PRANIKEE

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Brief history :

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The Society was founded in 1958 in order to promote effective communication between Zoologists through its publication, seminars and annual meetings.

Membership and subscription :

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THE EMBLEM

On the cover page is the emblem of "NABAGUNJARA" a chimeric animal peculiar to Orissan art and literature. Literally meaning "Nineform" it is a common motif in Orissan paintings. This form has been described by poet Sarala Das in his epic Mahabharata written in Oriya. Apparently Lord Krishna appeared in "Nabagunjara" form consisting of the body of an elephant, a leg each of a horse, a deer and a tiger; throat of a peacock, tail in the from of a serpent, waist of the lion, hump of the bull and the head of a cock, to fool his friend Arjuna. The chimera was holding a lotus flower in a human hand. Arjuna had never seen such a creature in his life and guessed that this cannot be a real animal and must be a form assumed by Lord Krishna and bowed down at its feet. It is said that the human hand with the lotus provided the clue. In the paintings and sculptures however, the lotus is often replaced by the "Chakra" or the "stylized discuss" of Lord Krishna.

Chimeric forms are encountered in literature and art all over the world. However, as far as I know, a chimera of nine animals, is peculiarly Orissan. Therefore, we thought that this will be an appropriate emblem for the journal of the Zoological Society of Orissa.

—P. Mohanty-Hejmadi

The Zoological Society of Orissa published the first volume of the journal in 1980 and with the full co-operation of members and contributors it has been possible to bring out subsequent volumes regularly. The financial aid for this publication has been provided by the Director of Public Instruction, Orissa; State Youth Welfare Board; Orissa; Utkal University and Zoological Society of Orissa

B. K. BEHURA
Editor

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CONTENTS

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STUDIES ON THE LIFE HISTORY OF *CHRYSOPA ORESTES* BANKS (NEUROPTERA : CHRYSOPIDÆ) WITH NOTES ON ITS PREDATORY HABITS

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ABSTRACT

The rearing technique of *Chrysopa orestes* Banks is described. Its larvae are predatory on arthropods (e. g., aphids, mealy bugs, thrips and spider mites) but not its adults. In the laboratory the adults breed readily when provided with a diet consisting of lactalbumin, yeast extract and cane sugar (5 : 6 : 10).

INTRODUCTION

Chrysopids are efficient predators of Homoptera, spider mites and young caterpillars. In temperate countries many species are employed for control of noxious aphid pests (Scopes, 1969; Bondarenko and Moiseev, 1972). *Chrysopa orestes* Banks is an important aphidophagous predator in Orissa (Patnaik *et al.*, 1977). The present paper reports its life history with particular reference to its rearing technique and predatory habits.

MATERIALS AND METHODS

The initial collection of *C. orestes* adults was made from a light source adjacent to a mango tree which was heavily infested with the mealy bug, *Rastrococcus iceryoides* (Green). The stock culture of the predators was confined in cloth-lined wooden rearing cages (30 × 30 × 30 cm) in the insectary of the Department of Entomology, Orissa University of Agriculture and Technology, Bhubaneswar. The adults were fed with a formulated proteinous diet comprising 5 parts of lactalbumin, 6 parts of yeast extract and 10 parts of cane sugar (W/W). Sufficient water was mixed to make it a thin paste. To obviate fermentation, fresh diet was prepared daily and was pasted on the inner wall of the cloth lining. Later when the females oviposited on the cloth lining, the eggs

were harvested by clipping the egg stalks with scissors and kept apart in petri dishes for further study. Upon hatching, the larvae were provided with sorghum aphid, *Longiunguis sacchari* (Zhnt.),

To study the habits of the adults, freshly emerged couples (1 : 1) were sexed in breeding glass cages (14 × 9 cm) stoppered with muslin cloth lining. Each set was replicated 7 times. If mates died earlier than the females in the breeding cage new males, maintained separately, were introduced into the cage to provent the females reproducing asexually. The breeding cages were changed daily.

To study the feeding efficiency, the larvae were provided with counted number of sorghum aphids, cotton mealy bug, onion thrips and red spider mites. Each prey group formed a separate set by itself for the purpose of study. The number of prey, introduced at intervals of 24 hr. was always in excess of the predator's requirement.

RESULTS AND DISCUSSION

Developmental stages :

The eggs of *C. orestes* are oblong (1.99 × 0.6 mm) and usually stand erect on hyaline stalks (7 mm). There are three larval instars and all are typically chrysopoid. The full-grown third instar larva prepares for pupation by spinning a silken cocoon. Cocoons are white, roundish (3 mm dia) having extraneous debris adhering to the surface. The pupae were parasited in nature by *Xanthocampoplex* sp. (Hymenoptera : Ichneumonidae) but parasitization rate was negligible. Emergence of adults took place during night. The duration of the pre-imaginal stages of the insect is presented in Table 1.

Fecundity, longevity and sex-ratio :

Various types of diets have been suggested by workers for rearing *Chrysopa* (Sundby, 1967; Vanderzant, 1969; Hagen and Tassan, 1970). The lactalbumin diet used in the present study worked satisfactorily in inducing oviposition and sustained the adults which were not zoophagous (Fig. 1). Egg laying commenced after 7.27 ± 1.37 days of adult emergence and lasted for 28.85 ± 4.39 days on an average, during which period 86.33 ± 34.91 eggs were laid/female. Every day each individual usually laid a single egg mass but occasionally even two were laid. Females lived longer (38.00 ± 7.05 days) than males (17.50 ± 1.50 days) and were also preponderant than the latter (F : M = 21 : 17) (Table 2).

2 mm

Fig. 1—Adult of *C. crestes*.

TABLE 1

Developmental duration of pre-imaginal stages of *C. orestes* under insectary conditions (30.5 – 31.9°C temp. and 61.7 – 65.4 % R. H.) at Bhubaneswar.

Stage	Duration (days)	
	Range	*Mean ± SD
Egg	3 — 6	3 88 ± 0.58
Larva : I instar	4 — 5	4 75 ± 0 43
II instar	4 — 5	4.10 ± 0.79
III instar	4 — 6	4.75 ± 0.90
Pupa	8 — 12	9.77 ± 1.04

* Mean of 20 replicates.

TABLE 2

Longevity and fecundity of *C. orestes* adults on artifical diet under insectary conditions.

Observation on	Range	*Mean ± SD
Longevity of adults (days) :		
Male :	13 — 19	17.50 ± 1.50
Female :		
Pre-oviposition	5 — 9	7.27 ± 1.37
Oviposition	19 — 31	21.85 ± 4.39
Post-oviposition	4 — 7	5.42 ± 1.29
Fecundity :		
No. of eggs laid/female	40 — 152	86.33 ± 34.91
No. of eggs laid/female/day	5 — 28	13.61 ± 4.47
No. of eggs/egg batch	5 — 28	11.92 ± 5.36

* Mean of 7 replicates

Predatory efficiency :

The larvae consumed aphids, mealy bugs, thrips and spider mites but the development was completed on the former two. In their predatory potentiality *C. orestes* larvae were close rivals of syrphid flies and ladybird beetles (Simpson and Burkhardt, 1960; Patnaik *et al.*, 1977). In the present study each larva consumed on an average 280.27 aphids (*L. sacchari*) and 116.40 mealy bugs (*Ferrisiana virgata* (Cockerell)) during its larval stages (Table 3).

TABLE 3

Feeding rate of *C. orestes* larva

Prey species	No. of days fed (Mean)	*** No. of prey consumed/ larva/day	Total prey consumed during larval stage/larva	Stage of the prey
Sorghum aphid (*Longiunguis sacchari*)	11.1*	52.25	289.27	III & IV instar
Cotton mealy bug (*Ferrisiana virgata*)	12.9*	9.70	116.49	II instar
Onion thrips (*Thrips tabaci*)	6.6**	29.28	—	Adults
Red spider mile (*Tetranychus telarius*)	9.0**	27.83	—	Adults

* Larval duration.

** Larvae did not moult nor pupate.

*** Mean of 10 replicates.

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BHARATPUR BIRD SANCTUARY
A WONDERLAND OF NATURE

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INTRODUCTION

Bharatpur sanctuary is one of the most spectacular waterbird sanctuaries of the world. Situated at a place called Keoladev Ghana, it is a winter resort and breeding ground for the migratory birds. Popularly known as the Keoladeo Ghana Bird Sanctuary after the presiding god Keoladeo (Lord Shiva) it was a renowned duck shooting reserve of the erstwhile Bharatpur State. The record inscribed on a stone board inside the sanctuary shows the details of duck shootings organised during the period 1902-1964. These duck shootings used to be arranged in honour of visiting dignitaries in winter when migratory ducks were abundant in Ghana waters. Thousands of ducks used to be shot every year and the highest bag recorded was on the 12th Nov. 1938 when Lord Linlithgow and his party shot 4273 ducks. Over the years the number of duck shot has fortunately dwindled.

With the promulgation of the Rajasthan Wild Animals and Birds Protection Act of 1951, Keoladev Ghana forest block was declared a reserve area for a Bird Sanctuary on the 13th March 1956. But the Maharaja of Bharatpur who had exclusive shooting rights continued to enjoy them in spite of the declaration till 1972 when such rights were stopped under the Indian Wild Life (Protection) Act, 1972.

Location and fauna

Bharatpur Bird Sanctuary is situated about 50 km from the historic Tajmahal. The bird sanctuary lies near the old city of Bharatpur (lat. 27°13′ and long. 77°32′). It is encircled by some of the big cities of India : Delhi-176 km, Agra-52 km, Mathura-35 km and Jaipur-176 km. The sanctuary is surrounded by a concrete wall on all sides to avoid unauthorised entrance of cattle and human beings.

The area of the Sanctuary is 29 sq km. (2900 hectares), divided into smaller compartments by numerous roads and bundhs to provide better views to the visitor. During monsoon and the winter months major part of the sanctuary is submerged under water. With the approach of summer the sanctuary starts drying up and by about June the sanctuary becomes almost dry. By this time majority of the resident aquatic birds move to other places. With the onset of monsoon both resident and locally migratory birds start coming into the sanctuary. By August the sanctuary presents a panoramic view of nesting. The shallow and extensive water with plenty of aquatic vegetation, insects, molluscs, fishes, amphibians, planktons and trees growing all over the sanctuary, provide ideal condition for nesting.

