

OCCASIONAL PAPER NO. 197

**RECORDS OF THE
ZOOLOGICAL SURVEY OF INDIA**

**A Catalogue of Experimental Studies on
Grasshopper Chromosomes in India 1928 to 2000**

ASHOK K. SINGH

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**A Catalogue of Experimental Studies on Grasshopper
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Edited by the Director, Zoological Survey of India, Kolkata



**Zoological Survey of India
Kolkata**

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INTRODUCTION

Cytogenetic investigations on grasshopper chromosomes in India started as early as 1928. It was J. J. Asana who initiated it with his observations on the spermatogenesis of *Poecilocera picta*. During the 72 years that have followed the publication of the first work (Asana 1928), there has been an amazing expansion of work on cytogenetics. As such, a need was felt for a systematic presentation of the total work published upto the year 2000. The present catalogue and chronological bibliography is an attempt towards this objective.

Since the very beginning, even before the re-discovery of Mandel's work in the turn of the century, grasshoppers had drawn the attention of cytologists as their material for investigation. Since then, grasshopper remained the classical animal for the learning of the grammar of chromosome biology. Their availability in most of the places, easy maintenance in laboratory, relatively short life cycle, large size of chromosomes with low numbers in their compliments made them the material of choice to animal cytologists. The ease with which meiosis can be studied and aberrations can be scored made the investigators use them as good experimental systems.

The nature of studies can be grouped under two broad categories, viz., Experimental cytogenetics and General cytogenetics. The scheme presented below reveals a large variety of publications available on the grasshopper chromosomes.

Experimental Cytogenetics

- A Parthenogones
- B Induced structural heterozygotes
- C DNA replication
- D Meiotic progression and interference
- E Meiotic calendar of a grasshopper species
- F Effects of radiations and chemicals on chromosomes
 - (i) Physical clastogens
 - (ii) Chemical clastogens

General Cytogenetics

- A Karyology
 - (i) Chromosome number and morphology
 - (ii) Constitutive heterochromatin and C-banding
 - (iii) Nucleolus organising regions (NORs)
 - (iv) Lamp brush type chromosomes
 - (v) Different techniques used in the study of grasshopper chromosomes

E Meiotic calendar of a grasshopper species viz., *Spathosternum prasiniferum* (Walker)

188 1995

F Effects of radiations and chemicals on chromosomes**Physical Agents****1 Cold treatment**

14, 203 1949, 1950

2 Electric sparks

256 1970

3 Magnetic force

122 1975

4 Constant temperatures

101, 240 1967, 1971

5 P³² - Radioactive phosphorus - radioisotope

(Radioactive substance part of the DNA of the chromosomes)

