorgarh Dist. (3,182 sq. miles).
25. Dungarpur Dist. (1,460 sq. miles).
26. Udaipur Dist. (6,215 sq. miles).

### III—SUMMARY

1. After a brief historical introduction, it is pointed out that in this series of papers the fauna of Rajasthan, whose study has hitherto been neglected, will be dealt with.

2. This work is based largely on the programme of several surveys carried out in Rajasthan by the Zoological Survey of India during the years 1941-1963 and more particularly during 1956-62. Some other material is also utilised.

3. A brief account is given of the following features of Rajasthan :—Topography, geography, geology, climate and vegetation. A list of administrative districts is also given.

4. A list of 279 collecting localities (together with their approximate latitudes, longitudes, etc.) in 23 districts of Rajasthan is given in Appendix 1 (Table 1).

5. A bibliography of the published references on Rajasthan zoology is given in Appendix 2. About 550 references are included, and an author index and a subject index are also provided.

6. In this series of papers, the results on various groups of animals will be published as they are completed by the various specialists.

### IV—APPENDIX 1

TABLE 1.—*List of Collecting Stations for fauna of Rajasthan (1941-63).*

*Note.*—The districts, as well as the individual Collecting Stations within each district, are arranged alphabetically.

*Abbreviations for names of Collectors.*—AKD, Dr. A.K. Datta ; AKM, Mr. A.K. Mukherjee ; BB, Dr. B. Biswas ; BNC, Dr. B.N. Chopra ; GCS, Mr. G.C. Saha ; JCB, Mr. J.C. Bhatti ; JCP, Mr. J.C. Purohit ; KCK, Mr. K.C. Kansal ; KKT, Dr. K.K. Tiwari ; KKM, Mr. K.K. Mahajan ; KSK, Dr. K.S. Kushwaha ; KSP, Mr. K.S. Pradhan ; ML, Mr. M. Lall ; MLR, Dr. M.L. Roonwal ; NM, Mr. N. Majumdar ; PDG, Dr. P.D. Gupta ; RCS, Mr. R.C. Sharma ; RKB, Mr. R.K. Bhatnagar ; RNB, Mr. R.N. Bhargava ; SB, Mr. S. Biswas ; SDG, Prof. S.D. Gupta ; SKS, Mr. S.K. Sharma ; TGV, Mr. T. G. Vazirani ; YKS, Mr. Y.K. Srivastava ; ZSP, Zoological Survey of India Party.

*Abbreviations for directions.*—N., north ; S., south ; E., east ; W., west.

*Meaning of some vernacular (Rajasthani) words used in the names of Collecting Stations.*—*Baori*, a large well ; *Bas*, habitation ; *Berra*, well ; *Bhakri*, hillock ; *Bund*, small dam ; *Dhani*, hamlet ; *Jharna*, waterfall ; *Ka, ki*, of ; *Nadi*, stream, river ; *Nala, nalla*, streamlet ; *-Sagar, -sarovar, -samand*, lake ; *Talab, talao*, tank ; *Talai*, small tank.

TABLE I

| Serial No.               | Collecting Station                          | Altitude, above mean sea-level (Metres) | Approx. latitude (N.) | Approx. longitude (E.) | Name of collector (and year of collection)          |
|--------------------------|---------------------------------------------|-----------------------------------------|-----------------------|------------------------|-----------------------------------------------------|
| 1                        | 2                                           | 3                                       | 4                     | 5                      | 6                                                   |
| <b>1. AJMER DISTRICT</b> |                                             |                                         |                       |                        |                                                     |
| 1.                       | Ajmer (and nity).                           | vici- 483 m.                            | 26°27'                | 74°42'                 | MLR (1952) ;<br>BB (1956-57) ;<br>RNB & GCS (1961). |
| 2.                       | Anasagar Ajmer.                             | Lake,                                   | 26°25'                | 74°35'                 | RNB & GCS (1961).                                   |
| 3.                       | Danta forest (ca. 20 Km. S. of Ajmer).      | —                                       | 26°20'                | 74°40'                 | MLR (1952) ;<br>BB (1956-57).                       |
| 4.                       | Faisagar 8 Km. N. of Ajmer).                | (ca. —                                  | 26°32'                | 74°37'                 | MLR (1952).                                         |
| 5.                       | Hathikhera 10 Km. NW. of Ajmer).            | (ca. —                                  | 26°30'                | 74°35'                 | MLR (1952).                                         |
| 6.                       | Kishangarh (and vicinity).                  | (and —                                  | 26°35'                | 74°50'                 | BB (1956-57) ;<br>AKM (1957).                       |
| 7.                       | Forest Plantation (5 Km. N. of Kishangarh). | —                                       | 26°36'                | 74°50'                 | BB (1956-57).                                       |
| 8.                       | Nagpahar Hill 10 Km. NW. of Ajmer).         | (ca. —                                  | 26°25'                | 74°31'                 | MLR (1952).                                         |
| —                        | Phaisagar Faisagar).                        | (See —                                  |                       |                        | —                                                   |
| 9.                       | (i) Nasirabad (and vicinity).               | (and —                                  | 26°11'                | 74°28'                 | BB (1956-57).                                       |
|                          | (ii) Chat village (5 Km. S. of Nasirabad).  | —                                       | 26°10'                | 74°40'                 | BB (1956-57).                                       |
|                          | (iii) Eastern Pond (3 Km. S. of Nasirabad). | —                                       | 26°11'                | 74°28'                 | BB (1956-57).                                       |
|                          | (iv) Western Pond (3 Km. S. of Nasirabad).  | —                                       | 26°11'                | 74°28'                 | BB (1956-57).                                       |

Table I—*contd.*

| Serial No.                | Collecting Station                                       | Altitude, above mean sea-level (Metres) | Approx. latitude (N.) | Approx. longitude (E.) | Name of collector (and year of collection) |
|---------------------------|----------------------------------------------------------|-----------------------------------------|-----------------------|------------------------|--------------------------------------------|
| 1                         | 2                                                        | 3                                       | 4                     | 5                      | 6                                          |
| 10.                       | Pushkar (ca. 15 Km. NW. of Ajmer).                       | —                                       | 26°32'                | 74°35'                 | MLR (1952).                                |
| 11.                       | Rajosi (11 Km. SE. of Ajmer).                            | —                                       | 26°20'                | 74°40'                 | BB (1956-57).                              |
| <b>2. ALWAR DISTRICT</b>  |                                                          |                                         |                       |                        |                                            |
| 12.                       | Alwar                                                    | —                                       | 27°34'                | 76°38'                 | —                                          |
| 13.                       | Bedkesharpur village (40 Km. S. of Alwar).               | —                                       | 27°10'                | 76°38'                 | AKD (1962).                                |
| 14.                       | Jaisamand (ca. 11 Km. SE. of Alwar) (Cf. No. 273 below). | —                                       | 27°25'                | 76°36'                 | NM (1963).                                 |
| 15.                       | Jeysagar Bund                                            | —                                       | 27°10'                | 76°36'                 | NM (1963).                                 |
| 16.                       | Mangalsar (ca. 5 Km. S. of Manasrover).                  | —                                       | 27°15'                | 76°36'                 | NM (1963).                                 |
| 17.                       | Mansarovar (ca. 61 Km. S. of Alwar, by road).            | —                                       | 27°15'                | 76°36'                 | NM (1963).                                 |
| 18.                       | Siliserh Bund (ca. 13 Km. SW. of Alwar).                 | —                                       | 27°25'                | 76°36'                 | NM (1963).                                 |
| <b>3. BARMER DISTRICT</b> |                                                          |                                         |                       |                        |                                            |
| 19.                       | Bhap Tank (ca. 18 Km. NE. of Barmer).                    | —                                       | 25°51'                | 71°26'                 | KKT & SB (1957-58); PDG (1962).            |
| 20.                       | Balotra Town                                             | —                                       | 25°50'                | 72°15'                 | KKT & SB (1957-58); RNB & GCS (1961).      |

Table I—*contd.*

| Serial No. | Collecting Station                             | Altitude above mean sea-level (Metres) | Approx. latitude (N.) | Approx. longitude (E.) | Name of collector (and year of collection) |
|------------|------------------------------------------------|----------------------------------------|-----------------------|------------------------|--------------------------------------------|
| 1          | 2                                              | 3                                      | 4                     | 5                      | 6                                          |
| 21.        | (i) Barmer (and vicinity).                     | —                                      | 25°45'                | 71°23'                 | KKT & SB (1957-58); PDG (1962).            |
|            | (ii) Nehru-Nagar (1 Km. E. of Barmer).         | —                                      | 25°45'                | 71°23'                 | PDG (1962).                                |
|            | (iii) Sujer Hills (2 Km. W. of Barmer).        | —                                      | 25°45'                | 71°23'                 | PDG (1962).                                |
| 22.        | Datani village (ca. 26 Km. NE. of Gadra Road). | —                                      | 25°48'                | 70°46'                 | KKT & SB (1957-58).                        |
| 23.        | Gadra Road (Railway Station).                  | —                                      | 25°45'                | 70°35'                 | KKT & SB (1957-58).                        |
| 24.        | Jalipa Tank (10 Km. N. of Barmer).             | —                                      | 25°50'                | 71°23'                 | PDG (1962).                                |
| 25.        | Jhalon forest belt.                            | —                                      | 25°49'                | 70°45'                 | KKT & SB (1957-58).                        |
| 26.        | Kapurdi (11 Km. N. of Barmer).                 | —                                      | 25°50'                | 71°20'                 | RNB & GCS (1961); PDG (1962).              |
| 27.        | Luni River bank (near Balotra).                | —                                      | 25°45'                | 72°15'                 | RNB & GCS (1961).                          |
| 28.        | Pachpadra Salt Dept (& vicinity).              | —                                      | 25°55'                | 72°20'                 | KKT & SB (1957-58).                        |
| 29.        | Ranasar (ca. 32 Km. NE. of Gadra Road).        | —                                      | 25°50'                | 70°44'                 | KKT & SB (1957-58).                        |
| 30.        | Tamlor (ca. 20 Km. W. of Gadra Road).          | —                                      | 25°44'                | 70°33'                 | KKT & SB (1957-58).                        |
| 31.        | Uttarlai Tank (ca. 11 Km. NE. of Barmer).      | —                                      | 25°45½'               | 71°25'                 | KKT & SB (1957-58); RNB & GCS (1961).      |

Table I—*contd.*

| Serial No.                   | Collecting Station                                      | Altitude, above mean sea-level (Metres) | Approx. latitude (N.) | Approx. longitude (E.) | Name of collector (and year of collection)                 |
|------------------------------|---------------------------------------------------------|-----------------------------------------|-----------------------|------------------------|------------------------------------------------------------|
| 1                            | 2                                                       | 3                                       | 4                     | 5                      | 6                                                          |
| <b>4. BHARATPUR DISTRICT</b> |                                                         |                                         |                       |                        |                                                            |
| 32.                          | Bharatpur                                               | —                                       | 27°15'                | 77°27'                 | KCK (1962).                                                |
| 33.                          | Dig Fort (35 Km. NW. of Bharatpur).                     | —                                       | 27°27'                | 77°20'                 | AKD (1962).                                                |
| 34.                          | Kherli Village (16 Km. SW. of Nagar Tehsil).            | —                                       | 27°00'                | 77°15'                 | KCK (1962).                                                |
| 35.                          | On way to Ghana Bird Sanctuary (6 Km. E. of Bharatpur). | —                                       | 27°15'                | 77°31'                 | KCK (1962).                                                |
| <b>5. BIKANER DISTRICT</b>   |                                                         |                                         |                       |                        |                                                            |
| 36.                          | Bichwal (8 Km. N. of Bikaner).                          | —                                       | 28°04'                | 73°22'                 | BB (1956-57).                                              |
| 37.                          | Bikaner (& vicinity).                                   | 224 m.                                  | 28°01'                | 73°22'                 | SDG (1952);<br>MLR (1952);<br>BB (1956-57);<br>PDG (1962). |
| 38.                          | Devikund tank and garden (ca. 10 Km. SE. of Bikaner).   | —                                       | 27°56'                | 73°18'                 | MLR (1952);<br>PDG (1962).                                 |
| 39.                          | Gajner (ca. 35 Km. SW of Bikaner).                      | —                                       | 27°55'                | 73°04'                 | MLR (1952).                                                |
| 40.                          | Jorbir (ca. 16 Km. SW. of Bikaner).                     | —                                       | 27°58'                | 73°14'                 | BB (1956-57).                                              |
| 41.                          | 'Khans', west of Bikaner city.                          | —                                       | 28°06'                | 73°14'                 | BB (1956-57).                                              |
| 42.                          | Kodamdesar (ca. 32 Km. NW. of Bikaner).                 | —                                       | 28°00'                | 73°05'                 | MLR (1952).                                                |
| 43.                          | Kolayat (ca. 50 Km. W. of Bikaner).                     | —                                       | 27°50'                | 72°58'                 | MLR (1952);<br>BB (1960).                                  |
| 44.                          | Kotri (3 Km. N. of Kolayat).                            | 230 m.                                  | 27°51'                | 72°58'                 | BB (1960).                                                 |

Table I—*contd.*

| Serial No.               | Collecting Station                                        | Altitude above mean sea-level (Metres) | Approx. latitude (N.) | Approx. longitude (E.) | Name of collector (and year of collection) |
|--------------------------|-----------------------------------------------------------|----------------------------------------|-----------------------|------------------------|--------------------------------------------|
| 1                        | 2                                                         | 3                                      | 4                     | 5                      | 6                                          |
| 45.                      | Lalgarh (6 Km. N. of Bikaner).                            | —                                      | 28°05'                | 73°22'                 | YKS (1952); BB (1956-57).                  |
| 46.                      | Lunkaransar village (8 Km. N. of Bikaner city).           | 202 m.                                 | 28°30'                | 73°45'                 | BB (1960).                                 |
| 47.                      | Pugal (80 Km. NW. of Bikaner city).                       | 160 m.                                 | 28°30'                | 72°48'                 | BB (1960).                                 |
| 48.                      | Sand-dunes (ca. 17 Km. N. of Bikaner).                    | —                                      | 28°08'                | 73°22'                 | BB (1956-57).                              |
| 49.                      | Siasar                                                    | —                                      | 28°35'                | 72°34'                 | BB (1960).                                 |
| 50.                      | Shivbari (ca. 6 Km. SE. of Bikaner).                      | —                                      | 28°00'                | 73°23'                 | MLR (1952); SDG (1952).                    |
| 51.                      | Sobasar (14 Km. NW. of Bikaner).                          | —                                      | 28°08'                | 73°10'                 | PDG (1962).                                |
| <b>6. BUNDI DISTRICT</b> |                                                           |                                        |                       |                        |                                            |
| 52.                      | Bardah-ka-Talab (Bardah Tank) (ca. 28 Km. NW. of Kotach). | —                                      | 25°20'                | 75°40'                 | MLR (1952).                                |
| 53.                      | Bundi                                                     | 366 m.                                 | 25°27'                | 75°41'                 | MLR (1952); RNB & GCS (1961).              |
| 54.                      | Jaitsagar (ca. 4 Km. SW. of Bundi town).                  | —                                      | 25°20'                | 75°30'                 | RNB & GCS (1961).                          |
| 55.                      | Khatkar (ca. 30 Km. NE. of Bundi).                        | —                                      | 25°34'                | 75°46'                 | RNB & GCS (1961).                          |
| 6.                       | Phulsagar forest (near Bundi).                            | —                                      | 25°25'                | 75°55'                 | MLR (1952).                                |

**Table I—contd.**

| Serial No.                     | Collecting Station                                                                  | Altitude above mean sea-level (Metres) | Approx. latitude (N.) | Approx. longitude (E.) | Name of collector (and year of collection) |
|--------------------------------|-------------------------------------------------------------------------------------|----------------------------------------|-----------------------|------------------------|--------------------------------------------|
| 1                              | 2                                                                                   | 3                                      | 4                     | 5                      | 6                                          |
| <b>7. CHITTORGARH DISTRICT</b> |                                                                                     |                                        |                       |                        |                                            |
| 57.                            | Chittorgarh                                                                         | —                                      | 25°00'                | 74°45'                 | BNC & MLR (1941).                          |
| 58.                            | River Berach (near its junction with R. Gambheri near Chittorgarh Railway Station). | —                                      | 24°50'                | 74°37'                 | BNC & MLR (1941).                          |
| <b>8. CHURU DISTRICT</b>       |                                                                                     |                                        |                       |                        |                                            |
| 59.                            | Churu                                                                               | —                                      | 28°11'                | 75°06'                 | BB (1956-57).                              |
| 60.                            | Huderd Railway Station.                                                             | —                                      | 28°00'                | 74°35'                 | BB (1956-57).                              |
| 61.                            | Ratangarh Railway Junction.                                                         | —                                      | 28°07'                | 74°35'                 | BB (1956-57).                              |
| 62.                            | Sardarshahr                                                                         | —                                      | 28°30'                | 74°29'                 | BB (1956-57).                              |
| 63.                            | Taranagar town                                                                      | —                                      | 28°40'                | 75°02'                 | BB (1960).                                 |
| <b>9. DUNGARPUR DISTRICT</b>   |                                                                                     |                                        |                       |                        |                                            |
| 64.                            | (i) Dungarpur town.                                                                 | —                                      | 23°50'                | 73°40'                 | BNC & MLR (1941).                          |
|                                | (ii) Soorpur-ki-Nadi (4 Km. from Dungarpur town).                                   | —                                      | 23°50'                | 73°40'                 | BNC & MLR (1941).                          |
| 65.                            | Som River (15 Km. N. of Dungarpur town).                                            | —                                      | 24°00'                | 73°40'                 | BNC & MLR (1941).                          |

Table I—*contd.*

| Serial No.                     | Collecting Station                         | Altitude above mean sea-level (Metres) | Approx. latitude (N.) | Approx. longitude (E.) | Name of collector (and year of collection) |
|--------------------------------|--------------------------------------------|----------------------------------------|-----------------------|------------------------|--------------------------------------------|
| 1                              | 2                                          | 3                                      | 4                     | 5                      | 6                                          |
| <b>10. GANGANAGAR DISTRICT</b> |                                            |                                        |                       |                        |                                            |
| 66.                            | Asarjana ( <i>ca.</i> 16 Km. W. of Nohar). | —                                      | 29°10'                | 74°38'                 | BB (1960).                                 |
| 67.                            | Badbirana (16 Km. E. of Nohar).            | —                                      | 29°08'                | 74°53'                 | BB (1960).                                 |
| 68.                            | Bhukarka (10 Km. NW. of Nohar).            | —                                      | 29°14'                | 74°45'                 | BB (1960).                                 |
| 69.                            | Charano-ki-Dhani (10 Km. S. of Nohar).     | —                                      | 29°09'                | 74°48'                 | BB (1960).                                 |
| 70.                            | Deidas ( <i>ca.</i> 18 Km. NW. of Nohar).  | 193 m.                                 | 29°16'                | 74°41'                 | BB (1960).                                 |
| 71.                            | Diplana (13 Km. E. of Nohar.)              | —                                      | 29°11'                | 74°53'                 | BB (1960).                                 |
| 72.                            | Guria (20 Km. NE. of Nohar).               | —                                      | 29°18'                | 74°54'                 | BB (1960).                                 |
| 73.                            | Kishanpura                                 | —                                      | 29°19'                | 73°58'                 | BB (1960).                                 |
| 74.                            | Nohar                                      | —                                      | 29°11'                | 74°46'                 | BB (1960).                                 |
| 75.                            | Padampura (25 Km. N. of Nohar).            | —                                      | 29°18'                | 74°56'                 | BB (1960).                                 |
| 76.                            | Rangmahal (8 Km. E. of Suratgarh).         | —                                      | 29°21'                | 73°58'                 | BB (1960).                                 |
| 77.                            | Sardarpurabas                              | —                                      | 29°10'                | 74°48'                 | BB (1960).                                 |
| 78.                            | Sonri (10 Km. W. of Nohar).                | —                                      | 29°10'                | 74°42'                 | BB (1960).                                 |
| 79.                            | Sothi ( <i>ca.</i> 10 Km. E. of Nohar).    | —                                      | 29°10'                | 74°50'                 | BB (1960).                                 |
| 80.                            | Suratgarh                                  | —                                      | 29°19'                | 73°54'                 | BB (1960).                                 |
| 81.                            | Surpura (20 Km. S. of Nohar).              | —                                      | 29°05'                | 74°50'                 | BB (1960).                                 |
| 82.                            | Tanks near Suratgarh.                      | —                                      | 29°19'                | 73°02'                 | BB (1960).                                 |

**Table I—contd.**

| Serial No.                 | Collecting Station                           | Altitude above mean sea-level (Metres) | Approx. latitude (N.) | Approx. longitude (E.) | Name of collector (and year of collection)                        |
|----------------------------|----------------------------------------------|----------------------------------------|-----------------------|------------------------|-------------------------------------------------------------------|
| 1                          | 2                                            | 3                                      | 4                     | 5                      | 6                                                                 |
| <b>11. JAIPUR DISTRICT</b> |                                              |                                        |                       |                        |                                                                   |
| 83.                        | Achnol Forest (ca. 36 Km. N. of Jaipur).     | —                                      | 27°05'                | 75°52'                 | MLR (1952).                                                       |
| 84.                        | Amer (ca. 10 Km. N. of Jaipur).              | —                                      | 26°58'                | 75°52'                 | MLR (1952).                                                       |
| 85.                        | Bahadurpur (near Sambhar).                   | —                                      | 26°52'                | 75°16'                 | TGV (1958).                                                       |
| 86.                        | Chapparwara Lake (37 Km. S. of Sambhar)      | —                                      | 26°55'                | 75°02'                 | AKM(1957-58).                                                     |
| 87.                        | Chittoli Bund (10 Km. W. of Bairat village). | —                                      | 27°42'                | 76°10'                 | NM (1963).                                                        |
| 88.                        | Dausa (or Daosa) (ca. 60 Km. E. of Jaipur).  | —                                      | 26°55'                | 75°20'                 | MLR (1952).                                                       |
| 89.                        | Devdyani (near Sambhar).                     | —                                      | 26°55'                | 75°13'                 | TGV (1958) ;<br>SB (1958-59) ,<br>KKM (1962).                     |
| 90.                        | Dudu                                         | —                                      | 26°40'                | 75°10'                 | TGV (1958) ;<br>SB (1958-59).                                     |
| 91.                        | Galta (near Jaipur).                         | 427m.                                  | 27°00'                | 75°52'                 | MLR (1952).                                                       |
| 92.                        | Haripura                                     | —                                      | 26°55'                | 75°25'                 | TGV (1958).                                                       |
| 93.                        | Jaipur (and vicinity).                       | —                                      | 26°55'                | 75°52'                 | MLR (1952) ;<br>SDG (1952).                                       |
|                            | Jamwa Ramgarh (See Ramgarh No. 105 below).   | —                                      | —                     | —                      | —                                                                 |
| 94.                        | Jhapog (near Sambhar).                       | —                                      | 26°55'                | 75°02'                 | BB (1956-57) ;<br>AKM (1957-58).<br>TGV (1958) ;<br>SB (1958-59). |
| 95.                        | Khyra tank (6 Km. S. of Sambhar).            | —                                      | 26°52'                | 75°13'                 | KKM (1962).                                                       |
| 17 ZSI/63                  |                                              |                                        |                       |                        | 2                                                                 |

Table I—contd.

| Serial No. | Collecting Station                                                                                          | Altitude above mean sea-level (Metres) | Approx. latitude (N.) | Approx. longitude (E.) | Name of collector (and year of collection) |
|------------|-------------------------------------------------------------------------------------------------------------|----------------------------------------|-----------------------|------------------------|--------------------------------------------|
| 1          | 2                                                                                                           | 3                                      | 4                     | 5                      | 6                                          |
| 96.        | Korsina (ca. 10 Km. SW. of Jhapog).                                                                         | —                                      | 26°46'                | 75°02'                 | TGV (1958).                                |
| 97.        | Kotputli-ka-Talao                                                                                           | —                                      | 27°42'                | 76°12'                 | NM (1963).                                 |
| 98.        | Kukus (ca. 22 Km. N. of Jaipur).                                                                            | —                                      | 27°03'                | 75°55'                 | MLR (1952).                                |
| 99.        | Manoharpur (and vicinity).                                                                                  | —                                      | 27°18'                | 75°57'                 | NM (1963).                                 |
| 100.       | Mapdori-ka-Bund (7 Km. Sw. of Manoharpur Bus Station).                                                      | —                                      | 27°18'                | 75°56'                 | NM (1963).                                 |
| 101.       | Naraina village                                                                                             | —                                      | 26°45'                | 75°10'                 | TGV (1958) ; SB (1958-59).                 |
| 102.       | New Kyar (in Sambhar Salt Lake)                                                                             | —                                      | 26°54'                | 75°13'                 | BB (1956-57) ; KKM (1962).                 |
| 103.       | Padasauli (ca. 60 Km. SE. of Jaipur).                                                                       | —                                      | 26°35'                | 76°20'                 | SKS (1951).                                |
| 104.       | Phulera                                                                                                     | —                                      | 26°52'                | 75°16'                 | BB (1956-57) ; TGV (1958) ; SB (1958-59).  |
| 105.       | Ramgarh (or Jamwa Ramgarh) Forest, ca. 40 Km. NE. of Jaipur (cf. Ramgarh in Jaisamer Dist., No. 120 below). | —                                      | 27°10'                | 76°05'                 | MLR (1952).                                |
| 106.       | Sambhar                                                                                                     | —                                      | 26°54'                | 75°13'                 | TGV (1958) ; KKM (1962) ;                  |

Table I—*contd.*

| Serial No.                    | Collecting Station                                                         | Altitude above mean sea-level (Metres) | Approx. latitude (N.) | Approx. longitude (E.) | Name of collector (and year of collection)         |
|-------------------------------|----------------------------------------------------------------------------|----------------------------------------|-----------------------|------------------------|----------------------------------------------------|
| 1                             | 2                                                                          | 3                                      | 4                     | 5                      | 6                                                  |
| <b>12. JAISALMER DISTRICT</b> |                                                                            |                                        |                       |                        |                                                    |
| 107.                          | Badebagh ( <i>ca.</i> 12 Km. E. of Jaisalmer).                             | —                                      | 26°55'                | 71°00'                 | KKT & SB (1957-58) ;<br>RNB & GCS (1961).          |
| 108.                          | Balana ( <i>ca.</i> 80 Km. NE. of Jaisalmer).                              | —                                      | 27°15'                | 71°20'                 | KKT & SB (1957-58).                                |
| 109.                          | Biprasar ( <i>ca.</i> 12 Km. S. of Ramgarh, <i>vide</i> No. 120).          | —                                      | 27°18'                | 70°30'                 | KKT & SB (1957-58).                                |
| 110.                          | (i) Jaisalmer (and vicinity).                                              | —                                      | 26°55'                | 70°57'                 | KKT & SB (1957-58) ;<br>AKM (1959) ;<br>PDG (1962) |
|                               | (ii) Didanaar Tank ( <i>ca.</i> 2 Km. E. of Jaisalmer).                    | —                                      | 26°55'                | 70°57'                 | RNB & GCS (1961).                                  |
|                               | (iii) Gareshwar Tank (3 Km. SE. of Jaisalmer Fort).                        | —                                      | 26°55'                | 70°57'                 | PDG (1962).                                        |
|                               | (iv) Golabsagar (2 Km. E. of Jaisalmer Fort).                              | —                                      | 26°55'                | 70°57'                 | PDG (1962).                                        |
| 111.                          | Geodeasar (or Jaidesar) ( <i>ca.</i> 24 Km. S. of Ramgarh, No. 120 below). | —                                      | 27°16'                | 70°32'                 | KKT & SB (1957-58).                                |
| 112.                          | Jedbaisar ( <i>ca.</i> 26 Km. E. of Jaisalmer).                            | —                                      | 26°54'                | 71°10'                 | KKT & SB (1957-58).                                |
| 113.                          | Josirasar                                                                  | —                                      | 26°55'                | 71°00'                 | KKT & SB (1957-58).                                |
| 114.                          | Khejadi area ( <i>ca.</i> 12.5 Km. N. of Ramgarh' No. 120 below).          | —                                      | 27°29'                | 70°28'                 | KKT & SB (1957-58).                                |

Table I—*contd.*

| Serial No.                 | Collecting Station                                         | Altitude above mean sea-level (Metres) | Approx. latitude (N.) | Approx. longitude (E.) | Name of collector (and year of collection) |
|----------------------------|------------------------------------------------------------|----------------------------------------|-----------------------|------------------------|--------------------------------------------|
| 1                          | 2                                                          | 3                                      | 4                     | 5                      | 6                                          |
| 115.                       | Madanganj (near Kishangarh).                               | —                                      | 27°55'                | 70°35'                 | BB (1956-57).                              |
| 116.                       | Mulsagar (or Mulrajsagar).                                 | —                                      | 26°55'                | 70°50'                 | KKT & SB (1957-58);<br>RNB & GCS (1961).   |
| 117.                       | Mohangarh (ca. 130 Km. NE. of Jaisalmer).                  | —                                      | 27°20'                | 71°15'                 | KKT & SB (1957-58).                        |
| 118.                       | Nokh village                                               | 178 m.                                 | 27°33'                | 72°15'                 | BB (1960).                                 |
| 119.                       | Pokran (or Podaran).                                       | —                                      | 26°55'                | 71°56'                 | KKT & SB (19 57-58).                       |
| 120.                       | Ramgarh (cf. one in Jaipur Dist., No. 105 above).          | —                                      | 27°23'                | 70°30'                 | KKT & SB (1957-58);<br>RNB & GCS (1961).   |
| 121.                       | Tolla Berra (ca. 5 Km. W. of Pokaran of road to Ramdeora). | —                                      | 26°55'                | 71°48'                 | KKT & SB (1957-58).                        |
| <b>13. JALORE DISTRICT</b> |                                                            |                                        |                       |                        |                                            |
| 122.                       | Dadli-ka-Talao (ca. 3 Km. W. of Bhinmal).                  | —                                      | 25°00'                | 72°16'                 | NM (1963).                                 |
| 123.                       | Erinpura                                                   | —                                      | 25°29'                | 73°04'                 | NM (1963).                                 |
| 124.                       | Jalore town (and vicinity).                                | —                                      | 25°22'                | 72°58'                 | RNB & GCS (1961).                          |
| 125.                       | Jaswantpura                                                | —                                      | 24°50'                | 72°15'                 | NM (1963).                                 |
| 126.                       | Nadi                                                       | —                                      | 25°09'                | 73°04'                 | NM (1963).                                 |
| 127.                       | Sagi River                                                 | —                                      | 24°50'                | 72°15'                 | NM (1963).                                 |
| 128.                       | Talbi (tank ca. 2 Km. N. of Bhinmal Railway Station).      | —                                      | 25°00'                | 72°16'                 | NM (1963).                                 |

Table I—*contd.*

| Serial No. | Collecting Station | Altitude above mean sea-level (Metres) | Approx. latitude (N.) | Approx. longitude (E.) | Name of collector (and year of collection) |
|------------|--------------------|----------------------------------------|-----------------------|------------------------|--------------------------------------------|
| 1          | 2                  | 3                                      | 4                     | 5                      | 6                                          |

## 14. JHALAWAR DISTRICT

|      |                                            |   |        |        |            |
|------|--------------------------------------------|---|--------|--------|------------|
| 9.   | Ahu River                                  | — | 24°20' | 76°05' | NM (1963). |
| 130. | Aklera                                     | — | 24°20' | 76°30' | NM (1963). |
| 131. | Chandrasarovar (lake).                     | — | 24°36' | 76°10' | NM (1963). |
| 132. | Dhanwara-ka-Talao (tank).                  | — | 24°36' | 76°10' | NM (1963). |
| 133. | Gaduli Talai (tank).                       | — | 24°40' | 76°30' | NM (1963). |
| 134. | Gomti Sagar (ca. 3 Km. N. of Jhalrapatan). | — | 24°34' | 76°10' | NM (1963). |
| 135. | Khandia Tank (ca. 3.0 Km. S. of Jhalawar). | — | 24°34' | 76°10' | NM (1963). |
| 136. | Mudlia kheri (Jhalrapatan).                | — | 24°32' | 76°10' | NM (1963). |
| 137. | Shergarh (Parwan River).                   | — | 24°40' | 76°30' | NM (1963). |
| 138. | Shukla Talai                               | — | 24°36' | 76°10' | NM (1963). |
| 139. | Sunel                                      | — | 24°20' | 76°05' | NM (1963). |

## 15. JHUNJHUNU DISTRICT

|      |                                       |        |        |           |            |
|------|---------------------------------------|--------|--------|-----------|------------|
| 140. | Alsisar (29 Km. NNW. of Jhunjhunu).   | 305 m. | 28°19' | 75°18'    | BB (1960). |
| 141. | Bagar (15 Km. NE. of Jhunjhunu).      | 380 m. | 28°11' | 75°30'    | BB (1960). |
| 142. | Basri (ca. 19 km. NNW. of Jhunjhunu). | —      | 28°14' | 75°20'    | BB (1960). |
| 143. | Desusar (11 Km. E. of Jhunjhunu).     | 335 m. | 28°12' | 75°27'30" | BB (1960). |

Table I—*contd.*

| Serial No. | Collecting Station                       | Altitude above mean sea-level (Metres) | Approx. latitude (N.) | Approx. longitude (E.) | Name of collector (and year of collection) |
|------------|------------------------------------------|----------------------------------------|-----------------------|------------------------|--------------------------------------------|
| 1          | 2                                        | 3                                      | 4                     | 5                      | 6                                          |
| 144.       | Jitmullji Talao (5 Km. N. of Jhunjhunu). | 380 m.                                 | 28°10'                | 75°24'                 | BB (1960).                                 |
| 145.       | Jhunjhunu                                | —                                      | 28°06'                | 75°24'                 | BB (1960).                                 |
| 146.       | Malasisar (35 Km. NNW. of Jhun-jhunu).   | 305 m.                                 | 28°21'                | 75°18'                 | BB (1960).                                 |
| 147.       | Mandawa (32 Km. W. of Jhun-jhunu).       | —                                      | 28°03'                | 75°09'                 | BB (1960).                                 |
| 148.       | Municipal tank, Jhunjhunu.               | 380 m.                                 | 28°08'                | 75°24'                 | BB (1960).                                 |
| 149.       | Pura-ki-Dhani (15 Km. NE. of Sikar).     | —                                      | 28°05'                | 75°22'                 | BB (1960).                                 |
| 150.       | Samas Talao, Jhunjhunu.                  | 380 m.                                 | 28°08'                | 75°24'                 | BB (1960).                                 |
| 151.       | Vid Talao (8 Km E. of Jhun-jhunu).       | 335 m.                                 | 28°10'                | 75°27'                 | BB (1960).                                 |
| 152.       | Warsipura                                | 380 m.                                 | 28°05'                | 75°23'                 | BB (1960).                                 |

## 16. JODHPUR DISTRICT

|      |                                                     |   |        |        |                                           |
|------|-----------------------------------------------------|---|--------|--------|-------------------------------------------|
| 153. | Agolai village (46 Km. NW. of Jodhpur).             | — | 26°15' | 72°35' | KKM (1962).                               |
| 154. | Akhrajji-ka-Talab (12 Km. SW. of Jodhpur).          | — | 26°15' | 72°53' | KCK (1962).                               |
| 155. | Balsamand (near Jodhpur).                           | — | 26°18' | 73°04' | MLR (1952);<br>KKM (1962);<br>ZSP (1961). |
| 156. | Banganga (or Bariganga) (ca. 20 Km. N. of Jodhpur). | — | 26°25' | 73°04' | MLR (1952 ;<br>BB (1956-5).               |
| 157. | Barli Tank (19 Km. SW. of Jodhour                   | — | 26°60' | 72°55' | ML (1962).                                |

Table I—*contd.*

| Serial No. | Collecting Station                                                             | Altitude above mean sea-level (Metres) | Approx altitude (N.) | Approx. longitude (E.) | Name of collector (and year of collection)                                                                                  |
|------------|--------------------------------------------------------------------------------|----------------------------------------|----------------------|------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| 1          | 2                                                                              | 3                                      | 4                    | 5                      | 6                                                                                                                           |
| 158.       | Basni village (21 Km. on Jodhpur Balotra Road).                                | —                                      | 26°18'               | 72°50'                 | RCS (1962).                                                                                                                 |
| 159.       | Bhagat-ki-Kothi (ca. 7 Km. SW. of Jodhpur).                                    | —                                      | 26°15'               | 72°55'                 | BB (1956-57).                                                                                                               |
| 160.       | Bilaspur Dam (40 Km. E. of Jodhpur).                                           | —                                      | 26°18'               | 73°27'                 | PDG (1962).                                                                                                                 |
| 161.       | Bishalpur                                                                      | —                                      | 26°10'               | 72°15'                 | RKB (1960).                                                                                                                 |
| 162.       | Hanwant village (25 Km. SW. of Jodhpur).                                       | —                                      | 26°15'               | 72°48'                 | AKD (1961).                                                                                                                 |
| 163.       | (i) Jodhpur                                                                    | —                                      | 26°18'               | 73°04'                 | MLR (1952) ;<br>RNB (1960) ;<br>RKB (1960) ;<br>JSP (1961) ;<br>KCK (1961) ;<br>ZSP (1961) ;<br>KKM (1962) ;<br>PDG (1962). |
|            | (ii) Forest Plantations, Jodhpur.                                              | —                                      | 26°15'               | 73°00'                 | BB (1956-57).                                                                                                               |
| 164.       | Kaylana Desert Afforestation Demonstration Station (ca. 14 Km. W. of Jodhpur). | —                                      | 26°15'               | 72°45'                 | BB (1956-57).                                                                                                               |
| 165.       | Kaylana Desert control demonstration area (11 Km. W. of Jodhpur).              | —                                      | 26°18'               | 72°59'                 | BB (1956-57).                                                                                                               |
| 166.       | Kaylana Lake (ca. 8 Km. W. of Jodhpur).                                        | —                                      | 26°15'               | 72°55'                 | MLR (1952) ;<br>BB (1956-57) ;<br>KKM (1962) ;<br>PDG (1962).                                                               |
| 167.       | Khokhra village                                                                | —                                      | 26°20'               | 7°05'                  | RKB (1960) ;<br>ZSP (1962).                                                                                                 |