At the start of monsoon (July-August) storks, egrets, cormorants, darters, white ibis, spoonbills and herons start building their nests, lay eggs and rear their young in a disciplined and co-ordinated manner. There is co-existence of 8 to 10 species of birds nesting on a single tree, the nests often running into one another. There is no communal segregation and one can see white spoonbill, egrets (three species) and cormorants with a variety of coloured birds like painted stork. openbilled stork, white ibis and herons on the same tree. Many other species such as moorhen, white breasted waterhen, jacanas, coot, pond heron, night heron, nukta, cotton teal, dabchick, white necked stork, kingfishers and numerous other resident birds also nest in the sanctuary.

The sanctuary attracts birds from Siberia and beyond the Himalayas, after October. Among the migratory birds are a large veriety of geese and ducks, pintail, wigeon, mallard, gadwal, shoveller teals, pochard, pelican and the Siberian crane, etc.

Although, it is primarily a Bird Sanctuary a number of wild mammals have abode in the sanctuary. Prominent among the mammalian fauna inhabiting the area are :

1. *Macaca mulatta* — Rhesus macaque
2. *Presbytis entellus* — Common langur
3. *Felis chaus* — Jungle cat
4. *Herpestes edwardsi* — Common mongoose
5. *Herpestes auropunctatus* — Small Indian mongoose
6. *Canis aureus* — Jackal
7. *Vulpes bengalensis* — Indian Fox

8. *Lutra perspicillata* — Smooth Indian otter
9. *Funambulus pennanti* — Five stripped plam squirrel
10. *Tatera indica* — Indian gerbille
11. *Hystrix indica* — Indian porcupine
12. *Lepus nigricollis* — Indian hare
13. *Antilope cervicapra* — Blackbuck
14. *Boselaphus tragocamelus* — Nilgai
15. *Cervus unicolor* — Sambar
16. *Axis axis* — Spotted deer
17. *Sus scrofa* — Indian wild boar
18. *Manis crassicaudata* — Indian pangolin

Migration studies

The Bombay Natural History Society under the expert guidance of the celebrated ornithologist Dr. Salim Ali has been conducting some unique studies on the migration of birds over the years at Bharatpur.

Tourist facilities

Bharatpur is linked by Western Railway on Delhi-Bombay and Agra-Ahmedabad Rail route. There are regular buses from Delhi, Agra, Jaipur and Mathura. At the forest Rest House transport is available for going round the sanctuary. In addition to the permanent two-storeyed watch tower in water, temporary watch towers are built in the midst of nesting birds for facilitating photography and study of birds.

For visitors, tourists and specifically bird watchers the Bharatpur Bird sanctuary is one of the best water bird breeding sanctuary in the world.

RESIDENT BIRDS OF BHARATPUR

1. *Podiceps ruficollis* — Dabchick or Little grebe
2. *Phalacrocorax carbo* — Large cormorant
3. *Phalacrocorax fuscicollis* — Indian shag
4. *Phalacrocorax niger* — Little cormorant
5. *Anhinga rufa* — Snake bird or Darter
6. *Ardea alba* — Large egret
7. *Ardea cinerea* — Grey heron
8. *Ardea purpurea* — Purple heron
9. *Ardeola grayii* — Pond heron

10. *Bubulcus ibis* — Cattle egret
11. *Egretta intermedia* — Smaller or Median egret
12. *Egretta garzetta* — Little egret
13. *Nycticorax nycticorax* — Night heron
14. *Ibis leucocephalus* — Painted stork
15. *Anastomus oscitans* — Openbilled stork
16. *Ciconia episcopus* — Whitenecked stork
17. *Ephippiorhynchus asiaticus* — Black-necked stork
18. *Threskiornis aethiopica melanocephala* — White ibis
19. *Platalea leucorodia* — Spoonbill
20. *Anas poecilorhyncha* — Spotbill duck
21. *Nettapus coromandelianus* — Cotton teal
22. *Sarkidiornis melanotos* — Nukta
23. *Milvus migrans* — Pariah kite
24. *Haliaeetus leucorhyphus* — Pallas fishing eagle
25. *Sarcogyps calvus* — King vulture
26. *Gyps bengalensis* — Indian white backed vulture
27. *Gyps indicus* — Indian long billed vulture
28. *Neophron percnopterus* — Scavenger vulture
29. *Francolinus pondicerianus* — Grey partridge
30. *Francolinus francolinus* — Black partridge
31. *Coturnix coturnix* — Common quail
32. *Perdicula asiatica* — Jungle bush quail
33. *Pavo cristatus* — Peafowl
34. *Grus antigone* — Sarus crane
35. *Amaurornis phoenicurus* — White breasted waterhen
36. *Gallinula chloropus* — Indian moorhen
37. *Porphyrio porphyrio* — Purple moorhen
38. *Fulica atra* — Coot
39. *Hydrophasionus chirurgus* — Pheasant tailed jacana
40. *Metopidius indicus* — Bronze winged jacana
41. *Vanellus indicus* — Red wattled lapwing
42. *Vanellus malabaricus* — Yellow wattled lapwing
43. *Himantopus himantopus* — Black winged stilt
44. *Burhinus oedicnemus* — Stone curlew
45. *Columba livia* — Blue rock pigeon
46. *Streptopelia decaocto* — Indian ring dove
47. *Streptopelia tranquebarica* — Red turtle dove
48. *Streptopelia senegalensis* — Little brown dove
49. *Psittacula krameri*—Roseringed parakeet
50. *Cuculus varius* — Brainfever bird

51. *Centropus sinensis* — Crow pheasant
52. *Athene brama* — Spotted owlet
53. *Caprimulgus asiaticus* — Common Indian Little nightjar
54. *Ceryle rudis* — Pied kingfisher
55. *Alcedo athis* — Cowmon kingfisher
56. *Halcyon smyrnensis* — White breasted kingfisher
57. *Merops superciliosus* — Blue cheeked beeeater
58. *Merops philippinus* — Blue tailed beeater
59. *Merops orientalis* — Common green beeeater
60. *Coracias benghalensis* — Indian roller
61. *Tockus birostris* — Common grey hornbill
62. *Megalainaa haemacephala* — Coppersmith or Crimson breasted barbet
63. *Dinopium benghalense* — Golden backed woodpecker
64. *Picoides mahrattensis* — Maharatta woodpecker
65. *Dinopium nanus* — Pygmy woodpecker
66. *Galerida cristata* — Crested lark
67. *Hirundo concolor* — Dusky crag martin
68. *Hirundo fluvicola* — Indian cliff swallow
69. *Lanius excubitor* — Grey shrike
70. *Lanius vittatus* — Bay backed shrike
71. *Lanius schach* —Rufous backed shrike
72. *Dicrurus adsimilis* — Black drongo
73. *Dicrurus caesulescens* — White bellied drongo
74. *Slurnus pagodarum* — Brahminy myna
75. *Sturnus contra* — Pied myna
76. *Acridotheres tristis* — Common myna
77. *Acridotheres ginginianus* — Bank myna
78. *Dendrocitta vagabunda* — Indian treepie
79. *Corvus splendens* — House crow
80. *Corvus macrorhynchus* — Jungle crow
81. *Tephrodornis pondicerianus* — Common wood shrike
82. *Pericrocotus flammeus* — Scarlet minivet
83. *Pericrocotus cinnamomeus* — Small minivet
84. *Pycnonotus leucogenys leucogenys* — White cheeked bulbul
85. *Pycnonotus cafer* — Red vented bulbul
86. *Turdoides caudatus* — Common babbler
87. *Turdoidis striatus* — Jungle babbler
88. *Terpsiphone paradisi* — Paradise fly catcher
89. *Prinia socialis* — Ashy wren warb

90. *Orthotomus sutorius* — Tailer bird
91. *Copsychus saularis* — Magpie robin
92. *Saxicola caprata* — Pied bush chat
93. *Saxicoloides fulicata*— Indian Robin
94. *Nectarinia asiatica* — Purple sunbird
95. *Zosterops palpebrosa* — White eye
96. *Passer domesticus* — Indian house sparrow
97. *Ploceus philippinus* — Baya or Common weaver bird
98. *Lonchura malabarica* — White throated munia

MIGRATORY BIRDS IN BHARATPUR

Migratory birds sighted in Bharatpur are listed below :

1. *Podiceps cristatus* — Great crested grebe
2. *Pelecanus anocrotalus* — Rosy pelican
3. *Pelecanus philippensis* — Dalmatian pelican
4. *Ciconia ciconia*— White stork
5. *Anser anser* — Greylag goose
6. *Anser indicus* — Barheaded goose
7. *Tadorna ferruginea* — Brahminy duck
8. *Anas acuta* — Pintail duck
9. *Anas crecca* — Common teal
10. *Anas platyrhynchos* — Mallard
11. *Anas strepera* — Gadwal
12. *Anas falcata* — Falcated teal
13. *Anas penelope* — Wigeon
14. *Anas querquedula* — Garguney
15. *Anas clypeata* — Shoveller
16. *Netta rufina* — Red crested pochard
17. *Aythya ferina* — Common pochard
18. *Aythya nyroca* — White eyed pochard
19. *Aythya fuligula* — Tufted duck
20. *Accipiter gentilis* — Goshawk
21. *Accipiter nisus* — Sparrow hawk
22. *Accipiter nipalensis* — Steppe eagle
23. *Haliaeetus albicilla* — White tailed sea eagle
24. *Circus macrourus* — Pale harrier
25. *Circus aeruginosus* — Marsh harrier
26. *Pandion haliaetus* — Osprey
27. *Falco paregrinus* — Peregrine falcon
28. *Grus grus* — Common crane