34, 39, 40 1958, 1961

6 X - irradiation - as DNA - nicking agent

19, 20, 30, 35, 39, 40, 41, 1950, 1952, 1954, 1957, 1960,

42, 43, 54, 68, 69, 72, 73, 1961, 1962, 1963, 1965, 1966,

76, 80, 83, 86, 88, 89, 93, 1967, 1968, 1969, 1970, 1975,

124, 163, 176, 188, 204, 1978, 1980, 1986, 1987, 1989,

209, 211, 219, 223, 228, 1990, 1994, 1995

235, 236, 242, 245, 305,

306, 317, 321, 363, 364,

374, 382, 384

7 Y - (gamma) irradiation as DNA - nicking agent

22, 80, 126, 145, 211, 218, 1954, 1963, 1967, 1975, 1979

289

Chemical Agents**1 Acetic acid - Organic acid**

65, 226 1966

2 Actinomycin D - Organic compound, antibiotic, prevents RNA synthesis, binds to DNA and blocks the movement of RNA

71, 182, 233 1967, 1991

- 3 Adelphane - Organic compound (Reserpine + Dihydrallazine sulphate), antihypertensive, an alkaloid from the roots of Sarpagandha (*Rauwolfia serpentina* Benth., Family - Apocynaceae
143 1979
- 4 Aflatoxin - Organic compound, mycotoxin, metabolites of the fungus *Aspergillus flavus*
160, 331 1981, 1984
- 5 Aluminium chloride - Inorganic salt
57, 182 1965, 1991
- 6 3 - aminobenzamide (3AB) - Organic compound, a specific inhibitor of poly (ADP-ribose) polymerase
374 1990
- 7 Arginine - Organic compound, amino acid
283 1974
- 8 Atropine - Organic compound, alkaloid, obtained from the dried leaves of *Atropa belladonna* (Solanaceae) and is used to dilate the pupil.
137, 277, 285 1973, 1974, 1977
- 9 P - benzoquinone - Organic compound
278 1973
- 10 BrdU (5-Bromodeoxyuridine) - Organic compound, thymidine analogue, a halogenated pyrimidine deoxyriboside (synthetic nucleoside)
84, 182, 246, 392 1968, 1987, 1991
- 11 Cadmium chloride - Inorganic salt
135 1977
- 12 Caffeine - Organic compound, source - coffee beans, *Coffea arabica* and tea leaves, *Camellia sinensis*
385, 387 1997
- 13 Calcium chloride - Inorganic salt
108, 276 1972, 1973
- 14 Calcium lactate - Organic compound, a salt of organic lactic acid
159, 338, 367 1983, 1984, 1988
- 15 Carbamates - Organic compound, pesticide
360 1987
- 16 Ceresan - Organic compound
325 1981

- 17 Chemical agents
72, 88, 182 (summaries) 1967, 1969, 1991
- 18 Chloramphenicol - Organic compound, antibiotic, blocks the peptidyl transferase reaction on ribosomes
182, 237 1967, 1991
- 19 Chloroquine - Organic compound, alkaloid, plant source, antibiotic, anti malarial drug
364 1987
- 20 Ciplin (Combination of Trimethoprim and Sulfamethoxazole) - Organic compound, antibacterial drug
166 1986
- 21 Colchicine - Organic compound, alkaloid, used in treatment of Gout, causes disappearance of the mitotic spindle and blocks cells in mitosis. Plant source, roots of *Colchicum autumnale* (Liliaceae)
182, 220 1964, 1965, 1991
- 22 Cortisone acetate - Organic compound, Glucocorticoid steroid
109, 182 1968, 1972-73, 1991
- 23 Cupferron - Organic compound, chelating agent
64, 182 1966, 1991
- 24 Cycloheximide - Organic compound, reversibly inhibit peptidyl transferase, the ribosomal enzyme that forms peptide bonds thus prevents protein synthesis
151, 336 1981, 1983
- 25 Cysteamine (Cysteamine hydrochloride) - Organic compound, chelating agent, radio protective chemical
39, 40, 42 1961, 1962
- 26 Deoxyadenosine - Organic compound, nucleoside, base adenine
272 1972
- 27 Det - Sodium salt of organic acid, commercial detergent
351 1985
- 28 DIECA (Sodium diethyl dithiocarbamate) - Organic acid
153, 291, 315, 327 1975, 1979, 1981, 1982
- 29 2' - 4' - dihydroxychalcone - Organic compound, phenolic in nature
114, 116, 282 1973, 1974

- 30 Dimecron 100 - Organic compound, insecticide
301 1977
- 31 Dimethoate - Organic salt, ester, insecticide
288 1975
- 32 DMBA (7, 12 - dimethylbenz (α) anthracene) - Organic hydrocarbon
174, 343, 345, 352, 359 1984, 1985, 1987, 1988
- 33 2-4-Dinitrophenol - Organic compound, phenol group, acidic in nature
100, 182, 261 1971, 1991
- 34 Erythromycin - Organic compound, antibiotic, blocks the translocation reaction on ribosomes
284 1974
- 35 17β - Estradiol - Organic compound, hormone
109, 249 1968, 1972-73
- 36 Ethyl alcohol - Organic compound, alcohol
51, 55, 228, 252, 380 1964, 1965, 1966, 1969, 1993
- 37 Ethylene glycol - Organic compound, alcohol
334, 342 1982, 1984
- 38 Ethyl methanesulfonate - Organic compound, a monofunctional alkylating agent, clastogenic
in nature
178, 183, 185, 191, 370, 1989, 1990, 1992,
385, 386, 387, 388 1993, 1997, 1998
- 39 Formaline - Organic solution, solution of formaldehyde
75, 182, 227 1966, 1967, 1991
- 40 Furasol (Furaltadone) - Organic compound, antibacterial drug, acidic in nature
166 1986
- 41 Furea (Nitrofurazone + Urea) - Organic compound, antibacterial drug, basic in nature
166 1986
- 42 Gallic acid - Organic acid, phenolic in nature
182, 371 1989, 1991
- 43 Gramoneg (Nalidixic acid) - Organic acid, antibacterial drug. It has a high bacteriostatic
and bactericidal activity against infections caused by Gram - negative organisms
166 1986