Table I—*contd.*

| Serial No. | Collecting Station                                       | Altitude above mean sea-level (Metres) | Approx. latitude (N.) | Approx. longitude (E.) | Name of collector (and year of collection)                                    |
|------------|----------------------------------------------------------|----------------------------------------|-----------------------|------------------------|-------------------------------------------------------------------------------|
| 1          | 2                                                        | 3                                      | 4                     | 5                      | 6                                                                             |
| 168.       | Kolu ( <i>ca.</i> 26 Km. S. of Phalodi on Jodhpur Road). | —                                      | 26°56'                | 72°17'                 | KKT & SB (1957).                                                              |
| 169.       | Kutri Bhenser Village (36 Km. NW. of Jodhpur).           | —                                      | 26°24'                | 72°41'                 | AKD (1961).                                                                   |
| 170.       | Loridi Village (16 Km. NW. of Jodhpur).                  | —                                      | 26°22'                | 72°53'                 | KKM (1962).                                                                   |
| 171.       | Luni (32 Km. W. of Jodhpur).                             | —                                      | 26°18'                | 72°38'                 | ZSP (1961).                                                                   |
| 172.       | Mandore ( <i>ca.</i> 12 Km. N. of Jodhpur).              | —                                      | 26°20'                | 73°00'                 | MLR (1952) ;<br>BB (1956-57) ;<br>RKB (1960) ;<br>JCB (1961) ;<br>KKM (1962). |
| 173.       | Mataji-ki-Bhakari (36 Km. S. of Jodhpur).                | —                                      | 25°58'                | 73°04'                 | ZSP (1961).                                                                   |
| 174.       | Nagkund (10 Km. NE. of Jodhpur).                         | —                                      | 26°19'                | 73°02'                 | KKM (1962).                                                                   |
| 175.       | Nandri Village (14 Km. E. of Jodhpur).                   | —                                      | 26°15'                | 73°05'                 | AKD & ZSP (1961).<br>RNB (1962).                                              |
| 176.       | Nettra (38 Km. NNB. of Jodhpur).                         | —                                      | 26°20'                | 73°15'                 | KKM (1962).                                                                   |
| 177.       | Phalodi                                                  | —                                      | 27°09'                | 72°24'                 | KKT & SB (1958).                                                              |
| 178.       | Pipar Road village (36 Km. N. of Jodhpur).               | —                                      | 26°34'                | 73°04'                 | ZSP (1961).                                                                   |
| 179.       | Pipar City (14 Km. E. of Pipar Road).                    | —                                      | 26°34'                | 73°10'                 | ZSP (1961).                                                                   |
| 180.       | Pratapsagar (8 Km. W. of Jodhpur city).                  | —                                      | 26°18'                | 73°09'                 | KKM (1962).                                                                   |

**Table I—contd.**

| Serial No.                | Collecting Station                                         | Altitude above mean sea-level (Metres) | Approx. latitude (N.) | Approx. longitude (E.) | Name of collector (and year of collection) |
|---------------------------|------------------------------------------------------------|----------------------------------------|-----------------------|------------------------|--------------------------------------------|
| 1                         | 2                                                          | 3                                      | 4                     | 5                      | 6                                          |
| 181.                      | Takhatsagar (part of Lake Kay-lana) (9 Km. W. of Jodhpur). | —                                      | 26°18'                | 73°00'                 | KKM (1962).                                |
| 182.                      | Umedsagar (10 Km. W. of Jodhpur).                          | —                                      | 26°15'                | 72°55'                 | BB (1956-57) ; KKM (1962) ; PDG (1962).    |
| 183.                      | Vyas-ki-Baori (Forest Plantations) (8 Km. S. of Jodhpur).  | —                                      | 26°14'                | 73°04'                 | BB (1956-57).                              |
| <b>17. KOTAH DISTRICT</b> |                                                            |                                        |                       |                        |                                            |
| 184.                      | Alani Tank (ca. 19 Km. SB. of Kotah).                      | —                                      | 25°00'                | 76°03'                 | RNB & GCS (1961).                          |
| 185.                      | Chitonpur (Forest School) (ca. 8 Km. S. of Kotah).         | —                                      | 25°05'                | 75°52'                 | MLR (1952).                                |
| 186.                      | Dadhdevi (ca. 13 Km. SE. of Kotah).                        | —                                      | 25°03'                | 75°55'                 | MLR (1952).                                |
| 187.                      | Darah (ca. 70 Km. SE. of Kotah).                           | 301 m.                                 | 24°49'                | 76°02'                 | MLR (1952) ; RNB & GCS (1961).             |
| 188.                      | Jagupura (ca. 20 Km. S. of Kotah).                         | —                                      | 24°55'                | 73°35'                 | MLR (1952).                                |
| 189.                      | Kanswa (ca. 6 Km. E. of Kotah).                            | —                                      | 25°10'                | 76°00'                 | MLR (1952).                                |
| 190.                      | Kolipura (ca. 50 Km. E. of Kotah).                         | —                                      | 24°55'                | 75°40'                 | MLR (1952).                                |
| 191.                      | Kotah                                                      | —                                      | 25°10'                | 75°52'                 | MLR (1952) ; RNB & GCS (1961).             |
| 192.                      | Mandana (ca. 40 Km. SE. of Kotah).                         | —                                      | 24°56'                | 75°55'                 | MLR (1952).                                |

Table I—*contd.*

| Serial No.                 | Collecting Station                                  | Altitude above mean sea-level (Metres) | Approx. latitude (N.) | Approx. longitude (E.) | Name of collector (and year of collection)                                            |
|----------------------------|-----------------------------------------------------|----------------------------------------|-----------------------|------------------------|---------------------------------------------------------------------------------------|
| 1                          | 2                                                   | 3                                      | 4                     | 5                      | 6                                                                                     |
| 193.                       | Morak (ca. 80 Km. SE. of Kotah).                    | 301 m.                                 | 24°45'                | 75°55'                 | MLR (1952).                                                                           |
| 194.                       | Nanta Tank No. 3. (ca. 10 Km. NW. of Kotah).        | —                                      | 25°11'                | 75°48'                 | RNB & GCS (1961).                                                                     |
| 195.                       | Palaita                                             | —                                      | 25°05'                | 76°10'                 | NM (1963).                                                                            |
| 196.                       | Parwan River                                        | —                                      | 25°05'                | 76°10'                 | NM (1963).                                                                            |
| 197.                       | Umedganj (ca. 15 Km. SE. of Kotah).                 | —                                      | 25°05'                | 75°55'                 | MLR (1952).                                                                           |
| <b>18. NAGOUR DISTRICT</b> |                                                     |                                        |                       |                        |                                                                                       |
| 198.                       | Balaia (19 Km. SSW. of Nagaur).                     | —                                      | 27°03'                | 73°40'                 | BB (1960).                                                                            |
| 199.                       | Balwa (ca. 8 Km. NW. of Nagaur).                    | —                                      | 27°15'                | 73°40'                 | BB (1960).                                                                            |
| 200.                       | Barni (15 Km. NW. of Nagaur).                       | —                                      | 27°11'                | 73°37'                 | BB (1960).                                                                            |
| 201.                       | Basni (8 Km. W. of Nagaur).                         | 275 m.                                 | 27°11'                | 73°39'                 | BB (1960).                                                                            |
| 202.                       | Bhakrod (ca. 24 Km. SW. of Nagaur).                 | —                                      | 27°03'                | 73°36'                 | BB (1960).                                                                            |
| 203.                       | (i) Didia (20 Km. SE. of Nagaur).                   | —                                      | 27°07'                | 73°55'                 | BB (1960).                                                                            |
|                            | (ii) Between Indana & Didia (16 Km. SE. of Nagaur). | —                                      | 27°08'                | 73°54'                 | BB (1960).                                                                            |
| 204.                       | Gogolai                                             | —                                      | 27°15'                | 73°39'                 | BB (1960).                                                                            |
| 205.                       | (i) Gudha (on Sambhar Lake).                        | —                                      | 26°55'                | 75°25'                 | BB (1956-57) ;<br>AKM (1957-58) ;<br>KKT (1957-58) ;<br>TGV (1958) ;<br>SB (1958-59). |
|                            | (ii) Main Sambhar Lake (near Gudha).                | —                                      | 26°55'                | 75°25'                 | KKM (1961).                                                                           |

Table I—*contd.*

| Serial No. | Collecting Station                        | Altitude above mean sea-level (Metres) | Approx. latitude (N.) | Approx. longitude (E.) | Name of collector (and year of collection)      |
|------------|-------------------------------------------|----------------------------------------|-----------------------|------------------------|-------------------------------------------------|
| 1          | 2                                         | 3                                      | 4                     | 5                      | 6                                               |
| 206.       | Gurha ( <i>ca.</i> 26 Km. W. of Nagaur).  | —                                      | 27°13'                | 73°29'                 | BB (1960).                                      |
| 207.       | Imirti (16 Km. SWW. of Nagaur).           | —                                      | 27°06'                | 73°39'                 | BB (1960).                                      |
| 208.       | Kharnal (17 Km. SW. of Nagaur.)           | 307 m.                                 | 27°05'                | 73°39'                 | BB (1960).                                      |
| 209.       | Kuni ( <i>ca.</i> 5 Km. N. of Gudha).     | —                                      | 27°00'                | 75°11'                 | TGV (1958).                                     |
| 210.       | Lihorana                                  | —                                      | 27°02'                | 75°25'                 | TGV (1958).                                     |
| 211.       | Merta City                                | —                                      | 26°35'                | 74°06'                 | BB (1956-57).                                   |
| 212.       | Nagaur                                    | 297 m.                                 | 27°11'                | 73°41'                 | BB (1960).                                      |
| 213.       | Nandana Nadi (Nawa).                      | —                                      | 27°00'                | 75°00'                 | BB (1956-57).                                   |
| 214.       | Nawa                                      | —                                      | 27°00'                | 75°00'                 | BB (1956-57) ;<br>TGV (1958) ;<br>SB (1958-59). |
| 215.       | Nawa Kyar (in Sambhar Lake).              | —                                      | 27°00'                | 75°00'                 | BB (1956-57) ;<br>SB (1958-59).                 |
| 216.       | Palri                                     | —                                      | 27°03'                | 73°38'                 | BB (1960).                                      |
| 217.       | Rol Qazian (20 Km. E. of Nagaur).         | 275 m.                                 | 27°09'                | 73°56'                 | BB (1960).                                      |
| 218.       | (i) Sanodai (48 Km. North of Kishangarh). | —                                      | 26°55'                | 74°55'                 | BB (1956-57).                                   |
|            | (ii) Bandi Nadi (near Sanodia).           | —                                      | 26°55'                | 74°55'                 | BB (1956-57).                                   |
| 219.       | Sarau                                     | —                                      | 27°15'                | 73°44'                 | BB (1960).                                      |
| 220.       | Saydapura Salt Colony (near Gudha).       | —                                      | 26°54'                | 75°25'                 | SB (1958-59).                                   |
| 221.       | Singar ( <i>ca.</i> 16 Km. W. of Nagaur). | 310 m.                                 | 27°13'                | 73°37'                 | BB (1960).                                      |

Table I—contd.

| Serial No.               | Collecting Station                                     | Altitude, above mean sea-level (Metres) | Approx. latitude (N.) | Approx. longitude (E.) | Name of collector (and year of collection) |
|--------------------------|--------------------------------------------------------|-----------------------------------------|-----------------------|------------------------|--------------------------------------------|
| 1                        | 2                                                      | 3                                       | 4                     | 5                      | 6                                          |
| <b>19. PALI DISTRICT</b> |                                                        |                                         |                       |                        |                                            |
| 222.                     | Aravalli Hills base (ca. 12 Km. from Sadri).           | —                                       | 25°04'                | 73°25'                 | MLR (1952).                                |
| 223.                     | Awa village                                            | —                                       | 25°45'                | 73°50'                 | ZSP (1961).                                |
| 224.                     | Falna                                                  | —                                       | 25°10'                | 73°10'                 | MLR (1952).                                |
| 225.                     | Hemawas Tank (ca. 8 Km. S. of Pali).                   | —                                       | 25°40'                | 73°20'                 | BB (1956-57).                              |
| 226.                     | Jogmande Jharna (20 Km. E. of Phulad Railway Station). | —                                       | 25°35'                | 74°00'                 | KSP (1948).                                |
| 227.                     | Marwar (and vicinity).                                 | —                                       | 25°45'                | 73°38'                 | ZSP (1961).                                |
| 228.                     | (i) Pali (Afforestation Nursery).                      | —                                       | 25°46'                | 73°25'                 | BB (1956-57); RNB & GCS (1961).            |
|                          | (ii) Pali (Bandi Nadi area).                           | —                                       | 25°46'                | 73°25'                 | BB (1956-57).                              |
|                          | (iii) Pali-Jodhpur Road (41st milepost).               | —                                       | 25°50'                | 73°10'                 | BB (1956-57).                              |
| 229.                     | Phulad Railway Station.                                | —                                       | 25°35'                | 73°48'                 | KSP (1948).                                |
| 230.                     | Pipli village (29 Km. NNW. of Phulad).                 | —                                       | 25°55'                | 73°45'                 | KSP (1948).                                |
| 231.                     | Sadri and vicinity (foot-hills of Aravalli).           | 366 m.                                  | 25°10'                | 73°25'                 | MLR (1952).                                |
| 232.                     | Saran village (30 Km. SE. of Marwar).                  | —                                       | 25°29'                | 73°47'                 | ZSP (1961).                                |
| 233.                     | Sardar Samand (55 Km. SE. of Jodhpur city).            | —                                       | 25°54'                | 73°25'                 | KKM (1962); AKD (1962).                    |

Table I—*contd.*

| Serial No.                         | Collecting Station                                             | Altitude above mean sea-level (Metres) | Approx. latitude (N.) | Approx. longitude (E.) | Name of collector (and year of collection) |
|------------------------------------|----------------------------------------------------------------|----------------------------------------|-----------------------|------------------------|--------------------------------------------|
| 1                                  | 2                                                              | 3                                      | 4                     | 5                      | 6                                          |
| <b>20. SAWAI MADHOPUR DISTRICT</b> |                                                                |                                        |                       |                        |                                            |
| 234.                               | Bhagwatigarh Bund.                                             | —                                      | 25°58'                | 76°23'                 | NM (1963).                                 |
| 235.                               | Bhairu Dara (ca. 5 Km. NW. of Sawai Madhopur Railway Station). | —                                      | 26°00'                | 76°23'                 | NM (1963).                                 |
| 236.                               | Gambhir River (Hindaun).                                       | —                                      | 26°45'                | 77°02'                 | NM (1963).                                 |
| 237.                               | Karauli                                                        | —                                      | 26°30'                | 77°02'                 | NM (1963).                                 |
| 238.                               | Kiyarda Bund                                                   | —                                      | 26°45'                | 77°02'                 | NM (1963).                                 |
| 239.                               | Mui Bund                                                       | —                                      | 26°00'                | 76°23'                 | NM (1963).                                 |
| 240.                               | Sawai Madhopur                                                 | —                                      | 25°58'                | 76°30'                 | MLR (1952); RNB & GCS (1961); NM (1963).   |
| 241.                               | Srimahabirji                                                   | —                                      | 26°40'                | 76°55'                 | NM (1963).                                 |
| 242.                               | Surwal Bund                                                    | —                                      | 26°00'                | 76°21'                 | NM (1963).                                 |
| <b>21. SIKAR DISTRICT</b>          |                                                                |                                        |                       |                        |                                            |
| 243.                               | Charanbas (ca. 10 Km. E. of Sikar).                            | 472 m.                                 | 27°37'                | 75°14'                 | BB (1960).                                 |
| 244.                               | Chokha-ka-Bas (ca. 16 Km. S. of Sikar).                        | 500 m.                                 | 27°29'                | 75°08'                 | BB (1960); ZSP (1960).                     |
| 245.                               | Dadhia (17 Km. NNE. of Sikar).                                 | 480 m.                                 | 27°44'                | 75°14'                 | BB (1960).                                 |
| 246.                               | Dasa-ki-Dhani (ca. 8 Km. SE. of Sikar).                        | 445 m.                                 | 27°35'                | 75°12'                 | BB (1960).                                 |

Table I—*contd.*

| Serial No. | Collecting Station                                  | Altitude above mean sea-level (Metres) | Approx. latitude (N.) | Approx. longitude (E.) | Name of collector (and year of collection) |
|------------|-----------------------------------------------------|----------------------------------------|-----------------------|------------------------|--------------------------------------------|
| 1          | 2                                                   | 3                                      | 4                     | 5                      | 6                                          |
| 247.       | Gotera (13 Km. N. of Sikar).                        | 425 m.                                 | 27°44'                | 75°10'                 | BB (1960).                                 |
| 248.       | (i) Gungara (ca. 18 Km. NE. of Sikar).              | 520 m.                                 | 27°41'                | 75°17'                 | BB (1960).                                 |
|            | (ii) 3 Km. W. of Gungara (ca. 16 Km. NE. of Sikar). | 505 m.                                 | 27°40'                | 75°16'                 | BB (1960).                                 |
| 249.       | Harsnath (15 Km. ESE of Sikar).                     | 490 m.                                 | 27°03'                | 75°12'                 | BB (1960).                                 |
| 250.       | Kadma-ka-Bar (15 Km. S. of Sikar).                  | 472 m.                                 | 27°30'                | 75°08'                 | BB (1960).                                 |
| 251.       | Kanwarpura (10 Km. W. of Sikar).                    | 425 m.                                 | 27°36'                | 75°05'                 | BB (1960).                                 |
| 252.       | Kasli (ca. 12 Km. SW. of Sikar).                    | 425 m.                                 | 27°33'                | 75°04'                 | BB (1960); ZSP (1960).                     |
| 253.       | Khori (15 Km. SSE. of Sikar).                       | 490 m.                                 | 27°31'                | 75°10'                 | BB (1960).                                 |
| 254.       | Mandaora (14 Km. SSE. of Sikar).                    | 490 m.                                 | 27°31'                | 75°11'                 | BB (1960).                                 |
| 255.       | Molasi (16 Km. W. of Sikar).                        | 425 m.                                 | 27°36'                | 75°00'                 | BB (1960).                                 |
| 256.       | Mundaora (18 Km. S. of Sikar).                      | 472 m.                                 | 27°29'                | 75°05'                 | BB (1960).                                 |
| 257.       | Phagalwa (ca. 17 Km. W. of Sikar).                  | 390 m.                                 | 27°38'                | 74°59'                 | BB (1960); ZSP (1960).                     |
| 258.       | Piprali                                             | 505 m.                                 | 27°38'                | 75°16'                 | BB (1960).                                 |
| 259.       | Puran Bari (14 Km. S. of Sikar).                    | 490 m.                                 | 27°31'                | 75°06'                 | BB (1960).                                 |
| 260.       | Puran Chhoti (15 Km. SSW. of Sikar).                | 490 m.                                 | 27°31'                | 75°05'                 | BB (1960).                                 |

**Table I—contd.**

| Serial No.                  | Collecting Station                                            | Altitude above mean sea-level (Metres) | Approx. latitude (N.) | Approx. longitude (E.) | Name of collector (and year of collection) |
|-----------------------------|---------------------------------------------------------------|----------------------------------------|-----------------------|------------------------|--------------------------------------------|
| 1                           | 2                                                             | 3                                      | 4                     | 5                      | 6                                          |
| 261.                        | Purat-ki-Dhani (ca. 15 Km. ENE. of Sikar).                    | 558 m.                                 | 27°38'                | 75°18'                 | BB (1960); ZSP (1960).                     |
| 262.                        | Rampura (ca. 10 Km. S. of Sikar).                             | 435 m.                                 | 27°34'                | 75°06'                 | BB (1960).                                 |
| 263.                        | Rashidpura (13 Km. NNW. of Sikar).                            | 410 m.                                 | 27°43'                | 75°05'                 | BB (1960).                                 |
| 264.                        | Sikar (and vicinity).                                         | 435 m.                                 | 27°38'                | 75°08'                 | BB (1960).                                 |
| 265.                        | Singhasan (11 Km. NE. of Sikar).                              | 475 m.                                 | 27°40'                | 75°15'                 | BB (1960).                                 |
| <b>22. SIROHI DISTRICT</b>  |                                                               |                                        |                       |                        |                                            |
| 266.                        | (i) Mount Abu                                                 | —                                      | 24°35'                | 72°45'                 | KSP (1948).                                |
|                             | (ii) Bandermere Lake.                                         | —                                      | 24°35'                | 72°45'                 | KSP (1948).                                |
|                             | (iii) Jayavilas Palace.                                       | —                                      | 24°35'                | 72°45'                 | KSP (1948).                                |
|                             | (iv) Kudra Nalla                                              | —                                      | 24°35'                | 72°45'                 | KSP (1948).                                |
| <b>23. UDAIPUR DISTRICT</b> |                                                               |                                        |                       |                        |                                            |
| 267.                        | Balicha                                                       | —                                      | 24°20'                | 73°40'                 | KSK (1959).                                |
| 268.                        | (i) Barapal village                                           | —                                      | 24°20'                | 73°35'                 | BNC & MLR (1941).                          |
|                             | (ii) Barapal-ka-Nalla (a stream 1 Km. S. of Barapal village). | —                                      | 24°20'                | 73°35'                 | BNC & MLR (1941).                          |
|                             | (iii) Kherpena Nalla (3 Km. N. of Barapal village).           | —                                      | 24°20'                | 73°35'                 | BNC & MLR (1941).                          |

Table I—*contd.*

| Serial No. | Collecting Station                                   | Altitude above mean sea-level (Metres) | Approx. latitude (N.) | Approx. longitude (E.) | Name of collector (and year of collection)   |
|------------|------------------------------------------------------|----------------------------------------|-----------------------|------------------------|----------------------------------------------|
| 1          | 2                                                    | 3                                      | 4                     | 5                      | 6                                            |
| 269.       | Bhupalsagar (near Udaipur).                          | —                                      | 24°35'                | 73°40'                 | KSK (1960).                                  |
| 270.       | Dewali (near Udaipur).                               | —                                      | 24°36'                | 73°38'                 | KSK (1959).                                  |
| 271.       | Fatehsagar Lake (near Udaipur).                      | —                                      | 24°35'                | 73°35'                 | RNB & GCS (1961).                            |
| 272.       | Game Sanctuary (50 Km. N. of Udaipur).               | —                                      | 24°55'                | 73°35'                 | RNB & GCS (1961).                            |
| 273.       | Jaisamand (53 Km. N. of Udaipur) [Cf. No. 14 above.] | —                                      | 24°57'                | 73°35'                 | KSK (1959); RNB & GCS (1961).                |
| 274.       | Kotra                                                | —                                      | 24°22'                | 73°13'                 | AKD (1961).                                  |
| 275.       | Madri (near Udaipur).                                | —                                      | 24°30'                | 73°40'                 | KSK (1959).                                  |
| 276.       | Nethala tank (1 Km. S. of Mavli Railway Station).    | —                                      | 24°54'                | 73°42'                 | KSP (1948).                                  |
| 277.       | (i) Parshad (or Parsad).                             | —                                      | 24°12'                | 73°45'                 | BNC & MLR (1941).                            |
|            | (ii) Large tank (5 Km. N. of Parsad).                | —                                      |                       |                        | BNC & MLR (1941).                            |
|            | (iii) Parai-ki-Nadi (2 Km. S. of Parshad).           |                                        |                       |                        | BNC & MLR (1941).                            |
| 278.       | (i) Udaipur                                          | 753 m.                                 | 24°35'                | 73°42'                 | KSK (1958-59); AKD (1961); RNB & GCS (1961). |
|            | (ii) Veela (near Udaipur).                           | —                                      | 24°35'                | 73°42'3                | KSK (1959).                                  |
| 279.       | Vithal Nivas (2 Km. S. of Kankroli).                 | —                                      | 25°05'                | 73°50'                 | AKD (1961).                                  |

## V—APPENDIX 2

## BIBLIOGRAPHY OF RAJASTHAN ZOOLOGY.

(Including a few references on general aspects e.g., geography, geology, soil, climate, vegetation, etc.)

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The following bibliography, of about 550 individual references, is a comprehensive and, I hope, a nearly complete bibliography of the published works on the zoology of Rajasthan up to the end of the year 1962. A few references for 1963 have also been included. To enhance its usefulness from the ecological point of view, a few references dealing with some other aspects of Rajasthan, such as geography, geology, soil, climate, vegetation, etc., are also included. Reference dealing either exclusively or mainly with Rajasthan are marked with an asterick(\*). All references are serially numbered, but corss references are unnumbered and carry a small dash in place of the serial number. An author index and a subject index are provided at the end.

It is hoped that the bibliography will prove useful to the students of Rajasthan fauna. I shall be grateful if readers will be kind enough to bring to my attention any errors or omissions in the bibliography.

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| 1. General Aspects. (Including geography, geology, soil, climate, vegetation, etc.) | (c) Dermaptera.   |
| 2. General Zoology. (Including wild life and wild life conservation.)               | (d) Isoptera.     |
| 3. Protozoa.                                                                        | (e) Odonata.      |
| 4. Porifera.                                                                        | (f) Thysanoptera. |
| 5. Platyhelminthes.                                                                 | (h) Hemiptera.    |
| 6. Nemethelminthes.                                                                 | (g) Lepidoptera.  |
| 7. Annelida                                                                         | (i) Coleoptera.   |
| 8. Crustacea.                                                                       | (j) Hymenoptera.  |
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| (a) General.                                                                        | 10. Arachnida.    |
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|                                                                                     | 14. Reptilia.     |
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1. GENERAL ASPECTS

*(Including geography, geology, soil, climate, vegetation, etc.)*

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*(Including wild life and wild life conservation)*

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(b) *Orthoptera* : 57, 81, 86-98, 98*a*, 152, 193*a*, 220, 228, 233, 250*a*, 352, 360-364, 367-380, 382, 383, 390-392, 396, 399, 406, 421*a*, 423-427, 439, 440, 508.

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(h) *Lepidoptera* : 8, 57-79, 82, 105, 106, 176, 199-202, 252, 254, 260, 261, 264, 266, 268, 279, 284, 299, 308, 315, 363, 391, 438*a*, 439, 440, 490, 491, 543-545.

(i) *Coleoptera* : 5, 22, 23, 27-31, 57, 97, 99, 133, 134-138, 144*a*, 145, 146, 181, 188, 221, 251, 255, 257, 259, 260, 262, 263, 265, 266, 268, 281, 283, 287-289, 363, 439, 439*b*, 440, 443, 510.

(j) *Hymenoptera* : 12, 13, 14, 57, 102-104, 133, 260, 268, 306, 309, 311, 505, 506, 531.

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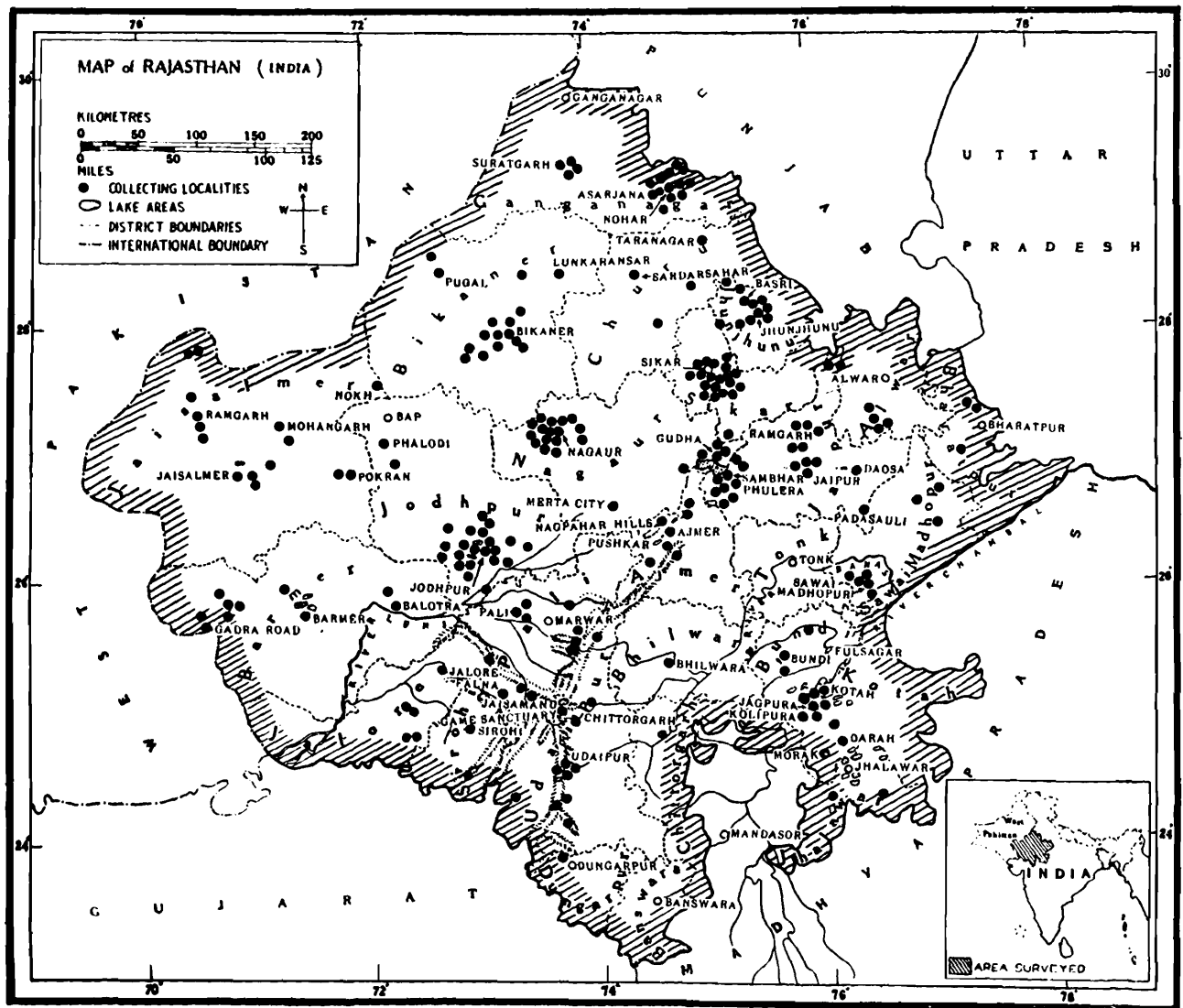
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**PLATE 9**

**Map of Rajasthan, showing the collecting localities (solid dots)  
for zoological specimens.**



## PLATE 10

Ecological habitats in Jaisalmer District, western Rajasthan. Photos G. C. Saha, 1961. A very arid region with scanty rainfall. But where water is available, a luxurious garden can be raised (*see* Fig. 3, Mulsagar Garden).

FIG. 1.—View 2 Km. east of Balebagh, showing fossiliferous yellow sandstone and *Cactus* and *Prosopis* vegetation. 23 February, 1961. (Photo No. G32.)

FIG. 2.—View 2 Km. from Jaisalmer on way to Mulsagar, showing rocky land and *Prosopis* and *Cactus* vegetation. 18 February, 1961. (Photo No. G5.)

FIG. 3.—View of Mulsagar Garden near Mulsagar. 18th February, 1961. (Photo No. G2.)



4



2



3

## PLATE 11

Ecological habitats in Barmer and Jalore District, western Rajasthan. A dry, semi-rocky area. Photos *G. C. Saha*, 1961.

FIG. 1.—View about 1.5 Km. north of Barmer Railway Station (Barmer District), showing hills and xerophytic vegetation (*Cactus*, *Capparis*, etc.). 27th February, 1961. (Photo No. G51.)

FIG. 2.—View about 5 Km. north of Jalore town (Jalore District), showing xerophytic plants like *Cactus*, *Prosopis*, *Capparis aphylla*, etc. 4th March, 1961. (Photo No. G71.)

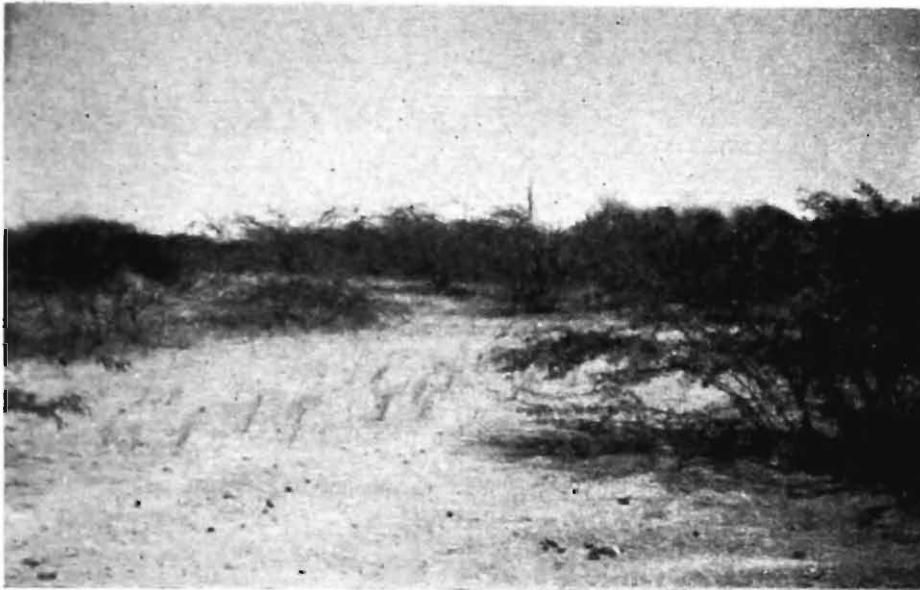
FIG. 3.—View about 2 Km. south-east of Jalore town (Jalore District), showing a rather thick growth of babool (*Acacia arabica* Willd.). 4th March, 1961. (Photo No. G74.)



1



2



3

PLATE 12

Ecological habitats in dry sandy areas of western Rajasthan (districts of Bikaner, Churu and Sikar). Photos *B. Biswas*, 1960.

FIG. 1.—A part of Pugal village (Bikaner District), from terrace of the mud fort. Note the open, almost treeless waste in the background. The Zoological Survey of India Field Party's camp is in the foreground. September, 1960. (Photo No. B35.)

FIG. 2.—Sand dunes south-west of Taranagar (Churu District). October, 1960. (Photo No. B44.)

FIG. 3.—Kapurialao, a small tank at Charanbas (Sikar District). November, 1960. (Photo No. B61.)



1



2



3

## PLATE 13

Certain aquatic (lake) habitats in Rajasthan (Nagaur and Jodhpur Districts). Photos *B. Biswas*, 1956-57.

FIG. 1.—Main part of Sambhar Salt Lake, south-west of Gudah Pumping Station (Nagaur District). The lake waters become extremely salty in summer but are almost like freshwater during and immediately after the monsoon rains (July-September). 1956. (Photo No. B7.)

FIG. 2.—Pools of accumulated rain water on the southern bank of Sambhar Lake. These pools provide abundant aquatic fauna. 1956. (Photo No. B4.)

FIG. 3.—Kaylana Lake near Jodhpur (Jodhpur District), a semi-natural freshwater lake formed by high hills and a dam. It is a rich source for collecting aquatic fauna. 1956. (Photo No. B44.)



## PLATE 14

Ecological habitats in Rajasthan. A semi-wet area (Ajmer District ) and a dry area (Jhunjhunu District).

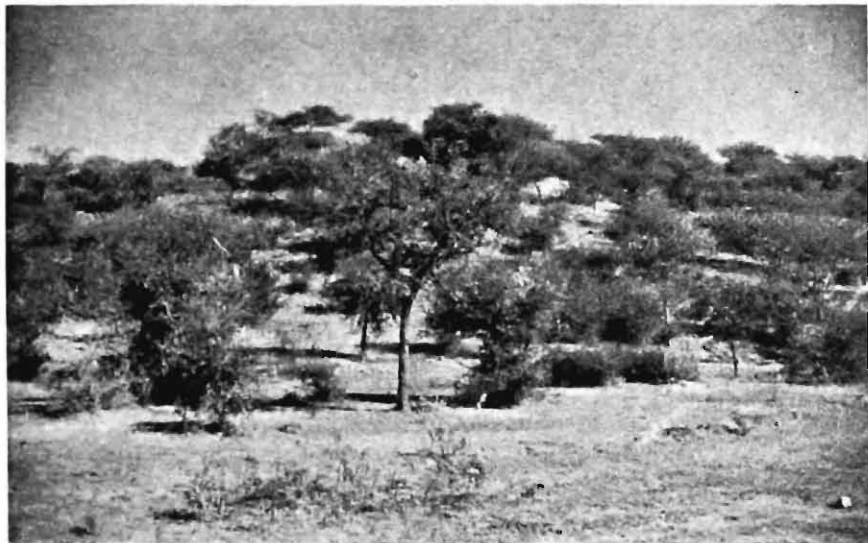
FIG. 1.—Scrub jungle on hill about 6 Km. from Danta (Ajmer District). Mainly *Anogeissus pendula*. Photo *G. C. Saha*, 13th March, 1961. (Photo No. G115.)

FIG. 2.—Rajosi reserve forest near Rajosi (Ajmer District). Photo *B. Biswas*, 1956. (Photo No. B23.)

FIG. 3.—A dense swarm of the Desert Locust, *Schistocerca gregaria* (Forsk.), over a *bajri* field near Basri (Jhunjhunu District). Photo *B. Biswas*, 3rd September, 1960. (Photo No. B27.)



1



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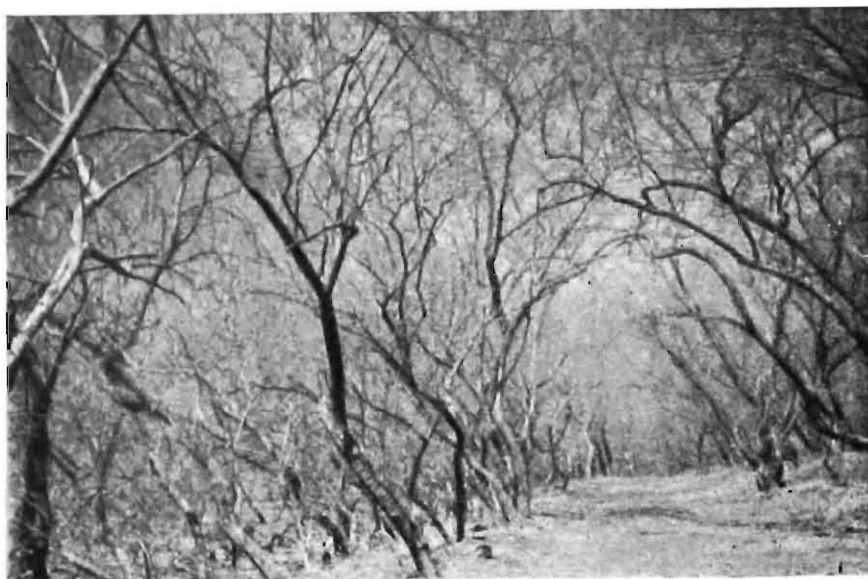
PLATE 15

Ecological habitats in the wet southern part of Rajasthan (Udaipur and Kotah Districts).

FIG. 1.—Jaisamand Game Sanctuary (Udaipur District), showing *Anogeissus pendula* forest on both sides of a road. 9th March, 1961. (Photo No. G87.)

FIG. 2.—Another view of Jaisamand Game Sanctuary (Udaipur District), showing edaphic vegetation like *Typha*, *Ficus*, date palms, etc. 9th March, 1961. (Photo No. G90.)

FIG. 3.—View of a mixed forest, mainly of *Acacia* sp., about 1·5 Km. from Kotah Railway Station (Kotah District). 18th March, 1961. (Photo No. G153.)



1



2



3

## PLATE 16

The hard ecological conditions of summer in Rajasthan. Frogs (*Rana cyanophlyctis* Schneider) in a drying tank in summer in Durasani village (Jodhpur District), *ca.* 45 Km. south of Jodhpur. As the tank dries up, the frogs concentrate more and more in the limited water left. Ultimately many frogs die, and some aestivate. Photos A. Basit, 5th July, 1963.

