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ZOOLOGICAL SURVEY OF INDIA, 1942-1945.

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I. TEMPORARY REMOVAL OF HEADQUARTERS FROM CALCUTTA.

On the outbreak of war with Japan in December, 1941, the safety of the standard zoological collection of the Indian Empire, which is under the charge of the Zoological Survey of India and had been housed in the Indian Museum at Calcutta since the museum came into existence, became liable to serious damage or destruction by enemy action. As a first step all the type-specimens and class I exhibits of the Indian Museum were evacuated to the Forest Research Institute, Derha Dun. Though all normal air-raid precautions were adopted, it was however, felt that the safety of the collections that were still in Calcutta could not be ensured, unless they were totally removed to a less vulnerable area. On account of the very large quantities of Rectified Spirit, Naphthalene and other chemicals that are used for the preservation of the collections, books and other articles, there was not only the risk of serious damage to these highly inflaminable collections, but it was apprehended that the safety of the whole Museum and even of men and property in the locality would be threatened. The Government of India, in consultation with the Bengal Government, therefore, decided that the entire collections and library etc. should be removed from Calcutta at as early a date as possible. As the Zoological Survey of India could not function without its collections and library, it became necessary to shift the entire headquarters of the Survey.

The finding of suitable accommodation, reasonably out of range of possible enemy action and sufficiently large to house the Survey, with its vast collections, library, laboratories and offices etc. was a difficult problem. Through the kindness of H. E. Supradipta Manyabara Commanding General Sir Kaiser Shamshere Jung Bahadur Rana, G. B. E., who generously placed his " Kaiser Castle " at Benares at the disposal of the Government free of rent, this difficulty was, however, ultimately overcome and the Government of India decided to remove the Zoological Survey of India to Benares. The evacuation to Benares was completed in a remarkably short time, with comparatively little damage to the collections, and Kaiser Castle, Benares Cantt. became the temporary headquarters of the Zoological Survey of India, with effect from the 11th May, 1942.

II. DAMAGE TO THE COLLECTIONS AND LIBRARY ETC. IN THE VARUNA FLOOD OF 1943.

Kaiser Castle is a large building, or rather a number of semi-detached and detached buildings, in its own compound, situated on the bank of the Varuna River, well above its water-level. Some of the buildings are on somewhat higher ground than others and the plinth-level is not

the same even throughout the main building. The Varuna is a tributary of the Ganges, and, except during the rains, is a very small stream, with water only a few feet in depth. During the rains it swells up considerably and in many years of even normal rainfall, a small amount of its water enters the compound of the Kaiser Castle. At the time of the shifting of the Zoological Survey of India to Benares, the Varuna had never been in real flood within, living memory.

For the sake of safety, the spirit collections of the Survey are stored in a series of rooms in a separate block in the Kaiser Castle. These are arranged in open racks, six feet high, the racks being made firm to the walls by iron tie-rods. Two cellars in this block are also used for the storage of collections, but as the walls of these are lined with thick slabs of stone, it had not been found possible to fix tie-rods there. The dry collections of the Insect Section were housed in another separate building. In the main building were located, among others, the offices, laboratories, library, and most of the dry collections, excluding Insects.

In September, 1943, owing to very heavy and continuous rain for about three days all along its water-shed, there was a heavy flood in the Varuna, the water-level rising to an unprecedented height. By the evening of the 26th September water had entered the compound of the Kaiser Castle. The level continued rising, and on the afternoon of the 27th there was more than three feet of water above the plinth-level in most parts of the main building and even more in the other buildings. The flood began to recede on the morning of the 28th and by the 29th most of the rooms were more or less dry, though the underground cellars had still water in them up to the ceiling. The cellars had to be cleared later by means of trailer and centrifugal pumps.

As a result of the flood, large parts of the collections and library etc. were thus under water for more than two days and naturally suffered serious damage. Large numbers of bottles were washed off the shelves by the force of the current and were smashed. In the cellars, where no tie-rods had been fixed, the racks were lifted bodily and overturned. Some almirahs and boxes that had been stored on the verandahs were washed away. Labels came off the bottles in many cases even when the bottles remained standing on the shelves, and in most other cases became practically illegible by the deposition of silt. Parts of the building, including floors, were seriously damaged and caused further damage to the collections. Unfortunately the type-specimens had just been got back from Dehra Dun and were being unpacked and arranged in some sections, when the calamity occurred. Books in the library, Specimen Registers and other records also suffered serious damage on account of long immersion in water.

The work of salvaging the collections etc. was taken in hand immediately, and every effort was made to save as much as possible. Books, registers, records and dry collection were put out in the sun and thoroughly dried and first-aid rendered promptly, wherever possible. The collections were put in some sort of order as soon as the buildings had been repaired and with the help of temporary staff, specially sanctioned by the Government, the work of repair and reconstruction was started without delay, and is still going on. Thanks to the zeal, untiring efforts

and willing co-operation of the whole staff, who had to work under high pressure for months without a single holiday, a great deal has been saved. I take this opportunity of expressing my sincere thanks to the officers and staff of the Zoological Survey of India, but for whose selfless and sustained labour the damage to the national collections would have been far more serious than it is now.

Though the work of accurately assessing the extent of damage caused to the collections etc. in the Varuna flood of September, 1943, could not be started till the more urgent work of repair and reconstruction had been more or less completed, it is considered desirable to give to the scientific world at least a preliminary and rough idea of the damage suffered by the standard zoological collections of India. It is hoped that the work of correctly assessing the extent of damage, which on account of its nature and the size of collections involved, is bound to be long, slow and laborious, will be taken in hand shortly.

FISHES.

The collections of the Fish Section had been stored on 67 racks, 25 in one large room and 42 in a cellar under this room. In addition to the Cyclostoma, the Elasmobranchii, the Chondrostei and the Holostei, fishes of the sub-orders Ostariophysii and Malacopterygii of the order Teleostei and the entire unregistered collection of this Section had been kept in the cellar. In the upper room, where the rest of the collection had been stored, the racks, held fast and the damage was only slight. In the cellar, however, on account of the overturning of racks, large numbers of bottles were smashed and the specimens contained in them, including some types, remained in water for a number of days. Many of these specimens were lost and some, especially those of small size, disintegrated more or less completely on account of long immersion in water. Most of the type-specimens were fortunately saved, but a few of the deep-sea fishes of the sub-order Malacopterygii, which are generally brittle, were badly damaged or lost. Further, on account of the breaking of bottles, large numbers of specimens got mixed. In many cases number-tags made of metal had been fixed to individual specimens ; the correct sorting of these presented little difficulty, but where no tags or other labels remained attached to the specimens, the work was extremely difficult and in many cases hopeless. Great care has been taken in this sorting out, and as far as possible, only specimens, about the authenticity of which there is no reasonable doubt, have been put back in the named collection. The bulk of the remaining material has been kept aside for the present and will be dealt with gradually.

A considerable part of the affected material consisted of unnamed specimens, and the damage suffered by these should not be regarded as serious. The loss and damage in the sub-orders Ostariophysii and Malacopterygii of the order Teleostei is however, of a serious nature. The following families of these sub-orders have been affected :—

Ostariophysii : Amblycipitidae, Ariidae, Bagridae, Chacidae Clariidae, Mochokidae, Pangasidae, Plotosidae, Schilbeidae, Siluridae, Sisoridae, Homalopteridae, Psilorhynchidae, Cyprinidae, Cobitidae and

Adiposiidae ; Malacopterygii : Alepocephalidae, Stomiatidae, Engraulidae, Clupeidae, Dorosomidae, Dussumieriidae, Chanidae, Chirocentidae, Elopidae, Megalopidae, Notopteridae and Salmonidae.

Two other orders of the Teleostomi, *viz.* Chondrostei, with its single family, the Acipenseridae and Holostei, also with its single family, the Amiidae, were also affected.

In the Elasmobranchii, the damage, though quite extensive, was not as serious as in the Teleostomi, on account of the fact that most of the Elasmobranchs are of a large size and could, therefore, better stand the effects of long immersion in water. The following families of the different orders and sub-orders have been damaged :—

Order Palagiostomi, sub-order Selachii : Scyllidae, Carchariidae, Sphyrinidae, Spinacidae and Rhinidae ; sub-order Batoidei : Pristidae, Rhinobatidae, Rajidae, Trygonidae, Torpedinidae, Myliobatidae and Rhinopteridae ; Order Holocephali : Chimeridae.

In the Cyclostoma, the few specimens in the collection of the families Bodellostmoatidae, Myxinidae and Petromyzontidae were damaged.

It is impossible at this stage to give anything like an accurate assessment of the extent of damage suffered by the fish collections of the Zoological Survey of India. The orders and families mentioned above have been affected seriously, some others have suffered lightly, while many more have completely escaped damage. It is very roughly estimated that the total loss to these collections is in the neighbourhood of 20%.

REPTILIA AND AMPHIBIA.

The collections of this Section were stored in two rooms above ground and a small part in one of the cellars. In the smaller room, on account of the subsidence of floor, a rack, containing Amphibia, was overturned, but fortunately damage to the collection was only slight. In the other room in which Lizards and most of the Snakes were kept, the racks held fast and the damage there also was slight. The Chelonia and the larger Snakes were stored in the cellar and damage to these was heavy, on account of their long immersion in water. Fortunately very few types have been lost in this Section also.

In the order Testudines, the families Emydidae and Trionychidae and in the order Squamata, sub-order Serpentes, the family Uropeltidae have been seriously damaged. The Agamidae, Scincidae and Lacertidae in the sub-order Sauria and the Colubridae in the Serpentes have also been somewhat damaged. The Amphibians have practically escaped damage.

The total damage to the collections of the Reptilia and Amphibia Section is very roughly estimated at under 20%.

BIRDS AND MAMMALS.

More than half the collection of this Section was under water. Fortunately no specimens were actually lost, but nearly 27,000 of them (skins, bones, eggs and nests) got soaked and were more or less damaged. These are being attended to, but the work of repairing and restoring them is very slow and laborious. Many of the skins were very old, and it

is feared that damage to some of them can never be satisfactorily repaired. The Mammal types were not affected, except the type of dolphin *Tursiops perniger* (Blyth) which suffered damage, but it is now repaired, but nearly half the bird types were submerged ; with proper care it has been possible to save practically all of them.