- 44 Griseofulvin - Organic compound, antibiotic, antifungal
182, 266 1972, 1991
- 45 Gudaku (Processed tobacco) - Organic compound, nicotine
333 1982
- 46 Hoechst 33258 2-[2-(4-hydroxyphenol)-6-benzimidazolyl]-6-(1-methyl-4-piperazyl)-
benzimidazol-trihydrochloridean alkaline dibenzimidazole derivative
142, 297, 304 1977, 1978, 1979
- 47 Hydrocortisone - Organic compound, hormone. It is a natural glucocorticoid hormone of
the adrenal cortex possessing anti-inflammatory, anti-allergic, anti-exudative and anti-
fibroblastic properties.
232 1966
- 48 Hydrochloric acid - Inorganic acid
52, 65 1964, 1966
- 49 Hydroquinone - Organic compound, phenolic in nature
318 1980
- 50 Hydroxylamine hydrochloride - Organic compound, salt
265, 300 1972, 1977
- 51 8-Hydroxyquinoline - Organic compound, chelating agent, acidic in nature
173, 292, 303 1975, 1977, 1988
- 52 Insulin - Organic compound, hormone, physiologically related to carbohydrate metabolism
104, 182, 270 1972, 1991
- 53 Isopropanol - Organic compound
376 1991
- 54 Largactil - Organic compound, tranquillizer drug
279 1973
- 55 Lead acetate - Lead salt of organic acid
294 1976
- 56 L-leucine - Organic compound, amino acid
287 1975
- 57 3H Lysine - Organic compound, amino acid
335 1983

- 58 Maleic hydrazide - Organic compound, nucleic acid analogue
106, 182 1972, 1991
- 59 Mercuric chloride - Inorganic salt
146, 164, 296, 309, 311 1976, 1978, 1979, 1986
- 60 Methanol - Organic compound, alcohol
115, 286 1974
- 61 2-methyl-3-acetyl-1, 8-naphthyridine - Organic compound, water soluble
141 1978
- 62 Methyl methanesulfonate - Organic compound, a monofunctional alkylating agent
187, 191, 192, 387 1994, 1997, 1998
- 63 Mitomycin C - Organic compound, antibiotic, an antitumor agent. It inhibits DNA synthesis
124, 132, 290 1975, 1976
- 64 Myleran - Organic compound, a chemotherapeutic drug, active against chronic myleoid leukemia in human patients
306 1978
- 65 Nitrogen mustard [di(2-chloroethyl)-methyl-aminehydrochloride] - Organic compound
27, 28, 29 1955, 1956
- 66 Novobiocin - Organic compound, antibiotic
182, 250 1969, 1991
- 67 Oleandomycin - Organic compound, antibiotic
182, 254 1970, 1991
- 68 Pederine - Organic compound, obtained from Coleopteran insect, *Paederus fuscipes*
361 1987
- 69 Penicillin - Organic compound, antibiotic, bactericidal
107, 127, 182, 257 1970, 1972, 1975, 1991
- 70 2-(3-pyridyl)-1, 8-naphthyridine - Organic compound, water soluble
141 1978
- 71 Pyrocatechol - Organic compound, phenol group, acidic in nature
210 1953
- 72 Pyrogallol - Organic compound, phenol group, acidic in nature
100, 182, 210, 261 1953, 1971, 1991

- 73 Semicarbazide - Organic compound
275 1973
- 74 Sevin (1 naphthyl-n-methyl carbamate) - Organic compound, carbamate group of insecticide
112 1974
- 75 Sodium azide - Sodium salt of Inorganic acid, respiratory inhibitor
39, 40, 140, 302, 328 1961, 1977, 1978, 1981
- 76 Sodium barbitone - Organic salt of sodium
231 1966
- 77 Sodium citrate - Organic compound, sodium salt of Citric acid, anticoagulant
150, 310 1978, 1981
- 78 Sodium hydroxide - Inorganic alkali
52, 65 1964, 1966
- 79 Sodium ribose nucleate (from Yeast) - Organic compound, sodium salt of ribosnucleic acid
28 1955
- 80 Streptomycin - Organic compound, antibiotic, antibacterial, antitubercular drug
127, 182 1975, 1991
- 81 Sulphanilamide - Organic compound, antibacterial drug, sulfa-drug
165, 307, 308, 356 1978, 1986
- 82 Tertiary butyl alcohol - Organic compound, alcohol
169, 281, 381 1973, 1987, 1993
- 83 Tetracycline - Organic compound, antibiotic. Tetracyclines have chelating property and form insoluble and unabsorbable complexes with calcium and other metals
105, 182, 260 1971, 1972, 1991
- 84 Trimethylbenzanthracene (TMBA) - Organic compound
180, 369, 375 1989, 1990
- 85 Tyrosine - Organic compound, amino acid
316 1980
- 86 Urea - Organic compound, carcinogenic agent
3, 19, 319, 321 1980
- 87 Urethane ($\text{HNHCOOCH}_2\text{CH}_3$) - Organic compound, carcinogenic agent, also known as narcotic, a sedative and a mitotic poison
25, 28, 36, 314, 319 1955, 1960, 1979, 1980