FIG. 1.—A general view of the tank with numerous frogs. (Negative No. 378.)

FIG. 2.—Same, but closer view. (Negative No. 379.)



1



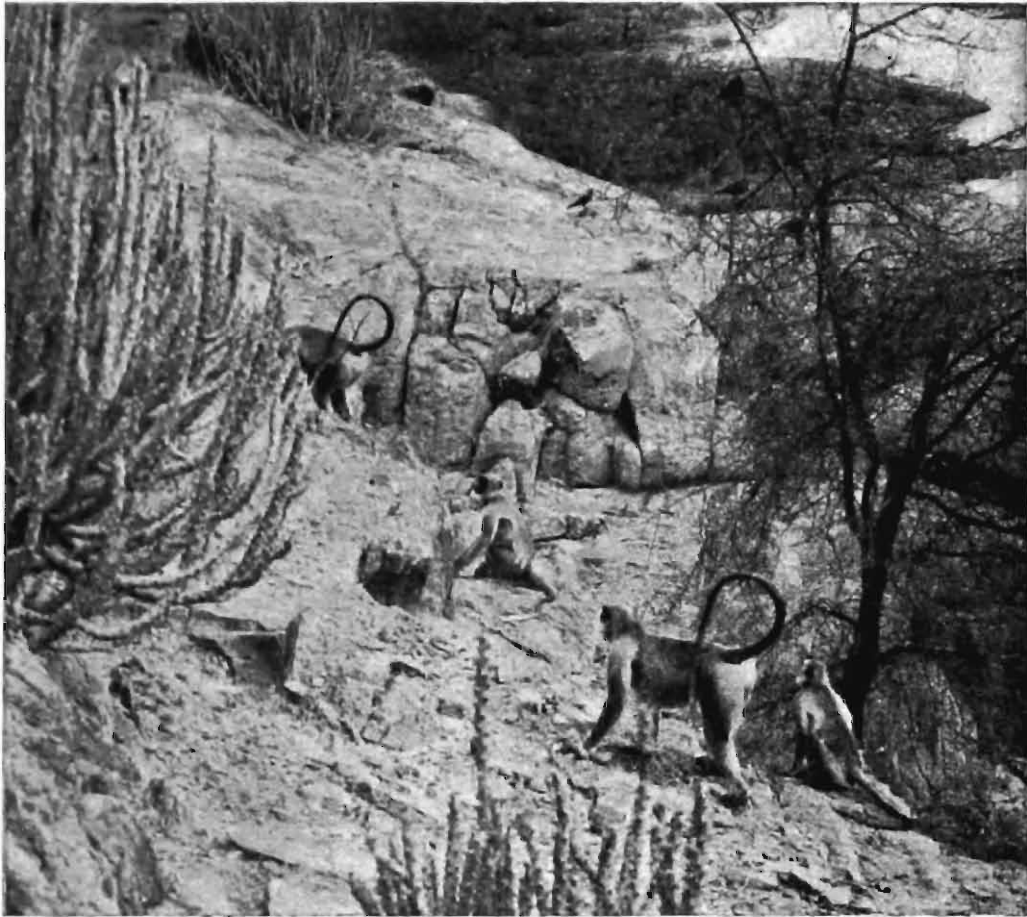
2

## PLATE 17

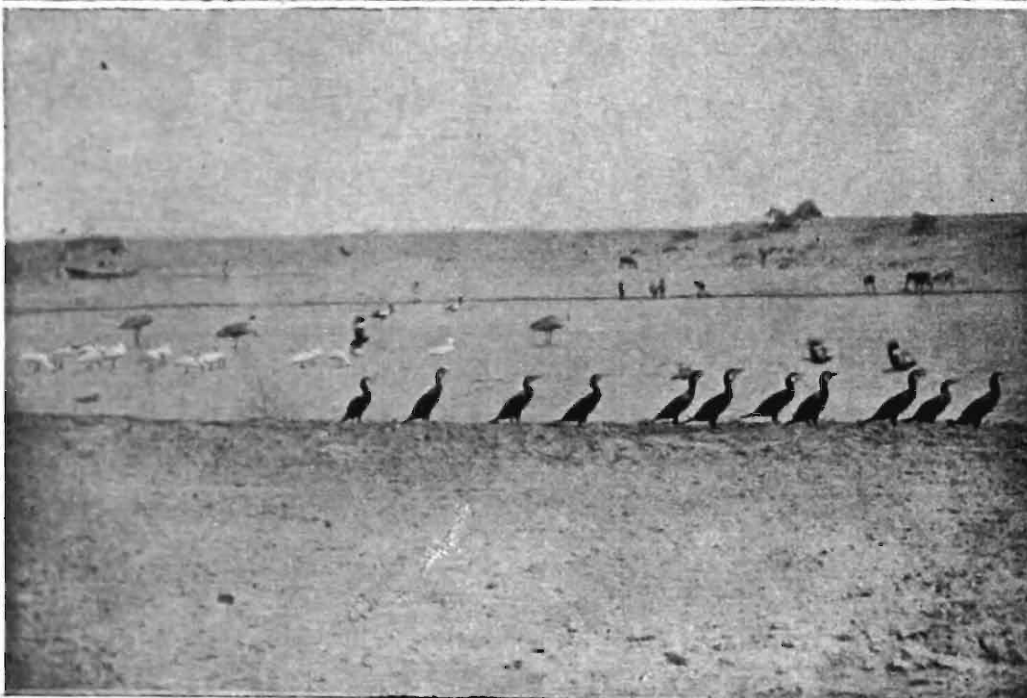
Ecological habitats in Rajasthan. Photos *A. Basit*, 1962-63.

FIG. 1.—Rocky area at Kayana Lake near Jodhpur (Jodhpur District), showing the typical habitat of the black-faced, long-tailed langur, *Presbytis entellus* (Duf.). They live and move about in troops, sometimes of as many as 50 or more individuals. 4th February, 1962. (Negative No. 10.)

FIG. 2.—Tank near Agolai village, *ca.* 46 Km. west of Jodhpur (Jodhpur District), showing bird life (cormorants, spoonbills, sarus crane and painted stork). 28th May, 1963. (Negative No. 338.)



1



2

# FAUNA OF RAJASTHAN, INDIA.

## PART 2.—PROTOZOA (No. 1)

By

K. K. MAHAJAN

*Zoological Survey of India, Calcutta*

(With one Table and 6 Text-figures)

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### I—INTRODUCTION

#### (a) *General*

This is the first of a series of papers on the fauna of free-living Protozoa of Rajasthan, and is based on the collections made by the author during February-April, 1962, from the districts of Jodhpur, Pali and the Sambhar Salt Lake and its vicinity (Nagaur and Jaipur districts). Field cultures were prepared to obtain examples of the various species. The material was subjected to appropriate intra vitam staining and also observed under a phase contrast microscope. In some cases, owing to scarcity of material, this could be done only for one or two individuals. For the study of Ciliates, silver-line observations were taken as far as possible, and the fixatives used were Champy's fluid and saline Da Fano's fixative. A total of 30 species are listed here. The number of examples mentioned in the text, relates to the permanent preparations made, where as many individuals were observed and studied in the field before reaching any conclusion.

For an account of the topography, climate, vegetation, etc. of Rajasthan, see Part I (General Introduction) of this series of papers. (Roonwal, 1968. *Records of the Zoological Survey of India*, Vol. 61 (3 & 4), pp. 291—375).

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(b) *Acknowledgements*

My thanks are due to the staff of the Protozoa Section for assistance in the field as well as in the laboratory and the staff of the Desert and Gangetic Plains Regional Station of the Zoological Survey of India at Jodhpur. To the authorities of the Sambhar Salt Lake I am thankful for considerable help in field work. I am also indebted to Dr. M. L. Roonwal, Director, Zoological Survey of India, for his kind suggestions and guidance.

(c) *Abbreviations used*

*Dist.*, District ; *Ex(s)*., Example(s) ; *Hom.*, Homonym ; *Syn(s)*., Synonym(s) ; *Z.S.I.*, Zoological Survey of India.

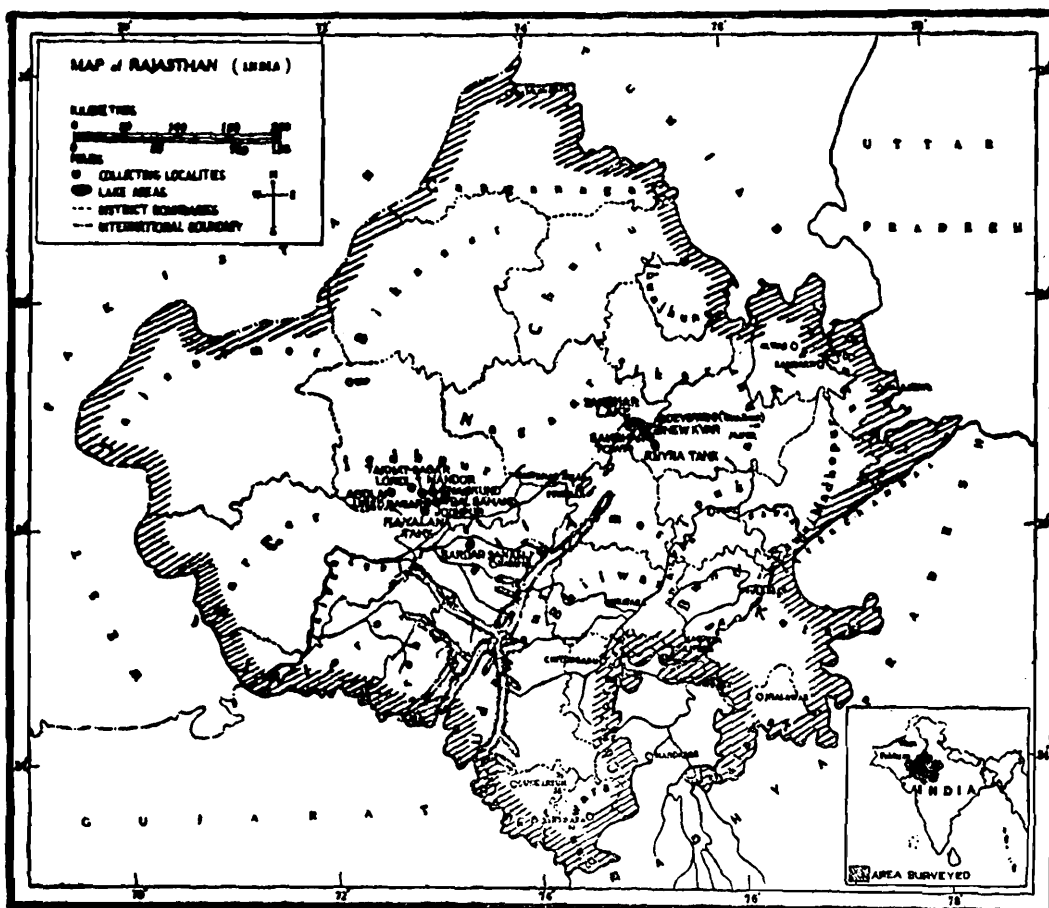
(d) *List of Collecting Stations*

A list of the Collecting Localities in the Jodhpur, Pali, Nagaur and Jaipur districts of Rajasthan is given in Table 1.

TABLE 1—*List of Collecting Stations for freshwater Protozoa in Rajasthan (February-April, 1961), K. K. Mahajan coll.*

(Also see Text-fig. 1)

| Collecting Station                                              | Latitude and Longitude<br>(approximate) |           |
|-----------------------------------------------------------------|-----------------------------------------|-----------|
|                                                                 | Lat. (N)                                | Long. (E) |
| (i) <i>Jodhpur District</i>                                     |                                         |           |
| 1 Tank inside Zoological Gardens, Jodhpur                       | 26° 18'                                 | 73° 04'   |
| 2. Tank $\frac{1}{2}$ Km. W of Jodhpur Fort                     | 26° 18'                                 | 73° 04'   |
| 3 Mandore (12 Km. N. of Jodhpur)                                | 26° 20'                                 | 73° 00'   |
| 4. Nagkund (near Mandore)                                       | 26° 19'                                 | 73° 02'   |
| 5. Balsamand (near Jodhpur)                                     | 26° 18'                                 | 73° 04'   |
| 6. Takhatsagar Lake (part of Kaylana Lake, 9 km. W. of Jodhpur) | 26° 18'                                 | 73° 00'   |
| 7. Pratapsagar (part of Kaylana Lake, 8 km. W. of Jodhpur)      | 26° 18'                                 | 73° 09'   |
| 8. Agolai village (46 Km. N.W. of Jodhpur)                      | 26° 15'                                 | 72° 35'   |
| 9. Loridi village (16 Km. N.W. of Jodhpur)                      | 26° 22'                                 | 72° 53'   |
| 10 Umedsagar Tank (10 Km. W. of Jodhpur)                        | 26° 15'                                 | 72° 55'   |
| (ii) <i>Pali District</i>                                       |                                         |           |
| 11. Sardar Samand (Lake) (55 Km. S.E. of Jodhpur).              | 25° 54'                                 | 73° 25'   |
| (iii) <i>Nagaur District</i>                                    |                                         |           |
| 12. Sambhar Salt Lake (main lake)                               | 26° 55'                                 | 75° 25'   |
| (iv) <i>Jaipur District</i>                                     |                                         |           |
| 13. New Kyar (near Sambhar Salt Lake)                           | 26° 54'                                 | 75° 13'   |
| 14. Devdyani (near Sambhar Salt Lake)                           | 26° 55'                                 | 75° 13'   |
| 15. A tank in Khyra village (7 Km. S. of Sambhar)               | 26° 52'                                 | 75° 13'   |
| 16. Erolai Dani village (near Phulera)                          | 26° 52'                                 | 75° 16'   |
| 17. A shallow well, 50 metres W. of tank in Erolai Dani village | 26° 52'                                 | 75° 16'   |

**II—LIST OF FREE-LIVING PROTOZOA KNOWN FROM RAJASTHAN****Class I. MASTIGOPHORA****Order 1. CRYPTOMONADINA****Family (i) CRYPTOMONADIDAE****Genus 1. *Chilomonas* Ehrenberg****1. *Chilomonas paramecium* Ehrenberg, 1831**

TEXT-FIG. 1.—Map of Rajasthan, showing collecting localities for Protozoa.

**Order 2. EUGLENOIDINA****Family (ii) EUGLENIDAE****Genus 2. *Euglena* Ehrenberg****2. *Euglena caudata* Hubner, 1886****Family (iii) ANISONEMIDAE****Genus 3. *Entosiphon* Stein****3. *Entosiphon ovatum* Stokes, 1885**

**Class II. SARCODINA****Order 1. TESTACEA****Family (iv) DIFFLUGIIDAE****Genus 4. Diffugia** *Lelerc***4. *Diffugia globulosa*** Dujardin, 1837**Class III. CILIATA****Subclass (A) Holotricha****Order 2. GYMNOSTOMATIDA****Family (v) COLEPIDAE****Genus 5. Coleps** *Nitzsch**(Syns. Cricocoleps, Dictyocoleps, Pinacocoleps)***5. *Coleps hirtus*** (Müller, 1786)**Family (vi) TRACHELIIDAE****Genus 6. Dileptus** *Dujardin**(Syn. Phragelliorhynchus)***6. *Dileptus americanus*** Kahl, 1931**Genus 7. Trachelius** *Schrank***7. *Trachelius ovum*** Ehrenberg, 1831**Family (vii) AMPHILEPTIDAE***(Syn. Litonotidae)***Genus 8. Litonotus** *Wrzes**(For Leionota ; Syn. Lionotus[hom.]***8. *Litonotus fasciola*** Ehrenberg, 1831**Family (viii) DIDINIIDAE***(For Cyclodinidae ; Syn. Liliimorphidae)***Genus 9. Didinium** *Stein***9. *Didinium nasutum*** (Müller, 1773)**Family (ix) CHLAMYDODONTIDAE***(Syns. Chilodonellidae [for Odontohypo Trichidae], Chilodontidae)***Genus 10. Chilodonella** *Strand**(For Chilodon)***10. *Chilodonella cucullulus*** (Müller, 1883)**11. *Chilodonella uncinata*** (Ehrenberg, 1838)**Order 3. SUCTORIDA****Family (x) PODOPHRYIDAE***(Syns. Metacinetidae, Sphaerophryidae, Urnulidae)***Genus 11. Sphaerophrya** *Clapar'ede & Lachmann***12. *Sphaerophrya pusilla*** *Clapar'ede & Lachmann, 1859*

Order 4. HYMENOSTOMATIDA

Family (xi) OPHRYOGLENIDAE

(Syn. Ichthyophthiriidae)

Genus 12. **Ophryoglena** Ehrenberg

(Syn. *Otostoma*)

13. *Ophryoglena flava* Ehrenberg, 1838

Family (xii) COHNILEMBIDAE

(For Lembidae)

Genus 13. **Cohnilembus** Kahl

(For *Lembus* ; syn. *Sparobucha*)

14. *Cohnilembus subulatus* (Kent, 1882)

Family (xiii) TETRAHYMENIIDAE

(Syn. Leucophryidae)

Genus 14. **Claucoma** Ehrenberg

(Syns. *Dallasia*, *Diplomastix*, *Diplomestoma*)

15. *Glaucoma pyriformis* (Ehrenberg, 1838)

Genus 15. **Monochilum** Schewiakoff

16. *Monochilum ovale* (Schewiakoff, 1893)

Family (xiv) PARAMECIIDAE

Genus 16. **Paramecium** Müller

(Syns. *Paramaccidium*, *Paramoccium*)

17. *Paramecium caudatum* Ehrenberg, 1833

Family (xv) CINETOCHILIDAE

Genus 17. **Cinetochilum** Perty

18. *Cinetochilum margaritaceum* Perty, 1852

Family (xvi) FRONTONIIDAE

(For Chiliferidae)

Genus 18. **Frontonia** Ehrenberg

(Syns. *Cyrtostomum*, *Frontoniella*, *Panophrys*)

19. *Frontonia leucas* Ehrenberg, 1838

Family (xvii) PLEURONEMATIDAE

(For Aphthoniidae ; Syn. Cyclidiidae)

Genus 19. **Cyclidium** Müller

(Syn. *Alyscum*)

20. *Cylidium gloucom* Müller, 1786

## Order 5. PERITRICHIDA

## Family (xviii) VAGINICOLIDAE

(For Vaginiferidae)

Genus 20. **Cothurnia** Ehrenberg (emend. Claparede & Lachmann)21. *Cothurnia curva* Stein, 1854Subclass (B) *Spirotricha*

## Order 6. HETEROTRICHIDA

## Family (xix) STENTORIDAE

Genus 21. **Stentor** Oken(Syns. *Stentorella*, *Stentorina*)22. *Stentor* sp.

## Family (xx) GYROCORYTHIDAE

(Syns. *Caenomorphidae*, *Gyrocoridae*, *Gyrocorycidae*, *Metopidae*)Genus 22. **Metopus** Claparede & Lachmann(Syns. *Bothrostoma*, *Caenomorphina*, *Metopides* hom., *Spirorhynchus*  
*Trochella* hom.)23. *Metopus es* Müller, 178624. *Metopus es* var. *rectus* Kahl, 193225. *Metopus ovalis* Kahl, 1927

## Family (xxi) CONDYLOSTOMATIDAE

(Syn. *Condylostomidae*)Genus 23. **Condylostoma** Bory(Syns. *Kondyliostoma*, *Kondylostoma*)26. *Condylostoma patens* (Müller, 1786)27. *Condylostoma vorticella* (Ehrenberg, 1833)

## Order 7. HYPOTRICHIDA

## Family (xxii) EUPLOTIDAE

(Syn. *Ploesconiidae*)Genus 24. **Euplotes** Ehrenberg(Syns. *Ploesconia*, *Crateromorpha* hom.)28. *Euplotes charon* (Müller, 1773)

## Family (xxiii) OXYTRICHIDAE

(Syns. *Keronidae*, *Kiitrichidae*, *Pleurotrichidae*, *Psilotrichidae*,  
*Spirofilida*, *Urostylidae*)Genus 25. **Chaetospira** Lachmann(Syns. *Archimedia*, *Stichospira*)29. *Chaetospira mulleri* Lachmann, 1856Genus 26. **Stylonychia** Ehrenberg(Syns. *Diplenrostyla*, *Drepanina*, *Prosopsenus*)30. *Stylonychia pustulata* Ehrenberg, 1838

## III—KEY TO GENERA OF FREE-LIVING PROTOZOA KNOWN FROM RAJASTHAN

- 1(3). Permanent locomotory organelle absent.
2. Body mononucleate, in a monolocular shell formed by reinforcement of sand grains *Diffugia*
- 3(1). Permanent locomotory organelle present.
- 4(8). Locomotory organelle long, flexible and whip-like (flagella) ; situated anteriorly.
5. Flagellum single and rooted in a reservoir *Euglena*
- 6(7). Flagella two, both directed forwards *Chilomonas*
- 7(6). Flagella two, one always trails behind during locomotion *Entosiphon*
- 8(4). Locomotory organelle short and generally all over body, but sometimes restricted to certain regions.
- 9(34). Individuals free-living.
- 10(20). Cytostome present on body surface.
- 11(12). Cytostome anterior and at tip of an apical cone. Body barrel-shaped with 2 or 4 girdles of cilia at various levels *Didinium*
- 12(11). Cytostome anterior, not apical but surrounded by slightly longer cilia. Body barrel-shaped and covered with regularly arranged, perforated ectoplasmic plates. *Coleps*
- 13(14). Cytostome slit-like and situated on a convex ventral surface of a flattened, flask-shaped laterally compressed body. Anterior region drawn into a neck-like portion. Cilia only on right side ; cytostome with trichocysts. *Litonotus*
- 14(13). Cytostome situated on a flattened ventral surface. Dorsal surface convex ; body dorso-ventrally flattened. Somatic ciliation restricted to ventral surface *Chilodonella*
- 15(16). Cytostome rounded and at base of an anteriorly drawn out finger-like process. Body oval and rounded posteriorly *Tracheliu*
- 16(15). Cytostome round and at base of a conspicuous neck-like projection. Body lanceolate and drawn out into a tail-like prolongation .. *Dileptus*
17. Cytostome at about one-fourth of body-length towards anterior end, with inconspicuous undulating membrane on right and three membranellae on left ; ciliation uniform ; one contractile vacuole .. *Glaucoma*
- 18(19). Cytostome at left of median line, at about one-fourth of body-length. Cilia dense, uniform and in rows. Short and conical cytopharynx ; one contractile vacuole, centrally located *Monochilum*
- 19(18). Cytostome at right of median line, in posterior half with a membrane on both edges which form a pocket. With one caudal cilium. Contractile vacuole single and terminal .. .. *Cinetochilum*
- 20(10). Cytostome not on body surface but situated within peristome.

- 21(22). Peristome funnel-shaped, runs from anterior left to posterior right. Two typical contractile vacuoles which discharge through temporary excretory pore. Body foot-shaped *Paramecium*
- 22(21). Peristome having no connection with cytostome, and with a complex organization. Body sole-shaped. Contractile vacuole with long radiating collecting canals *Frontonia*
- 23(24). Peristome sickle-shaped and as ciliated slit sunk at right angles to body surface. One or two contractile vacuoles with long radiating canals *Ophryoglena*
- 24(23). Peristome not sunk at right angles to body but starts from anterior end to middle of body ; curved to right. Body spindle-shaped.
- 25(28). Body uniformly ciliated. Individuals without cirri.
- 26(27). Conspicuous anterior peristome, slightly spirally diagonal, beginning at anterior end and reaching almost the middle of body. A narrow non-ciliated zone on right of adoral zone. Macronucleus one *Metopus*
- 27(26). Peristome wide anteriorly, V-shaped and without non-ciliated zone. A large undulating membrane on right edge and adoral zone on left of peristome. Macronucleus moniliform .. .. *Condylostoma*
- 28(25). Body ciliation extremely reduced ; individuals with cirri on ventral side and characteristic bristles on dorsal side.
- 29(31). Body loricated.
30. Individuals flask-shaped, flexible and free to move inside lorica. Cytostome at base of proboscis *Chaetospira*
- 31(29). Body not loricated.
- 32(33). Individuals reniform, not flexible ; five ventrals in rows, five anals, innumerable marginals, three caudals and with short bristles on dorsal side *Stylonychia*
- 33(32). Body ovoid, inflexible, longitudinally ridged ; nine fronto-ventrals, not in rows *Euplotes*
- 34(9). Individuals sessile.
- 35(37). Individuals with non-contracile stalk ; food-procurement and ingestion with help of tentacles *Sphaerophrya*
- 36(35). Individuals with a short contractile stalk, no suckorial tentacles and in a lorica *Cothurnia*
37. Body trumpet-shaped and contractile *Stentor*

#### IV—SYSTEMATIC ACCOUNT

##### 1. *Chilomonas paramecium* Ehrenberg

(Text-fig. 2a)

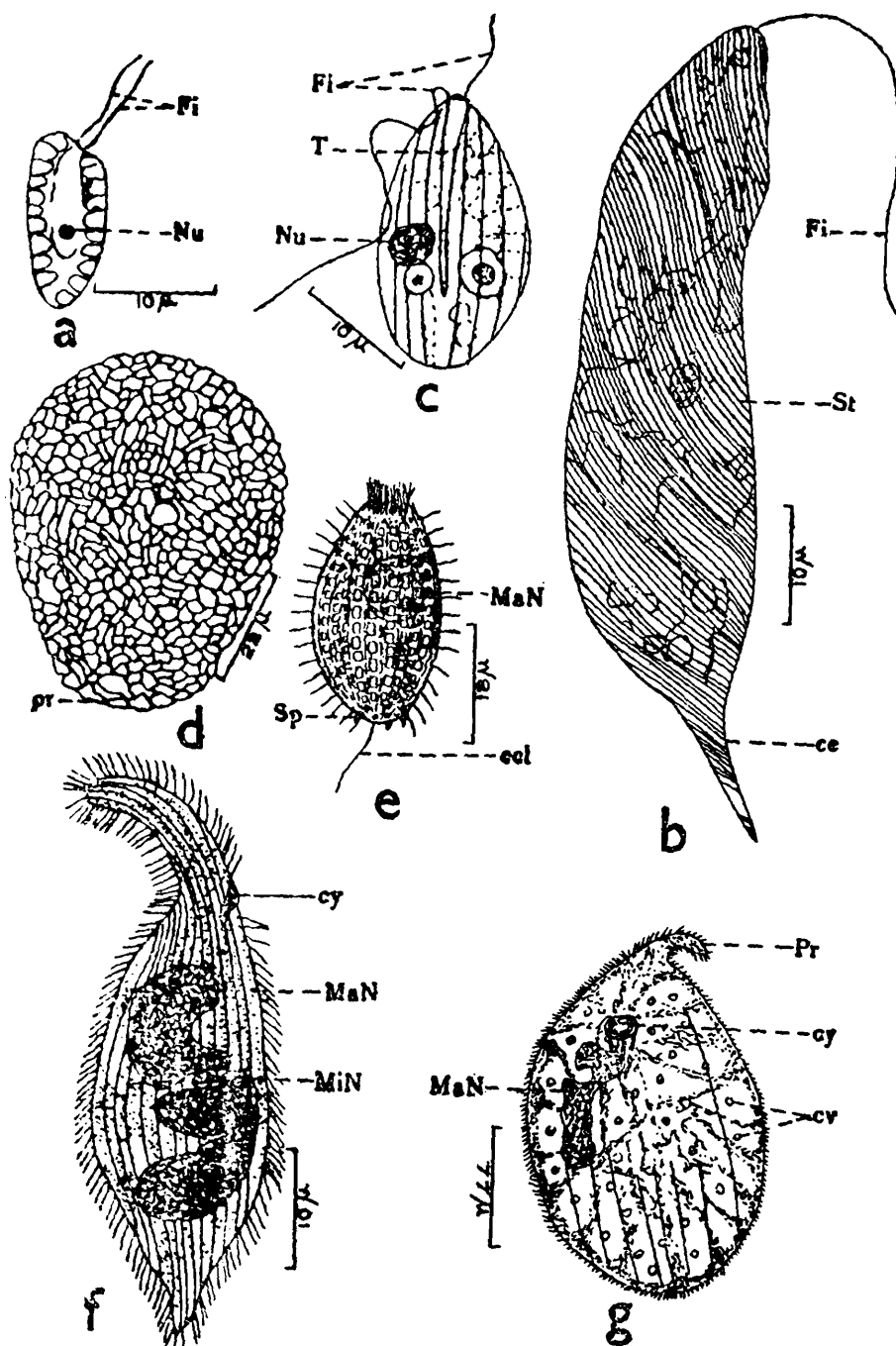
1931. *Chilomonas paramecium* Ehrenberg, *Adh. preuss. Akad. Wiss.*, Berlin, 2, p. 64, pl. IV, fig. 6.
1942. *Chilomonas paramecium*, Holland, *Arch. Zool. exp. gen.*, Paris, 83, pp. 25-26 pls. III, IV.

**Material.**—One lot, several exs., Takhatsagar, near Jodhpur (Jodhpur Dist.), 22, ii. 62.

**Diagnosis.**—Body posteriorly narrow in live specimens (but wider in prepared slides) ; slightly bent dorsally ; size  $16.5$  by  $7.5\mu$ . Saprozoic in stagnant water.

**Distribution.**—*Rajasthan* (first record from India) : As above, *Elsewhere* : Universal. Found abundantly in vegetable infusions.

**Remarks.**—My specimens are very small. Butschli (1878) recorded larger examples ( $30$ — $40\mu$  by  $10$ — $15\mu$ ) and so did Kent (1882,  $22$ — $39\mu$ , long).



TEXT-FIG. 2.—(a) *Chilomonas paramecium*. (b) *Euglena caudata*. (c) *Entosiphon ovatum*. (d) *Diffugia globulosa*. (e) *Coleps hirtus*. (f) *Dileptus americanus*. (g) *Trachelius ovum*.

cel., Caudal cilium ; ce., caudal projection ; cv., Contractile vacuole ; cy., Cylosome ; Fi., Flagellum ; MaN., Macronucleus ; Nu., Nucleus ; or., Orifice ; Pr., Proboscis ; Sp., Spine ; St., Striae.

2. *Euglena caudata* Hübner

(Text-fig. 2b)

1886. *Euglena caudata* Hübner, *Progr. Realgymn. Starlzund*, Starlzund, 20, p. 4.1956. *Euglena caudata* Pringshiem, *Nova Acta Leop.*, Leipzig, 18 (125), pp. 74-75, fig. 15.*Material*.—One ex., pond in Khyra village, near Phulera (Jaipur Dist.), 6. iv. 62.*Diagnosis*.—Body spindle-shaped, with a long tail-like posterior portion ; characteristic diagonal striations ; size 73.5 by 18  $\mu$ .*Distribution*.—*Rajasthan* (first record) : As above. *Elsewhere* : Universal in waters with decaying vegetation.*Remarks*.—My specimen is of medium size. Hübner (1886) recorded the largest (100 by 38  $\mu$ ) and Chu (1947) the smallest (30 by 10  $\mu$ ).3. *Entosiphon ovatum* Stokes

(Text-fig. 2c)

1885. *Entosiphon ovatus* Stokes, *Ann. Mag. nat. Hist.*, London, (5) 15, p. 440, pl. XV. fig. 12.1888. *Entosiphon ovatus* Stokes, *J. Trenton nat. Hist. Soc.*, Trenton, 1, p. 108. pl. I I. fig. 9.*Material*.—One ex., Sardar Samand Lake (Pali Dist.), 6. iii. 62.*Diagnosis*.—Cytopharyngeal tube very prominent ; two flagella ; nucleus centro-lateral ; size 24 by 13.5  $\mu$ .*Distribution*.—*Rajasthan* (first record from India) : As above. *Elsewhere* : Universal in large sheets of freshwaters.*Remarks*.—An extremely rare species. The only other record for the world was the first one by Stokes (1885) from N. America. The present is the first record from the Tropics. My specimens are rather small ; Stokes's specimens were 25-28  $\mu$  long.4. *Diffugia globulosa* Dujardin

(Text-fig. 2d)

1837. *Diffugia globulosa* Dujardin, *Ann. Sci. nat.*, Paris, 8, p. 311, pl. 9, figs. la, b.1958. *Diffugia globulosa* Gauthier-Lievre & Thomas, *Arch. Protistenk.*, Jena, 103, p. 130, figs. 36a, b, c.*Material*.—One ex., tank in Devdani, near Sambhar Lake (Jaipur Dist.), 22. iii. 62.*Diagnosis*.—Shell spheroidal, composed of quartz sand ; mouth terminal ; pseudopodia, are thrown out in living condition, simple and finger-like ; size 73 by 56  $\mu$ .*Distribution*.—*Rajasthan* (first record) : As above. *Elsewhere* : Universal, found generally on the pond ooze.*Remarks*.—My specimen is smaller to the earlier records. Dujardin (1837) recorded specimens 100  $\mu$  long and Gauthier-Lièvre & Thomas (1958) 100 by 80  $\mu$ .

**Coleps hirtus (Müller, O.F.) Nitzsch**

(Text-fig. 2e)

1786. *Cercaria hirta* Müller, O.F., *Animalc. infusoria fluviat. et marina etc.*, Hafniae et Lipsiae, p. 128, pl. xix, figs. 17-18.

1817. *Coleps hirtus*, Nitzsch, *Neue Schrift. der naturf. Ges. in Halle*, Halle, 3, p. 3.

1925. *Coleps hirtus*, Noland, *Trans. Amer. micr. Soc.*, Lancaster, 44, pp. 6-7, pl. 1, fig. 3.

**Material.**—(i) One ex., Takhatsagar Lake, near Jodhpur (Jodhpur Dist.), 22. ii. 62. (ii) One lot, two exs, Sardar Samand Lake (Pali Dist.) 6. iii. 62.

**Diagnosis.**—Body barrel-shaped, slightly narrower and truncated in front ; three spines at posterior end ; perforated quadrangular plates on cuticular surface ; size 34 by 19  $\mu$ .

**Distribution.**—*Rajasthan* (first record) : As above. *Elsewhere* : Universal. Other records from India are Srinagar (Kashmir) ; Calcutta.

**Remarks.**—My specimens are smaller than those of Noland (1925, 40—65  $\mu$  long).

**6. Dileptus americanus Kahl**

(Text-fig. 2f)

1931. *Dileptus americanus*, Kahl, *Urtiere order Protozoa, Tierwelt Dtsch.*, Jena, Pt. 21, p. 209, fig. 32a.

**Material.**—One, ex., pond inside Zoological Gardens, Jodhpur (Jodhpur Dist.), 19. ii. 60.

**Diagnosis.**—Body sickle-shaped ; proboscis bent dorsally ; two contractile vacuoles on dorsal side ; macronucleus with two horse-shoe shaped parts ; size 51 by 16.5  $\mu$ .

**Distribution.**—*Rajasthan* (first record from India) : As above. *Elsewhere* : Wisconsin (U.S.A.).

**Remarks.**—The specimen is very small compared to other species of the genus ; very rare form.

**7. Trachelius ovum Ehrenberg**

(Text-fig. 2g)

1833. *Trachelius ovum* Ehrenberg, *Abd. preuss. Akad. Wiss.*, Berlin, 1835, pp. 265, 277.

1931. *Trachelius ovum* Kahl, *Urtiere oder Protozoa. Tierwelt Dtsch.*, Jena, Pt. 21, pp. 210-211, figs. 26, 27.

**Material.**—One ex., tank in Devdani, near Sambhar Lake (Jaipur Dist.), 24. iii. 62.

**Diagnosis.**—Body somewhat oval, drawn out anteriorly into a finger-like process ; peristome at base of process ; anastomosing cytoplasmic branches penetrate endoplasm ; contractile vacuoles numerous ; macronucleus sausage-shaped ; size 124.5 by 85  $\mu$ .

**Distribution.**—*Rajasthan* (first record) : As above. *Elsewhere* : Universal ; in stagnant waters with decaying vegetation.

**Remarks.**—My specimen is much smaller than those of Kahl's (1930, 200—400  $\mu$  long).

8. *Litonotus fasciola* (Ehrenberg)

(Text-fig. 3a)

1831. *Amphileptus fasciola* Ehrenberg, *Abh. preuss. Akad. Wiss.*, Berlin, (1832), p. 116.

1870. *Litonotus fasciola*, Wrgesniowski, *Z. wiss. Zool.*, 20, Leipzig, p. 500, figs. 29-32.

*Material*.—Two lots : (i) One ex., Sardar Samand Lake (Pali Dist.), 6. iii. 62. (ii) One ex., shallow well in village Erolai Dani, near Sambhar Lake (Jaipur Dist.), 9. iv. 62.

*Diagnosis*.—Body lanceolate ; neck-like projection nearly one-half of body length ; single contractile vacuule at beginning of tail-like posterior projection ; macronucleus bipartite ; size :  $67.5\ \mu$  long.

*Distribution*.—*Rajasthan* (first record) : As above. *Elsewhere* : Universal. Other records from India are : Srinagar (Kashmir) and Calcutta.

*Remarks*.—My specimens are smaller (in no case more than  $67.5\ \mu$  long) than those of Kahl (1931,  $100\ \mu$  long) and Bhatia (1936,  $94\ \mu$  long).

9. *Didinium nasutum* (Müller)

(Text-fig. 3b)

1773. *Vorticella nasuta* Müller, O.F., *Verminum terrest. et. fluvatil s. animal infusor etc., historia*, Hafniae et Lipsiae, pp. 102-104.

1859. *Didinium nasutum*, Stein, *Lotos*, Prague, 9, p. 5.

1962. *Didinium nasutum*, Dingfelder, *Arch. Protistenk.*, Jena, 105, p. 547.

*Material*.—One lot, 3 exs., a well in village Erolai Dani, near Sambhar Lake (Jaipur Dist.), 9. iv. 62.

*Diagnosis*.—Body barrel-shaped, with 2 girdles of cilia ; a conical projection at anterior end ; a contractile vacuule at posterior end ; macronucleus curved and band-like ; size  $137$  by  $97\ \mu$ .

*Distribution*.—*Rajasthan* (first record) : As above. *Elsewhere* : Universal, in freshwater ponds.

*Remarks*.—My specimens are larger than those of Kent (1880,  $83\ \mu$ ), Conn & Edmondson (1918,  $100$ — $175\ \mu$ ) and Bhatia (1936,  $123$  by  $84\ \mu$ ).

10. *Chilodonella cucullulus* (Müller)

(Text-fig. 3c).

1883. *Kolpoda cucullulus* Müller, O.F., *Verminum terrest. et. fluviatil s. animal infusor etc., historia*, Hafniae et Lipsiae, p. 158.

1926. *Chilodonella cucullulus*, Strand, *Arch. Naturgesch.*, Berlin, 92, p. 31.