In the Mammals, the families Muridae, Ochotonidae and Leporidae of the order Rodentia, families Canidae, Mustelidae, Procyonidae and Ursidae of the Carnivora, and families Camelidae, Bovidae, Cervidae and Tragulidae of the order Ungulata have been seriously affected. The few specimens in the collections of the extra-Indian sub-order Hyracoidae of the Ungulata were also badly damaged.

In the Birds, the following families and subfamilies have suffered serious damage :—

Order Coraciifermes : Capitonidae, Coraciidae, Meropidae, Bucerotidae, Cypselidae, Caprimuldgidae, Podargidae, Trogonidae, Psittacidae, Strigidae, Asionidae and Cuculidae.

Order Accipitres : Falconidae, Gypaetinae and Pandionidae.

Order Gallinae : Phasianidae and Megapodidae.

Order Charadriiformes : Haematopodinae, Totaminae and Scolopacinae of the family Charadriidae.

Order Trubinares : Procellariidae.

Order Anseres : Anatidae.

It is roughly estimated that in about 15% of the Bird specimens and about 12% of the Mammals the damage is too serious to be satisfactorily repaired.

MOLLUSCA.

The spirit collection of this section has suffered very little damage. Though large parts of the collection were under water, very few specimens have been lost or damaged. The dry collection, which is a very large one, is stored in two rooms in the main building. In this also there was comparatively little actual loss of specimens, but heavy damage was caused by the mixing up of the specimen, on account of the disintegration of labels and the card-board boxes in which the shells were kept. Some amount of mixing up in this collection had already taken place, when the collections were evacuated from Calcutta. Every effort is being made to sort out the specimens correctly, but the work is proving extremely difficult. Most of the type-specimens are fortunately safe, but a few, that were very fragile, have been badly damaged, on account of continued immersion in water.

Dry specimens of about 40 families have been seriously damaged, and it is estimated that loss in the Section amounts to approximately 10% of the total collections.

CRUSTACEA.

Very little damage has been caused in the Crustacea Section. Some bottles were broken but most of the specimens contained in them have been saved and correctly sorted out. Practically all the types are safe. The total damage to the Crustacea collections will probably be in the neighbourhood of 5%.

Insecta.

The damage to the Insect collections has been unfortunately heavy. A considerable number of bottles in the spirit collections was broken, and a large number of specimens, including those of the Arachnida, were lost or got irretrievably mixed. The dry collection had been stored in a number of rooms in a separate block, and a part was kept in almirahs and racks on the verandah. Some almirahs and boxes stored on racks were washed away by the current and nearly 30% of the remaining dry collection was submerged in water. The damage to this collection has been serious not so much due to loss of specimens, but chiefly on account of the deposition of fine and sticky silt on a very large number of them. The work of removing this silt, even from hard-bodied insects, is bound to be very slow and extremely laborious, and will be almost impossible in the case of Diptera, Lepidopetra and other small and fragile insects. This work will take many years, and it is feared that a large number of specimens, in spite of every effort that is being made to restore them, will cease to be of much scientific value.

The dry types in the collection are fortunately all safe, but two boxes containing a large number of types in spirit, including a few of the Arachnida were washed away.

The following orders and families and special collections have suffered the greatest damage :—

Orthoptera : Phasmidae, Acridiidae and Gryllidae.

Rhynchota, Heteroptera : Pentatomidae, Lygaeidae and Reduviidae ; Homoptera : Fulgoridae, Cercopidae, Jassidae, Aleyrodidae, Aphididae and Coccidae.

Neuroptera, Megaloptera : Sialidae and Raphidiidae ; Planipennia : Myrmeleonidae, Ascalaphidae, Mantispidae, Hemerobiidae, Chtysopidae and Nemopteridae.

Mecoptera : Panorpidae.

Trichoptera : Rhyacophilidae, Hydroptilidae, Philopotamidae, Stenopsychidae, Psychomyidae, Polycentropidae, Arctopsychidae, Hydropsychidae, Calamoceratidae, Odontoceridae, Molannidae, Leptoceridae, Sericostomatidae, Phryganeidae and Limnophilidae.

Lepidoptera, Rhopalocera : Nymphalidae, and Hesperiidae ; Heterocera : Noctuidae, Bombycidae, Eupterotidae, Sphingidae, Lasiocampidae, Lymantriidae, Hypsidae, Uraniidae, Epiplemidae, Notodontidae, Cymatophoridae, Sessiidae, Tinaegeriidae, Zygaenidae, Psychidae, Hepialidae, Callidulidae, Drepanulidae, Cossidae and Saturniidae.

Green's Collection of Butterflies and Dudgeon's collection of moths have also suffered considerable damage.

Coleoptera, Adephaga : Carabidae, Dytiscidae, Gyrinidae, Paussidae, and Rhysodidae ; Polyphaga : Staphylinidae, Endomychidae, Dermestidae, Byrrhidae, Nosodendridae, Georyssidae,

Parnidae, Hydrophilidae, Hetereroceridae, Dascillidae, Helodidiae, Malacodermidae, Buprestidae, Elateridae, Xylophilidae, Anthicidae, Trictenotomidae, Bruchidae, Chrysomelidae, Cerambycidae, Lamiidae, Brenthidae, Curculionidae, Passalidae and Scarabaeidae.

Hymenoptera, Apocrita : Ichneumonidae, Formicidae, Vespidae, Mutillidae, Chrysididae, and Colletidae.

Diptera, Nematocera : Tipulidae, and Mycetophilidae ; Brachycera : Coenomyiidae, Tabanidae, Cyrtidae, Nemestrinidae, Therevidae, Bombyliidae and Asilidae ; Cyclorrhapha : Sapromyzidae, Ochthiphilidae, Agromyzidae, Celyphidae, Diopsidae, Borboridae, Heteroneuridae, Sciomyzidae, Helomyzidae, Cordyluridae, Oestridae, Tachinidae, Calliphoridae, Hippoboscidae, Nycteribidae and Streblidae.

Aphaniptera : Pulicidae.

In many of the families mentioned above, specimens of only one or two subfamilies have been damaged, while those of the remaining subfamilies are safe. Families that have been lightly affected and the very large number of those that have not suffered at all are not mentioned. It is very difficult to estimate at this stage even the approximate extent of damage to the collections of the Insect Section, but it seems likely that the total damage will turn out to be in the neighbourhood of 20%.

OTHER INVERTEBRATES.

The spirit collection of this Section has not been seriously affected, but the dry collection has suffered damage.

Porifera : The spirit collection is nearly intact, but approximately 15% of the dry specimens have been damaged on account of long soaking in water.

Coelentrata : The dry collections of the Madreporaria and the Gorgonacea have suffered most. In the former, paper-tags and plaster numbers attached to many specimens have been completely destroyed ; the sorting out of these specimens is proving extremely difficult, and it is possible that about 40% of these corals may have to be written off. The Gorgonacea had been left packed in boxes and, on opening, most of the specimens were found broken in bits, with their paper labels completely destroyed. The damage to the Hydrozoa, Alcyonaria and other groups is negligible.

Platyhelminths, Nemathelminths and Polyzoa, etc. have suffered practically no damage.

Echinodermata : A few dry specimens have been damaged or lost.

Annulata : In the Polychaeta about a hundred bottles were broken and some specimens, including two types of the family Nereidae, were lost. In the Oligochaeta, Hirudinea and other group there was very little damage.

The collection of slides, including some type-slides, has also been damaged. The slides were kept in cabinets in the main building, and, on account of long immersion in water, some of these were damaged

and the labels of most of them came off. These are being attended to, and it is hoped that a large number of them will be correctly sorted out.

The total damage to this Section is roughly estimated at about 10%.

SPECIMEN REGISTERS.

Out of the 70 Registers in which records of specimens in the collection are kept, 43 were immersed in water. Many of the Registers are very old and on account of the age and brittleness of their paper, have suffered considerable damage in the flood. Fortunately the entries in the Registers are still legible. All the damaged and old Registers are being copied and it is hoped that this work will be satisfactorily completed before long.

LIBRARY.

About one-third of the books in the Library, approximately 10,000 in number, were wholly or partially under water and, therefore, suffered damage. Most of these damaged books have been repaired and rebound, and fortunately total loss is only slight, as not more than 200 books only have to be written off. In another 500 or so, some pages have been torn or lost. In addition, in quite a large number, printed wholly or partially on art paper, pages, specially those containing illustrations, got stuck; these were separated with as much care as possible, but even then considerable damage has been caused. The stock of Departmental publications and unbound reprints and other papers also suffered some damage.

MICROSCOPES, CAMERAS AND OTHER INSTRUMENTS.

All these were submerged in water, but fortunately little permanent damage has been caused to these.

I have given in the foregoing paragraphs a brief account of the nature of damage suffered by the collections etc. of the Zoological Survey of India in the Varuna flood and have very roughly indicated the extent of this damage, as known at present. The damage to the National collections has been serious, but fortunately the collections are still substantially intact. Every effort is being made to repair and make good the damage and loss as far as possible. I take this opportunity of appealing to all naturalists, zoologists and other scientists in India and abroad to help us in adding to these collections and thus in not only making good the loss suffered, but in making them better and more representative of the Indian fauna than they have been ever before. Though all presentations and exchanges will be gratefully received, it will be specially appreciated if specimens of the orders and families that have been seriously damaged are sent to us.

III. THE PUBLICATIONS OF THE ZOOLOGICAL SURVEY OF INDIA.

The publication of the *Records of the Indian Museum, Memoirs of the Indian Museum* and *Report of the Zoological Survey of India* had unfortunately to be suspended in 1942, in view of the urgent need for

economy in the use of paper. The last issues of these publications, prior to suspension, were : *Records*, XLIV, part III, *Memoirs*, XIII, No. 4 and *Report*, for the years 1938-41.

The publication of the *Records of the Indian Museum* is now being resumed. The present issue will be the concluding part of volume XLIV, and an index to the volume will be issued as soon as possible. The next volume, XLV, will commence in 1947 and attempts will be made to complete it within the year. From 1948, it is hoped to bring out a yearly volume, as previously.

IV ANTHROPOLOGY.

The Anthropology Section of the Zoological Survey of India has been separated from the Survey with effect from the 1st December, 1945, with a view to converting it into a separate Department or Survey. Anthropological work, that was formerly being done in the Zoological Survey of India is now under the care of the Director, Anthropological Survey of India, with his temporary headquarters at 64, Cantonment Benares. The Ethnological and Anthropological collections are also now housed at the same address.