- 88 ^3H -uridine - radioactive RNA precursor
144 1979
- 89 Versene (EDTA) (Ethylenediaminetetra acetic acid) - Organic compound, salt, chelating agent, anticoagulant
37, 39, 40, 111, 113, 182, 1960, 1961, 1972, 1973, 1974, 1991
274, 280
- 90 Extract of *Abrus precatorius* L. seeds (Family : Leguminosae) - Organic compound. Aqueous extracts of the *Abrus* seeds on analysis have yielded toxic proteins of different electrophoretic mobility. Besides these toxic proteins, the extract on chromatography has shown the presence of phenolics
61, 97 1966, 1971
- 91 Extract of *Anisomeles heyneana* (Family : Labiatae) - Organic compound
380 1993
- 92 Extract of *Lathyrus sativus* seeds (Khesari) (Family : Leguminosae) - Organic compound, lathyrogens
175, 357 1986, 1989

SPECIES INDEX

A taxonomical arrangement of the species of grasshoppers along with publications as indicated by their reference numbers in the chronological bibliography. Species names are retained as printed in the publications.

Family	ACRIDIDAE
Subfamily	ACRIDINAE
1. <i>Acrida exaltata</i> (Walker)	8, 24, 117, 133, 136, 156, 167, 186, 193, 196, 264, 336, 355, 362, 391
2. <i>Acrida gigantea</i> (Herbst)	73, 83, 182, 329
3. <i>Acrida lugubris</i> Burr	329
4. <i>Acrida lugula</i>	73, 83, 106, 182
5. <i>Acrida turrita</i> (Linnaeus)	21, 129, 130, 138, 156, 167, 193, 264, 373
6. <i>Ceracris deflorata</i> (Brunner)	96, 150, 156, 160, 167, 177, 186, 193, 262, 331, 366, 390
7. <i>Ceracris nigricornis</i> (Walker)	21, 150, 156, 167, 193, 391
8. <i>Ceracris</i> Walker	329
9. <i>Gelastorrhinus filatus</i> (Walker)	156, 167, 177, 186, 193, 340, 366, 368, 390
10. <i>Phlaeoba angustidorsis</i> Bolivar	11

11. *Phlaeoba antennata* Brunner 51, 55, 57, 73, 83, 84, 89, 100, 106, 107, 156, 167, 182, 186, 193, 228, 236, 237, 246, 247, 252, 257, 267, 391
12. *Phlaeoba infumata* Brunner 156, 157, 158, 167, 186, 189, 193, 322, 330, 391
13. *Phlaeoba panteli* Bolivar 329
14. *Phlaeoba* Stal 9, 11
15. *Sikkimiana darjeelingensis* (Bolivar) 92, 102, 391
Morphacris fasciata Thunberg 393.
 Subfamily CALLIPTAMINAE
16. *Acorypha glaucopsis* 271
17. *Peripolus pedarius* (Stal) 391
 Subfamily CATANTOPINAE
18. *Catantops humilis* (Serville) 21
19. *Catantops indicus* 329
20. *Catantops karnyi* (Kirby) 133
21. *Catantops innotabilis* (Walker) 90, 133, 391, 393
22. *Catantops simlae* Dirsh 391
23. *Catantops trisinterassonute* 203
24. *Paraconophyma kashmiricum* Mistshenko 161, 189
25. *Stenocatantops splendens* (Thunberg) 391
26. *Xenocatantops karnyi* (Kirby) 391
27. *Xenocatantops humilis* (Serville) 258, 391
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28. *Coptarca punctoria* (Walker) 170
29. *Eucoptacra praemorsa* (Stal) 391
 Subfamily CYRTACANTHACRIDINAE
30. *Chondracris rosea* (de Geer) 391
31. *Cyrtacanthacris tatarica* (Linnaeus) 21, 133, 362, 391, 393
32. *Orthacanthacris flavescens* 73, 83, 182
33. *Pachyacris vinosa* (Walker) 21
34. *Patanga succincta* (Johansson) 391
35. *Schistocerca gregaria* (Forsk.) 35, 62, 71, 87, 90, 151, 168, 196, 199, 337, 341, 354, 392
 Subfamily EYPREPOCNEMIDINAE
36. *Choroedocus capensis* (Stal) 21, 156, 167, 181, 186, 193, 358
37. *Choroedocus robustus* (Serville) 391