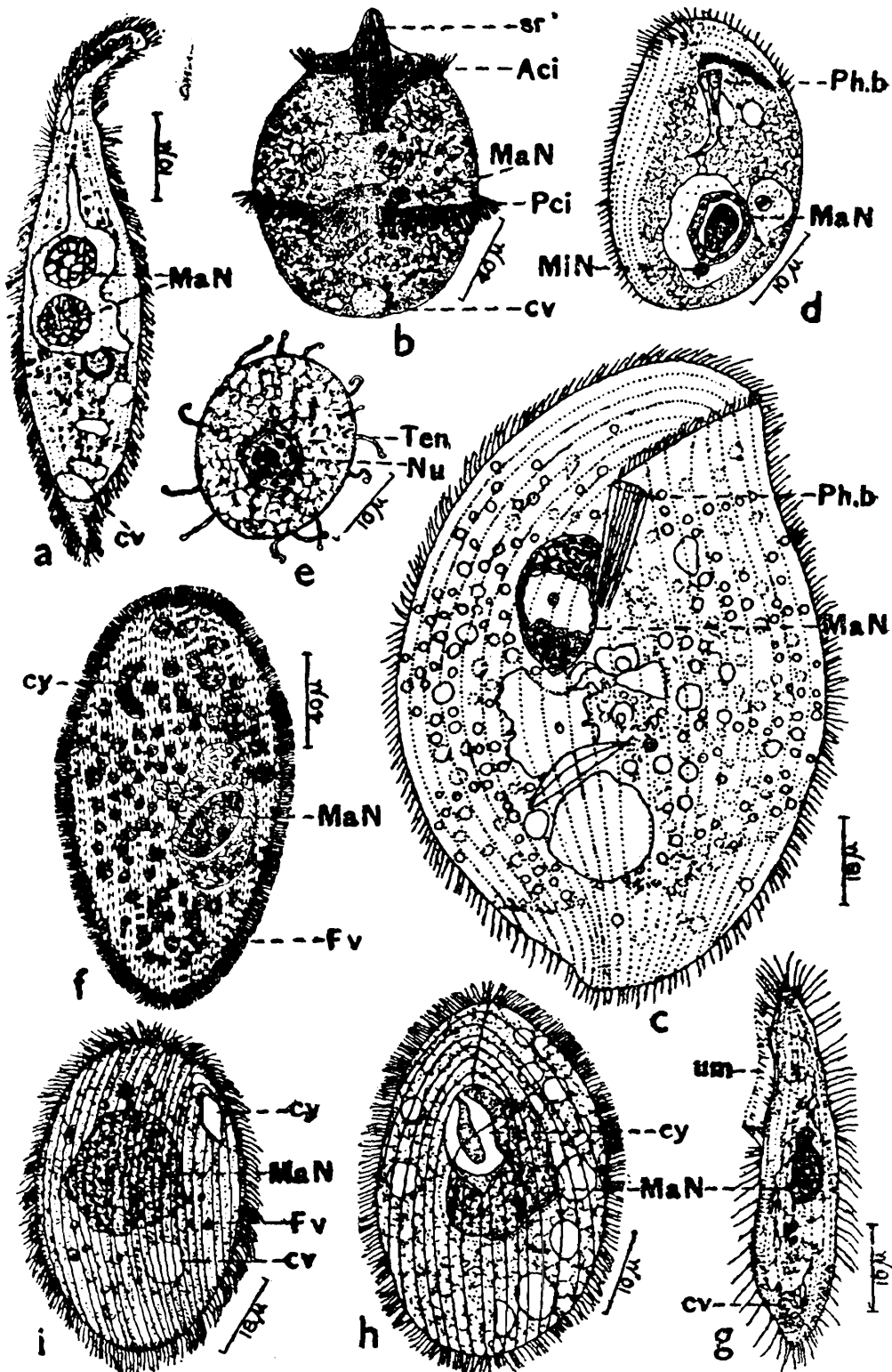
1962. *Chilodenella cucullulus* Dingfelder, *Arch. Protistenk.*, Jena, 105, p. 566.

*Material*.—One lot, 2 exs., Sardar Samand Lake (Pali Dist.), 6. iii. 62

*Diagnosis*.—Body dorso-ventrally flattened ; a beak-like projection at anterior end ; dorsal surface convex, ventral surface flat ; cytopharynx straight ; macronucleus oval and characteristic ; size  $130$  by  $87\ \mu$

*Distribution*.—*Rajasthan* (first record) : As above. *Elsewhere* : Universal. Other records from India are : Srinagar (Kashmir) and Bombay.

*Remarks.*—My specimens are of medium size. Previous records are : Kahl (1931, 130-150  $\mu$ , sometimes upto 300  $\mu$ ) ; Bhatia (1936, 90 by 42  $\mu$ ) ; and Dingfelder (1962, 100-110  $\mu$ ).



TEXT-FIG. 3.—(a) *Litonola asciola*. (b) *Didinium nasutum*. (c) *Chilodoneo cucullulus*. (d) *Chilodonella uncinata*. (e) *Sphaerophrya pusilla*. (f) *Ophryoglena fiava*. (g) *Cohnilembus subulatus*. (h) *Glaucoma pyriformis*. (i) *Monochilum ovale*.

Aci., Anterior cirri of cilia ; cv., contractile vacuole ; Cy., Cytostome ; Fv., Food vacuole ; MaN, Macronucleus ; MIN., Micronucleus ; Nu., Nucleus ; Pci., Posterior cirri of cilia ; Phb., Pharyngeal basket ; Sn., Snout ; Ten., Tentacles ; um., Undulating membrane.

11. *Chilodonella uncinata* (Ehrenberg)

(Text-fig. 3d)

1838. *Chilodon uncinatus* Ehrenberg, *Abh. preuss. Akad. Wiss.*, Berlin, 1838, p. 337.  
 1926. *Chilodonella uncinata*, Strand, *Arch. Naturgesch.*, Berlin, vol. 92, p. 31.  
 1962. *Chilodonella uncinata*, Dingfelder, *Arch. Protistenk.*, Jena, 105, p. 567.

*Material*.—One lot, 8 exs., Balsamand Lake, near Jodhpur (Jodhpur Dist.), 21. ii. 62.

*Diagnosis*.—Dorso-ventrally flattened body ; cytopharynx curved at posterior end ; macronucleus spherical and granular ; a micronucleus present posterior to it ; size 30 by 19 $\mu$ .

*Distribution*.—*Rajasthan* (first record from India) : As above. *Elsewhere* : Universal, in freshwater bodies with decaying vegetation.

*Remarks*.—My specimens are very small. Other records are : Kahl (1931, 50-90 $\mu$  long) ; Dingfelder (1962, 43-40 $\mu$  long).

12. *Sphaerophrya pusilla* Claparede & Lachmann

(Text-fig. 3e)

1859. *Sphaerophrya pusilla* Claparede & Lachmann, *Etudes sur les infusorie et les rhizopodes*, Genève, p. 385, pl. 1, fig. 11.  
 1936. *Sphaerophrya pusilla*, Bhatia, *Fauna Brit., India, Protozoa, Ciliophora*, London, pp. 433-435, figs. 213, 214.

*Material*.—One ex., New Kyar, Sambhar Lake (Jaipur Dist.), 18.iii.62.

*Diagnosis*.—Body spherical ; minute, with few short knobbed tentacles ; no stalk ; size : 25.5 $\mu$  diameter.

*Distribution*.—*Rajasthan* (first record) : As above. *Elsewhere* : Other records from India are : Hoshiarpur (Punjab) ; and Bombay.

*Remarks*.—My specimens are larger than those of Bhatia (1936, 12-15 $\mu$  diameter). A rare species.

13. *Ophryoglana flava* Ehrenberg

(Text-fig. 3f)

1838. *Ophryoglana flave* Ehrenberg. *Die Infusionsthierchen als vollkommene Organismen*, Leipzig, p. 330, pl. XXXV, fig.  
 1962. *Ophryoglana flava*, Dingfelder, *Arch. Protistenk.*, Jena, 105, p. 595.

*Material*.—One lot, 3 exs., Sardar Samand Lake (Pali Dist.), 6.iii.62.

*Diagnosis*.—Body elongated oval ; cytostome situated at one-third of body length from anterior and on ventral side ; contractile vacuoles two, with long radiating canals ; macronucleus elliptical ; size 178 by 99 $\mu$ .

*Distribution.*—*Rajasthan* (first record) : As above. *Elsewhere* : Universal, in stagnant water with decaying vegetation. Other record from India : Bombay.

*Remarks.*—My specimens are very small. Other records are : Roux (1901, 560 $\mu$  long), Penard (1922, 500 $\mu$  long), Kahl (1931, 250-400 $\mu$  long) and Dingfelder (1962, 200-207 by 255  $\mu$ ).

#### 14. *Cohnilembus tubulusus* (Kent)

(Text-fig. 3g)

1882. *Lembus subulatus* Kent, *A Manual of the Infusoria*, London, p. 548, pl. XXVII, figs. 66, 67.

1935. *Cohnilembus* (nom. nov.) *subulatus* Kahl, *Urtiere oder Protozoa, Tierwelt Dtsch.*, Jena, pt. 30, p. 835.

*Material.*—Two lots : (i) 2 exs., New Kyar, Sambhar Lake (Jaipur Dist.), 19.iii.62 ; (ii) 2 exs., Sambhar Salt Lake (main lake) (Nagpur Dist.), 30.iii.62.

*Diagnosis.*—Body slender, spindle-shaped ; peristome extends upto middle of body, with two undulating membranes ; macronucleus oval and central ; size 33 by 10 $\mu$ .

*Distribution.*—*Rajasthan* (first record from India) : As above. *Elsewhere* : Universal in salt waters, in association with the bacterial film on the water surface.

*Remarks.*—My specimens are the smallest recorded so far. Kahl (1931) had specimens 35 $\mu$  long. A rare species.

#### 15. *Glaucoma pyriformis* (Ehrenberg)

(Text-fig. 3h)

1838. *Leucophrys pyriformis* Ehrenberg, *Die Infusionsthierchen als vollkommene Organismen*, Leipzig, pp. 312-313, pl. XXXII, fig. 4.

1889. *Glaucoma pyriformis* Schewiakoff, *Bibl. zool.*, Leipzig, 5, pp. 35-36, pl. IV figs. 54, 55.

1936. *Glaucoma pyriformis*, Bhatia, *Fauna Brit India, Protozoa, Ciliophora*, London, pp. 170-171, fig. 75.

*Material.*—One lot, 4 exs., pond inside Zoological Gardens, (Jodhpur Dist.), 19.ii.62.

*Diagnosis.*—Body pear-shaped, narrowed but rounded anteriorly ; cytostome in anterior fourth of body, oval and elongated along long axis of body ; macronucleus rounded and central ; size 46 by 29 $\mu$ .

*Distribution.*—*Rajasthan* (first record) : As above. *Elsewhere* : Widely distributed in India also recorded from Srinagar (Kashmir).

*Remarks.*—My specimens are of medium size. Other records are : Kahl (1931) length 38-80 $\mu$  long ; and Bhatia (1936, 32-75 by 24-47 $\mu$ ).

16. *Monochilum ovale* (Schewiakoff)

(Text-fig. 3i)

1893. *Uronema ovale* Schewiakoff, *Mém. Acad. Sci. St-Petersb.*, St. Petersburg, (7) 41, (8), pp. 191-201, (Abstract in *Zool. Anz. (Literature)*, 17, p. 122.
1931. *Monochilum ovale* Kahl, *Urtiere oder Protozoa, Tierwelt Dtsch.*, Jena, pt. 21, p. 340, figs. 57, 30.

*Material*.—One lot, several exs., Mandore, near Jodhpur (Jodhpur Dist.), 20.ii.62.

*Diagnosis*.—Body ovoid ; cytostome oblong and placed in anterior fourth of body ; ciliation uniform and dense ; a contractile vacuole in middle ; size 64.5 by 37.5 $\mu$ .

*Distribution*.—*Rajasthan* (first record from India) : As above. *Elsewhere* : Universal in stagnant waters with decaying vegetation.

*Remarks*.—My specimens are of medium size. Kahl (1931) recorded specimens *cd.* 40-90 $\mu$  long.

17. *Paramecium caudatum* Ehrenberg

(Text-fig. 4a)

1833. *Paramecium caudatum* Ehrenberg, *Abh. preuss. Akad. Wiss.*, Berlin, 1833, pp. 268, 323, pl. III, fig. 2.
1962. *Paramecium caudatum*, Dingfelder, *Arch. Protistenk.*, Jena, 105, p. 587.

*Material*.—Two lots : (i) 2 exs., Mandore, near Jodhpur. (Jodhpur Dist.), 20.ii.62 ; (ii) 3 exs., Nagkund, near Jodhpur (Jodhpur Dist.), 20.ii.62.

*Diagnosis*.—Body foot-shaped ; anterior end broader and rounded ; posterior end gradually tapering and with a tuft of longer cilia ; single ; egg-shaped macronucleus ; a compact micronucleus ; size 198 by 56 $\mu$ .

*Distribution*.—*Rajasthan* (first record) ; As above. *Elsewhere* : Cosmopolitan. Other records from India are ; Srinagar (Kashmir) ; Lucknow (Uttar Pradesh) ; and Calcutta.

*Remarks*.—A common species occurring in vegetable infusions. My specimens are of medium size. Other records are : Kahl (1931, 180-300 $\mu$  long) ; Bhatia (1936, 120-330 $\mu$ , usually 200-300 $\mu$ , long) ; and Dingfelder (1962, 158-244 $\mu$  long).

18. *Cinetochilum margaritaceum* Perty

(Text-fig. 4b)

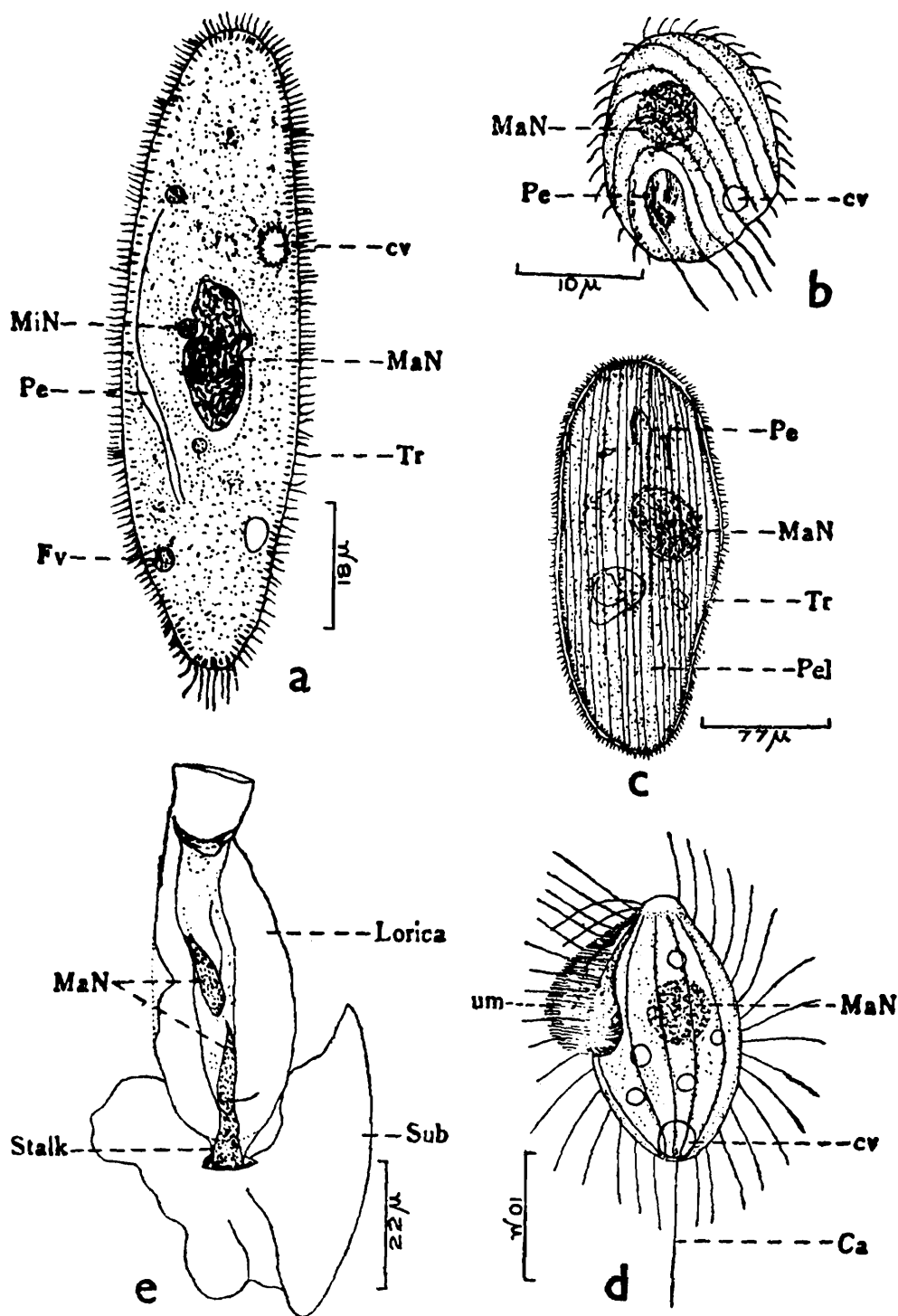
1852. *Cinetochilum margaritaceum* Perty, *Mitth. nat. Ges.*, Bern, 1849, p. 29.
1931. *Cinetochilum margaritaceum*, Kahl, *Urtiere oder Protozoa, Tierwelt Dtsch.* Pt. 21, p. 351, fig. 60, 39 & 41.

*Material*.—Two lots : (i) 6 exs., New Kyar, Sambhar Lake (Jaipur Dist.), 17-18.iii.62. (ii) 3 exs., Sambhar Lake (main lake) (Nagau Dist.), 29-30.iii.62.

*Diagnosis*.—Small ; body oval and highly flattened ; cytostome at right of median line in posterior half, with membranes ; macronucleus spherical and central ; contractile vacuole terminal ; caudal cilia long ; size 21 by 16.5 $\mu$ .

**Distribution.**—*Rajasthan* (first record from India) : As above.  
*Elsewhere* : Cosmopolitan. Inhabiting fresh and brackish waters.

**Remarks.**—My specimens are of medium size. Kahl (1931) recorded specimens 15-45 $\mu$  long.



TEXT-FIG. 4.—(a) *Paramecium caudatum*. (b) *Cinetochilum margaritaceum*. (c) *Frontonia leucas* (d) *Cyclidium glaucoma*. (e) *Cothurnia curva*.

Ca., Caudal cilium ; cv., Contractile vacuole ; Fv., Food vacuole ; MaN., Macronucleus ; MiN., Micronucleus ; Pe., Peristome ; Pel., Peristomial elongation ; Sub., Substratum ; Tr., Trichocyst ; um., Undulating membrane.

19. *Frontonia leucas* (Ehrenberg)

(Text-fig. 4c)

1838. *Bursaria leucas* Ehrenberg, *Die Infusionsthierchen als vollkommene Organismen*, Leipzig, p. 329, pl. XXXIV, fig. 8.  
 1858. *Frontonia leucas* Claparede & Lachmann, *Etudes sur les infusoires et les rhizopodes*, Geneve, pp. 259-60.  
 1939. *Frontonia leucas* Bullington, *Arch. Protistenk.*, Jena, 92, pp. 16-25, pl. 1, figs. 1-4.

*Material*.—One ex., Erolai Dani village, near Phulera (Jaipur Dist.), 9.iv.62.

*Diagnosis*.—Body foot-shaped, anterior end wider than posterior ; covered with fine short cilia arranged in longitudinal striations ; single contractile vacuole with long radiating canals in middle ; macronucleus single ; micronucleus few, around macronucleus ; size 330 by 142 $\mu$ .

*Distribution*.—*Rajasthan* (first record) : As above. *Elsewhere* : Universal, in freshwater bodies. Other records from India are : Srinagar (Kashmir) ; and Bombay.

*Remarks*.—My specimens are of medium size. Other records are : Bullington (1930, 258 by 96 $\mu$ ) ; Kahl (1931, 150-600 $\mu$  long).

20. *Cyclidium glaucoma* Müller

(Text-fig. 4d)

1786. *Cyclidium glaucoma* Müller, O.F., *Animale. infusoria fluviat. et marina, etc.*, Havnia, et Lipsiae, p. 80, pl. XI, figs. 6-8.  
 1936. *Cyclidium glaucoma*, Bhatia, *Fauna Brit. India, Protozoa, Ciliophora* London pp. 183-184. fig. 85.

*Material*.—Two lots, Jodhpur Dist. : (i) Several exs., Nagkund, near Jodhpur, 20.ii.62. (ii) Several exs., Mandore, near Jodhpur, 20.ii.62.

*Diagnosis*.—Body ovate and compressed ; contractile vacuole at posterior end ; long and fine cilia on general body surface ; a conspicuous long caudal cilium ; prominent undulating membrane ; macronucleus spherical ; a micronucleus ; size 22 by 13.5 $\mu$ .

*Distribution*.—*Rajasthan* (first record) : As above. *Elsewhere* ; Universal. Another record from India is Sibpur (W. Bengal).

*Remarks*.—My specimens are small. Kahl (1931) recorded a length of 25-30 $\mu$ .

21. *Cothurnia curva* Stein

(Text-fig. 4e)

1854. *Cothurnia curva* Stein, *Die Infusionsthier auf there Entwicklungsgeschichte untersucht*, Leipzig.  
 1935. *Cethurnia curva*. Kahl, *Urtiere oder Protozoa, Tierwelt Dtsch.*, Jena, Pt. 30, p. 777, fig. 143, 40.

*Material*.—One ex., Balsamand, near Jodhpur (Jodhpur Dist.), 20. ii. 62.

*Diagnosis*.—Animalcule housed in a lorica which is attached to submerged substratum by short stalk ; a bend at anterior region of lorica ; length of lorica  $70\mu$ .

*Distribution*.—*Rajasthan* (first record from India) : As above. *Elsewhere* ; Cosmopolitan. In freshwater bodies.

*Remarks*.—My specimen is the largest recorded so far. Kahl (1935) had specimens  $72\mu$  longer ; in extended condition the animal was *ca.*  $15\mu$  longer than the lorica.

## 22. *Stentor* sp.

(Text-fig. 5a)

*Material*.—One lot, 2 exs., pond inside Zoological Garden, Jodhpur (Jodhpur Dist.), 19.ii.62.

*Diagnosis*.—Body trumpet-shaped, colourless ; attached to submerged *Hydrilla* plants ; macronucleus long, band-shaped ; length in extended condition  $520\mu$ , in fixed condition  $105\mu$ .

*Distribution*.—*Rajasthan* (first record) : As above. *Elsewhere* ; Universal, in freshwater bodies.

*Remarks*.—My specimens resemble *Stentor polymorphus* (Müller) but differ somewhat in shape of macronucleus.

## 23. *Metopus* es Müller

(Text-fig. 5b)

1786. *Metopus* es Müller, O. F. *Animalc. infusoria, fluviat. et marina etc.*, Hafniae and Lipsiae, p. 126.

1932 *Metopus* es Kahl, *Urtiere oder Protozoa, Tierwelt Dtsch.*, Jena, pt. 25, pp. 416-417, figs. 70, 1.

*Material*.—One ex., Erolai Dani village, near Phulera (Jaipur Dist.), 9.iv.62.

*Diagnosis*.—Body S-shaped ; peristome conspicuous and slightly spirally diagonal ; ciliation uniform ; a conspicuous contractile vacuole at posterior end ; macronucleus in middle ; micronucleus adjacent to macronucleus ; size  $12$  by  $43\mu$ .

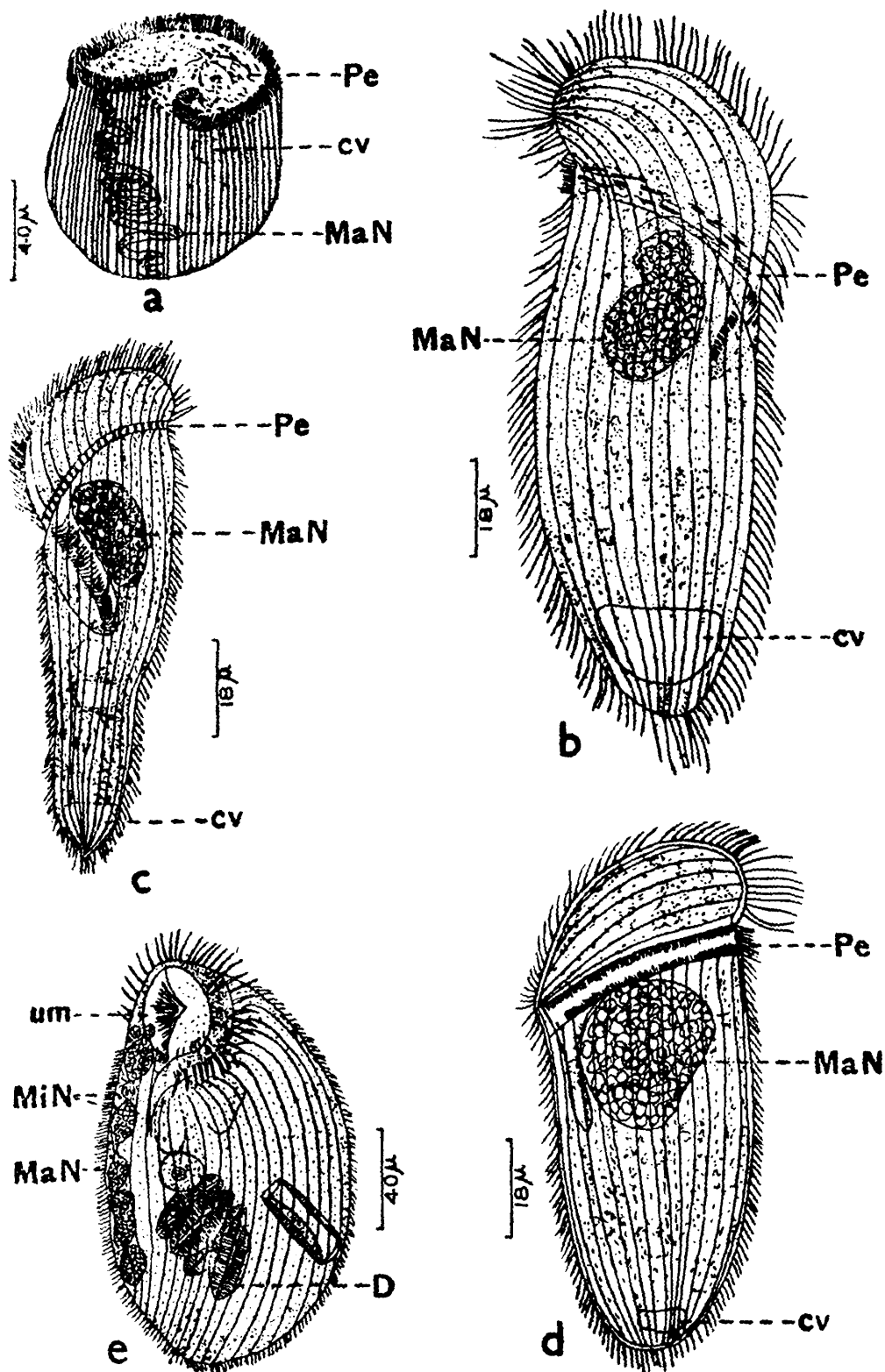
*Distribution*.—*Rajasthan* (first record) : As above. *Elsewhere* : India : Waltair (Andhra Pradesh). Not a common species. A few record also from Europe.

*Remarks*.—My specimen is of medium size Kahl (1932) recorded specimene  $120$ - $160\mu$  long.

24. *Metopus es* var *rectus* Kahl

(Text-fig. 5c)

1932. *Metopus es* var. *rectus* Kahl, *Urtiere oder Protozoa, Tierwelt Dtsch., Jena.*, 25, p. 417, figs. 70, 3.



TEXT-FIG. 5.—(a) *Stentor* sp. (b) *Metopus es*. (c) *Metopus es* var *rectus*. (d) *Metopus ovalis*. (e) *Condyllostoma patens*.

cv., Contractile vacuole ; D., Ingested diatoms ; MaN., Macronucleus ; Min. Micro-nucleus ; Pe., Peristome ; um., undulating membrane.

**Material.**—Two lots, Jodhpur Dist. : (i) One ex., Mandore, near Jodhpur, 20.ii.62. (ii) One ex., Nagkund, near Jodhpur, 20.ii.62.

**Diagnosis.**—Similar in shape to *Metopus es* Müller, but posterior end more tapering ; size 95 by 39 $\mu$ .

**Distribution.**—*Rajasthan* (first record from India) : As above. *Elsewhere* : Cosmopolitan, but very rare species. In stagnate water with decaying vegetation.

**Remarks.**—My specimens are small. Kahl (1932) recorded specimens 120 $\mu$  long.

## 25. *Metopus ovalis* Kahl

(Text-fig. 5d)

1927. *Metopus ovalis* Kahl, *Arch. Protistenk.*, Jena, 57, p. 142, figs. 11 a, b.

1932. *Metopus ovalis* Kahl, *Urtiere oder Protozoa, Tierwelt Dtsch.*, Jena, Pt. 25, p. 418, fig. 70, 5.

**Material.**—One ex., Erolai Dani village, near Phulera (Jaipur Dist.), 9.iv.62.

**Diagnosis.**—Body oval, posterior end broad and rounded ; macronucleus single, reniform and placed in middle ; micronucleus single, adjacent to macronucleus ; size 97.5 by 39 $\mu$ .

**Distribution.**—*Rajasthan* (first record from India) : As above. *Elsewhere* : In stagnant water. Very rare form. The only previous record is from Germany.

**Remarks.**—My specimen is small. Kahl (1927, 1932) recorded specimens 100-200 $\mu$  long.

## 26. *Condylostoma patens* (Müller)

(Text-fig. 5e)

1786. *Trichoda patens* Müller, O. F., *Animal infusoria fluviat. et marine etc.*, Hafniae et Lipsiae, p. 181, pl. 26, figs. 1, 2.

1841. *Kondylostoma patens*, Dujardin, *Histoire nat. des Zoophytes infusoires*, Paris, p. 516, pl. 22, fig. 2.

1932. *Condylostoma patens*, Kahl, *Urtiere oder Protozoa, Tierwelt Dtsch.*, Jena, Pt. 25, p. 453, fig. 75, 1.

**Material.**—One lot, 10 exs., Sardar Samand Lake (Pali Dist.), 6.ii.62.

**Diagnosis.**—Body nearly cylindrical, highly elastic ; irregularly triangular peristome at anterior end on ventral side ; a prominent undulating membrane extends along with right border of peristome ; canal-like contractile vacuole ; macronucleus elongate and moniliform ; many micronuclei ; size 172 by 102 $\mu$ .

**Distribution.**—*Rajasthan* (first record) : As above. *Elsewhere* : India: Mysore. Also Europe.

**Remarks.**—My specimens are very small. Kahl (1932) recorded specimens 500 $\mu$  long and Kudo (1960) 250-550 $\mu$  long.

## 27. *Condylostoma vorticella* (Ehrenberg)

(Text-fig. 6a)

1833. *Bursaria vorticella* Ehrenberg, *Abh. preuss. Akad. Wiss.*, Berlin, 1833, p. 237.

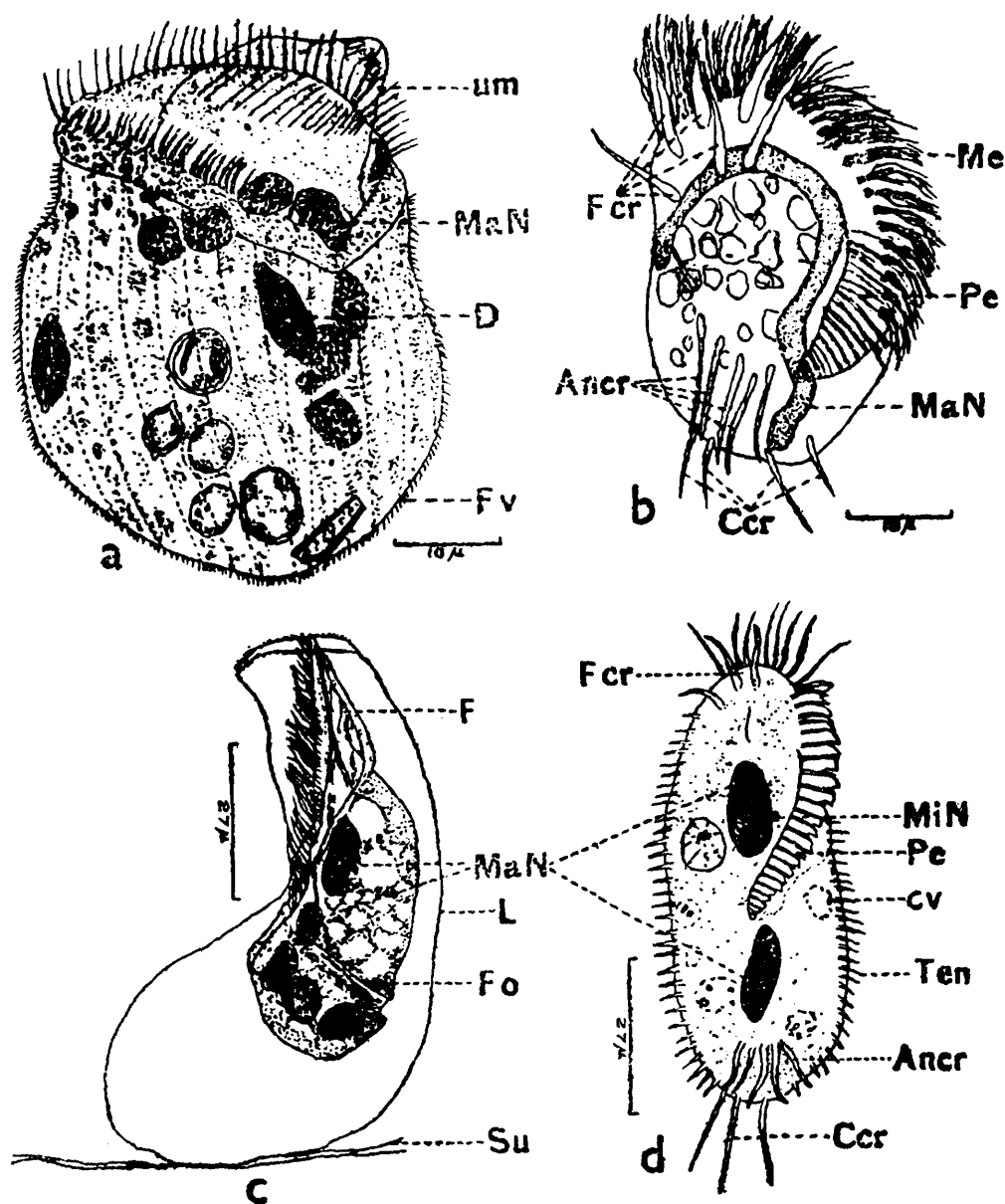
1932. *Condylostoma vorteiella*, Kahl, *Urtiere oder Protozoa, Tierwelt Dtsch.*, Jena, pt. 25, p. 457, figs. 12, 13, 14.

**Material.**—One lot, 2 exs., Khyra village near Phulera (Jaipur Dist.), 5.iv.62.

**Diagnosis.**—Body ellipsoid ; anterior end truncated, posterior end rounded ; a prominent undulating membrane on peristomial border ; macronucleus moniliform ; size 90 by 75 $\mu$ .

**Distribution.**—*Rajasthan* (first record from India) : As above. *Elsewhere* : Previous records from Europe in ponds with lot of vegetation.

**Remarks.**—My specimens are smaller than those of Kahl ( 1932, 100-200 $\mu$  long). Very rare form.



TEXT-FIG. 6.—(a) *Condyllostoma vorticella*. (b) *Euplotes charon*. (c) *Chaetod pira mulleri*. (d) *Stylonychia pustulata*.

*Ancr.*, Anal cirri ; *Ccr.*, caudal cirri ; *Cv.*, Contractile vacuole ; *D*, Ingested diatoms ; *F.*, Flexible Frontal end ; *Fer.*, Frontal cirri ; *Fo.*, Body fold ; *Fv.*, Food vacuole ; *L.*, Lorica ; *MaN.*, Macronucleus ; *Me.*, Membranella ; *Min.*, Micronucleus ; *Pe.*, Per stom ; *Su.*, Substratum ; *Ten.*, Marginal cirri.

28. *Euplotes charon* (Müller)

(Text-fig. 6b)

1773. *Trichoda charon* Müller, O. F., *Verminum terrest et fluviatil. s. animal infusor. et Historia*, Havinae et. Lipsia, p. 83.

1838. *Euplotes charon* Ehrenberg, *Die Infusionsthierchen als vollkommene Organismen*, Leipzig, p. 378, pl. 42, fig. 10.

1960. *Euplotes charon*, Kudo, *Protozoology* (4th ed.), Illinois, p. 841, fig. 358b.

**Material.**—One lot, 5 exs., in Devdani, near Sambhar Lake (Jaipur Dist.), 23 and 24.iii.62.

**Diagnosis.**—Body oval, medium sized, rounded at two extremities ; ten fronto-ventral cirri on anterior half of ventral side ; macronucleus band-shaped and curved ; size 66 by 45 $\mu$ .

**Distribution.**—*Rajasthan* (first record) : As above. *Elsewhere* : Cosmopolitan, India : Bombay.

**Remarks.**—My specimens are small. Kahl (1932) recorded specimens 70-90 $\mu$  long ; and Bhatia (1936) 80 by 38-40 $\mu$ .

29. *Chaetospira muelleri* (Lachmann)

(Text-fig. 6c)

1856. *Chaetospira muelleri* Lachmann, *Ann. Mag. nat. Hist.*, London, (2) 19, p. 216, figs. 6, 7.

1932. *Chaetospira muelleri* Kahl, *Urtiere oder Protozoa, Tierwelt. Dtsch.*, Jena, Pt. 25, p. 561, figs. 94, 24.

**Material.**—One lot, 2 exs., Sardar Samand Lake, (Pali Dist.), 6.iii.62.

**Diagnosis.**—Body flask-shaped, housed in a lorica, peristome bearing anterior part flexible ; macronucleus in 2-8 parts ; length 90 $\mu$ .

**Distribution.**—*Rajasthan* (first record from India) : As above. *Elsewhere* : Cosmopolitan, in freshwater bodies.

**Remarks.**—Very rare species. My specimens are small ; Kahl (1932) recorded specimens 150-250 $\mu$  long, and Kudo (1960) 60-200 $\mu$  long.

30. *Stylonychia pustulata* Ehrenberg

(Text-fig. 6d)

1838. *Stylonychia pustulata* Ehrenberg. *Die Infusiansthierche als volihommene Organismen*, Leipzig, p. 371, pl. 13 fig. 1.

1932. *Stylonychia pustulata* Kahl, *Urtiere oder Protozoa, Tierwelt Dtsch.*, Jena, pt. 25, p. 619, figs. 121, 21, 21a.