29. *G. leucogeranus* — Siberin crane
30. *Anthropoides virgo* — Demoiselle crane
31. *Rallus aquaticus* — Water rail
32. *Porzana porzana* — Spotted crane
33. *Fulica atra* — Coot
34. *Vanellus leucurus* — White tailed lapwing
35. *Vanellus vanellus* — Lapwing
36. *Vanellus cinereus* — Grey headed lapwing
37. *Pluvialis squatarola* — Grey plover
38. *Pluvialis dominica* — Eastern golden plover
39. *Charadrius hiaticula*—Ringed plover
40. *Charadrius dubius* — Little ringed plover
41. *Charadrius mongolus* — Lesser sand plover
42. *Numenius arquta* — Curlew
43. *Limosa limosa* — Black tailed godwit
44. *Tringa erythropus* — Spotted or Dusky red shank
45. *Tringa totanus* — Common red shank
46. *Tringa stagnatilis* — Marsh sandpiper
47. *Tringa nebularia* — Green shank
48. *Tringa ochropus* — Green sand piper
49. *Tringa glareola* — Spotted sand piper
50. *Tringa hypoleucos* — Common sandpiper
51. *Arenaria interpres* — Turnstone
52. *Capella stenura* — Pintail snipe
53. *Capella gallinago* — Fantail snipe
54. *Capella minima* — Jack snipe
55. *Calidris canutus* — Khot
56. *Calidris minutus* — Little stint
57. *Calidris temminckii* — Temminck's stint
58. *Calidris alpinus* — Dunlin
59. *Calidris testaceus* — Curlew sandpiper
60. *Limicola falcinellus* — Broadbilled sandpiper
61. *Philomachus pugnax* — Ruff
62. *Phalaropus labatus* — Red necked phalaropa
63. *Larus argentatus* — Herring gull
64. *Larus ichthyaetus* — Great black-headed gull
65. *Larus brunnicephalus* — Brown-headed gull
66. *Otus scops* — Scops owl
67. *Asio flammeus* — Short eared owl
68. *Caprimulgus mahrattensis* — Sykes night jar
69. *Jynx torguilla* — Wryneck

70. *Coracias garrulus* — European roller
71. *Lanius collurio* — Red-backed shrike
72. *Lanius cristatus* — Brown shrike
73. *Sturnus roseus* — Rosy pastor
74. *Sturnus vulgaris* — Starling
75. *Muscicapa parva* — Red-breasted flycatcher
76. *Phragamaticola aedon* — Thick-billed warbler
77. *Acrocephalus dumetorum* — Blyth's reed warbler
78. *Sylvia hortensis* — Orphean warbler
79. *Sylvia curruca* — Lesser white throat
80. *Phylloscopus collybita* — Brown leat warbler
81. *Phylloscopus trochiloides* — Green leaf warbler
82. *P. subaffinis* — Grants leaf warbler
83. *P. fuscatus* — Dusky leaf warbler
84. *P. proregulus* — Yellow rumped warbler
85. *Erithacus calliope* — Ruby throat
86. *Erithacus svecicus* — Blue throat
87. *Phoenicurus ochruros* — Black red-statt
88. *Saxicola torquata* — Collard bush chat
89. *Anthus hodgsoni* — Hodgeson's tree pipit
90. *A. trivialis* — Tree pipit
91. *A. campestris* — Tawny pipit
92. *Motacilla flava* — Yellow wagtail
93. *M. citreola* — Yellow headed wagtail
94. *M. caspica* — Grey wagtail
95. *M. alba* — White wagtail
96. *Emberiza melanocephala* — Black headed bunting
97. *E. bruniceps* — Red headed bunting

Bharatpur Bird Sanctuary has since been renamed as Keolodeo Ghana National Park.

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A COMPARATIVE STUDY OF THE LIFE HISTORY OE FOUR SPECIES OF APHIDS

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ABSTRACT

Apterous virginoparae of four species of aphids, viz., *Aphis nerii* Fonsc., *Myzus (Nectarosiphon) persicae* (Sulzer), *Pentalonia nigronervosa* Coq , and *Carolinaia (Hysteroneura) setariae* (Thomas), were reared on the leaves of *Nerium odorum*, tobacco, banana and wheat, respectively, in the laboratory at 27 ± 3°C and 60 ± 5% RH. It was found that the period of nymphal development is shortest in *M. persicae* and longest in *P. nigronervosa*. The reproductive period is the longest, 8 days, in *M. persicae* and the shortest, 5 days, in *C. setariae*. Fecundity (Total No. of nymphs produced per aphid) is the highest, 20, in *M. persicae* and the lowest, 15, in *P. nigronervosa*. The highest longevity of 23 days was recorded for *P. nigronervosa* and the shortest, of 15 days in *C. setariae*.

INTRODUCTION

The life-history of a number of species of aphids has been studied in India such as *Aphis nerii* Fonsc., (Mukherji and Behura, 1947), *Macrosiphum jaceae* Linn. (Trehan and Halleppnawar, 1949), *Myzus persicae* (Sulzer) (Lal, 1951), *Aphis craccivora* Koch. (Behura, 1956), *Lipaphis erysimi* (Kalt.) (Rout and Senapati, 1968), *Neotherioaphis chhenafuli* Behura and Dash (Behura and Dash, 1977), *Rhopalosiphum maidis* (Fitch.) (Behura and Dash, 1977) and *Carolinaia (Hysteroneura) setariae* (Thomas) (Garg and Sethi, 1976, 1978).

The present paper deals with a comparative study of the life-history of four species of aphids, viz., *Aphis nerii*, *Myzus persicae*, *Pentalonia nigronervosa* Coq., and *Carolinaia setariae* under similar conditions of temperature and humidity. Life-history of *P. nigronervosa* is studied for the first time in India.

MATERIALS AND METHODS

Cultures of *A. nerii*, *M. persicae*, *P. nigronervosa* and *C. setariae* were maintained on the leaves of *Nerium odorum*, *Nicotiana tabacum* (tobacco), *Musa* sp. (banana) and *Triticum vulgare* (wheat) respectively inside the laboratory at 27 ± 3°C and 60 ± 5 % RH. Freshly laid first instar nymphs of each species were transferred to petri dishes of 7 cm diameter containing moistened blotting paper and fresh leaf of respective host plant. Fresh leaves were provided every twentyfour hours. Observations on the duration of different instars, fecundity and longevity were noted.

RESULTS

The period of nymphal development is shortest, 6 days in *M. persicae* and longest, 12.5 days, in *P. nigronervosa* (Table 1). The reproductive period is longest, 8 days in *M. persicae* and with maximum fecundity, 20 in the same species against the shortest reproductive period lasting for 5 days in *C. setariae* and minimum fecundity, 15, in *P. nigronervosa*. The highest longevity of 23 days was recorded in *P. nigronervosa* and the shortest, 15 days in *C. setariae*.

TABLE 1

Duration of developmental period (in hours), fecundity and longevity (in days) of four species of aphids.

Name of aphid	Ist instar nymph	IInd instar nymph	IIIrd instar nymph	IVth instar nymph	Total developmental period	Fecundity	Longevity
Aphis nerii	43.21	68 56	55.14	24.46	191.37	19	15 7
Myzus persicae	35 70	33.24	33.46	35.59	145.90	20	17
P. nigronervosa	58.17	46.31	52.45	50.28	207.21	15	23
Carolinaia setariae	33.90	46.13	47.60	54.52	182.16	16	15

Weed (1927) and Sylvester (1954) studied the life-history of *M. persicae* on mustard and spinach plants respectively. The duration of the developmental period varied from 5 to 8 days in each case and compares favourably with our results. The longevity of 17 days recorded by

us almost tallies with the results obtained by them. But the fecundity recorded is 20 by us, against 54 by Weed (1927) and 80 by Sylvester (1954). Garg and Sethi (1978) studied the life-history of *C. Setariae* where they found the developmenal period to be 10 days and longevity 8-15 days agaigst 7.6 and 23 days respectively for *C. Setariae* studied by us. All these variations could be due to the different climatic effect at two different places of study.

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Pranikee, 5 : 18.21 (1984)

A BIOSTATISTICAL ANALYSIS OF SEX DIFFERENCE IN *PEDICULUS HUMANUS CAPITIS LINN.* (SIPHUNCULATA, PEDICULIDÆ)

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ABSTRACT

A biostatistical analysis of *Pediculus humanus capitis* L., shows that while the length and breadth of body of the female are significantly higher than that of the male, the segments of the leg especially the femur of male is significantly higher compared to that of the female.

INTRODUCTION

Pediculus humanus capitis Linn., is the common head louse of man. It is exclusively a blood sucking ectoparasite. A comprehensive study of this species has been given by Hopkins (1949) and Webb (1949). The morphology and biology have been extensively studied by Busvine (1948) and Buxton (1947) respectively. The present investigation deals with a biostatistical analyais of the morphological characters to evaluate sexual dimorphism in *P. humanus capitis*.

MATERIALS AND METHODS

Adult male and female specimens of *P. humanus capitis* were collected in 70% alcohol during May, 1978. The specimens were kept overnight in 10% KOH in an oven at 60°C. Specimens were thoroughly washed in distilled water, passed through ascending grades of alcohol and mounted in canada balsam. Measurements of at least 20 specimens of each sex were taken into consideration.

The individual characters were measured and subjected to student's 't' test of significance. The observed 't' values were compared with the 't' value at 5%, 1% and 0.1% probability levels. If the observed 't' value is greater at the 5% level, the difference is regarded as significant. If it is greater at the 1% level, the difference is highly significant and if

it is at 0.1% leval, then the difference is very highly significant. For a particular character between both the sexes, the sex having higher mean value is considered as more significant over the other sex.

RESULTS AND DISCUSSION

The data is presented in table 1. The following characters of the male showed significant difference over those of the female :—

(a) Very highly significant : length of fore-femur, fore-tibial process, fore-claws and hind femur.

(b) Highly significant : length of fore tarsus.

(c) Significant : Length of fore-trochanter, mid-femur and hind-tarsus.

The following characters of the female showed significant difference over those of the male :

(a) Highly significant : length of body, length of abdomen.

(b) Significant : breadth of body, head and abdomen; length of antennal segment II.