DESCRIPTION OF A NEW FILARIID WORM, *SQUAMOFILARIA CHOPRAI*, SP. NOV. (NEMATODA) FROM THE LUNG OF A SEA-TERN, FROM ADDU ATTOL, MALDIVE ISLANDS.

By B. S. CHAUHAN, *M. Sc., Ph. D., F.Z.S., Assistant Superintendent, Zoological Survey of India, Benares Cantt.*

A single specimen of a Filariid parasite was obtained by Major S. L. Kalra, in September 1944, from the lung of a sea-tern, from Addu Attol, Maldive Islands. It was kindly passed on to this department for study by Major Dr. M. L. Roonwal. Unfortunately, the specimen is not in a very good state of preservation ; nevertheless, a study of the worm reveals that it represents a new species of the nematode genus *Squamofilaria*.

Super Family FILARIOIDEA (Weinland, 1858) Stiles, 1907

Family FILARIIDAE (Cobbold, 1864) Claus, 1885.

Sub-Family *APROCTINAE* Yorke and Maplestone, 1926.

Genus **Squamofilaria** Schmerling, 1925.

1926 *Coronofilaria*, Yo ke and Maplestone, The Nematode Parasites of Vertebrates, London., p. 409.

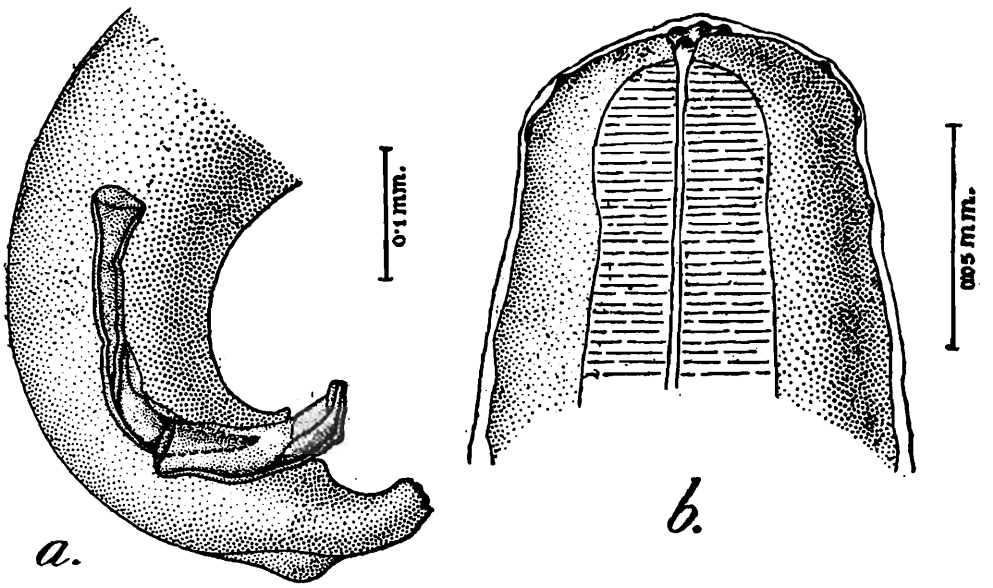
Squamofilaria choprai[1]. sp. nov.

Specific Diagnosis : *Squamofilaria*—with generic characters.

Body filiform, tapering at both extremities. Length about 15 mm., maximum width of body, in mid-region, about 0·3 mm. Head (Fig. 1*b*) round, tapering and broad ; mouth surrounded by a cuticular collar, festooned to form a crown-like structure, with six small ' lips '; head papillae submedian, two pairs, rather inconspicuous ; lateral papillae probably two. Cuticle very finely striated transversely, with occasional papilla-like bosses, varying much in their development, more conspicuous in posterior region, specially on ventral side. Mouth cavity small ; oesophagus simple. Posterior extremity (Fig. 2*a*) coiled spirally ; tail of male short and rounded ; caudal end flat, studded with spine-like round, cuticular papillae. Male genital opening situated at a distance of about 0·09 mm. from posterior end. A large and conspicuous median papilla situated just in front of cloacal opening ; a similar, but less conspicuous, median post anal papilla visible. Spicules two, subequal, thick and trough like. Anterior spicule much larger than posterior, about 0·26 mm. in length, bent like the letter L, probably with a ventral groove, its posterior extremity pointed. Posterior spicule short and stout with its posterior end bifid and spatulate, measuring

[1] Named after Dr. B. N. Chopra, Director, Zoological Survey of India.

0·16 mm., caudal alae absent. Lateral rows of small and oval, pigmented corpuscles, characteristic of the other two species of the genus, absent.



Text Fig. 1.—*Squamofilaria choprai*, sp. nov.
a. Posterior end ; *b*. Anterior end of the male.

The genus *Squamofilaria* was created by Schmerling, 1925 for *Filaria coronata* Rudolphi, 1809. Yorke and Maplestone (1926) created another genus *Coronofilaria* with *C. pillersi* as the type and *C. coronata* (Rud., 1809) as the other species of the genus. They also included, with some doubt, the species *Eucamptus obtusus* Dujardin, 1845, from *Caprimulgus europoeus*, in their genus, on the ground that the generic name *Eucamptus* is preoccupied. Thus the genus *Coronofilaria* of Yorke and Maplestone falls in the synonymy of the genus *Squamofilaria*. I am also not inclined to include the species *E. obtusus* in the genus. The genus *Squamofilaria*, therefore, now contains only two previously described species : *S. coronata* (Rud., 1809) from *Coracias garrula*, type species and *S. pillersi* (Yorke & Maplestone, 1926) from the blue warbler fly-catchers. The new species described above differs from the type in the nature of the mouth collar, the position of the submedian head papillae and the size and nature of the spicules. The nature of the posterior extremity is also different in the new species. *S. choprai* differs from *S. pillersi* in the nature of the mouth cavity, the size and nature of the spicules and the absence of two lateral rows of small and oval pigmented corpuscles.

Type-specimen.—W 3640/1, Zoological Survey of India.

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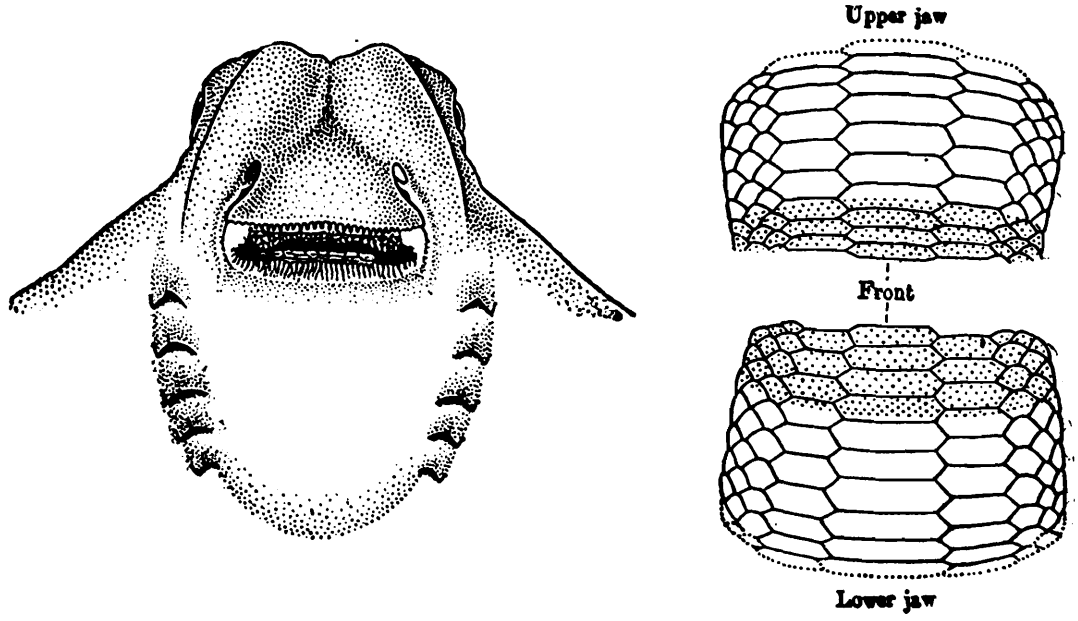
A NEW SPECIES OF RHINOPTERID FISH FROM SOUTH INDIA.

By K. S. Misra, *D. Sc., F.Z.S., Assistant Zoologist, Zoological Survey of India, Benares Cantt.*

(Plate I.)

Rhinoptera sewelli, sp. nov.

In the new species of *Rhinoptera*, described in this note, the length of disk is contained from 1·55 to 1·69 times in its depth and from 1·42 to 1·44 times in its tail. The head is notched in front of the fontanel and between the cephalic fins. The head is contained from 3·98 to 4·12 times in the length of the disk. The diameter of the eye is contained from 5·50 to 6·15 times in the head ; from 5·53 to 5·76 times in interorbital width and from 2·58 to 2·92 times in the length of the snout. One



Text-Fig. 1.—*Rhinoptera sewelli*, sp. nov.,
Ventral view of head ; ×1/3 ; Dentition in upper and lower jaws ; ×1.

edge of the upper lip is fringed, and that of the lower lip is papillated. The teeth are in nine rows on both the jaws, those in the median row 3·6 times as wide as long, those in the next row 2·3 times as wide as long and those in the outer three rows on each side as wide as long. Median rows are narrower on the lower jaw. The gill openings are moderate and equidistant. The last gill opening is the smallest. The spiracles are about double the size of the eye and are situated closely posterior to the eye. The tail is whip-like with a dorsal fin and two small serrated caudal spines above its basal portion. The anterior and posterior caudal spines are very closely apposed together. The anterior and posterior caudal spines are contained from 9·37 to 13·6 and from 2·42 to 3·2 times in the interorbital width respectively.

There is no anal fin. Both the front and the hind edges of the pectoral fins are concave.

The skin is smooth.

In specimens preserved in formalin the dorsal surface and the tail are blackish grey and the ventral surface is pinkish white.

Type-locality.—West Hill, off the Calicat coast, Arabian Sea, (Collected by Mr. K. C. Chacko, Govt. Fish curing Yard, West Hill, on 24-11-44.)

Holotype.—F79/2, Zoological Survey of India.