**Material.**—One lot, 4 exs., Mandore near Jodhpur (Jodhpur Dist.), 20.ii.62.

**Diagnosis.**—Body elongate oval, posterior end rounded. Cirri : frontal 8, ventral 5, anal 5, caudal 3. Setae on margins ; macronucleus in two parts ; two micronuclei ; size 78 by 31 $\mu$ .

**Distribution.**—*Rajasthan* (first record) : As above. *Elsewhere* : India : Srinagar (Kashmir). Previous records from Germany and U. S. A.

**Remarks.**—My specimens are very small. Kahl (1932) recorded specimens 150-220 $\mu$  long and Kudo (1960) 150 $\mu$  long.

## V—SUMMARY

1. This paper deals with freshwater Protozoa collected by the author during February-April, 1962 in western Rajasthan—districts of Jodhpur, Pali, Nagaur (Sambhar Lake and vicinity) and Jaipur.

2. Thirty species belonging to 26 genera and 23 families are described. The families are : Cryptomonadidae, Euglenidae, Anisomonadidae, Diffugiidae, Colepidae, Tracheliidae, Amphileptidae, Didiniidae, Chlamydodontidae, Podophryidae, Ophryoglenidae, Cohnilembidae, Tetrahymenidae, Parmeciidae, Cinetochilidae, Frontonudae, Pleuronematidae, Vaginicolidae, Stentoridae, Gyrocarythidae, Condyllostomatidae, Euplotidae, and Oxytrichidae.

3. All the species are first records from Rajasthan, and several are first records from India.

4. Keys for the identification of genera and brief diagnostic characters of each species are given.

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# FAUNA OF RAJASTHAN, INDIA

## PART 3.—MOLLUSCA

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(With 2 Text-figures and 3 Plates)

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### I—INTRODUCTION

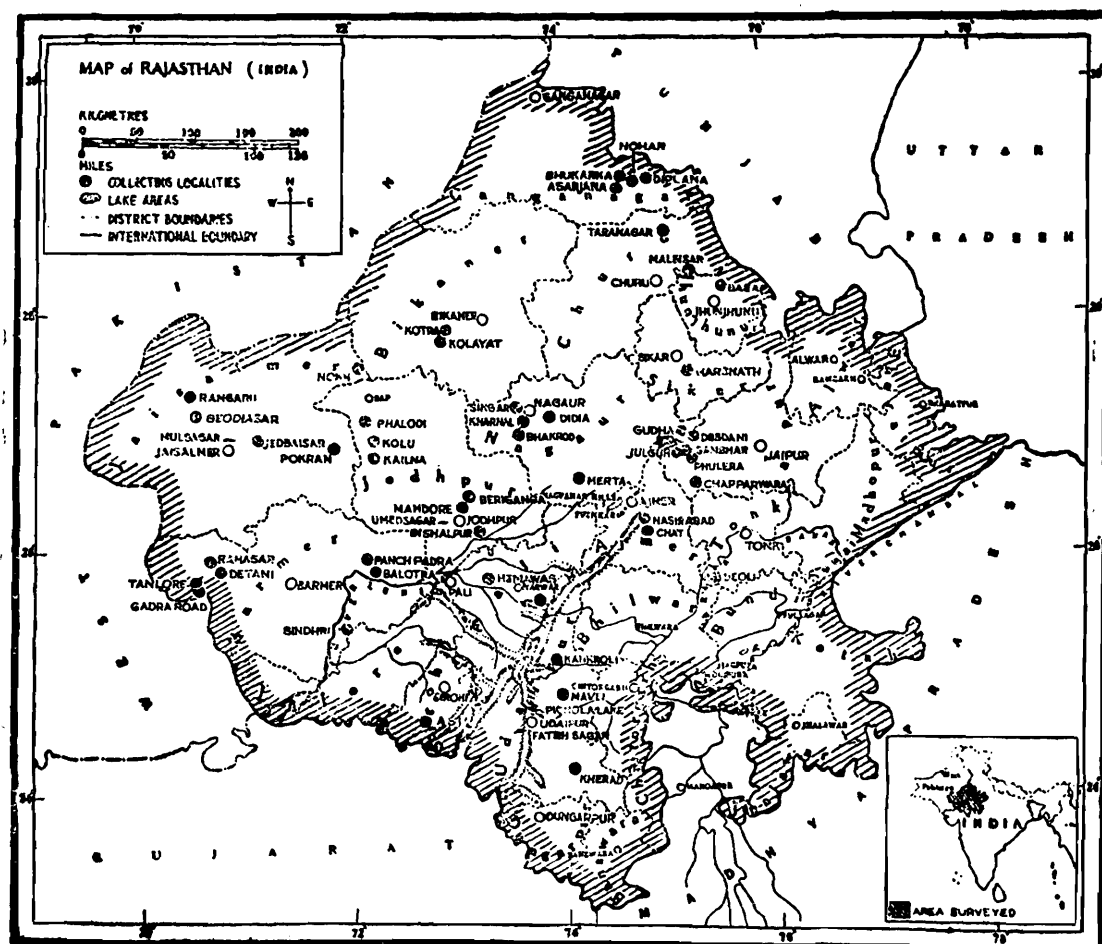
#### (a) *General*

The collection dealt with here includes mainly specimens of land and freshwater Mollusca and a few shell-remains of marine origin from excavations of a mound near Sambhar Lake. They were obtained from various localities of Rajasthan (from the districts of Ajmer, Barmer, Bikaner, Chittorgarh, Churu, Dungarpur, Ganganagar, Jaipur, Jaisalmer, Jhunjhunu, Jodhpur, Nagaur, Pali, Sikar, Sirohi, Tonk and Udaipur) mostly by different survey parties of the Zoological Survey of India during the years 1941-61, and a few by other institutions and individuals.

For an account of the topography, climate, vegetation, etc. of Rajasthan, see Part I (General Introduction) of this series of paper (Roonwal, 1968, *Rec. Zool. Surv. India*, Vol. 61 (3 & 4), pp. 291-375).

Since very little is known about the molluscan fauna of Rajasthan save some casual references by Hanley & Theobald (1876), Theobald (1876), Nevill (1878, 1884), Preston (1912, 1915), Gude (1914), Germain (1921), Annandale & Rao (1925) and Prashad (1925), an attempt is made

here to place on record the varied forms available in that area. Published records were also carefully examined. As a result, only one species, *Boysia boysil* (a tiny land snail), was added which was not available in the collection examined by us.



TEXT-FIG. 1.—Map showing the important collecting localities of Rajasthan Mollusca.

Out of the 36 forms listed here, only 11 were recorded earlier from Rajasthan, the remaining 25 (marked with an asterisk (\*) in the text) being new records from that area. The localities noted in the case of many of the forms studied are mostly new.

We have examined in the course of our study a large number of specimens (about 3,760) representing 21 genera and 15 families. In the case of some species, excellent series were available showing different stages of growth and development of the shells. The paucity of species in the area may possibly be due to the influence of the arid climate in which moisture loving animals of all groups do not thrive.

*Abbreviations used :—*

*D. & G. P. R. S.*, Survey Parties of the Desert and Gangetic Plains Regional Station (of the Zoological Survey of India), Jodhpur.

*Dist.*, District.

*Ex., Exs.*, Example, Examples.

*Nr.*, Near.

*Sta.*, Field Collecting Station.

*Z.S.I.*, Zoological Survey of India, Calcutta.

(b) *Acknowledgements*

We are grateful to Dr. M. L. Roonwal, Director, Zoological Survey of India, Calcutta, for providing the necessary help and facilities throughout the work and also for his valuable suggestions. Our best thanks are also due to Shri R. C. Bagchi, Head Artist, and Shri G. C. Saha, Photographer, for their care in taking the shell photographs.

## II—LIST OF SPECIES ARRANGED PHYLOGENETICALLY

## Class I. GASTROPODA

## Order (i) MESOGASTROPODA

## Family 1. VIVIPARIDAE

1. \**Viviparus bengalensis* (Lamarck).
  - (i) \*Form *typica* (Lamarck).
  - (ii) \*Race *mandiensis* Kobelt.
  - (iii) \*Race *gigantea* (Reeve).
  - (iv) \*Phase *annandalei* Kobelt.

2. \**Viviparus variatus* (Frauenfeld).

## Family 2. PILIDAE

3. *Pila globosa* (Swainson).

## Family 3. AMNICOLIDAE

4. \**Digoniostoma pulchella* (Benson).
5. *Digoniostoma cerameopoma* (Benson).
6. *Alocinma orcula* var. *products* (Nevill).

## Family 4. MELANIIDAE

7. *Melanoides (Melanoides) tuberculatus* (Müller).
8. \**Melanoides (Melanoides) pyramis* (Hutton).

## Family 5. CYPRAEIDAE

9. \**Erosaria lamarckii* (Gray).
  - (i) \*Race *redimita* (Melvill).

## Family 6. OLIVIDAE

10. \**Olivancillaria (Olivancillaria) acuminata* (Lamarck).

## Family 7. XANCIDAE

11. *Xancus pyrum* (Linnaeus)
  - \*(i) Form *pyrum* (Linnaeus).

## Order (ii) BASOMMATOPHORA

## Family 8. LYMNAEIDAE

12. *Lymnaea (Pseudosuccinea) acuminata* Lamarck.(i) Form *typica* Lamarck.(ii) \*Form *patula* Troschel.(iii) \*Form *chlamys* Benson.(iv) \*Form *rufescens* (Gray).13. \**Lymnaea (Pseudosuccinea) luteola* Lamarck.(i) \*Form *typica* Lamarck.(ii) \*Form *australis* Annandale & Rao.(iii) \*Form *impura* Troschel.

## Family 9. PLANORBIDAE

14. \**Indoplanorbis exustus* (Deshayes).15. *Gyraulus convexiusculus* (Hutton).

## Order (iii) STYLOMMATOPHORA

## Family 10. VERONICELLIDAE

16. \**Laevicaulis alte* (Ferussac).

## Family 11. VERTIGINIDAE

17. *Boysia boysii* (Pfeiffer).18. \**Pupoides coenopictus* (Hutton).

## Family 12. SUBULINIDAE

19. \**Opeas gracile* (Hutton).20. *Zootecus insularies* (Ehrenberg).21. *Zootecus estellus* (Benson).

## Class II. BIVALVIA (-PELECYPODA)

## Order (iv) ANISOMYARIA

## Family 13. PTERIIDAE

22. \**Pinctada margaritifera* (Linnaeus).

## Order (v) EULAMELLIBRANCHIATA

## Family 14. UNIONIDAE

23. *Parreysia favidens* (Benson).24. \**Parreysia corrugata* (Müller) var. *nagpoorensis* (Lea).25. *Indonaia caerulea* (Lea).26. \**Indonaia occata* (Lea).27. \**Lamellidens corrianus* (Lea).

## Family 15. CORBICULIDAE

28. \**Corbicula striatella* Deshayes.

## III—KEY TO IDENTIFICATION OF RAJASTHAN MOLLUSCA

1. Land slug without a shell ; anus rounded and situated submedially ; penis smooth, slender and free to its extremity ; pedal ganglion having shape of a spiral tube.

... *Laevicaulis* Simroth

- (a) Penis long, cylindrical, acrocaulous and has a sub-basal collar.

... *L. alte*

2. Shell small, globose-conoid ; aperture edentulate and lying on same level as penultimate whorl forming an acute angle.

.. *Baysia* Pfeiffer (the only species *boysii* representing this genus is not found in the collection studied)

3. Shell small, elongate-ovate ; aperture with one parietal tooth only ; peristome expanded, reflexed and edentulous, but not continuous.

... *Pupoides* Pfeiffern

- (a) Shell cylindro-pyramidal ; parietal denticle rudimentary or absent.

... *P. coenopictus*

- 4 Shell small, many-whorled ; spire slender or broader ; umbilicus narrow or closed ; columellar lip straight or concave, reflexed but not toothed or truncate below.

... *Opeas* Albers

- (a) Spire slender and crenulated near suture ; aperture longer than broad, with pillar lip straight and slightly reflexed ; umbilicus narrow.

... *O. gracile*

- 5 Shell rather small, many-whorled, cylindrical or oblong-cylindrical ; aperture widely ovate or sometimes very oblique ; peristome thick or thin.

... *Zootecus* Westerlund

- (a) Shell subcylindrical ; aperture semi-ovate, with inner lip slightly dilated and reflexed over small umbilicus and outer lip somewhat thickened inside.

... *Z. insularis*

- (b) Shell oblong-cylindrical, stouter than in *insularis* ; last whorl ascending near aperture which is angulate-oval ; inner lip vertical ; peristome obtuse.

... *Z. estelus*

6. Shell small or large (sometimes gigantic), ovate-conic or globose-conic ; whorls smooth or variously sculptured or banded and lineated with dark green ; umbilicus narrow or wide ; operculum shortly ovate, but not retractile ; lining of stomach without folds or chitinous thickenings.

... *Viviparus* Montfort

- (a)(i) Shell large, about  $1\frac{3}{4}$  times as high as broad ; surface conspicuously banded and lineated with dark green ; mouth sub-circular with margin narrow and black (when full-grown) ; umbilicus narrow.

... *V. bengalensis* f. *typica*

- (ii) Shell sometimes translucent like opal glass ; spire more conical and sharply pointed ; aperture not quite so broad as in form *typica*, but more projecting ; umbilicus slightly more broader.

... *V. bengalensis* race *mandeinsis*

- (iii) Shell of gigantic size, with spire short and stout, but sometimes narrow and elongate ; bodywhorl very large, obtusely swollen round upper part and then rounded ; aperture very large and almost circular, with outer margin much thickened and partially covering wide umbilicus.

... *V. bengalensis* race *gigantea*

- (iv) Shell very thin, usually small and translucent ; suture shallow ; dark spiral bands on whorls sometimes a little incrassated ; aperture distinctly subrhomboidal and subangulate at its inner extremity.

... *V. bengalensis* phase *annandalei*

- (b) Shell somewhat ovate-conical and deeply umbilicate ; bodywhorl descending behind aperture which is rather pyriform ; an obscure but constant whitish band running round periphery of bodywhorl.

... *V. variatus*

7. Shell large or very large, usually dextral (very rarely sinistral) ; spire depressed or sometimes conical ; umbilicus perforate or broadly open, rarely vestigial ; columella not thickened ; operculum thick and internally calcareous.

... *Pila* Röding

- (a) Shell large, globose, with spire usually depressed but sometimes abnormally long and exerted giving shell a somewhat ovate appearance ; aperture large and its thickened outer margin often lined with a band of orange or pale yellow ; umbilicus wide.

... *P. globosa*

8. Shell small, narrowly umbilicate or sub-umbilicate ; outer lip slightly thickened, produced and angulate or subangulate at its inner extremity ; operculum showing no spiral on surface and its nucleus almost central ; columellar lip forming a sharp and prominent ridge.

... *Digoniostoma* Annandale

- (a) Columellar margin less projecting below and blunt ; umbilicus practically closed and groove running forward from it not so deep or well defined.

... *D. pulchella*

- (b) Columellar margin more acutely angled below ; umbilicus moderately narrow, deep and slightly covered by peristome.

... *D. cerameopoma*

9. Shell with umbilicus closed or rimate and without an oblique channel running forward on lower surface of shell ; operculum with spirals on both surfaces and its nucleus eccentric ; columellar fold ridge-like, but not prominent ; peristome continuous, but not thickened.

... *Alocinma* Annandale & Prasad

- (a) Shell much narrower and more elongate than in typical *orcula*.

... *A. orcula* var. *producta*

10. Shell slender and imperforate ; spire much longer than bodywhorl and evenly descending ; surface smooth or sculptured with axial and spiral ridges sometimes becoming spinose round upper part of whorls ; operculum ovate, with nucleus near lower margin ; aperture ovate, but never produced above.

... *Melanoides* Olivier

- (a) Shell bearing numerous fine tubercles all over ; bodywhorl comparatively small in size ; umbilical region marked with a brown spiral band ; aperture less than  $\frac{1}{3}$  the total length of shell.

... *M. tuberculatus*

- (b) Bodywhorl relatively large and much more swollen ; aperture tapering more abruptly and at least more than  $\frac{1}{2}$  as long as shell.

... *M. pyramis*

11. Shell relatively large and thick, discoidal ; whorls rounded but without peripheral keel ; penial stylet absent.

... *Indoplanorbis* Annandale & Prashad

- (a) Shell corneous or olive (rarely black) ; aperture broad and sickle-shaped.

... *I. cxustus*

12. Shell small, thin and fragile, with whorls convex both above and below ; periphery often carinate (carina, when present, lies in middle of whorl) ; penial stylet present.

... *Gyraulus* Charpentier

- (a) Whorls not much compressed ; periphery mostly subangular in middle ; aperture small and lunate-oval.

... *G. convexiusculus*

Shell small or large with bodywhorl generally very large, but spire short or produced and sharply pointed ; columellar fold conspicuously twisted longitudinally ; aperture wide (ovate or rotund) with fragile peristome ; umbilicus closed.

... *Lymnaea* Lamarck

- (a)(i) Shell always fairly large, with a regularly ovate outline ; spire short narrow and gradually tapering ; aperture more than twice as long as broad.

... *L. acuminata* f. *typica*

- (ii) Shell with a relatively much larger spire ; bodywhorl nearly four-fifth as broad as long ; mouth less expanded especially towards anterior extremity.

... *L. acuminata* f. *patula*

- (iii) Form intermediate between *typica* and *patula*, with spire narrower than in either and columella a little more twisted ; outer lip obscurely angled near upper end.

... *L. acuminata* f. *chlamys*

- (iv) Spire more large, attenuate and acuminate ; surface sometimes tinged with red ; mouth of shell relatively shorter and less expanded.

... *L. acuminata* f. *rufescens*

- (b)(i) Shell of large or larger size and rather thicker texture ; bodywhorl a little compressed and spire short, broad and conical ; sutures more oblique ; aperture twice as long as broad, with outer lip slightly dilated.

... *L. luteola* f. *typica*

- (ii) Shell small, with much narrower and elongate spire ; bodywhorl showing no compression ; outer margin of aperture nearly straight for greater part of its length and inner lip rather straight and obliquely angled below.

... *L. luteola* f. *australis*

- (iii) Shell of smaller size, with rather narrower bodywhorl which is sometimes slightly angular on the back ; surface usually, covered with a black deposit ; mouth pyriform ; sutures more impressed but sometimes shallow.

... *L. luteola* f. *impura*

14. Shell large, thick and heavy, with spire obtuse ; canal long, narrow and straight ; columella 2 to 5 plaited and outer lip thin and simple.  
 ... *Xancus Röding*  
 (a) Columella distinctly triplicate.  
 ... *X. pyrum pyrum*  
 (In female shell upper part of columella is calloused when full-grown and outer lip slightly more thickened).
15. Cowry with back sometimes slightly gibbous and copiously sprinkled with small rounded white specks sometimes ocellated with brown ; extremities distinctly pitted, crenated and lineated with brown.  
 ... *Erosaria Troschel*  
 (a) Shell ochraceous, with dorsal specks purely white, indistinct and lacking in pupils ; margins less broad, but thickened and angular.  
 ... *E. lamarckii redimita*
16. Shell somewhat large, with spire raised, exerted and sharply acuminate ; surface mostly marked with interrupted zigzag streaks and a delicate net work pattern next sutures ; columella bearing numerous and sometimes close-set plications.  
 ... *Olivancillaria d'Orbigny*  
 (a) Spire more acuminate and surface frequently adorned with faint, close, orange-red strigations and suture beneath with fasciculatus frequently reduced to a row of white spots ; base marked with a spiral fawn zone interrupted with light flashes.  
 ... *O. acuminata*
17. True mother-of-pearl oysters, with valves as high as long ; hind angle slightly produced ; surface marked with more conspicuous and scaly layers.  
 ... *Pinctada Röding*  
 (a) Hinge toothless and hinge margin shorter ; outer surface marked with radial rows of white or yellow spots running from umbo to margin ; margin of nacre usually dark or smoky.  
 ... *P. margaritifera*
18. Shell small or large, subtrigonal to cordiform ; umbones prominent and concentrically grooved ; lateral teeth well-developed in both valves, long and finely crenulate ; pallial sinus entire.  
 ... *Corbicula Megerle V. Mühlfeld*  
 (a) Shell triangular-ovate (when young) and almost ovate rounded (when fully mature) ; posterior side distinctly truncated in adult ; raised concentric ridges on surface becoming indistinct with age in posterior part ; anterior cardinals longer and more arched than posterior ones.  
 ... *C. striatella*
19. Shell small or large, oval to subrhomboidal and thick, with full, high, zigzag, radially sculptured beaks (sculpture mostly extending over disk) ; left valve with two irregular pseudocardinals which are more or less broken into ragged denticles or strongly vertically striate, and two laterals, while right valve with one or sometimes two pseudocardinals (upper one small and compressed) and two laterals (upper one larger) ; gills three to five times as long as broad and inner pair of gills nearly as broad as outer except in anterior part.  
 ... *Parreysia Conrad*  
 (a) Shell very thick and triangularly wedge-shaped ; zigzag sculpture on beaks not extending over disk ; posterior ridge well-marked ; pseudocardinals strong and very much split up ; all four gills marsupials  
 ... *P. favidens*  
 (b) Shell subtriangular and subinflated, with anterior side more produced and rounded, while posterior side obliquely biangular ; central zigzag ridges on disk generally united at their lower points to form chevroy-shaped markings ; outer left gill filled with embryos, while outer right gill with a few only.  
 ... *P. corrugata* var. *nagpoorensis*

20. Shell rather thin, transverse, elliptical and slightly compressed in middle; cicatrices shallow; inner pair of gills broader than outer throughout its length.

.. *Indonaia* Prashad

- (a) Shell elongate-elliptical, pointed about midway up behind; beaks sculptured with numerous fine radiating riblets which are sometimes zigzagged; teeth lamellar and delicate.

.. *I. carerulea*

- (b) Shell subrhomboidal; surface covered throughout with granular concentric ridges and traces of zigzag sculpture.

.. *I. occata*

21. Shell elongate-oval or elongate-elliptical or rhomboidal, with dorsal slope nearly straight or a little curved, posterior ridge often biangulate with two sharp radiating lirae above it; left valve with two compressed pseudocardinals (front one roughened) and two laterals, while right valve with two parallel lamellar pseudocardinals and one lateral; entire length of outer pair of gills marsupial.

.....*Lamellidens* Simpson

- (a) Shell very thin and elongate-elliptical, with dorsal slope comparatively long and straight and posterior wing much broader; upper pseudocardinals in right valve rather small and thin, while those in left valve feebly developed.

.....*L. corrianus*

#### IV—SYSTEMATIC ACCOUNT

It is convenient, from the point of view of the field worker, to divide this Systematic Account under three ecological categories, viz., land, molluscs, fresh-water molluscs and marine molluscs (from excavations).

##### (a) LAND MOLLUSCS

##### Family VERONICELLIDAE

##### 1. \**Laevicaulis alta* (Férussac)

(Pl.18, Figs. 1, 1a)

1821. *Vaginulus alte* Férussac, *Tabl. Syst. Anim. Moll.*, Paris, p. 14.

1925. *Meisenheimeria alte*. Hoffmann. *Jena. Z. Naturw.*, Jena, 61, pp. 226-228. Pl. V, Fig. 45b\* (penis).

1953. *Laevicaulis alte*, Forcart, *Ann. Mus. Congo, Zool. Wct. Sci. Zool.* Tervuren, 23 : 13, 15, 17, 22, 63-68, Pl. II, Fig. 4, Pl. IV, Fig. 7, Map 6 (p. 65), Table 14 (p. 64).

*Material*.—Udaipur District : Coll. R. K. Kaushik : 1 ex., Udaipur 28.x.57.

*Distribution*.—*Rajasthan* (first record) : Udaipur (Udaipur Dist.), is above. *Elsewhere* : Extremely wide : Africa to Asia (India, Ceylon, Malay Peninsula and Archipelago, Hong Kong, Formosa, Philippines, China) and Australia (Queensland), Loyalty Islands and New Caledonia (See Ray, 1961, p. 275; Benthem Jutting, 1952, pp. 330, 331).

*Remarks*.—Specimen young, but skin colour and genitalia suggest its close identity with the species *alte*. Length 35.5 mm., diameter 14 mm.

## Family VERTIGINIDAE

2. *Boysia boysii* (Pfeiffer)

1846. *Tomogeres boysii* Pfeiffer, *Symb. Hist. Helic.*, Cassel, 3, p. 82 : Also *Z. Malak.*, Cassel, 6, p. 105 (1849).

1914. *Boysia boysii* Gude, *Faun. Brit. India, Moll.*, London, 2 (*Trochomorphidae-Janellidae*) pp. 297, 298.

*Material*.—None. Recorded from Chittorgarh and Ajmer (Rajasthan) by Hanley & Theobald (1876, p. 4), Theobald (1876, p. 31) and Gude (1914, p. 298).

*Distribution*.—*Rajasthan* : Chittorgarh (Chittorgarh Dist.) and Ajmer (Ajmer District), as above. *Elsewhere* : India : West Bengal and Nerbada Valley.

3. \**Pupoides coenopictus* (Hutton)

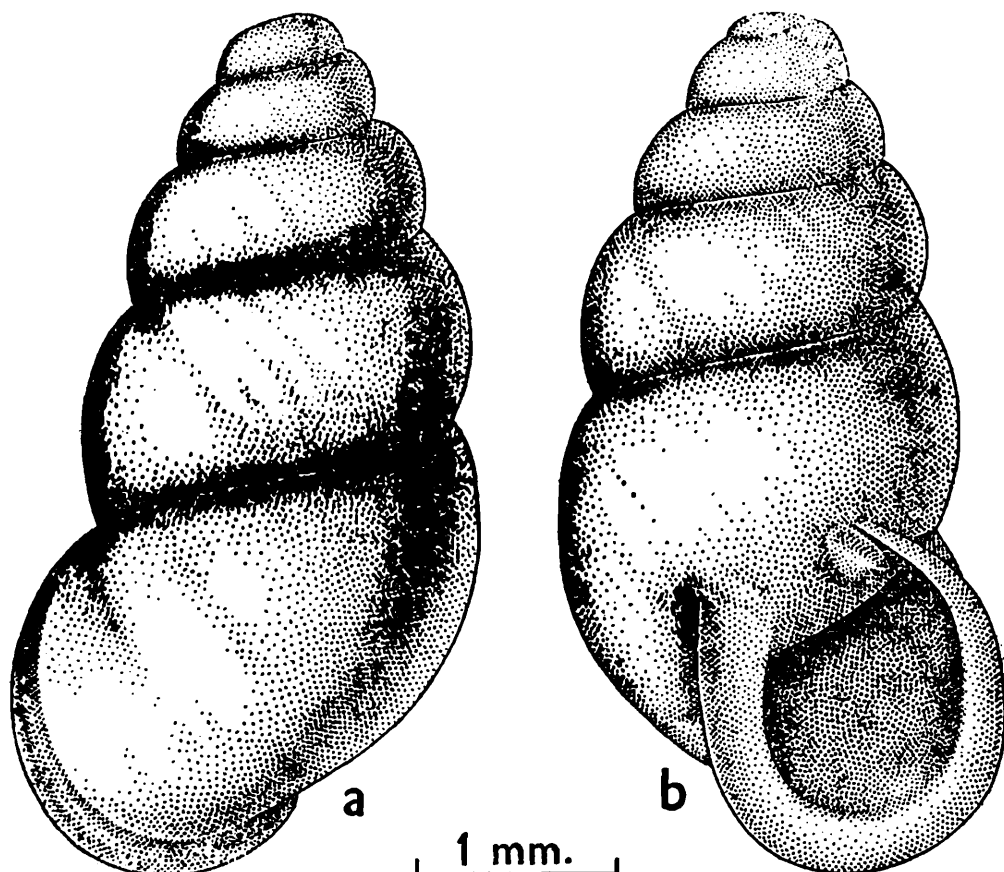
1834. *Pupa coenopicta* Hutton, *J. Asiat. Soc. Bengal*, Calcutta, 3, p. 85.

1878. *Pupa (Leucochila) coenopicta*, Nevill, *Handlist Moll. Indian Mus.*, Calcutt, 1, p. 193.

*Material*.—Nagaur District : Coll. S. Biswas : 1 ex., Sta. 13, Kuchaman Road, 5.ix.58.

*Distribution*.—*Rajasthan* (first record) : Kuchaman Road (Nagaur Dist.), as above. *Elsewhere* : India : Bihar, Madras, Kerala, Gujarat, Delhi, Maharashtra, Punjab, Kashmir. Also Afghanistan, Ceylon, Upper Burma and Abyssinia (See Blanford, 1865, p. 94 ; Hanley & Theobald, 1876, p. 12 ; Annandale & Rao, 1925, pp. 388, 393 ; Gude, 1914, pp. 259, 260).

TEXT-FIG. 2.—Shell of *Pupoides coenopictus* (Hutton). Kuchaman Road; Nagaur, District, Rajasthan, (a) Dorsal view. (b) Ventral view.



**Remarks.**—Shell tiny, fragile and pale brown, with the parietal denticle rudimentary ; spire obtuse and peristome well-developed and recurved. Height 4.4 mm., diameter (round bodywhorl) 2.2 mm., whorls 5 ; aperture : length 1.8 mm., breadth 1.6 mm.

#### Family SUBULINIDAE

#### 4. \**Opeas gracile* (Hutton)

1834. *Bulimus Gracilis* Hutton, *J. Asiat. Soc. Bengal, Calcutta*, 3, p. 84.

1878. *Opeas gracile*, Theobald, *J. Asiat. Soc. Bengal, Calcutta*, 47 (3), p. 146.

1914. *Opeas gracile*, Gude, *Faun. Brit. India, Moll.*, London, 2 (Trochomorphidae-Janellidae), pp. 355-357.

**Material.**—Jaipur District : (i) Coll. A. K. Mukherjee : 1 ex., Sta. 22, Ratan *tālāb* nr. Sambhar Lake, 9.i.58. (ii) Coll. S. Biswas : 2 exs., Debdani Temple tank nr. Sambhar town, 13.xii.58.

Nagaur District : Coll. S. Biswas : 1 ex., Sta. 13, Kuchaman Road, 5.ix.58.

**Distribution.**—*Rajasthan* (first record) : Ratan *tālāb* and Debdani Temple tank (Jaipur Dist.) ; Kuchaman Road (Nagaur Dist.)  
*Elsewhere* : Widespread : East Africa to Asia (Aden, India, Ceylon, Burma, East and West Pakistan, Malay Peninsula and Archipelago, Annam, Indo-China, China, Papua, Philippines, Japan) and Polynesia.

**Remarks.**—The largest example (Pl. 18, Fig. 2) is from Ratan *tālāb* (tank) (height 11 mm., diameter 3 mm., whorls  $8\frac{1}{2}$ ) and agrees with the Fig. 4 in Pl. xxiii of Hanley & Theobald (1876).

This snail, though small, is known to cause (like *Achatina fulica*, the Giant African Land Snail) considerable damage to potted plants and other garden crops.

#### 5. *Zootecus insularis* (Ehrenberg)

(Plate 18, Fig. 3)

1831. *Pupa insularis* Ehrenberg, *Symb. Phys. Anim. Avcr. Moll.*, Berlin' 1, p. 3.

1923. *Zootecus insularis*, Annandale & Rao, *Rec. Indian Mus.*, Calcutta, 25, p. 394, pl. IX, figs. 8, 9 (shells).

**Material.**—Bikaner District : Coll. B. Biswas : (i) 4 exs., Kolayat, 10.ix.60. (ii) 5 exs., Kotra, ca. 2 km. N. of Kolayat, 15.ix.60.

Ganganagar District : Coll. B. Biswas : 14 exs., Suratgarh, 9.x.60.

Jaipur District : Coll. C. A. Hackett : 7 exs., Sambhar Lake, no date.

Jaisalmer District : Coll. B. Biswas : 1 ex., Nokh, 25.viii.60.

Jhunjhunu District : Coll. B. Biswas : (i) 5 exs., Sta. 51, Municipal tank, Jhunjhunu, 3.xi.60. (ii) 7 exs., Sta. 52, Samas *tālāb* (tank), Jhunjhunu, 3.xi.60.

Nagaur District : Coll. *B. Biswas* : (i) 28 exs., stony waste land between Indana and Didia, *ca.* 16 km. S.E. of Nagaur, 4.ix.60. (ii) 5 exs., Kharnal, *ca.* 17 km. S.W. of Nagaur, 6.ix.60.

*Distribution.*—*Rajasthan* : Sambhar Lake (Jaipur Dist., Nevill, 1878, p. 195 ; Gude, 1914, p. 368). The other localities as mentioned above (districts of Bikaner, Ganganagar, Jaisalmer, Jhunjhunu and Nagaur) are new records. *Elsewhere* : Very widespread : Africa to Arabia, India, Ceylon, Burma and West Pakistan (Baluchistan). Prashad's record (1936) from excavations at Harappa in the Punjab shows that the species lived in the prehistoric times also.

*Remarks.*—Shells are of different sizes and in different stages of growth, and agree well with the figures of *insularis* given by Annandale & Rao (1923) on specimens from the Salt Range, Punjab. The largest example (Pl. 18, Fig. 3) is from Sambhar Lake (height 16.5 mm., diameter 5.5 mm., whorls  $8\frac{1}{2}$ ).

## 6. *Zootecus estellus* (Benson)

(Plate 18, Fig. 4)

1857. *Bulimus estellus* Benson, *Ann. & Mag. Nat. Hist.*, London, (2) 19, p. 327.

*Material.*—Barmer District : Coll. *K. K. Tiwari and S. Biswas* : (i) 120 exs., Sta. 6, rocky hill, S.W. of Barmer town, 26.i.58. (ii) 15 exs., Sta. 7, on way to Detani, *ca.* 21 km. N.E. of Gadra Road, 30.i.58. (iii) 11 exs., Sta. 7, *ca.* 2 km. W. of Afforestation Nursery, Gadra Road, 31.i.58. (iv) 5 exs., nr. Ranasar village, *ca.* 26 km. N.E. of Gadra Road, 1.ii.58. (v) 2 exs., Sta. 7, nr. Tamlore village, *ca.* 21 km. W. of Gadra Road, 3.ii.58. (vi) 2 exs., Sta. 8, bank of Luni R. at Syndhri, *ca.* 58 km. from Balotra, 10.ii.58. (vii) 3 exs., salt pits, N.E. side of the Circuit House, Panchpadra, 12.ii.58.

Jaipur District : Coll. *B. Biswas* : (i) 8 exs., Japog nr. Sambhar Lake, 12.xi.56. Coll. *A. K. Mukherjee* : 130 exs., bank of Sambhar Lake, 25.iv.57. Coll. *S. Biswas* : (i) 1 ex., a ditch nr. Sambhar Lake, Gudha, 9.x.58. (ii) 24 exs., Sambhar Lake nr. Gudha *kyars*, 30.viii.59.

Jaisalmer District : Coll. *K. K. Tiwari & S. Biswas* : (i) 50 exs., Sta. 3, Badabagh, Jaisalmer, 25.xii.57. (ii) 3 exs., Sta. 3, Mulsagar nr. Jaisalmer, 27.xii.57. (iii) 9 exs., Sta. 3, W. of Dak Bungalow, Jaisalmer, 31.xii.57. (iv) 10 exs., Sta. 4, Ramgarh, *ca.* 5 km. W. of Ramgarh, low scrub vegetation, 3.i.58. (v) 2 exs., Sta. 3, on way to Jaisalmer, *ca.* 7 km. from Dak Bungalow, Jaisalmer, 9.i.58. (vi) 2 exs., Jedbaiser, *ca.* 21 km. E. of Jaisalmer, 21.i.58.

Jodhpur District : Coll. *F. Stoliczka* : 30 exs., Balmir, no date. Coll. *K. K. Tiwari & S. Biswas* : (i) 1 ex., on land nr. Shivasagar, Phalodi, 16.xii.57. (ii) 10 exs., Kolu, *ca.* 21 km. from Phalodi on Jodhpur Road, 17.xii.57. Coll. *R. K. Bhatnagar* : 9 exs., bush nr. dried up canal, Bishalpur, 14.xii.61.

Nagaur District : Coll. *S. Biswas* : 10 exs., Sta. 13, Kuohaman Road, 5.ix.58.

*Distribution.*—*Rajasthan* : Balmir (Jodhpur Dist., Nevill, 1878, p. 195 ; Gude, 1914, p. 369). The other localities mentioned above (districts of Barmer, Jaipur, Jaisalmer, Jodhpur and Nagaur) are new records. *Elsewhere* : India : Andhra Pradesh. Also West Pakistan (Sind).

*Remarks.*—Like *Zootecus insularis*, this species is also very variable though not so widely distributed. It is represented by a good series of specimens, of which the largest one (Pl. 18, Fig. 4) is from Balmir (Jodhpur Dist.) (height 16.5 mm., diameter 6.5 mm., whorls 8) and very closely resembles the Fig. 4 in Pl. xxii of Hanley & Theobald (1876).

## (b) FRESHWATER MOLLUSCS

### Family VIVIPARIDAE

#### 7. *Viviparus bengalensis* Lamarck

##### (i) \*Form *typica* (Lamarck)

##### The Bengal Viviparus

(Plate 18, Fig. 5)

1822. *Paludina bengalensis* Lamarck, *Hist. Nat. Anim. sans Verteb.*, Paris, 6 (2), p. 174.

1921. *Vivipara bengalensis* f. *typica*, Annandale, *Rec. Indian Mus.*, Calcutta, 22, pp. 267, 270, 271, Pl. I, Figs. 1-5.

*Material.*—Pali District : Coll. K. S. Pradhan : 2 exs., Jogmandi *jharnā* (stream) downstream, from a pool with stagnant water and rotten leaves, ca. 19 km. from Phulad Railway Station, 3.iii.48.

*Distribution.*—*Rajasthan* (first record) : Jogmandi *jharnā*, as above. *Elsewhere* : India : Common throughout. Also East Pakistan, Ceylon and Burma.

*Remarks.*—Though the colouration and the dark spiral bands on the surface are much faded, other characters of the shells agree well with those of the *forma typica*. The largest example (Pl. 18, Fig. 5) has height 26.5 mm., diameter 17.5 mm. and whorls  $8\frac{1}{2}$ .

##### (ii) \*Race *mandiensis* Kobelt.

(Plate 18, Fig. 7)

1909. *Vivipara bengalensis* var. *mandiensis*, Kobelt, in Martini & Chemnitzs, *Syst. Conch-Cab.*, Nür-enberg, 1 (21), p. 414, Pl. LXXVII, Figs. 8-10.

1921. *Vivipara bengalensis* race *mandiensis*, Annandale, *Rec. Indian Mus.*, Calcutta, 22, pp. 271, 272, Pl. I, Figs. 4 and 10.

*Material.*—Chittorgarh District : Coll. B. N. Chopra & M. L. Roonwal : (i) 4 exs., R. Berach (Bedach) nr. Chittorgarh, 8-9.x.41. (ii) 33 exs., Sta. 10, a large tank, ca. 5 km. N. of Parsad (Palsad), 16-21.x. 41.