The following characters of the male showed a greater mean value but not statistically significant, over those of the female : length of thorax, antennal segment III, IV, V; fore-coxa, fore-tibia, mid-coxa, mid-tibia, mid-claws, hind tibia, hind-tibial process and hind claws.

The following characters of the female showed a greater mean value statistically significant, over those of the male : but not length of head, breadth of thorax, length of antennal segment I, mid-trochanter, mid-tibial process, mid-tarsus, and hind trochanter.

The length of mid-coxa of both the sexes showed equal mean values.

In head louse, males and females are usually distinguishable by their external genitalia and also the females are bigger in size than the males. In *P. humanus capitis*, a biostatistical analysis confirms the same in that the body length and the length of abdomen of the female are very highly significant ($P > 0.1\%$), the breadth of body, head and abdomen are significant ($P > 5\%$) over that of the male. On the other hand, the length of leg parts especially the fore-femur and hind femur of

the male are very highly significant (P > 0.1%), and length of mid femur is significant (P > 5%) over that of the female. This might be due to the fact that the males are more active than the females.

TABLE 1

Measurements and calculated 't' values of different morphological characters of *Pediculus humanus capitis* Linn.

Characters	Male mean value in mm	Female mean value in mm	Calculated 't' value	Remarks
Length of body	2.25	2.52	3.00	hs
Breadth of body	0.69	0.79	2.76	s
Length of head	0.36	0.38	0.95	
Breadth of head	0.30	0.32	2.01	s
Length of thorax	0.48	0.47	0.79	
Breadth of thorax	0.47	0.49	0.79	
Length of abdomen	1.40	1.66	3.95	hs
Breadth of abdomen	0.69	0.79	2.76	s
Length of antennal Segment I	0·06	0.06	0.63	
Length of antennal Segment II	0.06	0.07	2.25	s
Length of antennal Segment III	0.06	0.05	1.50	
Length of antennal Segment IV	0.04	0.04	0.57	
Length of antennal Segment V	0.06	0.05	1.66	
Length of fore-coxa	0.15	0.15	0.23	
Length of fore-trochanter	0.11	0.10	2.13	s
Length of fore-femur	0.22	0.19	5.03	vhs
Length of fore-tibia	0.21	0.21	0.16	
Length of fore-tibial process	0.11	0.08	5.74	vhs
Length of fore-tarsus	0.16	0.14	3.60	hs
Length of fore-claws	0.18	0.14	7.85	vhs
Length of mid-coxa	0.17	0.16	0.93	
Length of mid-trochanter	0.11	0.12	1.64	

Table 1—*(contd.)*

Characters	Male mean value in mm	Female mean value in mm	Calculated 't' value	Remarks
Length of mid-femur	0.20	0.18	2.94	s
Length of mid-tibia	0.22	0.21	1.60	
Length of mid-tibial process	0.08	0.09	1.89	
Length of mid-tarsus	0.11	0.12	0.33	
Length of mid-claws	0.14	0.14	0.15	
Length of hind-coxa	0.20	0.20	0.00	
Length of hind-trochanter	0.13	0.13	0.65	
Length of hind-femur	0.23	0.19	7.36	vhs
Length of hind-tibia	0.23	0.22	1.80	
Length of hind tibial process	0.09	0.08	1.17	
Length of hind tarsus	0.12	0.11	2.49	s
Length of hind-claws	0.14	0.14	0.80	

hs—highly significant; s—significant; vhs—very highly significant.

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MORPHOLOGICAL STAGING OF OVARY IN FRESH WATER SNAKE-HEAD MURREL *CHANNA PUNCTATA* (BLOCH)

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ABSTRACT

Six morphological stages are described according to colour and blood vascular supply of the ovary in *Channa punctata*.

INTRODUCTION

Channa puncta (Bloch), commonly known as fresh water snake-head murrel, is widely distributed in the pools, ponds and reservoirs in India. *Channa punctata* is synonymous with *Ophiocephalus punctatus* and *Channa punctatus*. However, in the present work the name *Channa punctata* is used as per the Article 30 and 34 (b) of the International Code of Zoological Nomenclature. *C. punctata* is commonly known as Phool-dhok in Hindi, Mitta in Telugu, Kaychil in Malayalam, Taki in Bengali, Korava in Tamil and Dulloonga in Punjabi (Chandy, 1970). It is commonly called Garrissa in Eastern Orissa and Kabsa in Western Orissa (Behera, 1972). Several workers (Narain, 1930; Nath and Nangia, 1931; Chopra, 1958; Belsare, 1962; Qayyum and Qasim, 1964; Majumdar *et al.*, 1969,1974; and Malhotra *et al.*, 1978) have published data on the reproduction and ovarian cycle of the North Indian population of *C. punctata*, however, little work has been done on the populations of the Eastern region. Therefore, the ovarian cycle of *C. punctata* from Bhubaneswar, Orissa was determined by morphological staging of ovary.

MATERIALS AND METHODS

The fishes were collected from Bhubaneswar and the surrounding village markets such as Santharapur, Balakati, Pipli, Barang and Balianta within a radius of thirty kilometers. Bhubaneswar is located in 20°12′ — 20°19′ N latitude and 85°48′ — 85°53′ E longitude. Live

fishes were collected on the 10th of every month from January to December, 1976 from Bhubaneswar market. When fishes in satisfactory conditions were not available, the collection was made from the surrounding village markets. Then the ovaries of fishes were dissected out, examined and were classified following the methods of Qayyum and Qasim (1964).

RESULTS

Morphology of the ovary :

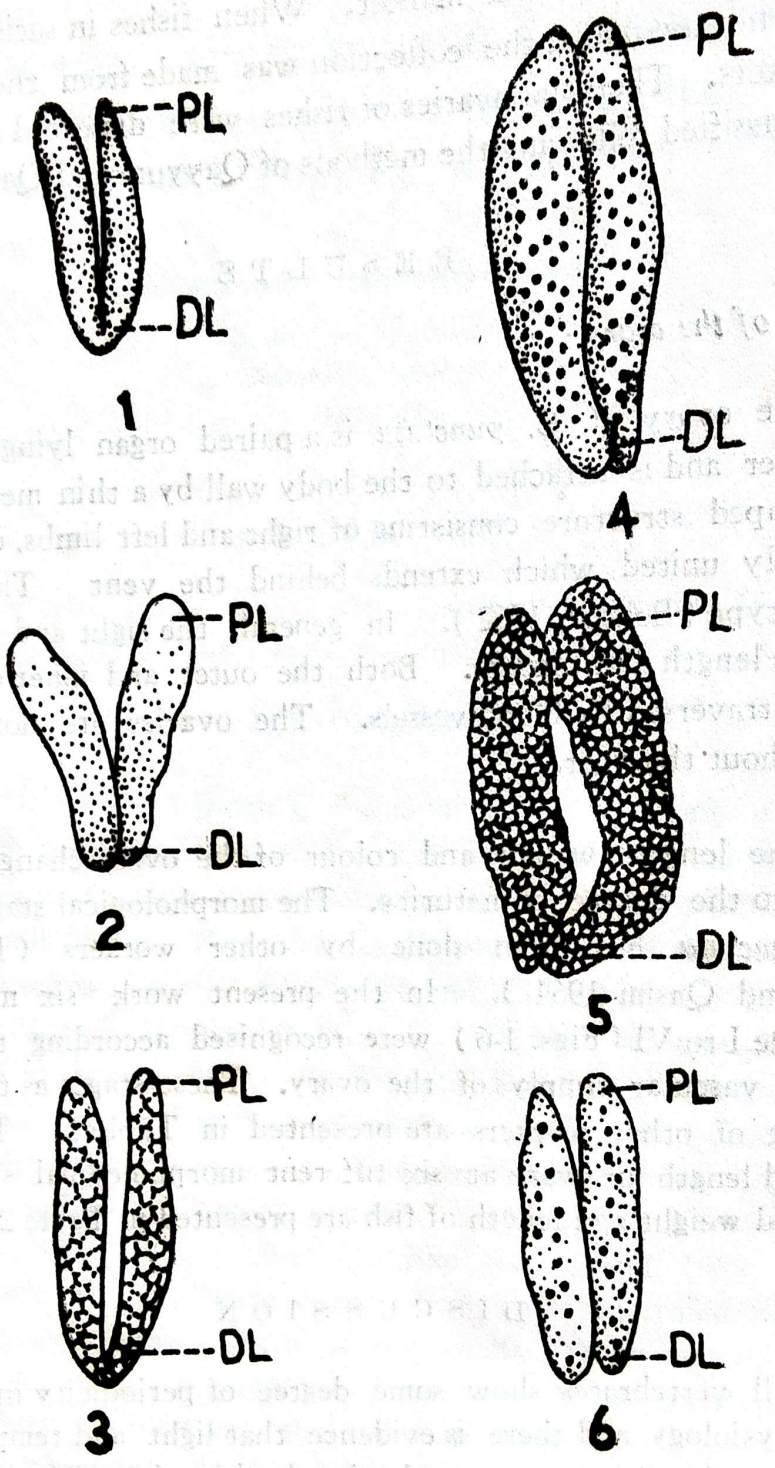
The ovary of *C. punctata* is a paired organ lying just ventral to air bladder and is attached to the body wall by a thin mesovarium. It is an 'Y' shaped structure consisting of right and left limbs, cranially free, but caudally united which extends behind the vent The ovary is of cystoarian type (Belsare, 1962). In general, the right and left limbs are of the same length and texture. Both the outer and inner surface of the ovary are traversed by blood vessels. The ovaries are not uniform in size throughout the year.

The length, weight and colour of the ovary changed seasonally according to the degree of maturity. The morphological staging of ovary for *C. punctata* has been done by other workers (Belsare 1962, Qayyum and Qasim 1964). In the present work six morphological stages, stage I to VI (Figs. 1-6) were recognised according to the colour and blood vascular supply of the ovary. These stages as they relate to the staging of other workers are presented in Table 1. The per cent weight and length of ovary at six different morphological stages in relation to total weight and length of fish are presented in Table 2.

DISCUSSION

All vertebrates show some degree of periodicity in their reproductive physiology and there is evidence that light and temperature are the external stimuli most commonly involved in the regulation of reproductive cycles (Dodd, 1972). It is generally agreed that these clues are integrated by the hypothalamus which in turn control the gonadotropic activity of the pituitary gland.