38. *Eyprepocnemis alacris* (Serville) 21, 128, 156, 157, 167, 181, 189, 193, 330, 358, 389, 391, 393
39. *Eyprepocnemis rosea* Uvarov 96, 133, 255, 391
40. *Eyprepocnemis* Fieber 33, 47, 72, 182
41. *Heteracris nobilis* (Uvarov) 156, 166, 318, 349.
42. *Heteracris robusta* 73, 83, 182
43. *Heteracris* Walker 391
44. *Thisiocetrus nobilis* Uvarov 156, 167, 181, 186, 189, 358, 389
45. *Thisiocetrus pulchra* Bolivar 18, 136
46. *Tylotropidius varicornis* (Walker) 355, 391
- Subfamily GOMPHOCERINAE
47. *Aulacobothrus collinus* Uvarov 391
48. *Aulacobothrus luteipes* (Walker) 96, 196
49. *Aulacobothrus physopoda* Navas 329
50. *Aulacobothrus socius* (Bolivar) 329
51. *Aulacobothrus taeniatus* Bolivar 156, 157, 167, 189, 193, 313, 330
52. *Aulacobothrus* Jago 128, 196
53. *Chorthippus indus* Uvarov 128, 391
54. *Leva cruciata* Bolivar 391
55. *Stenohippus mundus* (Walker) 24
- Subfamily HEMIACRIDINAE
56. *Gesonula punctifrons* (Stal) 14, 19, 20, 21, 22, 27, 29, 30, 34, 37, 39, 40, 41, 42, 54, 72, 123, 124, 144, 204, 209, 210, 211, 219, 299, 326, 391
57. *Hieroglyphus banian* (Fabricius) 8, 24, 96, 156, 167, 186, 193, 313
58. *Hieroglyphus nigrorepletus* Bolivar 156, 167, 177, 186, 189, 193, 195, 390
59. *Parahieroglyphus biliniatus* (Bolivar) 156, 167, 171, 186, 193, 353, 366, 368
60. *Spathosternum prasiniferum* (Walker) 8, 9, 29, 52, 54, 58, 63, 64, 65, 73, 83, 95, 98, 104, 105, 106, 108, 111, 114, 116, 123, 133, 137, 139, 140, 142, 146, 150, 153, 156, 159, 164, 165, 167, 169, 171, 172, 173, 174, 175, 177, 180, 182, 184, 186, 188, 193, 220, 241, 250, 254, 260, 265, 266, 274, 275, 281, 282, 283, 284, 287, 291, 292, 295, 297, 302, 303, 304, 307, 308, 309, 310, 311, 314, 315, 316, 318, 319, 320, 321, 323, 327, 328, 334, 340, 342, 343, 344, 345, 353, 356, 359, 362, 366, 367, 368, 371, 374, 376, 380, 381, 382, 390, 391

61. <i>Spathosternum</i> Karsch	213
Subfamily OEDIPODINAE	
62. <i>Acrotylus humbertianus</i> Saussure	21, 24, 90, 99, 156, 167, 193, 259, 349
63. <i>Acrotylus inficita</i> (Walker)	391
64. <i>Acrotylus</i> Fieber	207, 264
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70. <i>Gastrimargus transversus</i> Thunberg	59, 156, 167, 171, 186, 193, 349, 353, 368
71. <i>Gastrimargus</i> Saussure	48, 217, 222, 383
72. <i>Heteropternis respondens</i> (Walker)	156, 167, 171, 186, 189, 193, 349, 353, 391
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83. <i>Caryanda paravicina</i> (Willemse)	391
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SUMMARY

The "Catalogue of Experimental Studies on Grasshopper Chromosomes in India, 1928 to 2000" is a synthesis of vast literature. This includes studies on the mutagenic effects of 92 chemical and 7 physical agents on the chromosomes. Another part of the experimental studies are on parthenogones, induced structural heterozygotes, DNA replication, meiotic progression and interference and meiotic calendar of a grasshopper species viz., *Spathosternum prasiniferum* (Walker). A taxonomical list of 117 species of the grasshoppers investigated, with a chronological bibliography of 393 publications provide total work as well as reveals prolific choice of grasshoppers as study material. Asana's (1928) work on *Poeciloceris pictus* (Fabricius) is also the beginning of animal cytogenetics in India.

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