Dungarpur District : Coll. *B. N. Chopra & M. L. Roonwal* : 2 exs., Sta. 11, Surpur-ki-Nadi (stream), *ca.* 5 km. from Dungarpur town, 26.x.41.

Jodhpur District : Coll. *B. Biswas* : (i) 2 exs., Umedsagar Lake, *ca.* 10 km. W. of Jodhpur, 22.xii.56. (ii) 7 exs., vicinity of Umedsagar Lake, 23.xii.56. Coll. *D. & G. P. R. S.* : (i) 6 exs., Nagadari kund, (pool), Mandore, *ca.* 11 km. N. of Jodhpur, 25.x.60. (ii) 32 exs. Mandore Canal, *ca.* 10 km. N. of Patodi House, Patodi, Jodhpur, 27.x.60. and 19 & 22.ii.61.

Tonk District : Coll. *Indian Museum Collector* : 3 exs., Talow nr. Deoli, 16.v.1890.

Udaipur District : Coll. *D. & G. P. R. S.* : (i) 4 exs., Kherad village, Jaisamand Lake, *ca.* 60 km. S.E. of Udaipur, 23.xii.61. (ii) 6 exs., Fatehsagar Lake, *ca.* 7 km. N.W. of Udaipur Railway Station, 24.xii.61. (iii) 2 exs., Sarupsagar Lake, nr. Pichola Lake, *ca.* 7 km. W. of Udaipur Railway Station, 24.xii.61. (iv) 2 exs., Rajsamand Lake, *ca.* 1 km. N.W. of Udaipur, 24.xii.61.

*Distribution.*—*Rajasthan* (first record) : R. Berach (Chittorgarh Dist.) ; Surpur-ki-Nadi (stream) (Dungarpur Dist.) ; Umedsagar, Nagadari Kund and Mandore Canal (Jodhpur Dist.) ; Talow (Tonk Dist.) ; Kherad village, Fatehsagar, Sarupsagar and Rajsamand (Udaipur Dist.). *Elsewhere* : India : Bihar, Uttar Pradesh, Maharashtra and Punjab.

That this snail existed in the prehistoric days is known from the record by Prashad (1936, pp. 3, 10) from the ie excavatons at Harappa, Punjab. Ray (1960, p. 542) has recorded from the relatively recent excavations at Navasa (Maharashtra).

*Remarks.*—Specimens available are of various sizes and in various stages of growth, and form a good series. The largest example is from Talow (height 42.5 mm., diameter 33 mm., whorls 6), while that illustrated here (Pl. 18, Fig. 7) from Umedsagar has height 32 mm., diameter 24 mm. and whorls 6.

### (iii) Race *\*gigantea* (Reeve)

#### The Gigantic Viviparus

(Plate 18, Figs. 6, 6a)

1862. *Paludina gigantea* (von dem Busch MSS.) Reeve, *Conch. Icon.*, London, 14, Pl. II, Fig. 7.

1915. *Vivipara bengalensis* var. *gigantea*, Preston, *Faun. Brit. India, Moll.*, London, (*Gastr. & Pelec.*), p. 84.

*Material.*—Jaipur District : Coll. *A. K. Mukherjee* : 6 exs., Chapparwara Lake, 5.v.57.

Udaipur District : Coll. *B. N. Chopra & M. L. Roonwal* : 34 exs., Sta. 10, a large tank, *ca.* 5 km. N. of Parsad (Palsad), 26-27. x. 41.

*Distribution.*—*Rajasthan* (first record) : Chapparwara Lake (Jaipur Dist.) ; a tank in Udaipur (Udaipur Dist.). *Elsewhere* : India : West Bengal and Bihar.

*Remarks.*—Out of the 40 specimens in the lot, only 6 (dry) from the Chapparwara Lake appear good and full-grown, attaining even a gigantic size, with the colour yellow to cream, spire narrow and elongate to short and stout, sutures deep, spiral bands broad and conspicuous, umbilicus mostly wide, and aperture very large, sub-orbicular to almost circular, with thick outer margin. The remaining specimens (young) are olive green. The largest example (Pl. 18, Figs. 6, 6a) is from the Chapparwara Lake (height 50 mm., diameter 42 mm., with somewhat narrow and elongate spire, and whorls  $6\frac{1}{2}$ ).

(iv) \*Phase *annandalei* Kobelt

(Plate 18, Figs. 10, 10a)

1908. *Vivipara annandalei* Kobelt, *Nachr. Malak. Gesell.*, Frankfurt, 60, pp. 161, 162.

1921. *Vivipara bengalensis* phase *annandalei*, Annandale, *Rec. Indian Mus. Calcutta*, 22, p. 276, Pl. II, Figs. 5-8.

*Material.*—Pali District : Coll. K. S. Pradhan : 1 ex., Jogmandi *jharnā* (stream) downstream, from a pool of stagnant water and rotten leaves, ca. 19 km. from Phulad Railway Station, 3.iii.48.

*Distribution.*—*Rajasthan* (first record) : Jogmandi *jharna* (stream) (Pali Dist.), as above. *Elsewhere* : India : West Bengal, Bihar and Andhra Pradesh.

*Remarks.*—The single shell (Pl. 18, Figs. 10, 10a) was found closely associated with specimens of typical *bengalensis*. It agrees well with the figures of *annandalei* given by Annandale (1921) and has height 22.5 mm., diameter 15.5 mm., whorls  $6\frac{1}{2}$ .

8. \**Viviparus variatus* (Frauenfeld)

The Varied *Viviparus*

(Plate 18, Fig. 11)

1862. *Paludina variata* Frauenfeld, *Verh. zool. bot. Ges. Wien*, Vienna, p. 1163.

1915. *Vivipara variata*, Preston, *Faun. Brit. India, Moll. (Gastr. & Pelec.)*, London, p. 89.

*Material.*—Barmer District : Coll. S. Biswas : 2 exs., bed of dried up Balu R., 7.i.59.

Tonk District : Coll. *Indian Museum Collector* : 6 exs., Talow nr. Deoli, 16.v.1890.

Udaipur District : Coll. D. & G. P. R. S. : 2 exs., Kherad village, Jaisamand Lake, ca. 60 km. S.E. of Udaipur, 23.xii.61.

*Distribution.*—*Rajasthan* (first record) : Balu R. (Barmer Dist.) ; Talow (Tonk Dist.) ; Kherad nr. Jaisamand Lake (Udaipur Dist.). *Elsewhere* : India : Orissa, Madras, Andhra Pradesh and Mysore State. Also Ceylon. It is more common in southern India than elsewhere.

*Remarks.*—Shells from Talow were found mixed with those of *V. bengalensis* race *mandiensis*, but are separable by their smaller size and ovately-conical shape, and a faint but constant whitish band running round the periphery of the bodywhorl. The largest example (Pl. 18 Fig. 11) is from the Balu R. bed (height 26 mm., diameter 20.5 mm., whorls 5).

#### Family PILIDAE

### 9. *Pila globosa* (Swainson)

#### The Indian Apple Snail

(Plate 20, Figs. 7, 7a)

1822, *Ampullaria globosa* Swainson, *Zool.*, London., *Illustr.*, 1 (2), Pl. cxix.

1925, *Pila globosa*, Prashad, *Mem. Indiaen Mus.*, Delhi, 8, pp. 70, 73, Pl. XIII, Figs 1-7,

*Material.*—Jodhpur District : Coll. *B. Biswas* ; 2 exs., a dried up ditch at Rajlani; ca. 48 km. N. E. of Jodhpur, 22.iii.62.

*Distribution.*—*Rajasthan* : Prashad (1925) gave no exact locality. The locality 'Rajlani' (Jodhpur Dist.) as noted in the present paper is a new record. *Elsewhere* : India : Throughout, except southern India and Punjab. Also East Pakistan. Morelet's (1875) record of *globosa* from Siam is wrong. A detailed account of the Indian Apple Snails is given by Prashad.

*Remarks.*—Of the two specimens, one (Pl. 20, Figs, 7, 7a) is full-grown, more globose and olive-coloured, with the spire depressed, peristome thickened and lined with a band of orange or pale yellow ; it has height 64 mm., diameter 68 mm. (aperture 46 mm. long, 26 mm. wide) and whorls 6. The other specimen is lemon yellow and has a slightly raised spire.

#### Family AMNICOLIDAE

### 10. \**Digoniostoma pulchella* (Benson)

(Plate 18, Figs. 8, 8a)

1836. *Paludina pulchella* Benson, *J. Asiat. Soc. Bengal*, Calcutta, 5, p. 746.

*Material.*—Ajmer District : Coll. *B. Biswas* : 6 exs., Sta. 17, Chat, ca. 6 km. S. of Nasirabad, 28. xii. 56.

Barmer District : Coll. *K. K. Tiwari* & *S. Biswas* : 5 exs., salt pits, N. E. of Circuit House, Panchpadra, 12. ii. 58.

Jaipur District : Coll. *T. G. Vazirani* : 2 exs., Ratan *tālāb* (tank) nr. Gudha and Japog, 3. ii. 58. Coll. *A. K. Mukherjee* : 10 exs., Sta. 23, Chapparwara Lake, 20. vii. 58. Coll. *S. Biswas* : (i) 5 exs., a ditch at Barbaryan in Narayana, 1. iii. 58. (ii) 14 exs., Ratan *tālāb* (tank), ca. 3 km. S. W. of Japog, 2. ix. 58. (iii) 26 exs., a ditch adjacent to Sambhar Lake nr. Gudha, 17. ix. 58. (iv) 1 ex., Chapparwara Bund Reservoir, ca. 40 km. from Sambhar Lake, 30. ix. 58. (v) 148 exs., Gudha *tālāb* (tank), ca. 2 km. N. W. of Gudha, 23. x. 58. (vi) 3 exs., Dhobala tank at Narayana, 31. x. 58. (vii) 4 exs., Narayana *tālāb* (tank) at Narayana, 2. xi. 58. (viii) 6 exs., Bala *tālāb* (tank), ca. 5 km. S. E. of Julguh, 24. xi. 58. (ix) 8 exs., a ditch, ca. 2 km. W. of Phulera, 3-4. xii. 58.

Jaisalmer District : Coll. *K. K. Tiwari & S. Biswas* : (i) 3 exs., Sta. 2, Ramsar (a large tank), ca. 1 km. S. W. of Rest House at Pokran, 20. xii. 57. (ii) 300 exs., Ramdeora, Pokran, 20. xii. 57. (iii) 6 exs., Sta. 3, Golabsagar tank, Jaisalmer, 26. xii. 57. (iv) 16 exs., Gadisar, E. of Dak Bungalow, Jaisalmer, 28. xii. 57. (v) 6 exs., Sta. 4, Geodiasar, ca. 19 km. S. of Ramgarh, 7. i. 58. (vi) 40 exs., Jedbaiser, ca. 21 km. E. of Jaisalmer, 21. i. 58.

Jhunjhunu District : Coll. *B. Biswas* : 100 exs., Sta. 45, Bagar, ca. 16 km. N. E. of Jhunjhunu, 3. xi. 60.

Jodhpur District : Coll. *B. Biswas* : 5 exs., Beriganga, ca. 16 km. N. of Jodhpur, 2. xii. 56. Coll. *K. K. Tiwari & S. Biswas* : (i) 5 exs., Ramsar, Phalodi, 14. xii. 57. (ii) 9 exs., on land at Shivasagar, Phalodi, 16. xii. 57. (iii) 3 exs., a tank at Ekar, ca. 3 km. N. W. of Phalodi, 17. xii. 57.

Nagaur District : Coll. *B. Biswas* : (i) 10 exs., Sta. 27, Merta, 26. xii. 56. (ii) 7 exs., Sta. 31, a pond at Merta, 31. xii. 56. (iii) 2 exs., Sta. 13, Kuchaman Road, 5. ix. 58. (iv) 28 exs., Sta. 2, a tank N. of Singar, ca. 16 km. W. of Nagaur, 2. ix. 60. (v) 3 exs., Sta. 9, a tank at Rol, ca. 20 km. E. of Nagaur, 4. ix. 60. (vi) 4 exs., Sta. 13, a tank at Imirti, ca. 16 km. S. W. of Nagaur, 6. ix. 60.

Pali District : Coll. *B. Biswas* : (i) 6 exs., Sta. 21, Hemawas tank, ca. 8 km. S. of Pali, 5. xii. 56. (ii) 14 exs., Sta. 23, Pali, 6. xii. 56.

Sikar District : Coll. *B. Biswas* : (i) 12 exs., Sta. 31, Harsnath tank, ca. 15 km. S. E. of Sikar, 14. ix. 60.

Sirohi District : Coll. *K. S. Pradhan* : (i) 3 exs., Nathela tank, ca. 1 km. from Mavli Camp, 28. ii. 48. (ii) 1 ex., Jaivilas Palace, Mount Abu, 7. iii. 48.

Udaipur District : Coll. *B. N. Chopra & M. L. Roonwal* : (i) 100 exs., Sta. 6, a large tank close to Dak Bungalow at Barapal village, ca. 24 km. S. of Udaipur, 15. x. 41. (ii) 4 exs., a large tank, ca. 5 km. N. of Parsad (Palsad), 26-27. x. 41. Coll. *D. & G. P. R. S.* : 2 exs., a pond, ca. 1 km. N. of Fatehsagar Lake, Udaipur, 24. xii. 61.

*Distribution.*—*Rajasthan* (first record) : Localities mentioned above (districts of Ajmer, Barmer, Jaipur, Jaisalmer, Jhunjhunu, Jodhpur, Nagaur, Pali, Sikar, Sirohi and Udaipur). *Elsewhere* : India : Common throughout. Also Burma and Malay Peninsula.

*Remarks.*—Ghose's *Paludomus baccula* var. *minuta* from the Batu Cave, Selangor (1929), is a synonym (see Laidlaw, 1940).

This large collection has specimens ranging from the very young to adults. The largest example (pl. 18, Figs. 8, 8a) is from Merta (height 8.5 mm., diameter 5.5 mm., whorls 5).

### 11. *Digoniostoma cerameopoma* (Benson)

(Plate 18, Figs. 9, 9a)

1830. *Plaudina cerameopoma* Benson, *Gleanings in Sci.*, Calcutta, 2, p. 125.

1929. *Bithynia (Digoniostoma) cerameopoma*, Thiele, *Handb. Syst. Wäsch-tierk.*, Jena, 1, p. 155.

*Material.*—Jaipur Dist. : Coll. F. Stoliczka : 4 exs., Sambhar Lake, no date.

*Distribution.*—*Rajasthan* : Sambhar Lake (Jaipur Dist.), as above, (*vide* Nevill, 1884, p. 34). *Elsewhere* : India : West Bengal, Bihar, Assam and Punjab. Also West Pakistan (Sind).

*Remarks.*—The largest example (Pl. 18, Figs. 9, 9a) has the following particulars : height 11.5 mm., diameter 7 mm., whorls 5½.

### 12. *Alocinma orcula* var. *producta* (Nevill)

(Plate 19, Figs. 1, 1a)

1884. *Bythinia orcula* var. *producta* Nevill, *Hand list Moll. Indian Mus.*, Calcutta, 2, p. 37.

1921. *Amnicola (Alocinma) orcula* var. *producta*, Annandale, *Rec. Indian Mus.*, Calcutta, 22, p. 540.

*Material.*—Jaipur District : Coll. F. Stoliczka : 3 exs., Sambhar Lake, no date.

*Distribution.*—*Rajasthan* : Sambhar Lake (Jaipur Dist.), as above (*vide* Nevill, 1884). *Elsewhere* : India : West Bengal, Assam, Bihar and Punjab.

*Remarks.*—This form often occurs along with the *forma typica*. Shells are very small and delicate; the largest one (Pl. 19, Figs. 1, 1a) with height 5 mm., diameter 4 mm., whorls 4.

## Family MELANIDÆ

### 13. *Melanoides (Melanoides) tuberculatus* (Müller)

The Tuberled Melania

(Plate 19, Figs. 2, 2a)

1774. *Nerita tuberculata* Müller, *Verm. Terr. Fluv. Testacea*, Havniae & Lipsiae, 2, p. 191.

1906. *Melania tuberculatus*, Comber, *J. Bombay nat. Hist. Soc.*, 17(1), p. 216.

1919. *Melanoides tuberculatus*, Annandale & Prasad, *Rec. Indian Mus* Calcutta, 18, pp. 31, 32, Pl. IV, Fig. 1.

*Material*.—Rajasthan : Coll. C. A. Hackett : 6 exs., no exact locality, no date.

Barmer District : Coll. K. K. Tiwari & S. Biswas : 475 exs., Sta. 8, Luni R. at Syndhri, ca. 58 km. from Balotra, 10. ii. 58.

Chittorgarh District : Coll. B. N. Chopra & M. L. Roonwal : 5 exs ; Sta. 1, R. Berach (Bedach) nr. Chittorgarh, 8-9. x. 41.

Jaipur District : Coll. T. G. Vazirani : 5 exs., Sambhar Lake nr. new *kyārs*, 29. v. 58. Coll. A. K. Mukherjee : 4 exs., Sta. 17, Gudha nr. Sambhar Lake, 10. vii. 58.

Pali District : Coll. K. S. Pradhan : 10 exs., Jogmandi *jharna* (waterfall) ca. 19 km. from Phulad, 3. iii. 48.

Sirohi District : Coll. K. S. Pradhan : (i) 18 exs., Kudra Dam, Mount Abu, 8. iii. 48. (ii) 8 exs., Gora Chapra *nullāh* (stream), ca. 3 km. E. of Abu Dak Bungalow, Mount Abu, 10. iii. 48.

Udaipur District : Coll. B. N. Chopra & M. L. Roonwal : 6 exs., Sta. 10, a large tank, ca. 5 km. N. of Parsad (Palsad), 26-27. x. 41. Coll. K. S. Pradhan : 1 ex., Rajsamand Lake, ca. 32 km. N. of Mavli (in water rich in aquatic vegetation), 27. ii. 48.

*Distribution*.—Rajasthan : Nevill (1884, p. 239) gave no exact locality. Other localities as mentioned above (districts of Barmer, Chittorgarh, Jaipur, Pali, Sirohi and Udaipur) are new records. *Elsewhere* : Very widespread : From southern and eastern shores of the Mediterranean and Africa to Asia (India, Ceylon, Burma, East and West Pakistan, Iran, Afghanistan, Malay Peninsula and Archipelago, China) and Philippines and Australia (see Annandale, 1918*a*, pp. 114, 115, 157 ; 1918*b*, p. 163 ; Benthem Jutting, 1956, pp. 412-418).

The occurrence of this species in prehistoric Jericho, Jordan (dating back to 5,000—7,000 years), is indicated by Biggs (1960).

*Remarks*.—Specimens are greatly variable in shape, size, etc., of their shells. The largest example (Pl. 19, Figs. 2, 2*a*) is from Jogmandi *jharnā* (height 22 mm., diameter 7.5 mm., whorls 6).

#### 14. \**Melanoides* (*Melanoides*) *pyramis* (Hutton)

##### The Pyramid Melania

(Plate 19, Figs. 3, 3*a*)

1850. *Melania pyramis* Hutton, *J. Asiat. Soc. Bengal*, Calcutta, 18(2), p. 658.

1919. *Melanoides pyramis*, Annandale & Prashad, *Rec. Indian Mus.*, Calcutta, 18, p. 32, Pl. IV, Fig. 3.

*Material*.—Jodhpur District : Coll. D. & G. P. R. S. : 1 ex., Mandore Canal, ca. 10 km. N. of Jodhpur, 22. ii. 61.

**Distribution.**—*Rajasthan* (first record) : Mandore Canal (Jodhpur Dist.), as above. *Elsewhere* : India : Quite common in the Gangetic plains. Also West Pakistan (Baluchistan), Iran and Iraq.

**Remarks.**—The single shell shows the typical features of *pyramis* and has height 23.5 mm., diameter 8 mm., whorls 9.

### Family PLANORBIDAE

#### 15. \**Indoplanorbis exustus* (Deshayes)

(Plate 19, Fig. 5)

1834. *Planorbis exustus* Deshayes, *Belang. Voy. Ind.-Orient. Zool. Moll.*, Paris, p. 417, Pl. 1, Figs. 11-13.

1921. *Planorbis* (*Panorbis*) *cxustus.*, Germain, *Rec. Indian Mus.*, Calcutta, 21, pp. 26-33, Pl. 1, Figs. 4-9.

1921. *Indoplanorbis exustus*, Annandale & Prashad, *Rec. Indian Mus.*, Calcutta, 22, pp. 578-582, Figs. 14A, B, genitalia (p. 579).

**Material.**—Ajmer District : Coll. *B. Biswas* : (i) exs., Sta. 18, Nasirabad, 29. xi. 56. (ii) 2 exs., Sta. 17, Chat, ca. 6 km. S. of Nasirabad, 28. xii. 56.

Barmer District : Coll. *K. K. Tiwari & S. Biswas* : (i) 1 ex., Sta. 6, rocky hill, S. W. of Barmer town, 26. i. 58. (ii) 4 exs., Sta. 9, nr. Circuit House, Panchpadra Salt Depot, 11. ii. 58. (iii) 18 exs., Sta. 9, salt pits, N. E. of Circuit House, Panchpadra Salt Depot, 12. ii. 58. (iv) 12 exs., Sta. 9, E. of Circuit House, Panchpadra Salt Depot, 14. ii. 58. Coll. *S. Biswas* : 2 exs., Balu R. bed, 7. i. 59.

Bikaner District : Coll. *B. Biswas* : 7 exs., Kotra, ca. 3 km. N. of Kolayat, 15. x. 60.

Churu District : Coll. *B. Biswas* : 55 exs., Sta. 43, a tank, S. of Tara-nagar, 26. x. 60.

Dungarpur District : Coll. *B. N. Chopra & M. L. Roonwal* : 18 exs., Sta. 13, tank and pools around Dungarpur town, 28. x. 41.

Ganganagar District : Coll. *B. Biswas* : (i) 2 exs., Sta. 26, Diplana, ca. 13 km. E. of Nohar, 13. x. 60. (ii) 12 exs., Sta. 31, Badbirana, ca. 16 km. S. E. of Nohar, 15. x. 60. (iii) 2 exs., Sta. 34, Asarjana, ca. 18 km. N. W. of Nohar, 15. x. 60. (iv) 6 exs., Sta. 38, Bhukarka, ca. 10 km. N. W. of Nohar, 16. x. 60.

Jaipur District : Coll. *B. Biswas* : (i) 9 exs., Bandi Nadi (river) at Sanodia, ca. 14 km. S. W. of Sambhar, 25. xi. 56. Coll. *S. Biswas* : (i) 6 exs., Sta. 3, Japog, Sambhar Lake, 12. xi. 56. (ii) 8 exs., Ratan *tālāb* (tank) (No. 5), ca. 3 km. S. of Japog, 2. ix. 58. (iii) 2 exs., a ditch nr. Sambhar Lake, Gudha, 9. x. 58. (iv) 36 exs., Gudha *tālāb* (tank) (No. 4), ca. 2 km. N. W. of Gudha village, 22. x. 58. (v) 3 exs., Dhobala tank, Narayana, 31. x. 58. (vi) 7 exs., Kalo *tālāb* (No. 5), Narayana, 1. xi. 58. (vii) 32 exs., Narayana *tālāb* (No. 4), Narayana, 2. xi. 58.

(viii) 3 exs., Gudha *tālāb* (No. 2), 20. ix. 58. (ix) 3 exs., Bala *tālāb* (No. 14), *ca.* 5 km. S. E. of Julguh, 24. xi. 58. (x) 28 exs., Dudu, on side of main road to Jaipur, 7. i. 59. (xi) 7 exs., Sambhar Lake nr. Gudha *kyārs*, 30. viii. 59. Coll. *A. K. Mukherjee* : (i) 10 exs., Sta. 22, Ratan *tālāb* (tank) nr. Sambhar Lake, 9. i. 58. (ii) 2 exs., Sta. 23, Chapparwara, 20. vii. 58. Coll. *T. G. Vazirani* : (i) 5 exs., Ratan *tālāb* (tank), Gudha, 3. ii. 58. (ii) 1 ex., Gudha, 8. iii. 58.

Jaisalmer District : Coll. *K. K. Tiwari & S. Biswas* : (i) 16 exs., Sta. 2, Salamsar, S. W. of Rest House, Pokran, 20. xii. 57. (ii) 8 exs., Sta. 2, Ranisar a large tank, S. W. of Rest House at Pokran, 20. xii. 57. (iii) 13 exs., Sta. 2, Ramdesar at Ramdeora, Pokran, 20-21. xii. 57. (iv) 2 exs., Sta. 2, a dried up pond nr. Sati shrine, *ca.* 2 km. W. of Rest House, Pokran, 22. xii. 57. (v) 8 exs., Sta. 3, Didansagar, *ca.* 3 km. E. of Jaisalmer town, 25. xii. 57. (vi) 3 exs., Sta. 3, Golabsagar tank, Jaisalmer, 26. xii. 57. (vii) 1 ex., Sta. 3, Gadisar, E. of Dak Bungalow, Jaisalmer, 28. xii. 57. (ix) 18 exs., Sta. 3, W. of Gadisar, Jaisalmer, 30. xii. 57. (x) 4 exs., Sta. 4, Geodiasar, *ca.* 19 km. S. of Ramgarh, 7. i. 58. (xi) 18 exs., Jedbaisar, *ca.* 21 km. E. of Jaisalmer, 21. i. 58.

Jhunjhunu District : Coll. *B. Biswas* : (i) 11 exs., Sta. 56, Malsisar, *ca.* 35 km. N. W. of Jhunjhunu, 4. xi. 60.

Jodhpur District : Coll. *B. Biswas* : (i) 4 exs., Sta. 24, Kailna Lake, *ca.* 8 km. W. of Jodhpur, 14. xii. 56. (ii) 28 exs., Sta. 25, Beriganga R., *ca.* 16 km. N. of Jodhpur, 19-20. xii. 56. Coll. *Dr. K. K. Tiwari & S. Biswas* : (i) 74 exs., Sta. 1, Ranisar tank, Phalodi, 13 & 15. xii. 57. (ii) 30 exs., Sta. 1, Khetri *nullāh* (stream), Phalodi, 14. xii. 57. (iii) 3 exs., Sta. 1, Ramsar tank, Phalodi, 14. xii. 57. (iv) 60 exs., Sta. 1, Shivasagar tank, Phalodi, 15. xii. 57. (v) 84 exs., Sta. 2, Magdasar tank, Bap, *ca.* 30 km. N. of Phalodi, 15. xii. 57. (vi) 8 exs., Sta. 1, on land nr. Shivasagar, Phalodi, 16. xii. 57. Coll. *D. & G. P. R. S.* : 11 exs., Mandore Canal, *ca.* 10 km. N. of Jodhpur, 25. x. 60.

Nagaur District : Coll. *B. Biswas* : (i) 10 exs., Nawa nr. Sambhar Lake, 16. xi. 56. (ii) 14 exs., Sta. 27, Merta, 26. xii. 56. (iii) 11 exs., Sta. 30, a pond in Merta, 28. xii. 56. (iv) 25 exs., a tank, N. of Singar, *ca.* 16 km. W. of Nagaur, 3. ix. 60. (v) 28 exs., Sta. 6, a tank at Basni, *ca.* 8 km. W. of Nagaur, 3. ix. 60. (vi) 1 ex., Sta. 8, a tank at Didia, *ca.* 20 km. S. E. of Nagaur, 14. ix. 60. (vii) 8 exs., Sta. 11, a tank at Balwa, *ca.* 8 km. N. W. of Nagaur, 5. ix. 60. (viii) 14 exs., Sta. 13, a tank at Imirti, *ca.* 16 km. S. W. of Nagaur, 6. ix. 60. (ix) 11 exs., Sta. 14, a tank at Kharnal, *ca.* 17 km. S. W. of Nagaur, 16. ix. 60. (x) 25 exs., Sta. 14, a tank at Bhakrod, *ca.* 24 km. S. W. of Nagaur, 16. ix. 60. Coll. *A. K. Mukherjee* : 10 exs., Sta. 20, Julga nr. Sambhar Lake, 24. vii. 58. Coll. *S. Biswas* : 3 exs., Sta. 13, Kuchaman Road, 5. ix. 58.

Pali District : Coll. *K. S. Pradhan* : 2 exs., stagnant pool, *ca.* 19 km. from Phulad Railway Station nr. Jogmandi *jharnā* (stream), 3. iii. 48. Coll. *B. Biswas* : (i) 1 ex., Sta. 21, Hemawas tank, *ca.* 8 km. S. of Pali, 5. xii. 56.

Sikar District : Coll. *B. Biswas* : (i) 1 ex., Sta. 82, a tank, S. E. of Sikar, 15. xi. 60.

Udaipur District : Coll. *B. N. Chopra & M. L. Roonwal* : (i) 24 exs., Sta. 4, a *bāori* (tank) nr. Dak Bungalow, Barapal village, *ca.* 24 km. from Udaipur, 13-14. x. 41. (ii) 74 exs., Sta. 3, Barapal-ka-*nullah* (stream), nr. Barapal village, *ca.* 24 km. S. of Udaipur, 14. x. 41. (iii) 45 exs., Sta. 6, a large tank close to Dak Bungalow, Barapal village, *ca.* 24 km. S. of Udaipur, 15. x. 41. (iv) 12 exs., Sta. 10, a large tank, *ca.* 5 km. N. of Parsad (Palsad), 16 & 21. x. 41. (v) 2 exs., Sta. 7, Parai-ki-Nadi (Parai streamlet), *ca.* 2 km. S. of Parsad (palsad), 17 & 23. x. 41. Coll. *K. S. Pradhan* : 4 exs., Nathela tank, *ca.* 1 km. from Mavli, 28. ii. 48. Coll. *D. & G. P. R. S.* : 1 ex., Ahar R., *ca.* 4 km. S. of railway bridge, Udaipur, 24. xii. 61.

*Distribution.*—*Rajasthan* (first record) : Localities mentioned above (districts of Ajmer, Barmer, Bikaner, Churu, Dungarpur, Ganganagar, Jaipur, Jaisalmer, Jhunjhunu, Jodhpur, Nagaur, Pali, Sikar and Udaipur). *Elsewhere* : Very common throughout Asia (India, East and West Pakistan, Ceylon, Burma, Malay Peninsula and Archipelago, Indo-China, Thailand, China, Tibet, Iran).

Sewell (1931) recorded this giant Planorbid mollusc from the prehistoric excavations at Mohenjodaro, Sind.

*Remarks.*—This is a very common species and forms the largest series in the collection showing various stages of growth and development of the shells from the bulla stage to the adult form. The largest example is from Nasirabad (height 9 mm., diameter 18.5 mm.). The example illustrated here from Jaisalmer (Pl. 19, Fig. 5) measures : height 7 mm. and diameter 19 mm. This mollusc is the carrier of a serious cattle-pest, *Schistosoma spindalis*.

## 16. *Gyraulus convexiusculus* (Hutton)

(Plate 19, Fig. 4)

1849. *Planorbis convexiusculus* Hutton, *J. Asiat. Soc., Bengal*, Calcutta, 18(2), p. 657.

1921. *Planorbis* (*Gyraulus*) *convexiusculus*, Germain, *Rec. Indian Mus.*, Calcutta, 21, pp. 118-121.

*Material.*—Jaipur District : Coll. *F. Stoliczka* : (i) 9 exs., Sambhar Lake, no date. Coll. *A. K. Mukherjee* : (i) 8 exs., Sta. 22, Ratan *tālāb* (tank), 9. i. 58. (ii) 2 exs., Sta. 23, Chapparwara Lake, 20, vii. 58. Coll. *S. Biswas* : (i) 3 exs., Sta. 7, Chapparwara Bund Reservoir, *ca.* 40 km. from Sambhar, 30. ix. 58. (ii) 4 exs., Sta. 6, Debdani Temple tank nr. Sambhar, 13. xi. 58.

Jodhpur District : Coll. *D. & G. P. R. S.* : 2 exs., Mandore Canal, *ca.* 10 km. N. of Jodhpur, 25. x. 60.

Nagaur District : Coll. *S. Biswas* : 8 exs., Sta. 13, Kuchaman Road, 15. ix. 58.

Sirohi District : Coll. *K. S. Pradhan* : (i) 8 exs., Kudra Dam, Mount Abu, 8. iii. 48. (ii) 7 exs., Gora Chapra *nullāh* (stream), *ca.* 3 km. E. of Abu Dak Bungalow, Mount Abu, 10. iii. 48.

Udaipur District : Coll. *B. N. Chopra & M. L. Roonwal* : 4 exs., Sta. 10, a large tank, *ca.* 5 km. N. of Parsad (Palsad), 26-27. x. 41. Coll. *D. & G. P. R. S.* : 4 ex., Pichola Lake, *ca.* 7 km. W. of Udaipur Railway Station, 24. xii. 61.

*Distribution.*—*Rajasthan* : Sambhar Lake (Jaipur Dist., *vide* Nevill, 1878, p. 244 ; Germain, 1921, p. 121). Other localities as mentioned above (districts of Jaipur, Jodhpur, Nagaur, Sirohi and Udaipur) are new records. *Elsewhere* : Throughout Asia (India, Ceylon, Burma, East and West Pakistan, Iran, Afghanistan, Malay Peninsula and Archipelago, Indo-China, Thailand, China, Philippines and Japan) (*see* Annandale & Prashad, 1919, pp. 52-54 ; Benthem Jutting, 1956, pp. 463-466).

*Remarks.*—The species is represented by a good series of typically flattened small shells of different sizes and in different phases of growth ; the periphery is subangular. The largest example (Pl. 19, Fig. 4) is from Chapparwara Lake (height 1.5 mm., diameter 5 mm.).

#### Family LYMNAEIDAE

#### 17. \**Lymnaea* (*Pseudosuccinea*) *acuminata* Lamarck

##### The Acuminated Lymnaea

##### (i) Form *typica* Lamarck

(Plate 19, Figs. 6, 6a)

1822. *Limnaea acuminata* Lamarck, *Hist. Nat. Anim. sans Vericb.*, Paris, 6(2), p. 160.

1925. *Limnaea* (*Pseudosuccinea*) *acuminata* f. *typica*, Annandale & Rao, *Rec. Indian Mus.*, Calcutta, 27, p. 156, 180, 181, 189, fig. iii, nos. 3 & 5.

*Material.*—Jaipur District : Coll. *A. K. Mukherjee* : 3 exs., Sta. 23, Chapparwara nr. Sambhar Lake, 20. vii. 58. Coll. *S. Biswas* : 1 ex., Sta. 6, Chapparwara Bund Reservoir, *ca.* 4 km. from Sambhar, 30. ix. 58.

Jodhpur District : Coll. *D. & G. P. R. S.* : (i) 3 exs., Mandore Canal, *ca.* 10 km. N. of Jodhpur, 19. ii. 61. (ii) 1 ex., Kailna Lake, *ca.* 1 km. N. W. of Jodhpur, 19. ii. 61.

Sirohi District : Coll. *K. S. Pradhan* : (i) 1 ex., a *nullāh* (streamlet) nr. Dilwara Temple, Mount Abu, 7. iii. 48.

Udaipur District : Coll. *K. S. Pradhan* : (i) 2 exs., a small pool nr. Rajsamand, *ca.* 32 km. N. of Mavli, Udaipur, 27. ii. 48. Coll. *D. & G. P. R. S.* : 1 ex., Pamri *Nadi*, a tributary of Wokal R., *ca.* 8 km. N. of Kotra ; Udaipur, 21. xii. 61.

*Distribution.*—*Rajasthan* : No exact locality (Nevill, 1878, p. 234 ; Annandale & Rao, 1925, p. 156). Other localities as mentioned above (district of Jaipur, Jodhpur, Sirohi and Udaipur) are new records. *Elsewhere* : India : Common throughout. Also East and West Pakistan and Burma.

*Remarks.*—The largest example (P. 19, Figs. 6, 6a) from a deep water pool nr. Trevor *tāl* (Mt. Abu) has height 17.5 mm., diameter 11.5 mm. and whorls 4.

(ii) \*Form **patula** Troschel

(Plate 19, Figs. 7, 7a)

1837. *Limnaeus patulus* Troschel, in Wiegmann's *Arch. f. Naturges.*, Berlin, 3, p. 167.

1925. *Limnaea (Pseudosuccinea) acuminata* f. *patula*, Annandale & Rao, *Rec. Indian Mus.*, Calcutta, 27, p. 181, fig. iii, no. 9.

*Material.*—Pali District : Coll. K. S. Pradhan : 3 exs., a pond on sandy bed of Phulad R., ca. 2 km. S. of Phulad Railway Station. 1. iii. 48.

Udaipur District : Coll. B. N. Chopra & M. L. Roonwal : 3 exs., Sta. 8, Parsad-ka-*nullāh* (Parsad stream) nr. Dak Bungalow at Parsad (Palsad), 18-19. x. 41. Coll. K. S. Pradhan : 50 exs., Udaipur, 17. iii. 48. Coll. D. & G. P. R. S. : 1 ex., Pichola Lake, ca. 7 km. W. of Udaipur Railway Station, 24. xii. 61.

*Distribution.*—*Rajasthan* (first record) : Localities as mentioned above (districts of Pali and Udaipur). *Elsewhere* : India : As common as *forma typica*. Also West Pakistan, Nepal and Burma.

*Remarks.*—The largest example (Pl. 19, Figs. 7, 7a) is from Udaipur (height 26.5 mm., diameter 15 mm., whorls  $3\frac{1}{2}$ ).

(iii) \*Form **chlamys** Benson

The Cloak *Lymnaea*

(Plate 19, Figs. 8, 8a)

1836. *Limnaea chlamys* Benson, *J. Asiat. Soc. Bengal*, Calcutta, 5, p. 744.

1925. *Limnaea (Pseudosuccinea) acuminata* f. *chlamys*, Annandale & Rao, *Rec. Indian Mus.*, Calcutta, 27, p. 181, fig. iii, no. 6.

*Material.*—*Rajasthan* : 4 exs., no exact locality.

Pali District : Coll. K. S. Pradhan : (i) 10 exs., Phulad R. (with rocky and pebbly bottom and swift current), ca. 2 km. S. of Phulad Railway Station, 1. iii. 48.

Sirohi District : Coll. K. S. Pradhan : (i) 4 exs., a *nullāh* (stream), nr. Dilwara Temple, Mount Abu, 7. iii. 48. (ii) 84 exs., Gora Chapra *nullāh* (stream), ca. 3 km. E. of Abu Dak Bungalow, Mount Abu, 10. iii. 48.

**Distribution.**—*Rajasthan* (first record) : Localities mentioned above (districts of Pali and Sirohi). *Elsewhere* : India : As common as the form *patula*.

**Remarks.**—This form is represented by a good series. The largest example (Pl. 19, Figs, 8, 8a) is from “*Rajasthan*” (no exact locality) and has height 23 mm., diameter 13.5 mm., whorls  $4\frac{1}{2}$ .

(iv) \*Form *rufescens* (Gray)

The Reddish *Lymnaea*

(Plate 19, Figs. 9, 9a)

1820. *Limnaea rufescens* Gray, in Sowerby's *Genera of Shells*, London, 1, *Limnaea*, Fig. 2.