In the present study also seasonal changes occurred in the ovarian cycle of *C. punctata* in the populations around Bhubaneswer area. It was found that this fish breeds once a year. From November to



Figs. 1-6: Stages of oocytes of *C. punctata*:
1-2 — Immature; 3-4 — maturing, 5 — mature;
6 — spent; PL—proximal limb, DL—distal limb.

TABLE 1

A compaison of the morphological stages in the ovary of *Channa punctata* (Bloch)

Stage	Qayyum and Qasim (1954)	Stage	Belsare (1962)	Stage	Present study
I	*Immature* : Ovary very small translucent measuring 0.7 to 1.8 cm in lenth. Elongated, cylindrical, rather oblong in shape, light red in colour. Eggs microscopic. Ovary weight 0.008 to 0.058 gm.	I	*Resting stage* : Ovary is transparent and appear whitish grey in colour. Blood vessels are few and conspicuous. Ovaries occupy less than half the length of body cavity.	I	*Immature* : Ovary is whitish, thread like and attached to viscera. Ovary extends over 17.91 % of length of body of fish and weight is 0.71% of the total body weight. Eggs are not visible to naked eye. Under microscope, immature oocytes are seen. Blood vessels are not conspicuous on the ovary.
II	*Maturing* : Ovary slightly enlarged occupying more than one third of the body cavity. Flesh coloured. Gonad weight 0.002 to 0.402 gm.	II	*Maturing phase* : Ovary is pale yellow and granular in appearance. Blood vascular supply is still inconspicuous. Ovary occupies half the length of abdominal cavity.	II	*Immature* : The colour of the ovary is pinkish white and thread like. Ovary extends over nearly 18.39% of body weight. Eggs are not visible to naked eye. Under microscope, immature oocytes are seen. Blood vessels are found at the caudal part of the ovary.
III	*Ripening* : Ovary enlarged and occupied more than half of the body cavity. Pinkish yellow in colour. Two groups of oocytes visible to the naked eye. Gonad weight 0.092 to 1.850 gm.	III	*Adanced towards maturity* : Ovary is pale yellow and granular in appearance. Blood supply is conspicuous. Ovaries cccupy half the length of body cavity.	III	*Early maturing phase* : The colour of the ovary is pinkish and flesh coloured. Ovary extends over nearly 21.47% of body length and is 1.145% of body weight. Blood vessels are present.

Table 1—*(contd.)*

Stage	Qayyum and Qasim (1964)	Stage	Belsare (1962)	Stage	Present study
IV	*Ripe* : Ovary very much enlarged, occupying the whole of body cavity. Yellow in colour. Eggs rounded, large yellow and opaque. Gonad weight 1.28 to 16.8 gm.	IV	*Mature ovary* : Ovary is orange yellow in colour. Blood vascular supply conspicuous. Ovary occupies the entire length of body cavity.	IV	*Late maturing phase* : Colour of the ovary is reddish or brownish. The length of ovary extends upto 22.47 % of body length. Ovary is 1.69 % of the total weight of fish. The oocytes are more or less spherical in shape. Blood vessels are conspicuous.
V	Ovary flesh coloured, flaccid and shrunken, with residual eggs. Gonad weight 0.047 and 1.10 gm.	V	*Ripe ovary (Running)* : Volume of ovary is maximum. Occupies entire length of body cavity. Orange yellow in colour with bulging appearance at various places due to pressure of ova. Blood vascular supply increases. Ova size 800 μ maximum.	V	*Mature* : Colour of the ovary varies from brown to yellow. Mostly the ovary is yellow in colour. Ovary is beaded like due to the presence of ripe oocytes. The length of ovary extends upto 28.65 % of body length and is 4.65 % of total weight of fish. Blood vessels are found all over the ovary.
		VI	*Spent* : Shrunken, reddish yellow in colour. High degree of vascularity and occupy 3/4 length of body cavity. Dark red spots of degenerating ova observed on the surface of ovary.	VI	*Spent* : The colour of ovary is pinkish or yellowish even brownish. Ovary loose and flabby. Ovary extends over 23.42 % of body length and is 1.61 % of total body weight. Oocytes are degenerated, immature eggs are also seen.

TABLE 2

Morphology, % of length, % of weight, condition of ovary and phase of ovary in *Channa punctata*.

Stage	Colour of ovary	Condition of ovary	Phase of ovary	% of body length	% of body weight	Ovary length	Ovary weight	Condition of oocytes
I	Whitish	Immature	Quiescent cum preparatory	17.91 %	0.717 %	1.77	0.134	Previtello-genesis
II	Pinkish white	Immature	- do -	18.39 %	0.820 %	1.77	0.151	
III	Pinkish	Early-matu-ring phase	Preparatory cum active	21.45 %	1.145 %	2.50	0.432	Vitellogenesis
IV	Reddish brown	Late-matu-ring phase	- do -	22.47 %	1.690 %	2.55	0.518	
V	Deep Yellowish	Mature	Active	28.65 %	4 650 %	3.64	2.035	Vitellogenesis
VI	Faint Yellowish	Spent		23.42 %	1.610 %	2.44	0.36	

January in the winter season, the ovary was in quiescent-cum-preparatory stage. Only ovary stages I to III were found during this period. The ovary contains immature oocytes and some entering vitellogenesis in January. February to May represented preparatory cum-active phase when in addition to immature and maturing, a few mature oocytes were also observed This period represents the end of the winter season and upto the middle of summer when the day length increases. From June to November, spent oocytes were observed representing the active breeding phase of the fish species. The rainy season starts around June and continues until October. So this fish breeds during the rainy season in Bhubaneswar. Thus, immature oocytes were present throughout the season, maturing oocytes from February to October, i. e., summer to the end of rainy season, and spent follicles were present from June to November with a peak from July to October coinciding with spawning.

Belsare (1962) has reported that the spawning season of *Ophiocephalus punctatus* varies from locality to locality. In Madras where there are two monsoon seasons this fish breeds twice a year i.e., in about January and February and again in July and August (Sundararaj, 1916); in Punjab the breeding season is from the middle of April to the end of July (Khan, 1924); in Bengal, June to August (Mookherjee, 1946); in Madhya pradesh May to September (Swarup, 1954); and in Jammu from May to September (Malhotra *et al.*, 1978). All these periods coincide with monsoons. This study shows that in Bhubaneswar area there is only one breeding season coinciding with the monsoon. In Gorakhpur, Guraya (1965) observed that vitellogenesis starts with the increase in day length in *C. marulia* and winter ovary contains only pre-vitellogenic oocytes. This is in agreement with the present study. Thus in addition to temperature and photoperiod, rainfall also has a key role in the breeding of this species.

Marza (1938) has classified the rhythm of maturation into two types, synchronism and the asynchronism Prabhu (1956) studied the spawning periodicity of several species of fishes and found variations in the spawning periods of different species. So he distinguished four types of spawning viz., spawning once in a year with longer duration, spawning once in a year with a short period, spawning twice a year and spawning throughout the year. Jhingran (1961), however, has reported that there is no such spawning periodicity in *Setipinna phasa*. Saxena (1976) described that *Glossogobius giuris* belongs to group synchronism of Marza (1938) and first catagory of Prabhu (1956). In the present investigation

it was found that *Channa punctata* belongs to group asynchronism and first catagoey of Prabhu (1956) as the fish breeds once in a year and has a long breeding period that extends from June to October.

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THE BHITARKANIKA WILD LIFE SANCTUARY, ORISSA

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ABSTRACT

A brief account of the flora and fauna of the 176 sq km Bhitarkanika Wildlife Sanctuary is given. It is an ideal habitat of *Crocodilus porosus*. *Lepidochelys olivacea* visit the shore in large numbers during January-March to lay eggs.

INTRODUCTION

Bhitarkanika Wildlife Sanctuary (gazetted in April, 1975), is one of the two last strongholds of mangrove (estuarine) forest and its ecosystem (the other one is, Sunderban, in West Bengal) in India. This is an ideal sanctuary and it is unique so far as its flora and fauna are concerned. It is situated approximately at Long. 86° 51'E and Lat. 20° 45'N covering an area of about 176 sq. km. (Kanungo, 1976), includes 26 reserve and protected forests, and is located in the delta region of the rivers Baitarani and Brahmani in Cuttack District, Orissa. The sanctuary provides an ideal habitat for the Saltwater crocodile (*Crocodylus porosus*), the only surriving representative in the peninsular India.

The sanctuary is located in the coastal areas bordering the Bay of Bengal and enjoys a moderate climate. Monsoon breaks in the first week of June and continues till late September. The mean annual rainfall is 1700 mm. In winter the temperature comes down to 10°C minimum and in summer the maximum temperature is 43°C. The area is also prone to severe cyclone with occasional tidal bore.

The soil is generally clay loam but sandy soil is common in the coast. Coastal part of the sanctuary is bathed by tidal water twice daily.

The area is thickly populated by both Oriya and non-Oriya (mostly from West-Bengal) people. The density per sq. km. is 300 which is very high compared to the State average of 141 per sq. km. (as per 1971 census).

Flora :

The rich estuarine forest is composed mainly of mangroves—Dhalabani (***Avicennia alba***), Kalabani (***A. officinalis***), Baniah (***Hibiscus tiliaceus***), Guan (***Excoecaria agallocha***), Garani (***Ceriops roxburghiana***), Susambar (***Carapa obovata***), Keruan (***Sonneratia apetala***), Rai (***Rhizophora mucronata***), Hentala (***Phoenix paludosa***) and Sundari (***Heritiera minor***). Plants like Harakancha (***Acanthus ilicifolius***), Mankada kendu (***Diospyros malabarica***), Karanja (***Derris indica***) and Kochila (***Strychnos nuxvomica***) etc., form association with other littoral flora on the high ground. The whole forest area consists of soft mud with numerous pneumataphores (breathing roots) of the mangrove trees. The trees are evergreen. The Hentala (***Phoenix paludosa***) bushes are scattered throughout the forest. The local people call this forest as 'Hentala forest' after the Hentala plants. This plant is used by the local people for the construction of house and for making other household items.