Remarks.—*Rhinoptera sewelli*, sp. nov. is distinguished from its congeners mainly by the following character :—

Teeth in nine rows in both the jaws (*versus* teeth in seven rows in *R. quadriloba* Lesueur, *R. lalandii* M. H., *R. javanica* M. H., *R. steindachneri* Evermann & Jenkins and *R. neglecta* Ogilby, teeth in nine rows in upper jaw and seven in the lower in *R. marginata* G. Saint-Hilaire, *R. adspersa* M. H., *R. jussieui* C., *R. jayakari* Blgr. and *R. peli* Blkr., teeth in 15 rows in upper and 19 in the lower in *R. polyodon* Gthr. and teeth in 14 rows in the lower jaw in *R. encenadae* Smith).

I have much pleasure in naming this new species in honour of Lt. Col. R. B. Seymour Sewell, C.I.E., F.R.S., I.M.S. (Retd.), formerly Director, Zoological Survey of India.

Measurements in millimetres.

Total length	619·0	684·0	752·0
Length of disk	272·0	291·0	330·0
Depth of disk	437·0	452·0	560·0
Length of head	66·0	73·0	80·0
Diameter of eye	12·0	12·0	13·0
Interorbital width	64·0	68·0	75·0
Length of snout	31·0	34·0	38·0
Width of mouth	48·0	50·0	54·0
Preoral length	42·0	45·0	47·0
Internarial length	35·0	36·0	40·0
Length of dorsal fin	28·0	29·0	33·0
Length of base of dorsal fin	24·0	28·0	29·0
Length of anterior caudal spine	5·0	5·0	8·0
Length of posterior caudal spine	20·0	28·0	damaged
Length of tail	387·0	425·0	473·0
Sex	♀	♂	♂

ACKNOWLEDGMENTS.

I am grateful to Dr. B. N. Chopra, D. Sc., F.N.I., Director, Zoological Survey of India for kindly going through the manuscript and for his helpful suggestions and to Mr. Devi Das Menon, B. Sc., (Hons.), Research Assistant, Marine Biological Station, West Hill, S. Malabar for supplying some specimens of this new species.

EXPLANATION OF PLATE I.

Rhinoptera sewelli, sp. nov., Dorsal view : ×7/16.

ACANTHOCEPHALA FROM INDIA.

III. On a New genus of Acanthocephalan parasite of the family Quadrigyridae, from a Calcutta fish, *Mystus cavasius* (Ham.).

By M. N. Datta, M.Sc., *Assistant Zoologist, Zoological Survey of India, Benares Cantt.*

The parasites described in the present note were collected by Dr. T. N. Podder of the Carmichael Medical College, Calcutta from the intestines of small siluroid fishes, *Mystus cavasius* (Ham.) found in the Calcutta fish markets. The worms are small and on examination revealed characters of the family Quadrigyridae. They do not, however, tally completely with the descriptions of any of the existing genera, and a new genus *Raosentis*, with *Raosentis podderi* as its genotype, is, therefore, proposed to accommodate them.

Raosentis, gen. nov.

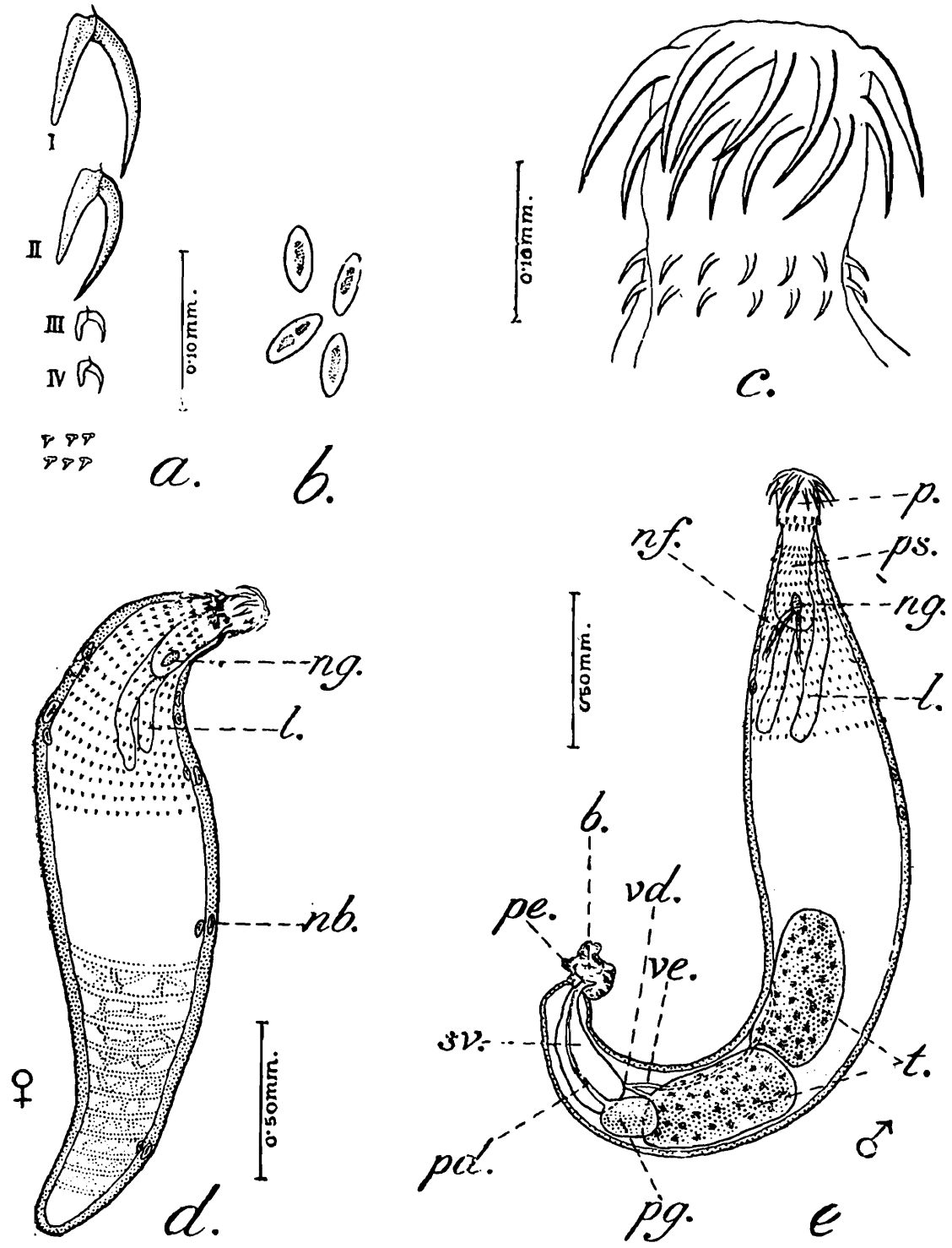
Generic diagnosis.—With the characters of the family Quadrigyridae; worms of small size parasitic as adult in the alimentary tracts of fishes. Proboscis slightly elongated or globular with 4 circles of hooks, 6 in the first two circles very long and stout and 7 in the next two circles small and slender. Some space devoid of spines, present between the second and third circles of proboscis hooks. Anterior region of the body provided with 17 rows of close-set rose-thorn-like spines. Proboscis-sheath composed of a single layer of muscles. Central nerve ganglion situated near the posterior end of proboscis-sheath. Subcuticular nuclei in pairs, 4 or 5 pairs on the dorsal and 1 or 2 on the ventral side.

Raosentis podderi, gen. *et* sp. nov.

The worms are of small size, spindle-shaped and whitish in colour. The proboscis is globular and sometimes slightly elongated, 0·14—0·25 × 0·12—0·18 mm. in size. The hooks on the proboscis are in four circles, the anterior two circles have 6 hooks in each and the posterior two circles have 7 in each. Hooks of the anterior two circles are stouter and longer than those of the third and fourth circles. There is a prominent gap of spineless space between the second and third circles of proboscis hooks. Measurements of proboscis hooks are: first circle 0·085—0·115 mm; second 0·070—0·095 mm; third 0·025—0·035 mm; fourth 0·025—0·030 mm. The anterior end of the body is provided with 16 or 17 circles of 32-34 rose-thorn-like hooks each; the basal plates of these hooks are embedded in the body-wall (Text-fig. 1, *a* and *c*).

The subcuticular nuclei are small and in pairs, four or five pairs on the dorsal and one or two pairs on the ventral side of the body-wall. The proboscis-sheath is a thin single-layered muscular sack. The retractor and protractor muscles controlling the movements of the

proboscis are thin but firmly attached to the proboscis-sheath. The central nerve ganglion is a small, elongated structure situated at the base of the proboscis-sheath and the nerve retinaculi coming out from the ganglion pass out to the body-wall through the posterior side of the proboscis-sheath. The two lemniscii are slightly longer than the sheath, 0·28—0·60×0·05—0·07 mm. (Text-fig. 1, *d.*).



TEXT-FIG. 1.—*Raosentis podderi*, gen. *et* sp. nov.

a. Hooks of the proboscis and body magnified; *b.* Eggs; *c.* Proboscis showing arrangement of hooks; *d.* Female showing arrangement of body hooks and lacunar system; *e.* Male showing genitalia, proboscis sheath, lemnisci, nerve ganglion and nerve fibres.

b. bursa; *l.* leminsci; *nb.* body nucleus; *nf.* nerve fibres; *ng.* central nerve ganglion; *p.* proboscis; *pd.* prostatic duct; *pe.* penis; *ps.* proboscis-sheath; *sv.* seminal vesicle; *t.* testes; *vd.* vas-deferens; *ve.* vas-efferens.

Lacunar system is clearly seen. There are two longitudinal canals running along the dorsal and ventral sides of the body and lateral canals coming out from these longitudinal canals run round the body at regular intervals, giving it a segmented appearance. Branches from the lateral canals, called canaliculi, are also present. In the females the lacunar system is very prominent in the posterior portion (Text-fig. 1, *d*).