1925. *Limnaea* (*Pseudosuccinea*) *acuminata* f. *rufescens*, Annandale & Rao, *Rec. Indian Mus.*, Calcutta, 27, p. 181, Fig. iii, no. 10.

**Material.**—Jodhpur District : Coll. D. & G.P.R.S. i (i) 7 exs. Mandore Canal, ca. 8 km. N. of Jodhpur, 19. ii. 61. (ii) 14 exs., Mandore Canal, ca. 10 km. N. of Jodhpur, 22.ii.61.

Udaipur District : Coll. B. N. Chepra & M. L. Roonwal : 16 exs., Sta. 10, a large tank, ca. 5 km. N. of Parsad (Palsad), 16-21.x.41.

**Distribution.**—*Rajasthan* (first record) : Localities as mentioned above (districts of Jodhpur and Udaipur). *Elsewhere* : India : As common as the forms *chlamys* and *patula*. Also East Pakistan and Burma.

**Remarks.**—Though a reddish tinge is not visible in all the specimens, other peculiarities show beyond doubt that they belong to the form *rufescens*. The largest example (Pl. 19, Figs. 9, 9a) is from a large tank nr. Parsad, and has height 25 mm., diameter 12 mm., whorls  $4\frac{1}{2}$ .

18. \**Lymnaea* [*Pseudosuccinea*] *luteola* Lamarck

(i) \*Form *typica* Lamarck

The Yellowish *Lymnaea*

(Plate 19, Figs. 10, 10a)

1822 *Limnaea luteola* Lamarck, *Hist. Nat. Anim. sans Verteb.*, Paris, 6(2), p. 160.

1925. *Limnaea* (*Pseudosuccinea*) *luteola* f. *typica*, Annandale & Rao, *Rec. Indian Mus.*, Calcutta, 27 p. 184, fig. iv, no. 1.

**Material.**—Pali District : Coll. K. S. Pradhan 2 exs., Jogmandi *Jharna* (stream), ca. 19 km. from Phulad, 3.iii.48.

Sirohi District : Coll. *K. S. Pradhan* : 8 exs., Gora Chapra nullāh (stream), ca. 3 km.E. of Abu Dak Bungalow, Mount Abu, 10.iii.48.

Udaipur District : Coll. *D. & G. P. R. S.* : 6 exs., a channel, ca. 1 km. S. of Kankroli, Udaipur, 24.xii.61.

*Distribution.*—*Rajasthan* (first record) : Localities as mentioned above (districts of Pali, Sirohi and Udaipur). *Elsewhere* : India : More common throughout than *L. acuminata*. Also East and West Pakistan, Burma and Nepal (Pharping).

*Remarks.*—The few shells in the collection, though rather damaged, show the typical features of *luteola*. The largest example is from the Gota Chapra nullāh, and has height 22 mm., diameter 12 mm. and whorls  $4\frac{1}{2}$ , while that illustrated here (Pl. 19, Figs. 10, 10a), from Kankroli, has height 19.5 mm., diameter 12 mm. and whorls 5.

(ii) Form *australis* Annandale & Rao, 1925

(Plate 19, Figs. 11, 11a)

1925. *Limnaea (Pseudosuccinea) luteola* f. *australis* Annandale & Rao, *Rec. Indian Mus.*, Calcutta, 27, p. 184, fig. iv, no. 3.

1943. *Limnaea (Pseudosuccinea) luteola* f. *australis*, Ray, J. Roy, *Asiat. Soc. Bengal (Sci.)*, Calcutta, 9, p. 64.

*Material.*—Jaipur District : Coll. *A. K. Mukherjee* : (i) 1 ex., Sta. 22, Ratan tālāb (tank) nr. Sambhar Lake, 9.i.58. (ii) 1 ex., Sta. 23, Chapparwara nr. Sambhar Lake, 20.vii.58.

Jodhpur District : Coll. *D. & G. P. R. S.* : 25 exs., Mandore Canal, ca. 8 km. N. of Jodhpur, 19.ii.61.

Sirohi District : Coll. *K. S. Pradhan* : 1 ex., a nullāh (stream) nr. Dilwara Temple, Mount Abu, 7.iii.48.

Udaipur District : Coll. *B. N. Chopra & M. L. Roonwal* : 2 exs., Sta. 10, a large tank, ca. 5 km. N. of Parsad (Palsad), 26-27.x.41. Coll. *K. S. Pradhan* : (i) 1 ex., a small pool nr. Rajsamand, ca. 32 km. N. of Mavli, 27.ii.48. (ii) 12 exs., Nathela tank, ca. 1 km. from Mavli, 28.ii.48. (iii) 34 exs., Nathela tank, ca. 2 km. from Mavli, 28.ii.48.

*Distribution.*—*Rajasthan* (first record) : Localities as mentioned above (districts of Jaipur, Jodhpur, Sirohi and Udaipur). *Elsewhere* : India : Common throughout. Also Ceylon, East and West Pakistan and Burma.

*Remarks.*—This form is represented by a good series. The largest example is from the Nathela tank nr. Mavli Camp, and has height 18 mm., diameter 11 mm. and whorls  $4\frac{1}{2}$ , while that shown here (Pl. 19, Figs. 11, 11a) is from a pool nr. Rajsamand, and has height 17 mm., diameter 9.5 mm. and whorls  $4\frac{1}{2}$ .

(iii) \*Form *impura* Troschel

(Plate 19, Figs. 12, 12a)

1837. *Limnaeus impurus* Troschel, in Wiegmann's *Arch. f. Naturges.* Berlin, 3, p. 172.

1925. *Limnaea (Pseudosuccinea) luteola* f. *impura*, Annandale & Rao, *Rec. Indian Mus.*, Calcutta, 27, p. 185, fig. iv, no. 7.

**Material.**—Jodhpur District : Coll. D. & G. P. R. S. : 36 exs., Mandore Canal, ca. 10 km. N. of Jodhpur, 22.ii.61.

Nagaur District : Coll. B. Biswas : 11 exs., Sta. 17, a pond in Merta, 26.xii.56.

**Distribution.**—*Rajasthan* (first record) : Mandore Canal (Jodhpur Dist.) and pond in Merta (Nagaur District), as above. *Elsewhere* : India : Common throughout. Also Ceylon and Burma.

**Remarks.**—Though no black deposit is found on the surface of any shell, other important characters clearly indicate their close identity with the form *impura*. The largest example (Pl. 19, Figs. 12, 12a) is from Merta, and has height 18.5 mm., diameter 11 mm. and whorls 5.

## Family UNIONIDAE

19. *Parreysia favidens* (Benson)

The Yellow-toothed Mussel

(Plate 20, Fig. 6)

1862. *Unio favidens* Benson, *Ann. & Mag. Nat. Hist.*, London, (3) 10, p. 188.

(1912) *Parreysia*, (*Parreysia*) *favidens*, Preston, *Rec. Indian Mus.*, Calcutta, 7, pp. 298, 299.

**Material.**—Chittorgarh District : 7 exs., Chittorgarh, 30.iv.1904.

**Distribution.**—*Rajasthan* : Preston (1912, p. 298; 1915, p. 159), no exact locality mentioned. The locality 'Chittorgarh', as mentioned above, is a new record. *Elsewhere* : India : Common throughout. Also East and West Pakistan.

**Remarks.**—Shells small, pale olive-green to olive-yellow, with the umbones prominent in most cases. The largest example (Pl. 20, Fig. 6) has length 37.5 mm., thickness 10 mm., and height 38 mm. (umbones much eroded).

20. \**Parreysia corrugata* (Müller) var. *nagpoorensis* (Lea)

(Plate 20, Fig. 5)

1859. *Unio nagpoorensis* Lea, *Proc. Acad. Nat. Sci. Philad.*, Philadelphia, 3, p. 331.

1915. *Parreysia* (*Parreysia*) *corrugata* var. *nagpoorensis*, Preston, *Faun. Brit. India, Moll.*, London (Gastropoda & Pelecypoda), p. 157.

**Material.**—Chittorgarh District : Coll. *B. N. Chopra & M. L. Roonwal* : 10 exs., Sta. 1, R. Berach (Bedach) nr. Chittorgarh, 8-9.x.41.

**Distribution.**—*Rajasthan* (first record) : R. Berach (Chittorgarh Dist.), as above. *Elsewhere* : India : West Bengal, Andhra Pradesh, Madras State and Maharashtra. Also recorded from the excavations of Navasa in Maharashtra (Ray, 1960, p. 547).

**Remarks.**—Shells mostly olive-yellow. The largest example (Pl. 20, Fig. 5) has length 33 mm., thickness 16 mm., height 25 mm.

## 21. *Indonaia caerulea* (Lea)

### The Caeruleus Mussel

(Plate 20, Fig. 4)

1834. *Unio caeruleus* Lea, *Trans. Amer. Philos. Soc.*, Philadelphia, 4, p. 95, Pl. XIII, fig. 25.

1912. *Nodularia (Nodularia) caerulea*, Preston, *Rec. Indian Mus.*, Calcutta, 7, pp. 288, 289.

**Material.**—*Rajasthan* : 10 exs., no locality, 23.v.10.

Chittorgarh District : Coll. *B. N. Chopra & M. L. Roonwal* : 31 exs., Sta. 1, R. Berach (Bedach) nr. Chittorgarh, 8-9.x.41.

Pali District : Coll. *K. S. Pradhan* : 44 exs., a pool on sandy bed of R. Phulad, ca. 2 km. S. of Phulad Railway Station, 1.iii.48.

Udaipur District : Coll. *D. & G. P. R. S.* : 1 ex., Wokal R., ca. 2 km. E. of Kotra, Udaipur, 20.xii.61.

**Distribution.**—*Rajasthan* : Preston (1921, p. 289 ; 1915, p. 136) gave no locality except 'Rajputana'. Other localities as mentioned above (districts of Chittorgarh, Pali and Udaipur) are new records. *Elsewhere* : India : Quite common throughout. Also East and West Pakistan, Burma and Nepal. Also recorded from the excavations of Navasa in Maharashtra (Ray, 1960, p. 546).

**Remarks.**—The largest example (Pl. 20, Fig. 4) in the series measures : length 50 mm., thickness 19 mm., height 29 mm.

## 22. *Indonaia occata* (Lea)

### The Harrowed Mussel

(Plate 20, Fig. 3)

1860. *Unio occatus* Lea, *Proc. Acad. Nat. Sci. Philad.*, Philadelphia, 4, p. 307.

1921. *Indonaia occata*, Prashad, *Rec. Indian Mus.*, Calcutta, 22, p. 603.

**Material.**—Pali District : Coll. K. S. Pradhan : 2 exs., a pool on sandy bed of R. Phulad, ca. 2 km. S. of Phulad Railway Station, 1. iii.48.

**Distribution.**—*Rajasthan* (first record) : Phulad R. (Pali Dist.), as above. *Elsewhere* : India : West Bengal, Assam, Uttar Pradesh and Madhya Pradesh. Also Burma.

**Remarks.**—Both the specimens are small and found closely associated with those of *Indonaia caerulea*, but easily distinguishable from the latter by their surface being characteristically occated throughout.

The larger example (Pl. 20, Fig. 3) measures : length 11 mm., thickness 4 mm. and height 6 mm.

### 23. \**Lamellidens corrianus* (Lea)

The Corrie's Mussel

(Plate 20, Fig. 1)

1834. *Unio corrianus* Lea, *Trans. Amer. Philos. Soc.*, Philadelphia, 6, P. 65, Pl. IX, Fig. 25.

1921. *Lamellidens corrianus*, Prashad, *Rec. Indian Mus.*, Calcutta, 22, pp. 605-609, Fig. 29c (p. 607).

**Material.**—*Rajasthan* : 1 ex., no exact locality, 4.v.10.

**Distribution.**—*Rajasthan* (first record) : No exact locality mentioned except 'Rajputana' *Elsewhere* : India : Almost as widespread as *L. marginalis* which is the commonest freshwater mussel of India. Also East Pakistan and Burma (see Prashad, 1922 ; Marshall, 1922).

**Remarks.**—The single shell (Pl. 20, Fig. 1) was found in the Z.S.I. Collections labelled as "*Lamellidens marginalis* Lamarck, Loc. Rajputana" but it is actually *L. corrianus*. Measurements : length 78 mm., thickness 26 mm. and height 38 mm.

## Family CORBICULIDAE

### 24. \**Corbicula striatella* Deshayes

The Small Striated Corbicula

(Plate 20, Fig. 2)

1854. *Corbicula striatella* Deshayes, *Proc. Zool. Soc. Lond.*, London, 22, p. 344.

1928. *Corbicula striatella*, Prashad, *Mem. Indian Mus.*, Delhi, 9, pp. 18-20, Pl. III, Figs. 9-11.

**Material.**—Chittorgarh District : Coll. B. N. Chopra & M. L. Roonwal : 2 exs., Sta. 1, R. Berach (Bedach) nr. Chittorgarh, 8-9.x.41.

**Distribution.**—*Rajasthan* (first record) : R. Berach (Chittorgarh Dist.), as above. *Elsewhere* : India : Quite common throughout. Also East and West Pakistan, Ceylon and Burma.

**Remarks.**—The two shells available were obtained along with specimens of *Indonaia caerulea*. A comprehensive account of the Indian Corbiculidae is given by Prashad (1928).

## (C) MARINE MOLLUSCS (FROM EXCAVATIONS)

Since the four species included in this category were based on the study of shell-remains only which were unearthed in an ancient mound near Sambhar Lake, by the department of Archaeology and Historical Research, of the erstwhile Jaipur State, Jaipur, and returned to that department after identification, in 1938, by the Zoological Survey of India, it has not been possible to illustrate them here. The species are included here for the sake of completeness of this account.

It is presumed that these marine forms must have been imported into Rajasthan from the neighbouring sea coast.

## Family XANCIDAE

25. \**Xancus pyrum* (Linnaeus)(i) \*Form *pyrum* (Linnaeus)

## The Sacred Chank

1767. *Voluta pyrum* Linnaeus, *Syst. Nat.*, Holmiae, ed. 12, p. 1195, No. 438.

1960. *Xancus pyrum pyrum*, Ray, *Navasa Excavation Publication No. 1*, University of Poona, Poona, pp. 537, 538, 540, 549. Figs. 212 (Nos. 24, 25) and 213 (Nos. 3-5).

*Distribution.*—*Rajasthan* (first record) : An ancient mound near Sambhar Lake (Jaipur Dist.).

*Elsewhere* : India : Tranquebar Coast (Madras State) and Bombay (Maharashtra). For details regarding the economic importance of this Sacred Chank, see Ray (1960), and for other information, see Winckworth (1939).

*Remarks.*—Only the top portion of the shell was found.

## Family CYPRAEIDAE

26. *Erosaria lamarckii* (Gray)(i) \*Race *redimita* (Melvill)

1888. *Cypraea lamarckii* var. *redimita* Melvill, *Mem. & Proc., Manch. Lit. & Philos. Soc.*, Manchester, (4) 1, pp. 226, 249, Pl. II, Fig. 16.

1938. *Erosaria (Erosaria) lamarckii* race *redimita*. Schilder & Schilder, *Proc. Malac. Soc. Lond.*, London, 23, p. 139, No. 33A.

*Distribution.*—*Rajasthan* (first record) : An ancient mound near Sambhar Lake (Jaipur Dist.) *Elsewhere* : Very widespread : East Africa and Persian Gulf to West Pakistan (Karachi), India, Ceylon, Burma (Mergui) and Sumatra.

*Remarks.*—The shell, though worn out and damaged, appears to be identical with race *redimita*. This cowry is used as an amulet and also for decoration and ornaments.

## Family OLIVIDAE

27. \**Olivancillaria* (*Olivancillaria*) *acuminata* (Lamarck)

## The Acuminated Oliva

1811. *Oliva acuminata* Lamarck, *Ann. du. Mus.*, Paris, 16, p. 323.

1883. *Oliva* (*Agaronia*) *acuminata*, Tryon, *Man. Conch.*, Philadelphia, 5, pp. 88, 89, Pl. XXXV, Fig. 71.

*Distribution.*—*Rajasthan* (first record) : An ancient mound near Sambhar Lake (Jaipur Dist.). *Elsewhere* : Coast of West Africa (Senegal and Gambia) and Arabia (Aden) to India, East Indies and Philippines.

*Remarks.*—The shell is small and slender, with the spire elevated and acuminate but slightly damaged. This *Oliva* shell is used as an amulet and for ornaments.

## Family PTERIIDAE

28. \**Pinctada margaritifera* (Linnaeus)

## The Black-lip Oyster

1758. *Mytilus margaritiferus*, Linnaeus, *Syst. Nat.*, Holmiae, ed. 10, p. 704, No. 209.

1933. *Pinctada margaritifera*, Prashad & Bhaduri, *Rec. Indian Mus.*, Delhi, 35, pp. 167-168.

*Distribution.*—*Rajasthan* (first record) : An ancient mound near Sambhar Lake (Jaipur Dist.). *Elsewhere* : More common in the Persian Gulf than in the Indian seas. This Oyster also occurs in the, Red Sea, East Africa, Ceylon, Burma (Mergui and its Archipelago), Cocos-Keeling Islands, Papua, Pulo-Condor, Solomon Islands, Philippines and Australia.

*Remarks.*—This large and 'Black-lip' mother-of-pearl oyster was represented only by a broken piece of shell. Hornell (1921) and Talavera & Faustino (1931) refer to its economic importance, while Prashad (1932) and Prashad & Bhaduri (1933) give other details about it.

## V—SUMMARY

1. A comprehensive systematic account of the molluscan fauna of Rajasthan is given here for the first time, and is based mainly on extensive collections made by the survey parties of the Zoological Survey of India during the years 1941-61. The few earlier published accounts in the literature make only casual references to a few species.

2. The present account includes 36 forms, of which 6 are land molluscs, 26 freshwater molluscs and 4 marine molluscs (obtained as shell-remains from excavations of an ancient mound near Sambhar Lake). Specimens were available for all these species except one, *Boysia oysisi* (Pfeiffer), which is included on the basis of literature only.

3. Out of these 36 forms, 25 marked with an asterisk (\*) in the text are new records from Rajasthan. Although the remaining 11 are not new records from this area, their earlier published references are sketchy and in many cases no exact locality is given, merely "Rajputana" being mentioned and the locality records given in the present account are in most cases new.

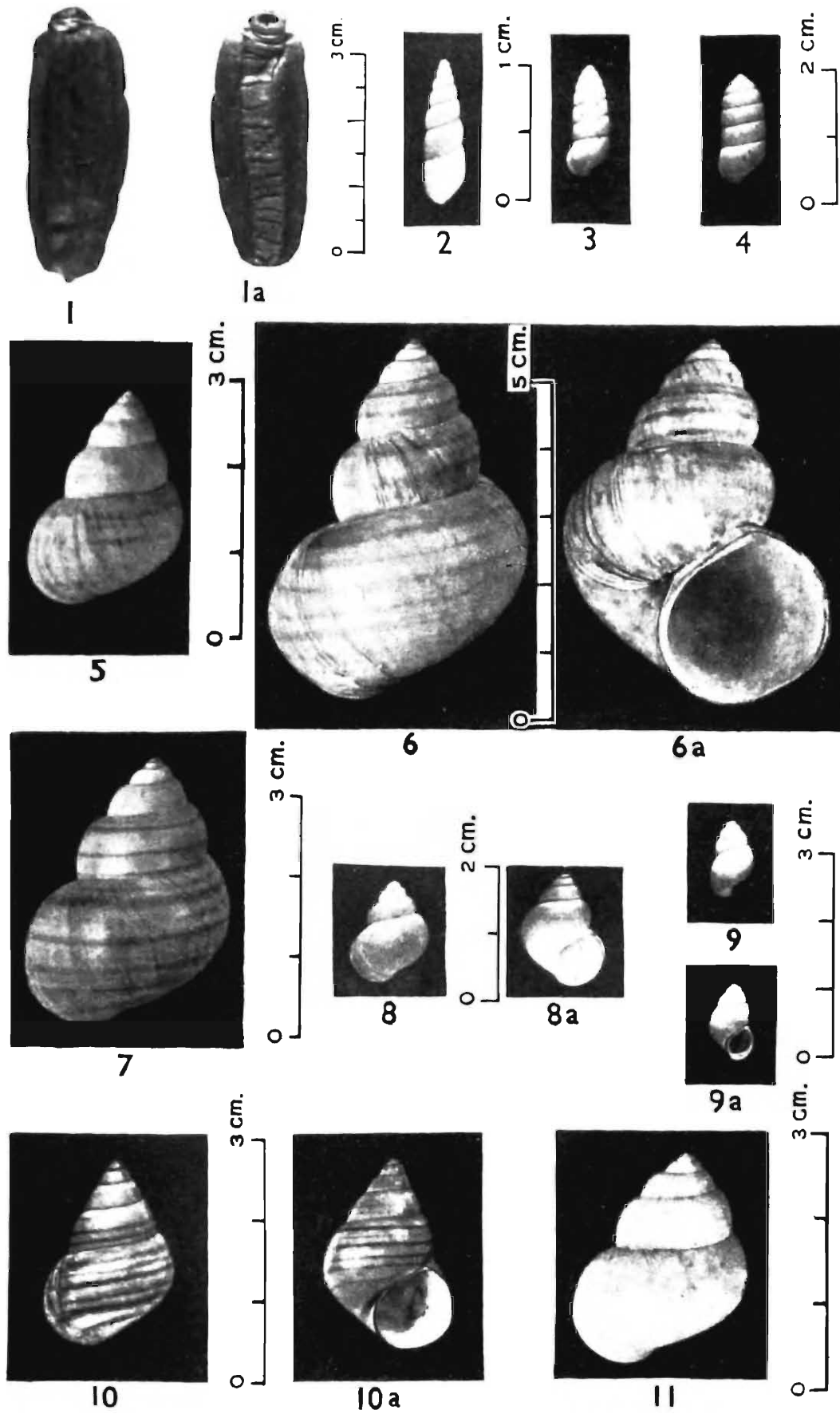
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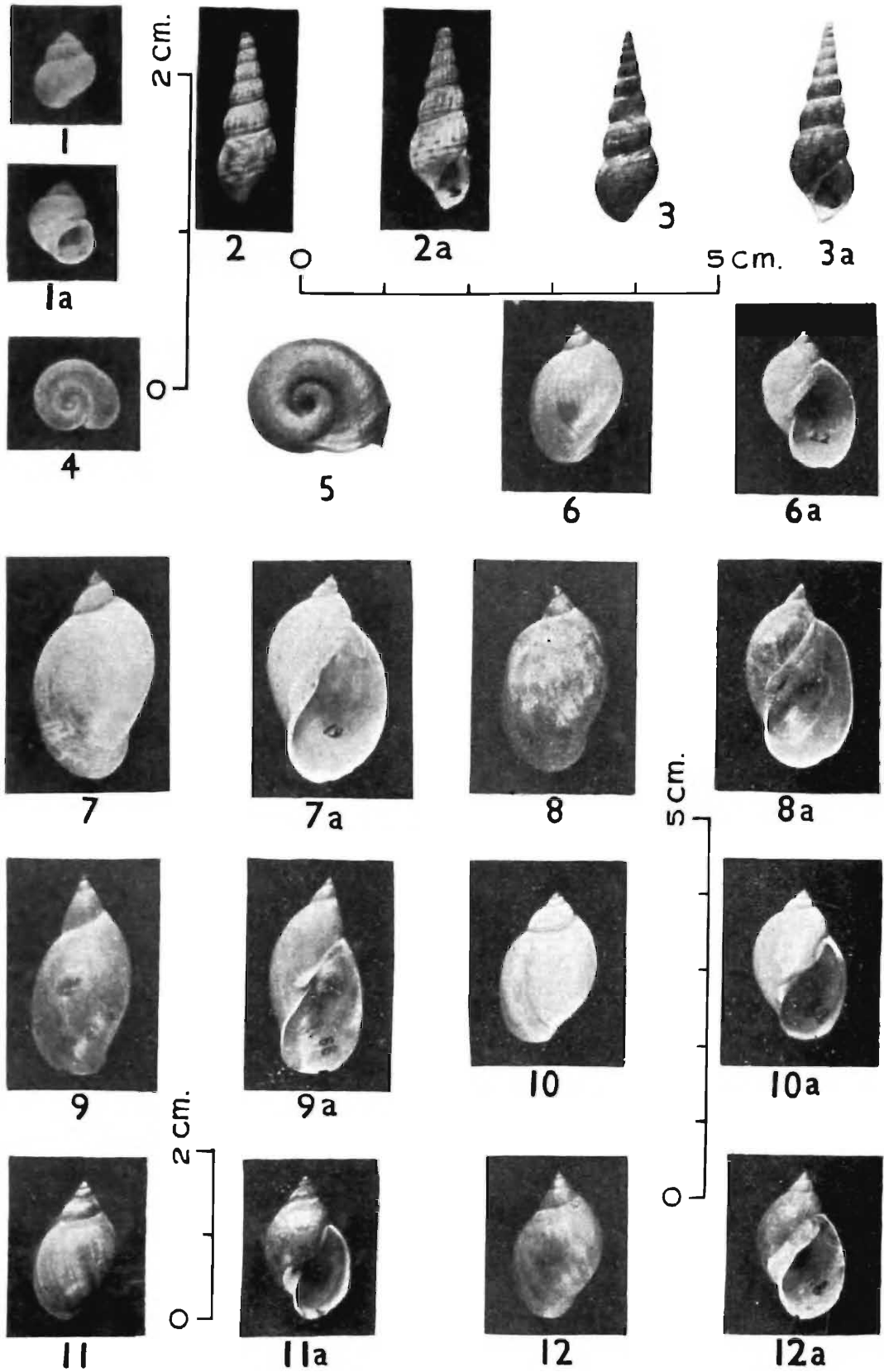
## PLATE 18

- Figs. 1, 1a.—Animal of *Laevicaulis alte* (Férussac). Udaipur, Udaipur District.
- Fig. 2.—Shell of *Opeas gracile* (Hutton). Ratan tālāb nr. Sambhar Lake, Jaipur District.
- Fig. 3.—Shell of *Zootecus insularis* (Ehrenberg). Sambhar Lake, Jaipur District.
- Fig. 4.—Shell of *Zootecus estellus* (Benson). Balmir, Jodhpur District.
- Fig. 5.—Shell of *Viviparus bengalensis* f. *typica* (Lamarck). Jogmandi jharnā, Pali District.
- Figs. 6, 6a.—Shell of *Viviparus bengalensis* race *gigantea* (Reeve). Chapparwara Lake, Jaipur District.
- Fig. 7.—Shell of *Viviparus bengalensis* race *mandiensis* Kobelt. Talow nr. Deoli, Tonk District.
- Figs. 8, 8a.—Shell of *Digoniostoma pulchella* (Benson). Merta. Nagaur District.
- Figs. 9, 9a.—Shell of *Digoniostoma cerameopoma* (Benson). Sambhar Lake, Jaipur District.
- Figs. 10, 10a.—Shell of *Viviparus bengalensis* phase *annandalei* Kobelt. Jogmandi jharnā, Pali District.
- Fig. 11.—Shell of *Viviparus variatus* (Frauenfeld). Balu River bed. Barmer District.



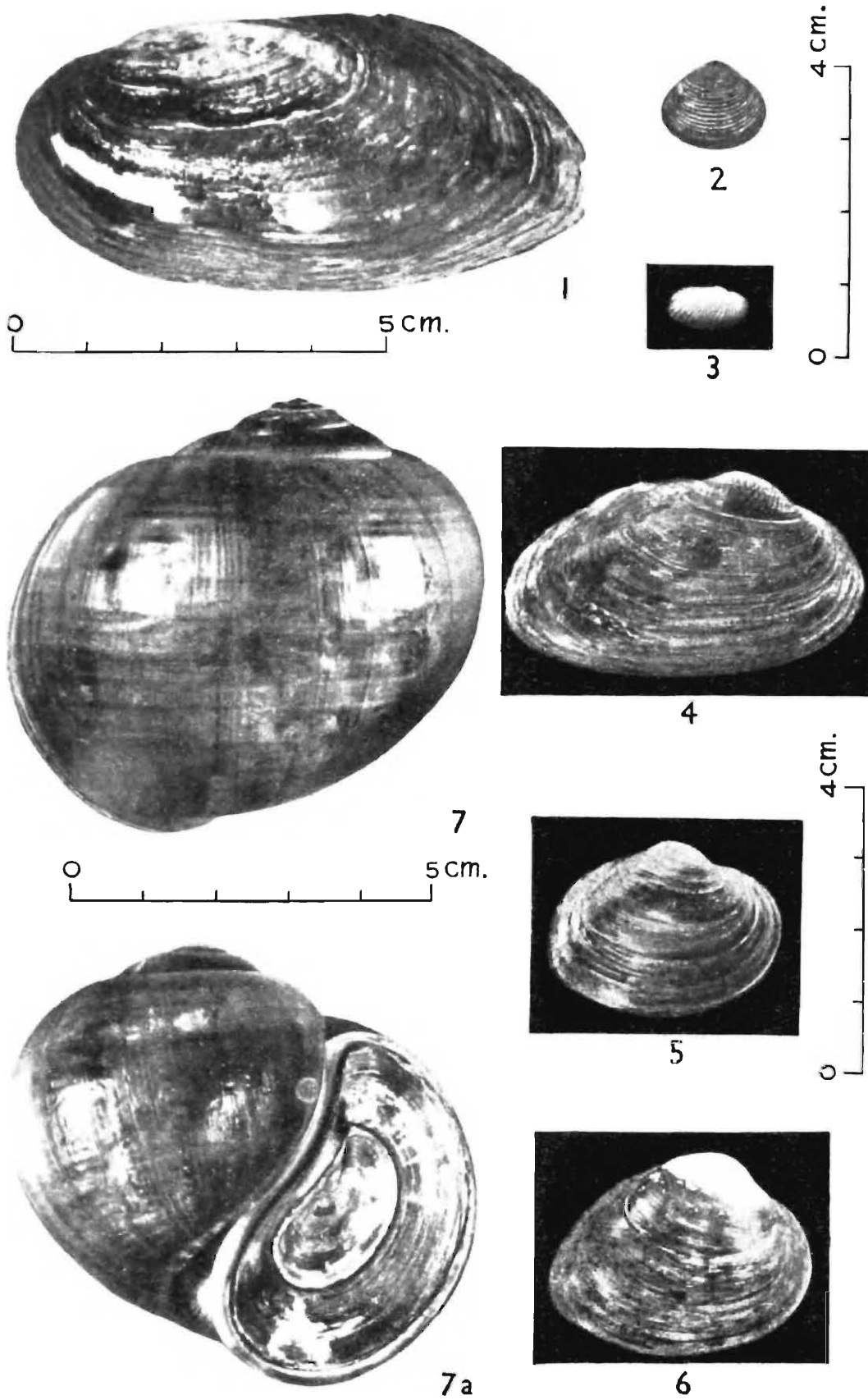
## PLATE 19

- Figs. 1, 1a.—Shell of *Alocinma orcula* var. *producta* (Nevill). Sambhar Lake, Jaipur District.
- Figs. 2, 2a.—Shell of *Melanoides (Melanoides) tuberculatus* (Müller). Jogmandi Jharnā, Pali District.
- Figs. 3, 3a.—Shell of *Melanoides (Melanoides) pyramis* (Hutton). Mandore Canal, Jodhpur District.
- Fig. 4.—Shell of *Gyraulus convexiusculus* (Hutton). Chapparwara Lake, Jaipur District.
- Fig. 5.—Shell of *Indoplanorbis exustus* (Deshayes). Nasirabad, Ajmer District.
- Figs. 6, 6a.—Shell of *Lymnaea (Pseudosuccinea) acuminata* f. *typica* Lamarck. A pool nr. Trevor Tal, Sirohi District.
- Figs. 7, 7a.—Shell of *Lymnaea (Pseudosuccinea) acuminata* f. *patula* Troschel. Udaipur, Udaipur District.
- Figs. 8, 8a.—Shell of *Lymnaea (Pseudosuccinea) acuminata* f. *chlamys* Benson. Rajasthan (particular locality not known).
- Figs. 9, 9a.—Shell of *Lymnaea (Pseudosuccinea) acuminata* f. *rufescens* (Gray). A tank, N. of Parsad, Udaipur District.
- Figs. 10, 10a.—*Lymnaea (Pseudosuccinea) luteola* f. *typica* Lamarck. A channel, S. of Kankroli, Udaipur District.
- Figs. 11, 11a.—Shell of *Lymnaea (Pseudosuccinea) luteola* f. *australis* Annandale and Rao. A pool nr. Rajsamand, Udaipur District.
- Figs. 12, 12a.—Shell of *Lymnaea (Pseudosuccinea) luteola* f. *impura* Troschel. A pond in Merta, Nagaur District.



## PLATE 20

- Fig. 1.—Shell of *Lamellidens corrianus* (Lea). Rajasthan (particular locality not known).
- Fig. 2.—Shell of *Corbicula striatella* Deshayes. Berach Kiver nr. Chittorgarh, Chittorgarh District.
- Fig. 3.—Shell of *Indonaia occata* (Lea). Phulad River bed, Pali District.
- Fig. 4.—Shell of *Indonaia caerulea* (Lea). Phulad River bed, Pali District.
- Fig. 5.—Shell of *Parreysia corrugata* var. *nagpoorensis* (Lea). Berach River nr. Chittorgarh, Chittorgarh District.
- Fig. 6.—Shell of *Parreysia favidens* (Benson). Chittorgarh, Chittorgarh District.
- Figs. 7, 7a.—Shell of *Pila globosa* (Swainson). A ditch at Rajlani, Jodhpur District.



# FAUNA OF RAJASTHAN, INDIA

## PART 4.—A CHECK-LIST OF RAJASTHAN TERMITES (INSECTA : ISOPTERA)

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(With 4 Plates)

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### I—INTRODUCTION

#### 1. General

The termite fauna of Rajasthan has until recently been practically unknown. Adams (1899, p. 387), in his account of the Western Rajputana States, while not mentioning the species, referred to control measures and wrote : "White ants are so very destructive that they require to be kept-down, and arsenic is the remedy." The next mention is by Pruthi and Bhatia (1952) who listed only three species in the desert region, namely, "*Hodotermes macrocephalus*, *Heterotermes* sp. and *Microtermes* sp.". Subsequently, a few species have been recorded by Roonwal & Pant (1953, p. 47), Roonwal and Sen-Sarma (1960), Kushwaha (1960*a, b*, 1961), Bhatnagar (1962), Roonwal (1962*a, b*), Roonwal & Bose (1960, 1962 *a, b*), and Roonwal, Chhotani & Bose (1962).

As a result of extensive collections made by one of us (M. L. R. in 1952) and later on (1956-61) by the field parties of the Zoological Survey of India, considerable material has accumulated from all over Rajasthan, except the extreme southern portions. This material has been studied by us and a total of 19 species and subspecies recorded, of which 3 are new. Here a check-list of these species is given, whilst a fuller account will be found elsewhere (Roonwal & Bose, 1964).

For an account of the topography, climate, vegetation, etc. of Rajasthan, see Part 1 (General Introduction) of this series of papers (Roonwal, 1968, *Rec. zool. Surv. India*, Vol. 61 (3 & 4), pp. 291-375).

## 2. Abbreviations used

|                                                            |                                     |
|------------------------------------------------------------|-------------------------------------|
| <i>Im.</i> , Imago (winged or dealate reproductive) caste. | <i>Sm.</i> , soldier minor caste.   |
| <i>Ny.</i> , nymph.                                        | <i>SMd.</i> , soldier medium caste. |
| <i>Pw.</i> , pseudoworker caste.                           | <i>Syn.</i> , synonym.              |
| <i>S.</i> , soldier caste.                                 | <i>W.</i> , worker caste.           |
| <i>SM.</i> , soldier major caste.                          | <i>WM.</i> , worker major caste.    |
|                                                            | <i>Wm.</i> , worker minor caste.    |

## II—A CHECK-LIST OF THE RAJASTHAN TERMITES

## Family I. HODOTERMITIDAE

Subfamily (a) *Hodotermitinae*1. *Anacanthotermes macrocephalus* (Desneux)

(Plate 21, Figs. 1-3)

1906. *Hodotermes macrocephalus* J. Desneux, *Ann. Soc. ent. Belg.*, Brussels, 49(12), pp. 344-348. *Im. S. and W. Type, locality* : Karachi (Sind, W. Pakistan).

*Castes found* : *Im.*, *S.* and *W.*

*Distribution.*—*Rajasthan* : Western desert area : Districts of Bikaner, Jaisalmer, Barmer and Jodhpur. *Elsewhere* : Punjab (India), W. Pakistan and S. E. Afghanistan.

*Remarks.*—For a detailed account of external morphology, see Gupta (1962a, b).

## Family II. RHINOTERMITIDAE

Subfamily (a) *Psammotermatinae*2. *Psammotermes rajasthanicus* Roonwal & Bose

( Plate 21, Figs. 4-6)

1960. *Psammotermes rajasthanicus* M. L. Roonwal & G. Bose, *Sci. & Cult.*, Calcutta, 26(1), pp. 38-39. *Sm. and W. Type-locality* : India : Balana (Jaisalmer District, Rajasthan).

1962. *Psammotermes rajasthanicus* M. L. Roonwal & G. Bose, *Rec. Indian Mus.*, Delhi, 58 (3 & 4), pp. 151-158, Pls. 12(S.) and 13(W.). Fuller description with illustrations.

*Castes Known* : *SM.*, *SMd.*, *Sm.* and *W.*

*Distribution.*—*Rajasthan only* : Western desert area : Districts of Barmer, Jaisalmer and Bikaner.

Subfamily (b) *Heterotermatinae*3. *Heterotermes indicola* (Wasmann)

(Plate 22, Fig. 1)

1902. *Leucotermes indicola* E. Wasmann, *Zool. Jb. (Syst.)*, Jena, 17 (1), pp. 118-119, Pl. 4, Fig. 2. *S. and W. Type-locality* : Bombay (India).

*Castes found* : *S.* and *W.*

**Distribution.**—*Rajasthan* : District of Jodhpur, Bikaner and Sirohi so far, but no doubt widespread. *Elsewhere* : Throughout India and W. Pakistan.

**Remarks.**—A species which is highly destructive to wood-work in houses, etc. A whole township may thus be ruined, as was the case in Sri Hargobindpur in the Punjab (*vide* Roonwal, 1955).

#### Subfamily (c) *Coptotermitinae*

#### 4. *Coptotermes heimi* (Wasmann)

( Plate 22, Fig. 2 )

(Synonym : *Coptotermes parvulus* Holmgren, *vide* Roonwal & Chhotani, 1962, *infra*.)

1902. (Oct.) *Arrhinotermes heimi* E. Wasmann, *Zool. Jb. (Syst.)*, Jena, 17 (1), p. 104, Pl. 4, Figs. 1 a-f (Im.) ; p. 160 (Syn.). Im. *Type-locality* : India : Wallon (Ahmadnagar Dist., Maharashtra).

1913. (21st Apr.) *Coptotermes parvulus* N. Holmgren, *J. Bombay nat. Hist. Soc.*, Bombay, 22 (1), pp. 102 and 104. S. and W. *Type-localities* : India : Anand and Wadval (both in Gujarat State—formerly in Bombay Presidency).