Fauna :

The fauna of the sanctuary includes Leopard (***Panthera pardus***), Jungle cat (***Felis chaus***), Leopard cat (***Felis bengalensis***), Hyaena (***Hyaena hyaena***), Spotted deer (***Axis axis***), Sambar (***Cervus unicolor***), Otter (***Lutra perspicillata***), Rhesus monkey (***Macaca mulatta***), Porcupine (***Hystrix indica***) and Dolphins. Chitals (***Axis axis***) and Wild boars (***Sus cristatus***) are found in large numbers. Some of these come close to the village bordering the sanctuary and damage the crops.

The Red jungle fowl (***Gallus gallus***), Open billed stork (***Anastomus oscitans***), Painted stork (***Ibis leucocephalus***), White ibis (***Threskiornis melanocephala***), Spoon bill (***Platalea leucorodia***), different types of egrets such as Little egret (***Egretta grazetta***), Cattle egret (***Eubulcus ibis***), Large egret (***Egretta alba***); herons, such as Pond heron (***Ardeola grayii***), Purple heron (***Ardea purpurea***), Grey heron (***Ardea cinerea***), Sea eagle (***Haliaeetus leucogaster***), Brahmny kite (***Haliaster indus***), Pariah kite (***Milvus migrans***), Cormorant (***Phalacrorox niger***), White breasted water hen (***Amaurornis phoenicurus***), Bengal vulture (***Gyps bengalensis***), common hornbill (***Anthracocerous coronatus***) and Darter (***Anhinga rufa***), are

found in large numbers. Red vented bulbul (***Pycnonotus cafer***), Common myna (***Acridotheres ginginianus***), Bee eater (***Merops orientalis***) and different types of doves and kingfishers are common birds in this sanctuary. Every winter a large number of migratory birds including various kinds of duck and teals, visit Bhitarkanika.

Nesting site of the storks, namely the Open billed stork (***Anastomus oscitans***), Painted stork (***Ibis leucocephalus***), Darters (***Anhinga rufa***), different species of egrets and herons, is a beautiful sight for the biologist as well as for the visitors. In the month of June these birds appear in numbers, build their nests, lay eggs and rear their young. In early winter, they leave the nesting site in search of food. The water-logged swamp is locally called 'Chadhei gahana' meaning assemblage of birds

The most important and common reptiles of the sanctuary are the Saltwater Crocodile (***Crocodylus porosus***), Giant water monitor (***Varanus salvator***), Land monitor (***Varanus flavescens***), Python (***Python molurus***), King cobra (***Ophiophagus hannah***) and Kraits. The Pacific Ridley turtle (***Lepidochelys olivacea***) is seen in large numbers near "Gahirmatha"—the south tip of Point Palmyrus. Every year, during the period January to March, about 150,000 — 200,000 turtles visit the sand beach of Bhitar Kanika sanctuary for nesting. As per FAO report (1975), this is the largest sea turtle rookery of its kind in the world.

Research and conservation programmes

Research and Conservation of the endangered Saltwater crocodile has been undertaken in this sanctuary since July, 1975. This conservation Project, located at Dangmal was established by the Government of Orissa / Govt. of India with assistance from the United Nations Development Programme and Food and Agriculture Organisation of the United Nations. So far (1983) 700 saltwater crocodiles have hatched from locally collected eggs and reared out of which 250 one metre long juveniles have been released back into nature to build up the depleted population. About 40 breeding size crocodiles are present in the sanctuary. The largest (which is no doubt the largest in the world) is a 7 — 7.3 metre (23-24′) long male the average length of males being 5.48 — 5.79 metres (18′ — 19′). Juvenile crocodiles are frequently observed from a motor launch or a boat. Winter is the ideal time to sight both young and adult crocodiles basking / resting on the exposed mud bank.

Twohundred-forty eggs of Salt water crocodiles collected from different forest blocks of the sanctuary were placed under incubation in the Project Hatchery in the third week of May, 1983. One hundred fifty eggs hatched out by the second week of August, 1983. They are being reared in special pools maintained for the purpose.

Sea turtle research and conservation programme has been effectively initiated by the Forst Department of Orissa since January 1976 at Gahiramatha. Unauthorised removal of turtle eggs and catching / killing of turtles are totally banned.

Accessibility and accommodation

The Bhitar Kanika Wildlife Sanctuary is accessible only by country boats, dinghis and motor launches from Chandbali which is located about 40 km from the sanctuary. Bhadrak is the nearest railway station being 52 km from Chandbali and is connected by an all-weather jeepable road. The nearest air port is Bhubaneswar situated about 200 km from Bhadrak and is connected by a National Highway and by railways. There is a regular motor launch service in the afternoon from Chandbali to Talchua via Nalitapatia. One has to walk about five km. from Nalitapatia to reach the Saltwater Crocodile Research and Conservation Centre at Dangmal.

Winter is the best period for visiting the sanctuary and the District Forest officer, Chandbali is the person to be contacted for accommodation and other facilities besides the Chief Wild Life Warden, Bhubaneswar.

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STAGE SPECIFIC REGENERATION AND ITS EFFECT ON THE LIFE HISTORY OF *BUFO MELANOSTICTUS* SCHNEIDER TADPOLES

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ABSTRACT

Amputation at different developmental stages revealed a stage specific regeneration capacity and an inherent rhythm for completion of life history in *Bufo melanostictus*.

INTRODUCTION

Amphibians offer an unique model for regeneration studies because while Urodela demonstrate a wide range of regeneration, anurans only regenerate certain organs before metamorphosis. Much of the regeneration studies have been done on the temperate amphibians[1–3] and the work on tropical species is rather limited[4–5]. Niazi[3] has demonstrated that the age and degree of differentiation of tissues determine the rate of tail regeneration in frog tadpoles. However, no attempt has been made to determine the effect of amputation of tail at different developmental stages on the life history parameters. Therefore, this study was undertaken to determine the regeneration capacity of the tail at different developmental stages and its effect on life history in the common Indian toad *Bufo melanostictus* tadpoles.

MATERIALS AND METHODS

Fertilized eggs were collected from a pair in amplexus and were raised under standardized conditions[6]. Upon reaching the desired stage, they were separated. Four stages (pre-limb, limb bud, well developed hind limb and with forelimbs) of tadpoles were used. After taking the snout to tip of tail length, each tadpole was anaesthetized in 1/3000 MS 222 and amputed 3 mm from base. The controls were not operated upon. All the groups were raised through metamorphosis.

RESULTS

At pre-limb and limb bud stages, the tail regenerated upto the length of that of the controls indicating compensatory growth and differentiation in the amputed tadpoles. There was no significant difference in size and in the time period of metamorphosis between the control and experimental groups in the pre-limb stage showing that both regeneration and normal differentiation occurred in the experimental groups. At the limb bud stage there was no significant difference in weight but the toadlets in the experimental groups were less in length. The time period for metamorphosis was the same. At well-developed hind limb stage, the tail regenerated but the life history was prolonged in the experimental group. The experimental toadlets weighed more than that of the controls however, there was no differenence in length. When amputation was done after emergence of fore limbs, metamorphosis was completed without any regeneration and the time period for completion of life history was the same. This indicated that a full length or a 3 mm tail were absorbed in the same time period. The size (length and weight) of the toadlets was significantly smaller than that of the controls ($p < 0.05$).

DISCUSSION

By amputing tails of *Rana sylvatica* Niazi[3] demonstrated that the rate of tail regeneration decreases with age and the retardation is due to the degree of differentiation. In the present study also the rate of regeneration was fastest in the early stages supporting Niazi's observation. The most interesting observation was the catching up of the experimental tadpoles with that of the controls in completion of metamorphosis indicative of an inherent rhythm for completion of life history. This would have a tremendous survival value for the tadpoles which develop in ephemeral ponds during the monsoon season. The rate of regeneration slowed down in the hind limb stage tadpoles causing a prolongation of life history in the experimental ones. At the initiation of metamorphosis (emergence of forelimb), there was no regeneration perhaps due to the inhibitory effect of thyroxine concentration[2]. There was no effect on life history. Since both normal length of tail and tail stump were absorbed within the same period it indicates that the metamorphosis period was indicative of the morphological and biochemical changes associated with metamorphosis independent of the rate of tail absorption. The tadpoles completed metamorphosis confirming Nakamura's

TABLE 1

Effect of tail amputation on the life history of *Bufo melanostictus*.

Stage amputation			Length before amputation[1]	Metamorphosed tadpoles		Mean number of days for metamorphosis[2]
				S-V length in mm.	Weight in mg.	
Pre-limb	Control	(N = 8)	13.0	8.6 ± 0.42[3]	55.0 ± 0.4	14
	Experimental	(N = 9)	13.0	8.05 ± 0.04	55.2 ± 0.18	12
Limb bud	Control	(N = 7)	15.0	8.23 ± 0.13	55.5 ± 0.7	10.5
	Experimental	(N = 8)	15.0	8.55 ± 0.16	56.5 ± 0.8	10.0
Well-developed hind limb	Control	(N = 6)	17.5	7.75 ± 0.04	49.5 ± 0.04	6.5
	Experimental	(N = 9)	17.5	7.76 ± 0.75	57.3 ± 0.9	9.5
Forelimb emerged	Control	(N = 8)	18.5	7.6 ± 0.2	49.7 ± 0.9	3.5
	Experimental	(N = 8)	18.5	7.0 ± 0.04	38.8 ± 0.4	3.5

1. Snout to tip of tail. 2. Number of days from amputation. 3. Standard deviation.

observations that the tadpoles deprived of the tails were provided with reserve material needed for successful completion of metamorphosis. Thus, this study demonstrated that there is a stage specific regeneration capacity associated with age and differentiation. The life history time period is kept constant if amputation is done at early or very late stage however, amputation in the middle period leads to the disruption of the rhythm and a prolongation of life history.

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SERUM CONSTITUENTS IN RELATION TO VITELLOGENESIS IN THE INDIAN BULL FROG *RANA TIGERINA* (DAUD.)