The genitalia are situated in the posterior half of the worms. The male genitalia (Text-fig. 1, *e*) consist of a pair of ovoid testes arranged tandemwise close to each other. The two vasa-efferentia leading from the two testes join together below the prostatic gland to form the vas-deferens before opening into the seminal vesicle. The prostatic gland is a round mass just behind the posterior testis and contains about 8-10 nuclei. A duct from the prostatic gland, the prostatic duct, opens in the seminal vesicle near the posterior end and the seminal vesicle opens into the thick muscular and conical penis, which hangs at the top of the eversible bursa. The seminal vesicle is a thin-walled muscular sac which, in the breeding season, is full of sperms. In some cases a couple of glandular structures are seen on top of the bursa, just on the sides of the seminal vesicle, and their function seems to be to lubricate the copulatory organs at the time of mating. The female genitalia consist of a uterine-bell, which hangs in the body cavity by means of some muscle fibres attached at the anterior extremity to the base of the proboscis-sheath. The uterine-bell leads into a long tubular uterus ; the uterus leads into the narrow vagina which opens at the posterior end of the worm by means of a small opening, the vulva. The vagina is guarded by two bands of muscles to control the extrusion of the mature ova in a single file. A pair of small glands, termed as vaginal glands, are seen on both sides of the vulva. At the base of the uterine-bell there are a few cells, known as guard cells, which serve to sort out the mature from immature ova ; the mature ones are allowed to pass into the uterus and the immature ones are thrown back into the body cavity for further development. Eggs are elliptical, measuring 0·050×0·020 mm. (Text-fig. 1, *b*.)

Measurements.—Males, 0·67—2·37×0·27—0·53 mm.; females, 1·31—2·53×0·42—0·64 mm.; proboscis, 0·14—0·25×0·11—0·18 mm.; proboscis hooks, (i) 0·085—0·115 mm. ; (ii) 0·070—0·095 mm.; (iii) 0·025—0·035 mm.; (iv) 0·025—0·030 mm.; proboscis-sheath, 0·16—0·37×0·05—0·14 mm., lemnisci, 0·28—0·60×0·05—0·07 mm.; testis anterior, 0·506×0·242 mm., posterior, 0·460×0·184 mm.; prostatic gland, 0·184 mm.; seminal vesicle, 0·368 mm.; bursa, 0·138 mm.

Host.—*Mystus cavasius* (*Ham.*).

Location.—Intestine.

Locality.—Calcutta (Market).

Types.—Male and female (W3679/1) deposited in the collections of the Zoological Survey of India.

Discussion.—It is evident from the accompanying table that the new genus agrees in some points with the existing genera of the family Quadrigyridae, but it differs considerably in the shape and size of the body, the size of the proboscis, circles of hooks on the proboscis, the position and number of hooks in each circle, the comparative size of the leminsci

Characters of genera of the family Quadrigyridae.

Names of genus.	Dimensions of body.	Measurements of proboscis.	Proboscis hooks.		Measurements of prob. hooks.	Body spines.	Lemnisci.	Body nuclei.	Host.
			No. of circles.	No. in each circle.					
1. *Quadrigyrus* Van-Cleave 1920	♂8·0—10·0 × 0·6 ♀10·0—20·0 × 9·0—1·25	0·024	4	5	i. 0·096—0·106 ii. 0·076—0·100 iii. 0·053—0·059 iv. 0·041—0·047	4 rows at anterior end	longer than prob.-sheath.	ant. elliptical in saggital plane, rest large branched, laterally placed.	fishes.
2. *Pallisentis* Van-Cleave 1928	6·0—10·0 × 0·3	0·2 in diameter.	4	6	i. 89—119 μ ii. 83—100 μ iii. 53—65 μ iv. 35—41 μ	collar of 6-9 rows of spines at ant. extremity followed by 20—40 widely separated rows.	long, cylindrical.		fishes.
3. *Acanthosentis* Verma & Datta 1929.	♂1·0—1·25 × 0·2—0·25 ♀2·0—3·0 × 0·75—1·0	0·04—0·25 × 0·04—0·16	3	6	i. 72·0 × 16·6 ii. 52·0 × 13·2 iii. 48·0 × 12·0	20—31 rings on anterior two-fifth of body.	longer than prob.-sheath. 0·04—0·34 × 0·03—0·10	few branched and oval nuclei.	fishes.
4. *Neosentis* Van-Cleave 1928	♂10·0 × 0·85 ♀17·0 × 1·70		4	8	i. 53—59μ ii. 53—59μ iii. 35—41μ iv. 30—35μ	5-6 rings at ant. extremity a gap and then 6-8 circles and scattered hooks.	long, cylindrical and in male reaching upto ant. testis.		fishes.
5. *Heterosentis* Van-Cleave 1931	♂4·94 × 0·59 ♀4·75—5.85 × 0·4—0·79		10	4 or 5					fishes.
6. *Raosentis*, gen. nov.	♂0·67—2·37 × 0·27—0·53 ♀1·31—2·53 × 0·42—0·64	0·14—0·25 × 0·12—0·18	4	1st and 2nd rows 6 each; 3rd and 4th rows 7 each.	i. 0·085—0·115 ii. 0·070—0·095 iii. 0·025—0·035 iv. 0·025—0·030	17 rings of close-set, rose-thorn-shaped spines.	a little longer than prob. -sheath.	small, in pairs, 4-5 dorsal, 1-2 ventral.	fishes.

Measurements are in millimetres, except where indicated.

and the proboscis-sheath and the shape and disposition of the body spines. From Van Cleave's description of the genera *Quadrigyrus*[1] *Pallisentis*,[2] *Neosentis*[3] and *Heterosentis*[4] it is evident that the specimens of these genera are much longer than those of the new genus. The number of circles of proboscis hooks is the same, but the number of hooks in each circle in the new genus differs from them and in Verma & Datta's *Acanthosentis*.[5] In the disposition of the body spines also there are considerable variations and the new genus is easily differentiated. In *Quadrigyrus* there are only four rows at the anterior end, in *Pallisentis* there is a collar of 6-9 rows of spines at the anterior extremity followed by 20-40 widely separated rows, in *Acanthosentis* there are 20-31 rings on the anterior two-fifth of the body and in *Neosentis* there are 5-6 rings at the anterior extremity, then a spineless gap, followed by 6-8 circles and scattered spines; in the new genus there are 17 rings of close-set rose-thorn-like small spines. In the size of the lemnisci and their comparative size with the proboscis-sheath, *Raosentis* differs from the existing genera. The body nuclei also differ in being peculiarly placed in pairs. On the basis of the characters enumerated above, the new genus *Raosentis* can be easily distinguished from all the existing genera of the family Quadrigyridae.

I have great pleasure in associating the generic name with that of Dr. H. S. Rao, D.Sc., Deputy Fisheries Development Adviser, Government of India. The specific name is associated with the name of Dr. T. N. Podder, M.Sc., M.B. of Carmichael Medical College, Calcutta who very kindly gave me the specimens for study. My thanks are due to Dr. B. N. Chopra, D.Sc., Director, Zoological Survey of India, for kindly giving me help and facilities for my work here. I must also record my thanks to Mr. R. C. Bagchi, our Artist who finished the figures for this paper.

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STUDIES IN INTRASPECIFIC VARIATION.

I. On the existence of two colour-types in the adults and hoppers of the *solitaria* phase in the Desert Locust, *Schistocerca gregaria* (Forskål). [Orthopetra, Acrididae.][1]

By M. L. Roonwal, *M.Sc., Ph.D. (Cantab.), F.N.I.*

Major, Indian Land Forces.

[*From the Zoological Survey of India, Benares Cantt.*]

Foreword.

The value of the study of intraspecific variations for the understanding of various problems of evolutionary biology needs no emphasis. Of such variations there exist numerous categories ranging from morphologically distinct geographical subspecies (many of which were formerly accorded full specific rank) to smoothly graduated clines and mere physiological races (*vide* Huxley, 1944, for summary). Recent experience has shown that every species and its lower systemetic units must be investigated intensively on its individual merits, and deductions or generalizations based on even closely allied species may often prove to be misleading and erroneous.

The Desert Locust, *Schistocerca gregaria* (Forskål), has proved to be an excellent material for the study of intraspecific variations. Apart from the ordinary allometric variations, there are, in this species, firstly, the phase variations, *viz.*, the existence of *gregaria* and *solitaria* phases (Uvarov, 1923, 1928; and others). Secondly, there are non-phasic variations of which the first instance was provided by me (Roonwal, 1936). This variation referred to the existence of two different kinds of individuals (6- and 7-eye-striped) in the *solitaria* phase. These observations were later confirmed and extended (Roonwal, 1937, 1938, 1941, 1945-1946; Rao, 1937, 1938; Rao and Gupta 1939; Volkonsky, 1938, 1938*a*; and Mukerji and Batra, 1938). As a result, we now know that in *solitaria* populations mostly 6- and 7-striped (rarely 8-striped) individuals occur, while in *gregaria* populations (swarms) only 6-striped individuals are found; occasionally, 5-striped individuals turn up in laboratory breedings.

In the present series of papers I propose to describe, in the Desert Locust, intraspecific variations particularly other than those referred to above, and also to discuss the biological significance of the variations especially concerning the eye-stripes.

Introduction.

Colour differences, in both adults and hoppers, between the two phases, *solitaria* and *gregaria*, are now well-known in the Desert Locust, *Schistocerca gregaria* (Forskål) (*vide* Uvarov, 1928). But I do not think it

[1] A preliminary report appeared in *Nature* CLV, p. 792 (1945).

is yet known that in the *solitaria* phase we can distinguish two distinct colour-types in both adults and hoppers. In the present paper I shall describe these colour-types and discuss their probable significance.

Adults.

Künckel d'Herculais (1892) first showed that swarming adults of the Desert Locust are at first pink, but later become yellow with maturity. Johnston (1926) showed that this colour change is characteristic of *gregaria* individuals only; the *solitaria* adults are greenish when young and become greyish later, but do not change colour with maturity; this was confirmed by Ballard, Mistikawi and El Zoheiry (1932).

I have, however, noticed that after a few days of the initial greenish tinge, two colour-types can be distinguished among the *solitaria* adults. Firstly, the type comprising those individuals which are suffused with a blue-grey tinge all over the body; these constitute the majority. Secondly, the type comprising those individuals which are pale buff or fawn in overtone, without any blue-grey; these occur in very small numbers.

For brevity, the two types of *solitaria* may be known as *blue* and *fawn*. The two types are clear in specimens freshly caught in the field. With preservation, however, the colours change, and in museum specimens it is no longer possible to distinguish the two types. In 367 *solitaria* individuals form southern Baluchistan (November, 1935 to September, 1936), 335 (161♂♂, 174♀♀) or 91 per cent. were blue and 32 (19♂♂, 13♀♀) or 9 per cent. fawn.