1962. *Coptotermes heimi* (Wasm.), M. L. Roonwal and O. B. Chhotani, *Monogr. Indian Species of Termite Genus Coptotermes*, New Delhi (Indian Counc. Agric. Res., Ent. Monogr. No. 2).

**Castes found** : Im., S. and W.

**Distribution.**—*Rajasthan* : Western and central Rajasthan : Districts of Jodhpur, Nagaur, Jaipur, Pali and Jaisalmer ; most probably all over. *Elsewhere* : All over India and West Pakistan.

**Remarks.**—A very variable species. Also one of the most destructive species to wood-work. For a summary of its biology, *vide* Roonwal (1959).

#### Family III—TERMITIDAE

#### Subfamily (a) *Amitermitinae*

#### 5. *Speculitermes cyclops* Wasmann

1902. *Speculitermes cyclops* E. Wasmann, *Zool. Jb. (Syst.)*, Jena, 17 (1), pp. 160-162, Im. and W. *Type-locality* : India : Khandala near Bombay (Maharashtra).

#### 5(a). *Speculitermes cyclops cyclops* Wasmann

1902. As above.

1960. *Speculitermes cyclops cyclops* Wasm., Roonwal and Sen Sarma, *Contrib. Syst. Orient. Termites*, New Delhi (Indian Counc. Agric. Res., Ent. Monogr. No. 1), pp. 16-23, Pl. 1 (Im.).

*Castes found* : Im. and W.

*Distribution*.—*Rajasthan* : Kotah District (Kolipura). Absent in the drier parts. *Elsewhere* : India : Uttar Pradesh, Madhya Pradesh and Maharashtra. Burma : Dawna Hills, Lower Burma (needs confirmation).

*Remarks*.—The soldier caste was, until recently, believed to be absent in the genus *Speculitermes* as well as in the allied genus *Anoplotermes*. Recently, however, Roonwal and Chhotani (1960*b*) have reported the occurrence of the soldier caste in *S. cyclops sinhalensis*, Roonwal & Sen-Sarma, collected from southern India.

## 6. *Amitermes belli* (Desneux)

(Plate 22, Fig. 3)

1906. *Termes belli* J. Desneux, *Ann. Soc. ent. Belg.*, Brussels, 49 (12), pp. 352-354. Im., S. and W. *Type-locality* : Karachi (Sind, West Pakistan).

*Castes found* : Im., S. and W.

*Distribution*.—*Rajasthan* : Districts of Jodhpur, Jaipur, Kotah and Bundi. *Elsewhere* : West Pakistan (Baluchistan, Sind and Punjab).

## 7. *Synhamitermes quadriceps* (Wasmann)

1902. *Amitermes quadriceps* E. Wasmann, *Zool. Jb. (Syst.)*, Jena, 17 (1), p. 123, Pl. 4, Fig. 5. S., W. and Ny. *Type-locality* : India : Kbandala near Bombay (Maharashtra).

1960. *Synhamitermes quadriceps*, M. L. Roonwal and P. K. Sen-Sarma, *Contrib. Syst. Orient. Termites*, New Delhi, (Indian Counc. Agric. Res., Ent. Monogr. No. 1), New Delhi. pp. 7-14.

*Castes found* : Im. (not Rajasthan), S. and W.

*Distribution*.—*Rajasthan* : Kotah District. *Elsewhere* : Maharashtra India).

*Remarks*.—The imago was described by Roonwal and Sen-Sarma (1960, pp. 7-14).

## 8. *Eremotermes neoparadoxalis* Ahmad

1955. *Eremotermes neoparadoxalis* M. Ahmad, *Biologia*, Lahore, 1 (2), pp. 252-253, Fig. 38 (S). *Type-locality* : West Pakistan : Shahdadpur (Sind).

1960. *Eremotermes neoparadoxalis*, Roonwal and Sen Sarma, *Contrib. Syst. Orient. Termites* (Indian Counc. Agric. Res., Ent. Monogr. No. 1), New Delhi, pp. 79-83 ; Pls. 15 and 16.

*Castes found* : S. and W.

*Distribution*.—*Rajasthan* : Districts of Jaipur and Bikaner. *Elsewhere* : Sind (West Pakistan).

**9. *Eremoterme paradoxalis* Holmgren**

(Plate 22, Fig. 4)

1913. *Eremoterme paradoxalis* N. Holmgren, *J. Bombay nat. Hist. Soc.*, Bombay, 22(1), pp. 115-116. S., WM., Wm. *Type-locality* : India : Bangalore (Mysore State).  
 1960. *Eremoterme paradoxalis* Holmg., Roonwal and Sen-Sarma, *Contrib. Syst. Orient. Termites* (Indian Counc. Agric. Res., Ent. Monogr. No. 1), New Delhi, pp. 83-92 ; Pls. 17 and 18.

*Castes found* : Im. (not Rajasthan), S. and W.*Distribution*.—*Rajasthan* : Districts of Jaipur and Kotah. *Elsewhere* : India (Punjab, Madhya Pradesh, Bihar, Mysore, Kerala). West Pakistan (Punjab, Sind and N. W. F. P.).**10. *Microcerotermes championi* Snyder**

1933. *Microcerotermes championi* T. E. Snyder, *Proc. U. S. nation. Mus.* Washington, 82 (art. 16), pp. 14-15. *Type-locality* : India : Haldwan, (Uttar Pradesh).

**10(a). *Microcerotermes championi raja* Roonwal and Bose**

(Plate 22, Fig. 5)

1964. *Microcerotermes championi raja* M. L. Roonwal and G. Bose, *Zoologica*, Stuttgart, 40 (113), pp. 26-28. *Type-locality* : India : Balsamand (near Jodhpur, Jodhpur District, Rajasthan).

*Castes found* : S. and W.*Distribution*.—*Rajasthan* : Jodhpur District.*Remarks*.—The typical subspecies, *M. c. championi*, is found in Uttar Pradesh (India) and Sind (W. Pakistan).**11. *Microcerotermes tenuignathus* Holmgren**

1913. *Microcerotermes tenuignathus* N. Holmgren, *J. Bombay nat. Hist. Soc.*, Bombay, 22 (1), pp. 116-117. S., WM., Wm. *Type-locality* : India : Vidtal (Gujarat).

**11(a). *Microcerotermes tenuignathus tenuignathus* Holmgren**

(Plate 23, Fig. 1)

1913. As above.

*Castes found* : S. and WM. and Wm.*Distribution*.—*Rajasthan* : Districts Jaisalmer, Barmer, Jodhpur, Jaipur and Kotah. *Elsewhere* : India (Gujarat). West Pakistan (Sind and Baluchistan).**11(b). *Microcerotermes tenuignathus laxmi* Roonwal & Bose**

(Plate 22, Fig. 6)

1964. *Microcerotermes tenuignathus laxmi* M. L. Roonwal and G. Bose, *Zoological Stuttgart*, 40(113). pp. 29-31, *Type-locality* : India : Kolayat (Bikaner District, Rajasthan).

*Castes found* : S. and W.*Distribution*.—*Rajasthan only* : Bikaner District (Kolayat).

12. *Microcerotermes* sp.

Some Rajasthan collections of this genus are represented by workers only and cannot, therefore, be identified specifically with certainty. They are from the districts of Jaisalmer, Bikaner, Jaipur and Kotah.

Subfamily (b) *Macrotermitinae*13. *Odontotermes bellahunisensis* Holmgren & Holmgren

1917. *Odontotermes bellahunisensis* K. Holmgren & N. Holmgren, *Mem. Dept. Agric. India*, Calcutta, 5 (3), pp. 150-151 (Im., S., W.)  
*Type-localities* : India : Mysore State : Bellahunisi (Bellary District\*) and Bangalore.
1962. *Odontotermes bellahunisensis*, . M. L. Roonwal and G. Bose, *J. Bombay nat. Hist. Soc.*, Bombay, 58 (3), pp. 580-594, Pl. 1. (S.) and Text-fig. 1 (WM.). Redescription of species.

13(a). *Odontotermes bellahunisensis guptai* Roonwal & Bose  
(Plate 23, Fig. 2)

1962. *Odontotermes bellahunisensis guptai* Roonwal and Bose, *J. Bombay nat. Hist. Soc.*, Bombay, 58 (3), pp. 588-593, Text-fig. 2(S.). *Type-locality* : India : Near Gudah village (Nagaur District, Rajasthan).

*Castes found* : S. and W.

*Distribution*.—*Rajasthan* : Districts of Bikaner, Nagaur, Jhunjhunu, Sikar and Udaipur. *Elsewhere* : West Pakistan (Karachi, Sind).

*Remarks*.—The typical subspecies, *O.b. bellahunisensis*, is known only from the Mysore State (Bellahunisi and Bangalore), S. India.

14. *Odontotermes brunneus* (Hagen)

1858. *Termes brunneus* H. Hagen, *Linn. Entom.*, 12, pp. 133-136, Pl. 3, Fig. 3 (Im.). Im. & S. *Type-locality* : India : "Bengalen". [A cotype imago stated to be in Berlin Museum is not traceable now. A second cotype imago in the Museum of Comparative Zoology, Harvard College, Cambridge (Mass., U.S.A.) was examined by us. Soldier of Hagen does not evidently belong to genus *Odontotermes*.]

14(a). *Odontotermes brunneus kushwahi* Roonwal & Bose  
(Plate 23, Fig. 3)

1964. *Odontotermes brunneus kushwahi*, M. L. Roonwal and G. Bose, *Zoological Stuttgart*, 40 (113), pp. 33-36. *Type-locality* : India : Bhupalsagar (Udaipur District, Rajasthan).

*Castes found* : S. and W.

*Distribution*.—*Rajasthan* : Udaipur District. *Elsewhere* : India : Kaira District (Gujarat) and Salem District (Madras State).

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\* Bellary District was formerly in the Madras State but was transferred to Mysore State during the reorganisation of States in 1957.

15. *Odontotermes obesus* (Rambur)

(Plate 23, Fig. 4)

1842. *Termes obesus* Rambur, *Hist. nat. Insectes, Neuropteres*, Paris, p. 304.  
(Im.). *Type-locality* : India : Bombay (Maharashtra).

*Castes found* : Im., S. and W.

*Distribution.*—*Rajasthan* : Districts of Ajmer, Barmer, Bikaner, Bundi, Ganganagar, Jaipur, Jaisalmer, Jalore, Jodhpur, Kotah, Nagaur, Pali, Sikar, Sawai Madhopur and Udaipur. Likely to occur all over. *Elsewhere* : India : All-India, except Kashmir (where *Od. ob. gurdaspurensis* H. & H. is said to occur), West Bengal and probably the southern portion of the Peninsula. Also, West Pakistan and Burma, the last being doubtful.

*Remarks.*—In size this is a very variable species (soldiers : head-length 1.00—1.53 mm.). In suitable niches it forms relatively small (ca. 100 cm. high) earthen mounds in Rajasthan. Elsewhere its mounds go up as high as about 2.6 metres.

16. *Microtermes anandi* Holmgren(Synonym : *Microtermes obesi* Holmgren)

(Plate 23, Fig. 5)

1913. (April 21). *Microtermes anandi* N. Holmgren, *J. Bombay nat. Hist. Soc.* Bombay, 22 (1), p. 114. S. and W. *Type-locality* : India : Anand (Gujarat).

1913. (May 23). *Microtermes obesi* N. Holmgren, *K. Sv. Vet. Akad. Handl.* Stockholm, 50 (2), p. 150, Pl. 6, Fig. 4. Im. *Type-locality* : India : Khandala (Maharashtra).

*Castes found* : Im., (not Rajasthan), S. and W.

*Distribution.*—*Rajasthan* : Districts of Barmer, Jaisalmer, Jodhpur, Jaipur and Kotah. *Elsewhere* : India : All-India, except the extreme north (Kashmir). West Pakistan (Sind, Punjab and N. W. F. P.).

17. *Microtermes mycophagus* (Desneux)

(Plate 23, Fig. 6)

1906. *Termes mycophagus* J. Desneux, *Ann. Soc. Ent. Belg.*, Brussels, 49, pp. 348-352. Im., S. and W. *Type-locality* : Karachi (Sind, West Pakistan).

*Castes found* : Im., S. and W.

*Distribution.*—*Rajasthan* : Widespread : Districts of Jaipur, Jaisalmer, Jodhpur, Bikaner, Ganganagar, Churu, Jaipur and Nagaur. *Elsewhere* : West Pakistan (Punjab, Sind and Baluchistan).

*Remarks.*—The species appears to be confined to the arid areas.

18. *Microtermes* sp.

A few Rajasthan collections of this genus are represented by workers only and cannot, therefore, be identified specifically with certainty. They are from the districts of Barmer, Jodhpur, Bikaner and Churu.

Subfamily (c) *Nasutitermitinae*.19. *Trinervitermes biformis* (Wasmann)

(Plate 24, Figs. 1 and 2)

1902. *Eutermes biformis* E. Wasmann, *Zool. Jb. (Syst.)*, Jena, 17 (1), pp. 133-135. Pl. 4, Figs. 10, 10a. Im., SM., Sm., W. *Type-localities* : Ceylon : Bandarawalla. India : Khandala (near Bombay, Maharashtra).

*Castes found* : Im. (not Rajasthan), SM., Sm., and W.

*Distribution*.—*Rajasthan* : Districts of Jaipur and Udaipur. *Elsewhere* : India (Maharashtra and Madhya Pradesh) ; and Ceylon.

20. *Trinervitermes heimi* (Wasmann)

(Plate 24, Figs. 3 and 4)

1902. *Eutermes heimi* E. Wasmann, *Zool. Jb. (Syst.)*, Jena, 17 (1), pp. 133 ; and 135-137. Im., SM., Sm., W. *Type-locality* : India ; Wallon (Ahmednagar District, Maharashtra).

*Castes found* : Im., SM., Sm., and W.

*Distribution*.—*Rajasthan* : Districts of Nagaur and Kotah. *Elsewhere* : Peninsular India (Maharashtra, Madras and Mysore States).

### III—KEY TO THE GENERA AND SPECIES OF RAJASTHAN TERMITES (BASED ON SOLDIERS)

The following key (based on the soldier caste), together with the illustrations provided here, will, it is hoped, assist in the easy identification of Rajasthan termites. Workers do not, as a rule, provide easy differentiating characters, and alates are known in too few species from Rajasthan to make the preparation of a key worthwhile. Unless otherwise stated, the total length includes the mandibles, but excludes the antennae.

#### *Key to termite soldiers from Rajasthan*

- 1(2) Soldier caste generally absent (rarely found in genus\*, but none so far in Rajasthan). (Workers and alates with a large circular, mid-dorsal ocellus-like spot on head).

...*Speculitermes cyclops cyclops*.

- 2(1). Soldier caste present. (Workers and alates with no such mid-dorsal spot on head.)

- 3(6). Mandibles non-functional and reduced to minute structures ; head rounded and prolonged into a median forwardly pointed horn (nasus). Two types of soldiers (large and small) present.

...*Trinervitermes*.

- 4(5). Antennae 13-segmented ; segment 3 more than twice as long as 2.

...*Trinervitermes biformis*.

- 5(4). Antennae 14-segmented ; segment 3 only slightly longer than 2.

...*Trinervitermes heimi*.

\* Found in genus *Speculitermes* by Roonural and Chhotami (*Sci. 4 culture*, Calcutta, 26 (3) pp. 143-144, 1960), in *S. cyclops sinhalensis* from Southern India.

6(3). Mandibles well developed and functional.

7(14) Pronotum flat.

8(9) Large species (10-15 mm. long) ; antennae with 25-29 segments ; eye-spots prominent.

...*Anacanthotermes macrocephalus*.

9(8). Smaller species. Antennae with not over 17 segments ; eye-spots absent.

10(11). Soldiers of 3 types (major, medium and minor). Mandibles with several large to small well defined teeth on inner margin.

...*Psammotermes rajasthanicus*.

11(10). Soldiers of one type; mandibles with only a few crenulations in basal half.

12(13). Head subrectangular ; fontanelle small and lying about middle of head.

...*Heterotermes indicola*.

13(12). Head oval or subcircular ; fontanelle large and lying far forward on head (just behind clypeus).

...*Coptotermes helmi*.

14(7). Pronotum saddle-shaped.

15(20). Mandibles with inner margin finely serrated.

...*Microcerotermes*.

16(19). Mandibular serrations weak and indistinct.

17(18). Mandibles shorter (0.70-0.88 mm.).

...*Microcerotermes tenuignathus tenuignathus*.

18(17). Mandibles longer (1.13—1.15 mm.).

...*Microcerotermes tenuignathus laxmi*.

19(16). Mandibular serrations distinct.

...*Microcerotermes championi raja*.

20(15). Mandibles not finely serrated, and with or without definite teeth on inner margin.

21(24). Small species (3—5 mm. long) ; mandibles without teeth.

...*Microtermes*.

22(23). Antennae 14-segmented; smaller species (3.1—4.2 mm.).

...*Microtermes anand*

23(22). Antennae 15-segmented ; larger species (3.2—4.8 mm.).

...*Microtermes mycophagus*.

24(21). Larger species ; mandibles usually with a tooth on inner margin.

25(30). Mandibles asymmetrical (left mandible with a prominent tooth in varying positions ; right mandible with only a vestigial tooth).

...*Odontotermes*.

26(29). Smaller species (head-length, to base of mandibles, 1.00—1.53 mm. ; maximum head-width 0.90—1.33 mm.) ; antennae with distal one-third brown to dark brown, rest paler.

27(28). Mandibles shorter stouter and more incurved (ratio Mandible-length/Head-length 0.52—0.57) ; posterior margin of pronotum with only a weak median notch (absent in the typical subspecies).

...*Odontotermes bellahunisensis guptai*.

- 28(27). Mandibles longer, more slender and less incurved (ratio Mandible-length/Head-length 0.59—0.70); posterior margin of pronotum with a well-marked median notch.

...*Odontotermes obesus*.

- 29(26). Larger species (head-length, to base of mandibles, 1.75—1.90 mm.; maximum head-width 1.40 mm.); antennae brownish throughout.

...*Odontotermes brunneus kushwahi*.

- 30(25). Mandibles symmetrical or nearly so, with a tooth lying near middle of inner margin.

- 31(32). Clypeus bilobed; mandibles stout, strongly incurved, and with a large tooth.

...*Amitermes belli*.

- 32(31). Clypeus not bilobed.

- 33(34). Mandibles short, stout, strongly incurved, and with a prominent tooth on inner margin.

...*Synhamitermes quadriceps*.

- 34(33). Mandibles long, slender, pointed and only weakly incurved (almost straight); tooth on inner margin either weak or prominent.

...*Eremotermes*.

- 35(36). Mandibular tooth strong and prominent; labrum longer (0.10—0.15 mm.).

...*Eremotermes paradoxalis*.

- 36(35). Mandibular tooth minute; labrum shorter (0.75—0.10 mm.).

...*Eremotermes neoparadoxalis*.

#### IV—SUMMARY

1. The termite fauna of Rajasthan has been studied adequately only during the last few years.

2. A list of the known species from Rajasthan, together with their distribution, etc., is given.

3. About 19 species are known from the region. They belong to 3 families and 12 genera as follows :—

Fam. I. HODOTERMITIDAE : *Anacanthotermes*.

Fam. II. RHINOTERMITIDAE : *Psammotermes*, *Heterotermes* and *Coptotermes*.

Fam. III. TERMITIDAE : *Speculitermes*, *Amitermes*, *Synhamitermes*, *Eremotermes*, *Microcerotermes*, *Odontotermes*, *Microtermes* and *Trinervitermes*.

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PLATE 21

Termites from Rajasthan.

Figs. 1-3.—*Anacanthotermes macrocephalus* (Desneux). Bikaner District.

1. Soldier. 2. Worker Minor. 3. Worker Major.

Figs. 4-6.—*Psammotermes rajasthanicus* Roonwal & Bose. Pugal, Bikaner District.

4. Soldier Major. 5. Soldier Medium. 6. Soldier Minor.

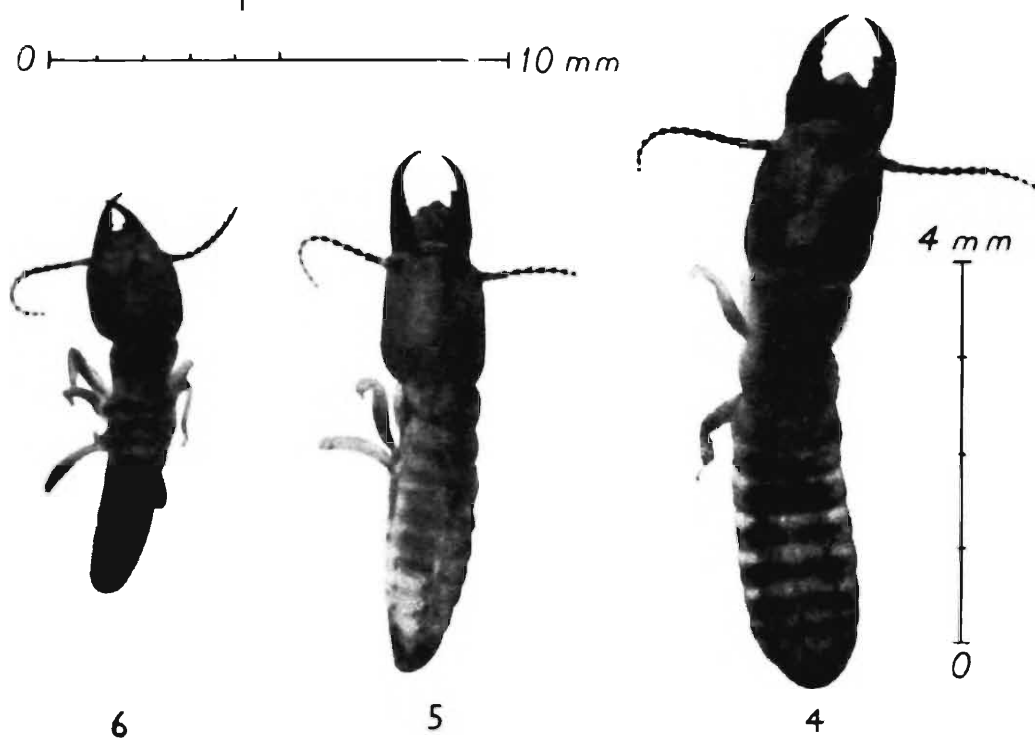
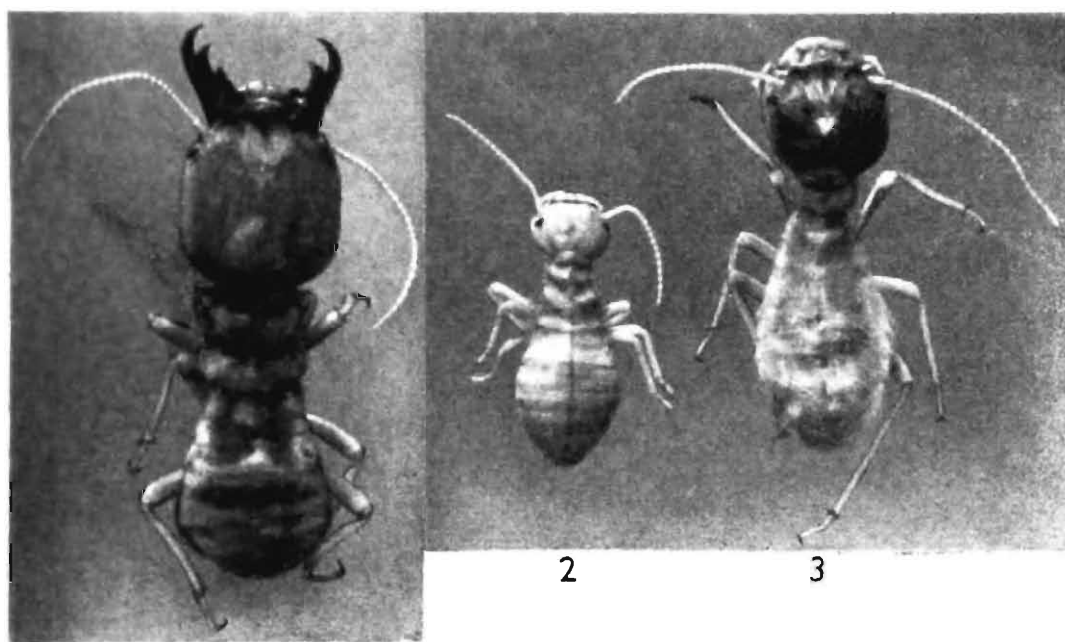


PLATE 22

Termite soldiers from Rajasthan.

- Fig. 1.—*Heterotermes indicola* (Wasmann). Bikaner District.  
 Fig. 2.—*Coptotermes heimi* (Wasmann). Jaipur District.  
 Fig. 3.—*Amitermes belli* (Desneux). Bundi District.  
 Fig. 4.—*Eremotermes paradoxalis* Holmgren. Jaipur District.  
 Fig. 5.—*Microcerotermes championi raja* Roonwal & Bose. Holotype. Jodhpur District.  
 Fig. 6.—*Microcerotermes tenuignathus laxmi* Roonwal & Bose. Holotype. Bikaner District.

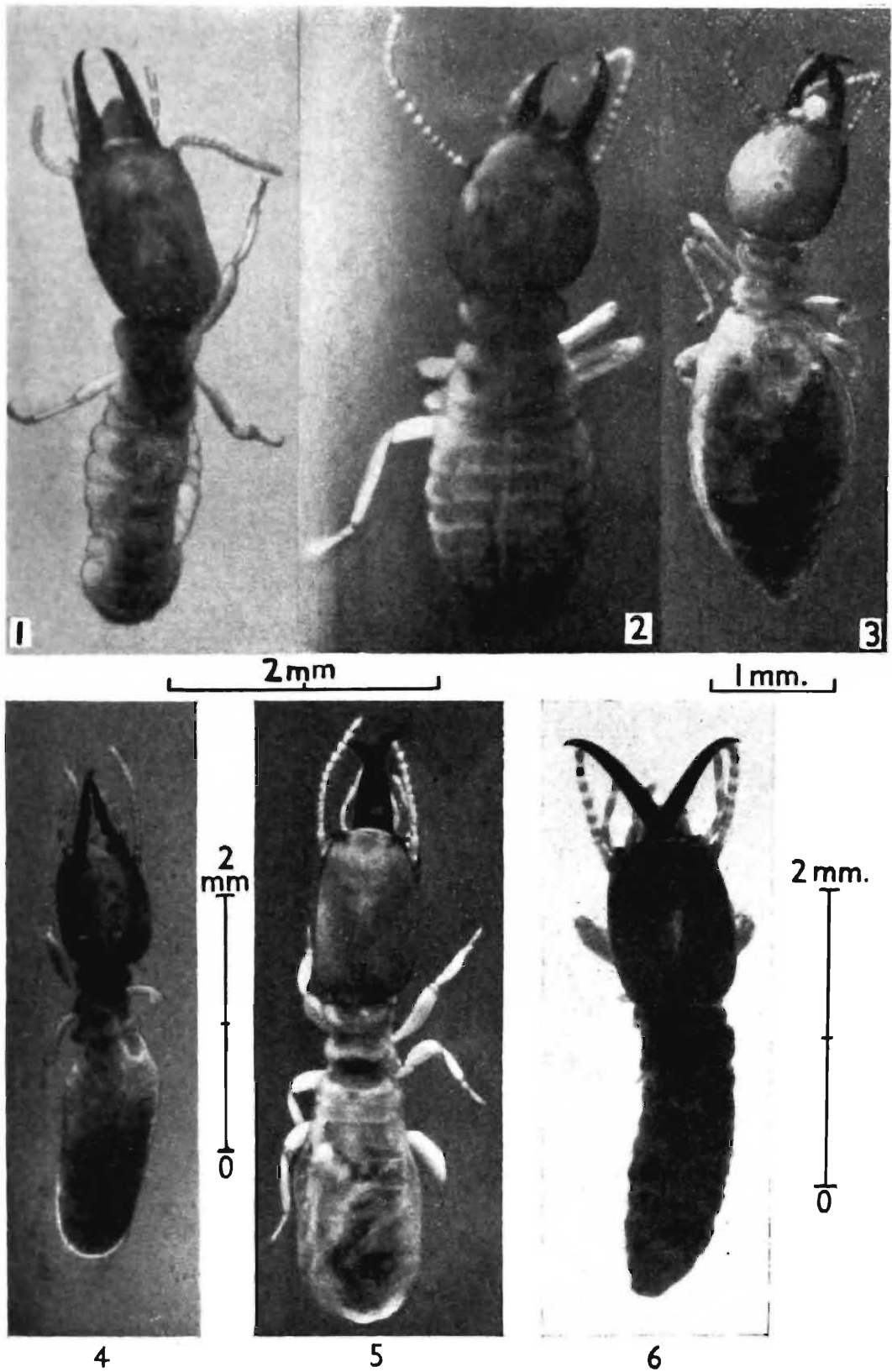


PLATE 23

Termite soldiers from Rajasthan.

FIG. 1.—*Microcerotermes tenuignathus tenuignathus* Holmgren. Barmer District.

FIG. 2.—*Odontotermes bellahunisensis guptai* Roonwal & Bose. Nagaur District.

FIG. 3.—*Odontotermes brunneus kushwahi* Roonwal & Bose. Udaipur District.

FIG. 4.—*Odontotermes obesus* (Rambur). Udaipur District.

FIG. 5.—*Microtermes anandi* Holmgren. Barmer District.

FIG. 6.—*Microtermes mycophagus* (Desneux). Churu District.

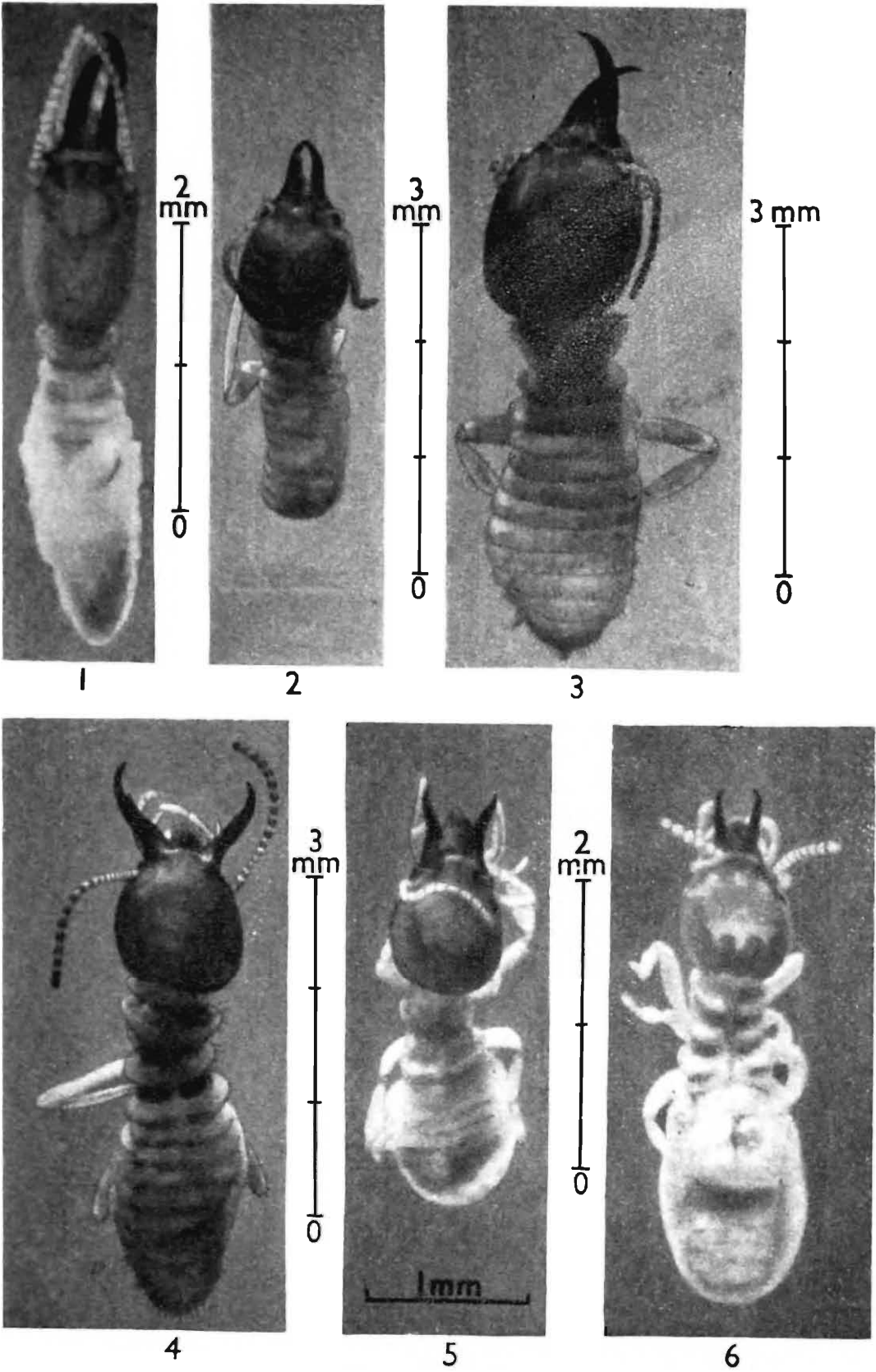


PLATE 24

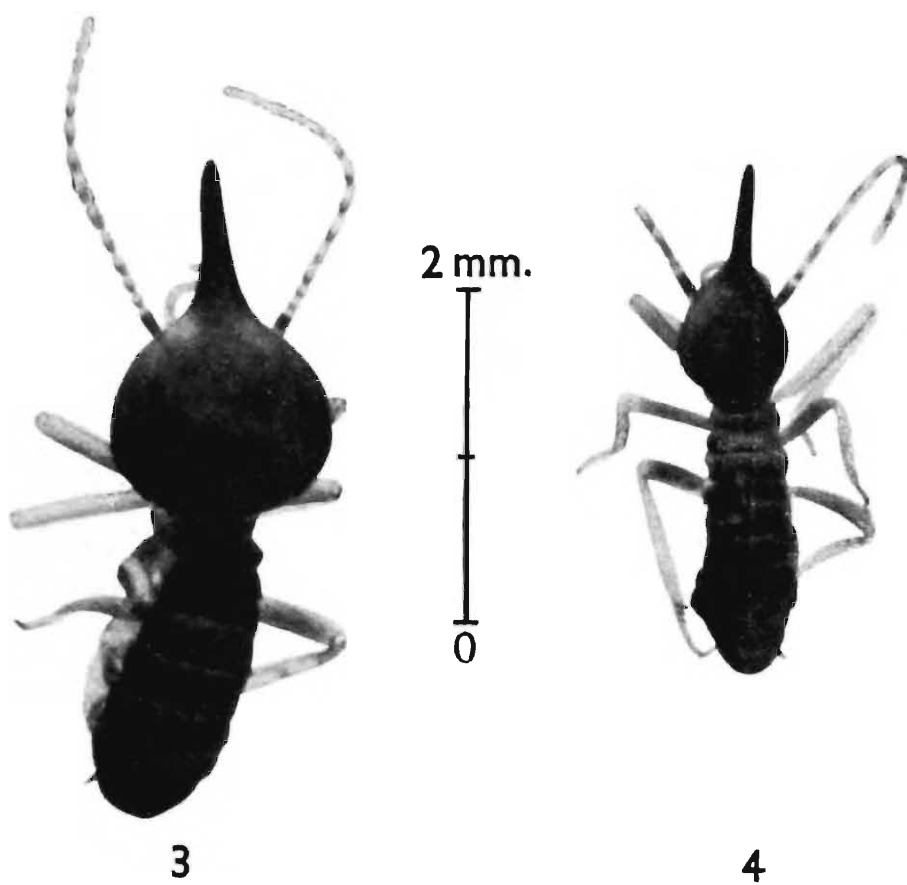
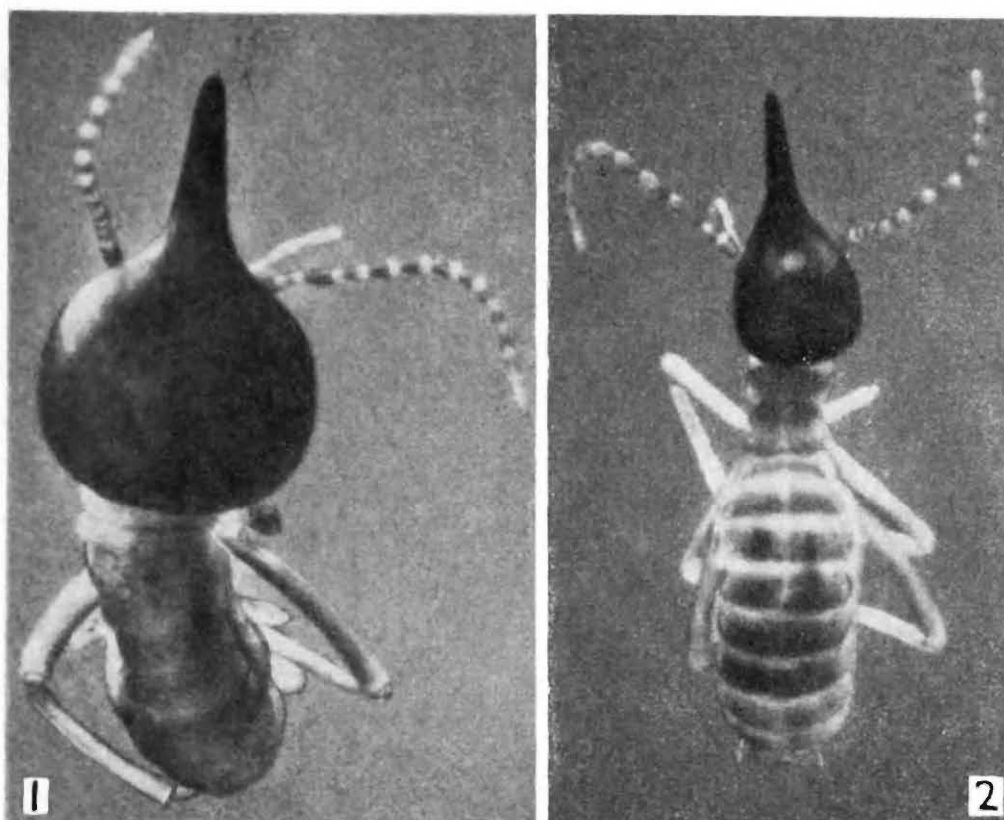
Termite soldiers from Rajasthan.

FIG. 1.—*Trinervitermes biformis* (Wasmann). Jaipur District.  
Soldier Major.

FIG. 2.—*Trinervitermes biformis* (Wasmann). Jaipur District.  
Soldier Minor.

FIG. 3.—*Trinervitermes heimi* (Wasmann). Nagaur District.  
Soldier Major.

FIG. 4.—*Trinervitermes heimi* (Wasmann). Nagaur District.  
Soldier Minor.



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