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ABSTRACT

Serum constituents such as protein, inorganic phosphorus, cholesterol and phospholipid phosphorus have been estimated and a correlation with the growth of oocytes (vitellogenesis) has been made.

INTRODUCTION

The annual reproductive cycle of the female Indian bull frog *Rana tigerina* can be divided into three main physiological periods viz., pre-spawning, spawning and post-spawning (Dutta, 1979). These periods correspond to stages of vitellogenesis : pre-vitellogenic (September-December) period characterised by the presence of young follicles (Y_0) in the ovary, the vitellogenic period (January-May) characterised by the presence of growing oocytes (Y_1, Y_2, Y_3 and Y_4) and spawning period during June to August with the ovary containing fully mature oocytes (Y_5).

Serological events in relation to vitellogenesis in amphibians have been studied extensively (Wallace and Jared, 1969, Panje and Kessel, 1968, Mohanty-Hejmadi, 1978). Since 'vitellogenin', the female-specific estradiol-inducible protein is a phospholipoprotein compound, the present investigation is made to find out the levels of some compounds in serum in relation to vitellogenesis. The concentration of total protein, free inorganic phosphates, cholesterol and phospholipid phosphorus were determined.

MATERIALS AND METHODS

Adult female bull frogs (*Rana tigerina*) were collected from Vani Vihar, Bhubaneswar area. The snout-vent length, volume and fat body condition of the frogs were noted down. Blood was taken out by puncturing the heart and was centrifuged to obtain the serum. Ovaries were classified according to Kemp (1953.)

Estimations of protein (Lowry *et al*, 1951), inorganic phosphorus (Fiske and Subbarow, 1925), Cholesterol (Sackett, 1925) and phospholipid phosphorus (Connerty *et al*, 1961) were done by using a spectrophotometer— 'SICOSPEC-100'.

RESULTS

Results are presented in Table 1. The total protein concentration was maximum (5.57 ± 0.11 gm / 100 ml) during the spawning period where the females had mature oocytes. There was a remarkable decrease (2.15 ± 0.05 gm / 100 ml) in this value during pre-vitellogenic period. In early vitellogenic period serum protein concentration was more than in pre-vitellogenic period, thereby suggesting that vitellogenin synthesis had already started to supplement the growth of oocytes.

There was no such change in serum inorganic phosphorus level, between the pre-vitellogenic and vitellogenic periods. But there was an increase in this value (6 5 ± 0.18 mg / 100 ml) during spawning period.

Serum cholesterol level was high in frogs with mature oocytes. It was lowest during early-vitellogenic period and showed a slight increase during pre-vitellogenic period.

Phospholipid phosphorus concentration in serum was high in frogs with mature oocytes, but the value was low in frogs having early-vitellogenic (Y_0 and Y_1) oocytes. The value was intermediate during the pre-vitellogenic period. During spawning season fat body was greatly reduced. During pre-vitellogenic and early-vitellognic periods fat body was also in a reduced state.

TABLE

Serum constituents during

Female	State of oocytes	Snout-vent length (cm)	Volume (cc)	Condition of fat body
Pre-vitellogenic	Y_0	13.2 ± 0.12	123 ± 2.02	Reduced
Early-vitellogenic	Y_0, Y_1	13.3 ± 0.93	126.6 ± 0.95	Reduced
Spawning	Y_5	11.0 ± 0.24	125.5 ± 0	Much reduced

DISCUSSION

Under normal conditions the level of serum phosphoprotein in females is relatively low (Wallace and Jared, 1967). But during the breeding season, a higher level of phosphoprotein has been observed in egg-laying females (Laskowski, 1936; Roepke and Hughes, 1936). In *Rana tigerina*, serum protein and inorganic phosphorus levels were found to be comparatively high during breeding season. Vitellogenin is synthesized by the liver, transported through plasma and incorporated into growing oocytes. If serum proteins were a reserve for growth purposes, then anabolic-catabolic relationship could explain the increase and decrease in serum protein levels. An increased catabolic rate of either gonadal or body tissues would explain the decrease in serum protein reserves. Lower levels of serum protein found during the winter could be due to lower rates of production of protein reserves resulting from decreased metabolic needs. Increase in serum proteins would meet the enhanced metabolic requirements like oocyte growth or vitellogenesis. Our data also confirm this. Electrophoretic studies on serum proteins in *Rana pipiens* during vitellogenesis (Mohanty-Hejmadi *et al*, 1978) reveals that serum protein concentration decreases during active vitellogenesis. Vitellogenic cycle in *Rana pipiens* has also been recently studied basing on this aspect (Smalley *et al*, 1983),

A higher value in serum cholesterol and phospholipid phosphorus level was marked during spawning period, while the oocytes were already mature and transfer of the constituents from the serum was reduced and therefore there was a build up in the serum.

1

vitellogenesis in *R. tigerina*.

Period of collection	Protein in gm/100 ml.	Inorganic phosphorus in mg/100 ml.	Cholesterol in mg/100ml	Phospholipid phosphorus in mg/100 ml.
September October	2.15 ± 0.05	5.92 ± 0.05	25.4 ± 0.22	3.22 ± 0.03
December	3.0 ± 0	5.76 ± 0.1	22.86 ± 0	2.0 ± 0
June, July and August	5.57 ± 0.11	6.5 ± 0.18	74.2 ± 0.12	6.72 ± 0.07

Fat body was almost indistinguishable during spawning period corresponding to the high gonadal metobolic demand. In early-vitellogenic and pre-vitellogenic females, fat body was noticeable though not large, during pre-vitellogenic and vitellogenic period indicating accumulation of fat during this period. The study indicates that processes occur in this frog during vitellogenesis that are comparable to the reports on temperate frogs.

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A PRELIMINARY STUDY OF THE OSSIFICATION OF HIND LIMB IN THE JUMPING FROG *RHACOPHORUS MACULATUS*

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ABSTRACT

A study of differentiation of hind-limbs during developmental stages of *Rhacophorus maculatus* by differential staining with alizarine red and alcian blue showed that ossification begins in the diaphysis of femur and tibio-fibula at stage VIII and progresses proximodistally to the phalanges except for the tarsals. Ossification of phalanges is completd by stage XXII and the tarsals ossify at stage XX to XXIV.

INTRODUCTION

Anurans constitute an important group of animals for biomedical studies and research. But relatively little work has been done on the amphibians of India. Bone is a vertebrate tissue which develops after larval differentiation of connective tissue and cartilage. Once osteogenesis commences bones ossify in a sequence which is characteristic of the species. Not much work has been done on the development of skeleton in Indian anurans and this work was undertaken to determine the ossification pattern of hind limb in the jumping frog *Rhacophorus maculatus*.

MATERIALS AND METHODS

Egg masses were collected from nature during July. The larvae were maintained following the methods standardized by Mohanty-Hejmadi (1977 a and b). To study the ossification in the hind limb, tadpoles at different stages (Taylor and Kollros, 1946) were fixed in 10% buffered formalin and double stained with alizarine red and alcian blue as recommended by Wassersug (1975). After staining 10 tadpoles of each stage were observed.

RESULTS

The progressive ossification of hindlimb bones are represented in Table 1. The table shows that ossification starts simultaneously in the diaphysis of femur and tibiofibula at stage VIII and is completed by stage XXIV.

TABLE 1

Order of ossification of bones of hind limb in *Rhacophorus maculatus* tadpoles.

Sl. No.	Name of bones	Taylor-Kollros stages ossification	
		Starting	Ending
1.	Femur	VIII	XII
2.	Tibiofibula	VIII	XV
3.	Calcaneum	IX	XVI
4.	Astragalus	X	XVI-XVII
5.	Metatarsals	XI	XV
6.	2nd row phalanges	XII	XV-XVI
7.	3rd row phalanges	XII	XVI
8.	4th row phalanges	XIV & XV	XVII
9.	5th row phalanges	XVI	XIX-XXII
10,	Tarsals	XX	XXIV

DISCUSSION

The ossification sequence follows a typical vertebrate pattern i. e., in a proximo-distal axis. The chondrification as well as ossification starts with femur and proceeds towards the digits except for the fact that ossification of tarsals are delayed.

According to Kemp and Hoyt (1969), in *Rana pipiens*, the ossification begins in the diaphysis of femur, tibiofibula, tarsals and metatarsals at stage X-XII. Ossification of phalanges takes places between XIII to XV. In other words, there is a distinct proximo distal sequence.

They concluded that the Taylor Kollros stages of growing and metamorphosing tadpoles provide a reliable index to the state of ossification of the skeleton of *Rana pipiens*. In the present study it was discovered that the proximodistal sequence is not strictly adhered to since the tarsals have a delaysd ossification. Such delayed ossification has been reported for carpals in the forelimb ossification in *Rana pipiens* (Kemp and Hoyt, 1969).

This study shows that the sequence of ossification is species-specific.

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OSSIFICATION OF CHONDROCRANIUM DURING DEVELOPMENT IN THE SKIPPER FROG *RANA CYANOPHLYCTIS*

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ABSTRACT

The ontogeny of ossification in the tadpoles of *Rana cyanophlyctis* has been studied by using Wassersug's technique of differential staining of cartilage and bone. The chondrocranium ossifies beginning with the parasphenoid (Taylor and Kollros Stages V-IX), followed by exoccipital (IX), frontoparietal (XI-XII), pro-otics (XII-XVII), premaxilla and maxilla (XXI-XXII), septomaxillary (XXII-XXIII), nasal (XXII), dentary and angular (XXII), pterygoid (XXIII), squamosal (XXV), quadratojugal (XXV), palatine (XIV-XXV). The sphenethmoid does not ossify until after metamorphosis.

INTRODUCTION

The development of bone in the skull of frog has been investigated by workers such as De Beer (1937), Gaup (1906), Erdmann (1933), Kemp and Hoyt (1963). They have mainly dealt with the temperate species : *Rana fusca*, *Rana esculenta* and *Rana pipiens*. But little information exists on the amphibians of India. Study on the development of bone and cartilage in the Indian species has been done by Ramaswamy (1940, 1943, 1944) who has dealt on the developmental sequence basing on six tadpoles of one stage (53 mm) of *Rana tigerina*. The only detailed investigation on the development of chondrocranium of Indian species of *Rana tigerina* has been done by Chacko (1976), which deals with development of cartilage basing on the size of tadpole collected without any reference to stage. This paper reviews the order of ossification in the chondrocranium of *R. cyanophlyctis* during development of the skipper frog.