From a careful analysis, I was unable to correlate the two types with age, sex, season, E/F ratio and the number of eye-stripes (*i.e.*, the proportion of 6- and 7- eye-striped individuals, *vide* Roonwal, 1936, 1945, 1945*a*) and phase.

Vayssiére and Lepesme (1939), from breedings in the Laboratoire central de Biologie acridienne, Paris, figure two adults of the Desert Locust (their Pl. III, figs. 3 and 5) which give a good idea of the coloration of the *blue* and *fawn* types as understood by me, though Vayssiére and Lepesme themselves interpret them quite differently. On p. 61 they describe fig. 3 (blue) as "Adulte type normal de l'élevage, 2 mois après la mue imaginale"; and fig. 5 (fawn) as "Adulte obtenu en élevage isolé". No further history is given, but the meaning of "type normal" can be partly inferred by reference to p. 44 where they state: "Les individus normaux de l'élevage son toujours du type *transiens*, parfois plus voisins du type *gregaria*, parfois plus près du type *solitaria*" And further: "Dans les conditions de notre élevage, les stades larvaire son trés voisins du type grégaire au point de vue de la pigmentation" Thus, since under the breeding conditions the hoppers were very close to the *gregaria* type in pigmentation, we may infer that these authors implied that the "type normal" adult illustrated in fig. 3 was in phase *gregaria* or at least *transiens*, in contrast to that in fig. 5 which is clearly stated to have been obtained in isolated breeding and so indicating that it was typical *solitaria*. Vayssiére and Lepesme thus imply a phase significance to these figures. From considerable field and laboratory experience regarding the Desert Locust, I can say that in general facies fig. 3, like fig. 5,

appears to be that of a *solitaria* phase individual. As regards pigmentation, there can be no doubt that fig. 3 *is not* that of a *gregaria* individual for, in that phase the immature adults are pinkish and the mature ones yellowish ; they are *never* bluish. The term *transiens* is very fluid. It is fairly useful in the study of biometrical ratios of adults and the pigmentation of hoppers. But as regards adult coloration it does not convey any clear impression, and distinction between *solitaria* and *transiens* colours is not at all possible.

HOPPERS.

Phase *solitaria* hoppers of the Desert Locust are generally known to have a bright green colour (Johnston, 1926 ; Ballard, Mistikawi and El Zoheîry, 1932 ; Faure, 1932 ; Husain and Mathur, 1936 ; and Kennedy, 1939). The majority are undoubtedly so.

Besides green hoppers, however, there occasionally turn up in laboratory breedings (briefly reported by Roonwal, 1937, p. 149 ; *vide infra*), as well as in field collections, a few fawn-coloured hoppers *without any green*. These fawn hoppers are undoubtedly *solitaria*, as judged from breeding records (isolated breeding) and from field observations. In the field, for instance, a fawn hopper may be found among a batch of 10 or 12 green ones in a desert bush. The fawn colour becomes well-marked in the older hopper stages only, especially the fourth and fifth. Exact figures were not recorded, but my impression is that the frequeney of appearance of the fawn hoppers does not exceed 10 per cent. of the total *solitaria* population, and is perhaps less. It must be emphasized that such hoppers are by no means abnormalities. Their occurrence is regular enough, and they are in no respect less healthy than green individuals. The appearance of fawn hoppers is not connected with food and such other external factors for, they occur simultaneously with green hoppers bred under identical conditions in the laboratory and also under identical conditions in the field, *e.g.*, on the same bush.

To a certain extent, according to Rao (1937, p. 24), *solitaria* hoppers tend to assume the environmental colour in the field. This evidently refers to green hoppers only, since Rao makes no mention of fawn hoppers.

Roonwal (1937) performed a number of experiments by rearing Desert Locust hoppers solitarily in small, wooden boxes, each painted on the inside in different colours, *e.g.*, lemon yellow, prussian blue, mahogany, black, dark green, signal red, white and light ochre (unpainted wood). He concluded (p. 149) as follows : " It will be seen ... that some colours were apparently simulated, whereas in others the results were indefinite. Colours which were simulated to a greater or less extent were : lemon yellow, black, dark green and white. Hoppers reared in the mahogany-coloured boxes became fawn-coloured in the fourth stage. This is not regarded as due to the mahogany box, since a hopper reared in the prussian blue box also became fawn. *Moreover, the fawn colour sporadically appears in solitary hoppers in identically coloured cages where the factor of environmental colour cannot be correlated with the colour of the hopper*" (italicized now).

These results regarding colour simulation broadly confirm those obtained in similar experiments on *Locustana pardalina* and *Locusta migratoria migratorioides* by Faure (1932) in S. Africa, although the simulated

colours are not always the same as in the Desert Locust. In Faure's experiments simulation occurred in white, black, grey, yellow and brown boxes, but not in green, pink, blue and black and orange. In this connection the experiments of Hertz and Imms (1937) on *Locusta migratoria migratorioides* are also of great interest for, they explain colour-response in terms of wave length of the light emitted by the surroundings, *i.e.*, of incident light to which the hoppers are subject.

In *gregaria* hoppers of the Desert Locust bred under identical conditions in the laboratory, Vayssiére and Lepesme (1939, p. 45.) record two extremes of colour-types with regard to background colour, *viz.*, a greenish yellow and a rose, the former type being numerically predominant; in both types the pattern is balck. They further state (p. 46) that the hoppers reared on a pale background are paler than those reared on a darker background ; no further details are given, and it is not possible to say whether this statement refers to *solitaria* or *gregaria* hoppers.

It is thus seen that, so far as the Desert Locust is concerned, though simulation to environment occurs to a certain extent, the production of fawn hoppers in the *solitaria* phase is evidently an independent phenomenon which is related neither to environment nor to phase. It seems probable that the fawn and green colour-types among hoppers of the same phase (*solitaria*) have a genetical significance. The fawn hoppers, as regards colour, remind one strongly of the fawn adults described above, and it is very probable that the two colour-types in hoppers are related to the two colour-types in adults—the fawn hoppers producing fawn adults, and the green hoppers producing blue adults. This supposition is supported by the relative frequency (of about the same degree) of occurrence of fawn hoppers and fawn adults (about 10 per cent.) on the one hand, and green hoppers and blue adults (about 90 per cent.) on the other.

Summary.

1. Two colour-types, termed *blue* and *fawn*, of *solitaria* adults occur in the Desert Locust. The blue type is predominant (91 per cent.), while the fawn type occurs less frequently (9 per cent.).

2. The occurrence of the two types of adults is not correlated with age, sex, season, E/F ratio, number of eye-stripes and phase.

3. Two colour-types also occur among *solitaria* hoppers of the Desert Locust, *viz.*, the *green* type which is common and is already well-known, and a *fawn* type which occurs rarely. This colour distinction is well-marked in the older (fourth and fifth) stages.

4. The occurrence of these two types of hoppers is not related to food and environmental factors (*e.g.*, background colour, etc.), nor to phase. It might possibly have a genetical significance.

5. It is probable, as is suggested by the relative frequency of their occurrence, that the two colour-types in the *solitaria* hoppers are related to the two colour-types in the *solitaria* adults — the green hoppers producing blue adults and the fawn hoppers producing fawn adults.

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ON VARIATION IN THE NUMBER OF OVARIOLES AND ITS PROBABLE ORIGIN IN THE DESERT LOCUST, *SCHISTOCERCA GREGARIA* (FORSKÅL). [ORTHOPTERA, ACRIDIDAE.]

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INTRODUCTION.

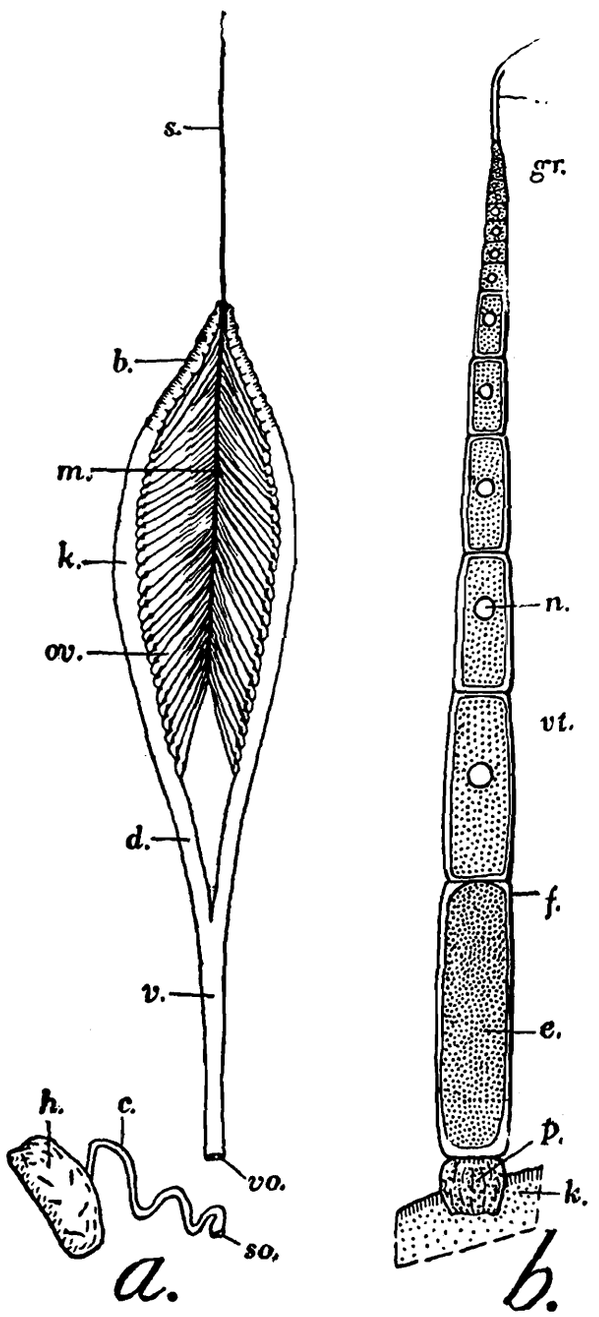
The Desert Locust, *Schistocerca gregaria* (Forskål), lays about 25 to over 100 eggs at each oviposition, the number varying from one oviposition to another and from female to female. This large number is to be coupled with an almost equally large number of ovarioles or eggs-tubes in the ovary, though the correspondence is not exact. Boldyrev (1929, p. 190) remarked for *Locusta migratoria* that " when a row of eggs matures, a certain percentage of the egg-tubes remains undeveloped, and the number of eggs produced is less than the number of egg-tubes" Nevertheless, in the Acrididae the number of ovarioles do provide us with a rough index of the number of eggs laid and thus of the reproductive capacity of the individuals. In this connection two problems, among several others, deserve consideration : (i) Is the difference in the reproductive rate under different environmental conditions, *e.g.*, at different temperatures and humidities, due to the reduction in the number of ovarioles ? (ii) Is there a difference in the number of ovarioles between the *gregaria* and *solitaria* phases, or between the various kinds of *solitaria* individuals (Roonwal, 1936, 1945-1946) ? Before, however, these and similar questions can be satisfactorily answered, we must know the natural variation in the number of ovarioles.

There are several accounts of the female reproductive organs of the Acrididae adults (Fénard, 1896, 1897 ; Berlese, 1909 ; Harman, 1925 ; Pospelov, 1926 ; Fedorov, 1927 ; Uvarov, 1928 ; Boldyrev, 1929 ; Nelsen, 1934 ; Snodgrass, 1935 ; Paoli, 1937 ; Jannone, 1938, 1939 ; Slifer, 1939-1943*a* ; Qadri, 1940 ; and others), and embryos and hoppers (Graber 1891 ; Nel, 1929 ; Nelsen 1934, 1934*a* ; Roonwal, 1937 ; and Qadri, 1940). Variation in the number of ovarioles, however, does not appear to have received attention except by Boldyrev (1929) and by Jannone (1938, pp. 318-319 ; 1939, pp. 280-281). Boldyrev noted in *Locusta migratoria* that the number of ovarioles varies in different individuals and in the right and left ovaries in the same individual. The total number, in eleven individuals, varied from 82-111, and the number in the right and left ovaries respectively from 40-55 and 42-56. The difference in the right and left ovaries of the same individual ranged from 0-4. In *Dociostaurus maroccanus* Jannone found no significant difference in the number of ovarioles between the phases *solitaria* and *transiens congregans* ; the number in each ovary is about 15-19, and that in both ovaries 30-37 An equal number in the two ovaries of a female is an exception rather than the rule. The first stage hopper has 15-16 ovarioles in each of the two ovaries.

I shall record here the variation in the number of ovarioles in the adults and hoppers of *Schistocerca gregaria* (phase *gregaria*) taken from various swarms in India. The probable mode of origin of asymmetry in the number of ovarioles in the right and left ovaries is also discussed.

The Ovaries.

A brief description of the adult ovaries (Text-fig. 1), as observed in phase *gregaria*, may first be given. In an immature adult the two



Text-fig. 1.—*Schistocerca gregaria* (Forskål).

(*a*). The ovary, its associated parts and the spermatheca of a freshly eclosed adult female. Dorsal view, with the antero-dorsal wall (not shown in the figure) of the genital cavity deflected backward. Semi-diagrammatic. x about 6. (*b*).—An ovariole from the same. Semi-diagrammatic. x about 60.

b., female accessory gland (*boyau calicial*); *c.*, canal of spermatheca; *d.*, oviduct; *e.*, developing egg; *f.*, wall of basal ovarian follicle; *gr.*, germarium; *h.*, head of spermatheca; *k.*, egg-calyx; *m.*, median ligament; *n.*, nucleus or germ-disc; *ov.*, ovarioles; *p.*, basal follicle or pedicel; *s.*, ovarian suspensorium; *so.*, spermathecal opening; *t.*, basal portion of terminal filament of ovariole; *v.*, common oviduct; *vo.*, vaginal opening; *vt.*, vitellarium.

ovaries are whitish, translucent bodies which measure about 7 mm. in length and 3 mm. in width and lie dorsal to the alimentary canal in the 4th to 6th abdominal segments. Each ovary is composed of a large and varying number of ovarioles (*ov.*). Each ovariole (Text-fig. 1*b*) consists of a chain of developing egg-cells, the oldest being at the base; towards the apex the ovariole passes into the terminal filament (*t.*). The ovarioles are disposed obliquely. The terminal filaments of the various ovarioles unite to form a median ligament (*m.*) which leads into the ovarian suspensorium (*s.*). The latter, in its turn, is attached to the dorsal body-wall of the mesonotum and holds the ovary in position. The ovarioles in each ovary lie close together in an obliquely longitudinal row of about 15-25 in a row, and roughly 2 or 3 deep. Each ovariole abuts on a muscular tube, the egg-calyx (*k.*), of its side which leads into the short (about 5 mm. long) oviduct (*d.*). The latter passes beneath the apodeme of the subgenital plate (8th sternum) and then bends inward to unite, below the alimentary canal, with its fellow of the opposite side to form the common oviduct or vagina (*v.*). The vagina opens into the "genital cavity" (*i.e.*, the exterior) near the posterior margin of the subgenital plate. In the same cavity, but more dorsally, lies the *independent* opening (*so.*) of the spermatheca[1]. Anteriorly, each egg-calyx leads into a single, blind, tubular and convoluted accessory gland or *boyau calicial* (*b.*); abnormally, the *boyau calicial* may possess an additional pouch (Roonwal, 1935). With maturity, the ovaries increase in size and also assume a yellow colour due to yolk in the ripening eggs. In a female about to oviposit the ovaries occupy the whole of the abdomen and also extend into the thorax; they then measure about 26 mm. long and 11 mm. wide.

THE NUMBER OF OVARIOLES IN ADULTS AND HOPPERS.

A total of 85 adult females from swarms was examined (Table 6), but later some of the readings were accidentally lost and only 49 were available for some purposes (Tables 1-4).

Table 1.

Number of ovarioles in right and left ovaries in 49 females of *Schistocerca gregaria* (phase *gregaria*, from swarms).

Serial No.	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*
Rt. ovary	43	45	46	46	47	48	48	49	49	49	49	50	51	52	52	53	53	53
Lt. ovary	49	54	54	54	48	55	52	54	52	58	54	53	54	53	76	40	63	53

[1]Qadri's (1940, p. 156) statement that the spermatheca opens on the common oviduct is incorrect both for *Locusta migratoria* (*vide* also Boldyrev, 1929; and several others) and *Schistocerca gregaria* (Karandikar, 1942; and the present account.) In fact in all the Acrididae so far studied the spermathecal opening is independent of the vaginal opening.

Table 1—continued.

Serial No.	*19*	*20*	*21*	*22*	*23*	*24*	*25*	*26*	*27*	*28*	*29*	*30*	*31*	*32*	*33*	*34*	*35*	*36*
Rt. ovary	53	54	54	54	55	55	56	56	57	57	57	57	57	58	58	58	58	58
Lt. ovary	53	53	47	53	63	53	81	50	56	52	54	51	51	72	55	58	48	59

Table 1—concluded.

Serial No.	*37*	*38*	*39*	*40*	*41*	*42*	*43*	*44*	*45*	*46*	*47*	*48*	*49*
Rt. ovary	59	64	64	68	68	70	70	72	73	73	73	74	83
Lt. ovary	51	57	45	68	53	66	73	73	68	72	69	69	53

Table 2.

Frequency distribution, etc. of the total number of ovarioles in the right and left ovaries of 49 individuals. [From Table 1.] *n*, number of ovarioles ; *f*, frequency. (In the numerals within the range of *n* which are omitted, *f*=0.)

(*a*) Right ovary. *Range* 43-83 ; *mean* 57·3.

n	43	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	64	68	70	72	73	74	83
f	1	1	2	1	2	4	1	1	2	4	3	2	2	5	5	1	2	2	2	1	3	1	1

(*b*) Left ovary. *Range* 40-81 ; *mean* 57·2.

n	40	45	47	48	49	50	51	52	53	54	55	56	57	58	59	63	66	68	69	72	73	76	81
f	1	1	1	2	1	1	3	3	8	8	2	1	1	2	1	2	1	2	2	2	2	1	1

Table 3.

Frequency distribution, etc. of the difference in the number of ovarioles in the right and left ovaries in each of the 49 individuals. [From Table 1.] *d*, difference; *f*, frequency. (In the numerals within the range of *d* which are omitted, $f=0$.)

Range 0-30; *mean* 6·5.

d	0	1	2	3	4	5	6	7	8	9	10	13	14	15	19	24	25	30
f	4	8	1	6	3	5	4	3	4	2	2	1	1	1	1	1	1	1

The total number of ovarioles (in the right and left ovaries together) varied in 49 individuals from 92-145, mean 114·5 (Table 4). The number of ovarioles in the right and left ovaries in different individuals (Table 2*a*, *b*) varied from 43-83 (mean 57·3) in the right ovary, and 40-81 (mean 57·2) in the left; there is, thus, no appreciable difference in the mean number of ovarioles in the right and left ovaries of different individuals. In the same individual, however, the number of ovarioles in the right and left ovaries is usually asymmetrical (Table 3), the difference ranging from 0-30 (mean 6·5). As will be seen from Table 4, there appears to be no apparent relation between the difference in the number of ovarioles in the right and left ovaries and the total number of ovarioles in the two ovaries.

Regarding the mode of origin of this asymmetry, the following, I believe, provides a fairly satisfactory answer. Examination of a few hoppers of second to fifth stages[2] showed (Table 5) two significant features: (i) That the number of ovarioles in the hoppers is already large (2nd stage 118, 126; 3rd stage 116, 124; 4th stage 108, 116; 5th stage 116, 136). The number even in the second stage hopper most probably represents the full quota for the adult stage of that individual, since the number in the hopper stages is not appreciably smaller than that in the adult (*cf.* Table 4). It may be added that the ovarioles are already differentiated in the freshly-hatched first stage hopper, but, owing to their extreme compactness, their number could not be accurately counted; I am certain, however, that this number is large. (ii) That in all the eight cases, the number of ovarioles in the right and left ovaries is symmetrical.

[2] In the *grejaria* phase the Desert Locust has 5 hopper stages, exclusive of the vermiform larva. The 5th stage hopper moults into the adult.

Table 4.

Frequency distribution, etc. of the total number of ovarioles in the two ovaries in each of the 49 individuals. [From Table 1.] *t*, total number ; *f*, frequency ; *d*, difference between right and left ovaries. (In the numerals within the range of *t* which are omitted, *f*=0.)