MATERIALS AND METHODS

R. cyanophlyctis larvae were collected in Bhubaneswar and were maintained by methods standardized by Mohanty-Hejmadi (1977a and b). The staging of tadpoles were done according to Taylor and Kollros (1946).

Tadpoles were stained with alcian blue-alizarine differential cartilage and bone stain developed by Wassersug (1976). The stained specimens were dissected under binocular microscope. Dorsal, ventral and lateral views of chondrocranium of all stages were drawn with the help of a camera lucida.

RESULTS

The ossification begins in the ventral side of chondrocranium, progresses to the posterior side of the skull to the occipital regions. Then it proceeds to the dorsal side continuing to the jaws and sensory capsules. The sequence of ossification is presented in table 1.

TABLE 1

Sequence of ossification in *R. cyanophlyctis*.

Name of bone	Stage of Ossification*	
	Beginning	Completing
Parasphenoid	IV	IX
Exoccipital	IX	IX
Frontoparietal	XI	XIII
Prootics	XII	XVII
Premaxilla	XXI	XXII
Maxilla	XXI	XXII
Septomaxilary	XXII	XXIII
Nasal	XXII	XXII
Dentary	XXII	XXII
Angular	XXII	XXII
Pterygoid	XXIII	XXIII
Palatine	XXIV	XXV
Squamosal	XXV	XXV
Quadratojugal	XXV	XXV
Columella	XXV	XXV

* By Taylor and Kollros.

Chondrocranium include: the cartilagenous cranium and the sense capsules. Among the premetamorphic bones parasphenoid starts the order of ossification as a small inverted cross-shaped bone in the floor of the cranium. The main shaft forms the floor of the cranium and the two wings extend beneath the auditory capsule. The mineralization is towards the middle of the shaft rather than towards the extremities. Exoccipitals are paired, each having two centres of mineralization, the first centre lying between parachordal cartilage and auditory capsule. The second centre appears later in the postero-medial wall of the auditory capsule. Frontal and parietal arise separately at the same stage, the frontals arising from the lateral side and the parietals dorsal to the parietal fontanelle. The prootics appear in the inner surface of the antero-medial margin of the auditory capsule. Premaxilla is one of the first metamorphic bones which is shield-shaped and appears at the level of superstal cartilage with a prominent spine. The maxilla remains attached anteriorly to the processus maxillaris, anterior cartilage of ligamentum orbitonasalis. Septomaxilla remains lateral to the nasal capsule and is V-shaped. Nasal appears anterior to fronto-parietal as a small irregular slender plate. Dentary and angular are two small rod shaped bones remaining attached to the Meckels cartilage.

Pterygoid appears as a slender bone lateral to the orbit attached to processus muscularis quadrati cartilage. Palatine is paired, appears at the same level as parasphenoid on ventrolateral side of nasal capsule. Squamosal is a slender bone irregularly shaped in the region of the quadrate. Quadratojugal appears near the quardrate cartilage as a small commashaped bone.

DISCUSSION

De Beer (1937) has reported the following order of ossification of bones in *Rana fusca* : parasphenoid, frontal, exoccipital, parietal, premaxilla, are the bones before metamorphosis; septomaxillary, maxilla, prootic, dentary, angular, squamosal, quadratojugal, pterygoid, Mentomeckelian during metamorphosis; nasal, prevomer, palatine, hyoids and sphenethmoid are the bones after metamorphosis. But our study indicates the following order of ossification in *R. cyanophlyctis* : parasphenoid, exoccipital, frontoparietal before metamorphosis; premaxilla, maxilla, septomaxillary, nasal, dentary, angular, pterygoid, palatine, squamosal and quadratojugal during metamorphosis; sphenethmoid after metamorphosis.

It can be concluded from the above observations that bones surrounding the brain ossify before metamorphosis—while the bones of the jaws, nasal capsules ossify during or after metamorphosis. In other words, the sequence differs from that observed by De Beer indicating a species specificify in the sequence of ossification for anurans.

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A COMPARATIVE STUDY OF THE REARING PERFORMANCE OF FIVE MULTIVOLTINE RACES OF THE MULBERRY SILKWORM *BOMBYX MORI* L. IN ORISSA

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ABSTRACT

An account is given of the comparative rearing performance of five multivoltine races of the mulberry silkworm *B. mori* L. viz., L_2 + 3, (O) Yellow, Oval (S), M_3 and HM in Orissa.

INTRODUCTION

Orissa is a silk producing state having both the traditional *tasar* and *eri* silk industries. The tasar silk worm, *Antheraea paphia* L., is extensively reared in the northern district of Keonjhar and to some extent in Mayurbhanj. Rearing of the Eri silk worm *Philosamia ricini* L., is mostly practised in Cuttack district and has extended to Bolangir, Ganjam, Koraput, Phulbani and Puri districts. Orissa ranks third in India in terms of non-mulberry silk-production but its contribution of mulberry silk is nil. Although the neighbouring states like West Bengal and Andhra Pradesh have well-developed mulberry silk culture, rearing of mulberry silk worm *Bombyx mori* L., is not practised in Orissa due to lack of knowledge about the races of mulberry silkworm which will be suitable for rearing in the state.

The aim of the present investigation was to study the comparative rearing performance of different races of the mulberry silkworm *Bombyx mori* L., in order to find out the races which will thrive well in the local climatic conditions of coastal Orissa.

MATERIALS AND METHODS

Five multivoltine races of mulberry silkworm *Bombyx mori* L., viz., L_2 + 3, (O) Yellow, Oval (S), M_3 and HM were reared for four

successive generations during the season January-February, February-March, April-May and June-July, 1978. Conventional methods of rearing was followed. No attempt was made to control the temperature and humidity of the rearing house by artificial means. The temperature and humidity data record during the period of these experiments were as follows:

Season	Average Temp (°F)	Relative Humidity (%)
January	75	62
February	79	66
March	83	67.5
April	86	70
May	88	76
June	90	80
July	85	84

The young larvae were raised by feeding them with chopped leaves of mulberry 4 times a day. The mature larvae were supplied with whole leaves and twigs 5 times daily. Two replications of each race were kept for rearing. On an average each replication consisted of 400 eggs. Observations were recorded from time to time.

The quantitative characters taken into consideration for this study are hatchability of eggs, effective rate of rearing, single cocooon weight, single shell weight, shell ratio, length of filament, larval weight and larval duration

RESULTS AND DISCUSSION

Data on the important economic characters were collected for all the five races for 3 generations only. All the races perished during the season June-July because of extreme climatic conditions. The average data on their rearing performance for 3 generations is presented in Table 1 and results of some of the important economic characters are discussed below.

1. *Hatching percentage*: Among all the races (O) Yellow and HM recorded highest percentage of hatching (90 %). Hatching of eggs was however satisfactory for all the races.

2. *Effective rate of rearing* : E. R. R. (%) is the yield per 10,000 larvae brushed. It is a measure of the proportion of cocoons harvested to the total number of worms brushed. Race M_3 showed the highest percentage of E. R. R. (87.5) and race HM the lowest (42 %).

3. *Single cocoon weight* : Highest single cocoon weight (2.3 gm) was recorded for HM and lowest in case of (O) Yellow (0.92 gm).

4. *Single shell weight* : Race $L_2 + 3$ gave highest single shell weight (0. 17 gms.) and race (O) Yellow the lowest (0.12 gms).

5. *Shell ratio* : This measure is an index of the actual silk producing capacity of the race. SR % was highest in M_3 (15.1) and lowest in in oval (S) (13.3).

6. *Length of filament* : This is a very useful commercial character. Among all the five races M_3 recorded the highest length of silk filament (596 meters) and (O) Yellow the lowest (520 metres).

TABLE 1

Average data on the rearing performance of five races of multivoltine silkworm *Bombyx mori* L.

Name of the race	% of Hatching	Larval duration	Weight of 10 mature larvae (gms.)	E.R.R. %	Single cocoon weight (gms.)	Single shell weight (gms.)	Shell ratio %	Length of filament (metres)
M_3	83	25	22.7	87.5	0.97	0.14	15.1	596
$L_2 + 3$	85.5	24.5	25	75.5	1.0	0.17	16.2	532
(O) Yellow	90	25	18.5	74.5	0.92	0.12	14	520
Oval (S)	85	25.5	21.8	82.2	0.96	0.13	13.3	544
HM	90	26.5	26.5	42	1.3	0.13	14.5	525

The rearing performance of race M_3 may be considered to be best among all the races under observation because M_3 recorded the highest percentage of E. R. R. (87.5) which means its rate of survival is highest. Highest length of filament was also obtained from M_3. Although race $L_2 + 3$ gave the highest shell ratio (16.2) its E. R. R. % was low (75.5)

compared to M_3. Similarly race HM gave highest single cocoon weight (31.3 gm) but E. R. R. % of this race is lowest among all the five.

However in all the races larval growth was slow and mortality of all stages except egg was high. Maximum number of worms died during the 5th larval stage. The following factors are suggested to be responsible for the high mortality rate of the worm : low protein content of the mulbery leaves fed to them, extreme fluctuation of temperature and humidity and disease.

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INSTRUCTIONS TO AUTHORS

Manuscripts should be typewritten, double spaced, in English. Tables should by typed on separate pages. Illustrations should not be larger than 22 × 28 cm (8½ × 11 inches). Reference to literature should be alphabetically arranged under author's name in the following format :

Gould, S. J., 1977—Ontogeny. Belkmap Press, Cambridge, Mass.

Martin, R. F., 1972—Evidence from osteology, pp. 37-70, In : Evolution of the genus Bufo. W. F. Blair (eds.). Univ. Texas Press, Austin, Texas.

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Two copies of the manuscript with an abstract should be sent to :

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