Range 92-145 ; *mean* 114·5.

t	92	93	95	99	100	101	103	105	106	107	108	109	110	111	113	116	117	118	121	128	130	136	137	141	142	143	145
f	1	1	1	1	3	2	4	2	4	3	3	2	1	1	2	2	1	1	2	1	1	3	1	1	1	2	2
d	6	13	1	9	4-8	3-7	3-7	1-3	0-10	1-9	2-6	5-19	8	3	1-3	0-10	1	8	7-15	24	14	0-30	25	5	4	3-5	

Table 5.

Number of ovarioles in the right and left ovaries in 8 hoppers of 2nd to 5th stages. *Rt.*, right ovary; *Lt.*, left ovary.

Stage	2nd		3rd		4th		5th	
Ovary	*Rt.*	*Lt.*	*Rt.*	*Lt.*	*Rt.*	*Lt.*	*Rt.*	*Lt.*
Number of ovarioles	63	63	58	58	54	54	68	68
	59	59	62	62	58	58	58	58

Again, a comparison of freshly eclosed or very young females with older females (nearing maturity or already mature) shows that in the 85 females which were examined (Table 6) the proportion of symmetrical or nearly symmetrical ovaries was much higher in young (42%) than in older females (29%). The criterion of symmetry adopted was that the difference in the number of ovarioles in the right and left ovaries in a female should not exceed 2.

Table 6.

Number and percentage of hoppers and adult females with symmetrical or nearly symmetrical ovaries.

Stage	Total number examined	Cases with symmetrical or nearly symmetrical ovaries	
		Number	%
Hoppers (2nd-5th stages)	8	8	100%
Freshly eclosed or very young females	19	8	42%
Females nearing maturity or already mature	66	19	29%

Though the number of specimens examined was rather small, the presence of symmetry in the hoppers and the greater frequency of symmetry in very young females as compared to mature ones, strongly suggest that the asymmetry is acquired not earlier than either the late hopper stages (late 5th) or some time after eclosion. The asymmetry probably arises by the unequal resorption in the right and left ovaries of the already differentiated ovarioles caused by competition for space and nutriment in a rapidly developing ovary crowded with ovarioles. This view finds support from the following observations.

In the ovary of a freshly hatched hopper all the ovarioles are of approximately the same size. Already in the fourth stage it is noticed that some ovarioles are markedly smaller than the others. In a mature female about to oviposit for the first time, though the majority of the ovarioles are large and each contains a ripe yellow egg in the basal follicle, there are some which are extremely underdeveloped and do not contain ripe eggs. This feature, incidentally, explains why the number of eggs laid is not equal to the number of ovarioles present in an ovary. Regarding the origin of the difference in the development of the various ovarioles which compose an ovary, there are two possibilities: (i) That the first differentiation of the ovarioles in an ovary does not occur at the same or nearly the same time. This is unlikely since the full quota of ovarioles is evidently differentiated even as early as the 2nd hopper stage (probably earlier), as is suggested by their large number and almost equal size in the early hopper stages. (ii) That in an ovary some ovarioles, though at first they start developing together with the others, lag behind in later development due to competition for space and nutrition. Owing to the causes already mentioned, some ovarioles are completely resorbed but in varying numbers in the right and left ovaries, thus leading to asymmetry.

SUMMARY.

1. The ovary of the Desert Locust is briefly described.

2. The number of ovarioles was examined in several adult females of phase *gregaria* (from swarms) and a few phase *gregaria* hoppers of second to fifth stages, and their natural variation analysed.

3. The total number of ovarioles in the two ovaries (right and left) varied in 49 females from 92-145, mean 114·5.

4. There was no significant difference in the mean number of ovarioles in the right and left ovaries in different individuals. The figures for 49 females were: right ovary 43-83, mean 57·3; left ovary 40-81, mean 57·2.

5. In the same female, however, the number of ovarioles in the right and left ovaries usually differs. The difference in 49 females was 0-30, mean 6·5. This asymmetry is absent in hoppers. It is evidently acquired in the late fifth stage hopper or in the young adult, and is accentuated with maturity in the adults.

6. The ovarioles are already differentiated in the freshly hatched hopper. Even in the 2nd stage hopper their number is large and probably represents the full quota for that individual; no further increase probably occurs.

7 At first (*i.e.*, in a freshly hatched first stage hopper) all the ovarioles in an ovary are subequal in size. Already in the 4th stage hopper, however, some of the ovarioles are markedly smaller than the others. The unequal development, probably caused by competition for space and nutrition, is accentuated as the ovary matures and, ultimately, a varying number of ovarioles is completely resorbed, thus leading to reduction and asymmetry in the right and left ovaries. The unequal development also explains why the number of eggs laid is smaller than the number of ovarioles.

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MEGACEPON CHOPRAI, GEN. *ET* SP. NOV., A BOPYRID ISOPOD FROM THE GILL CHAMBER OF *SESARMA TETRAGONUM* (FABR.).

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While examining the branchial chamber of the semi-terrestrial crab, *Sesarma tetragonum*, collected from burrows on the banks of the Adyar River near Madras, a bopyrid was found attached to the gills. Other parasites were noticed even earlier in the gill chambers, but the present species attracted attention by its large size and feathery appendages. The specimen obtained was a female. Very careful examination of the gill chambers of thirty crabs captured from the same locality was subsequently made, but the bopyrid has not again been observed. Since the species does not agree with any of the known bopyrids, it is here described as new.

Family BOPYRIDAE.

Megacepon, gen. nov.

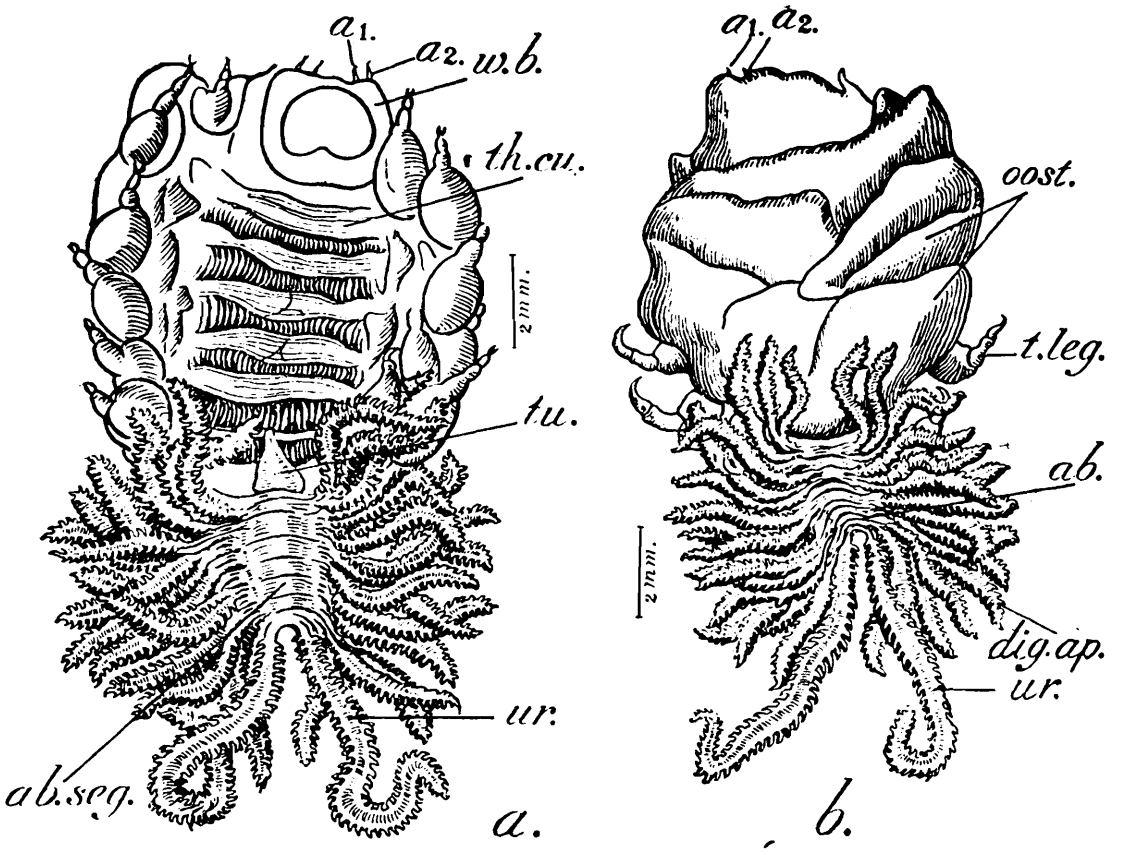
Female with one median dorsal tubercle on the last thoracic segment. All seven thoracic segments raised in the form of cushions. Exopodites present. Pleura of abdominal segments produced into long digitate prolongations. External as well as internal rami of pleopods equally modified. Uropods in the form of long feathery appendages.

Type-species.—Megacepon choprai, sp. nov.

Megacepan choprai, sp. nov.

Habitat and External Characters.—The animal was alive when removed from the branchial chamber of the crab and it showed pulsations in the region of the neck. The movement stopped after a few minutes of exposure to air. It has a globular appearance, the convexity being greater on the ventral side. The large size of the animal is mainly due to the numerous feathery appendages in the abdominal region and to the cushion-like elevations on the dorsal side (Text-fig. 1*a*). The ventral side is completely masked by the incubatory plates (Text-fig. 1 *b*), which are milky-white in colour. On the dorsal side are seen the rose-red lateral borders which stand out in sharp contrast to the milky white cushions and digitate appendages. The median dorsal tubercle is conical and can be seen prominently protruding from the last thoracic cushion. The head and the abdomen are in a lower plane when compared with the thorax, and the body tapers towards the posterior end.

I have pleasure in naming this species after Dr. B. N. Chopra, the author of the Monograph on Bopyrid Isopods from Indian Decapods (1923).



Text-fig. 1.—*Megacepon choprai*, gen. *et.* sp. nov. *a.* dorsal view; *b.* ventral view.

*a*1., first antenna; *a*2., second antenna; *ab.seg.*, abdominal segment; *dig. ap.*, digitate appendage; *oost.*, oostegite; *t. leg.*, thoracic appendage; *th. cu.*, thoracic cushion; *tu.*, tubercle; *ur.*, uropod; *w b.*, wavy border.

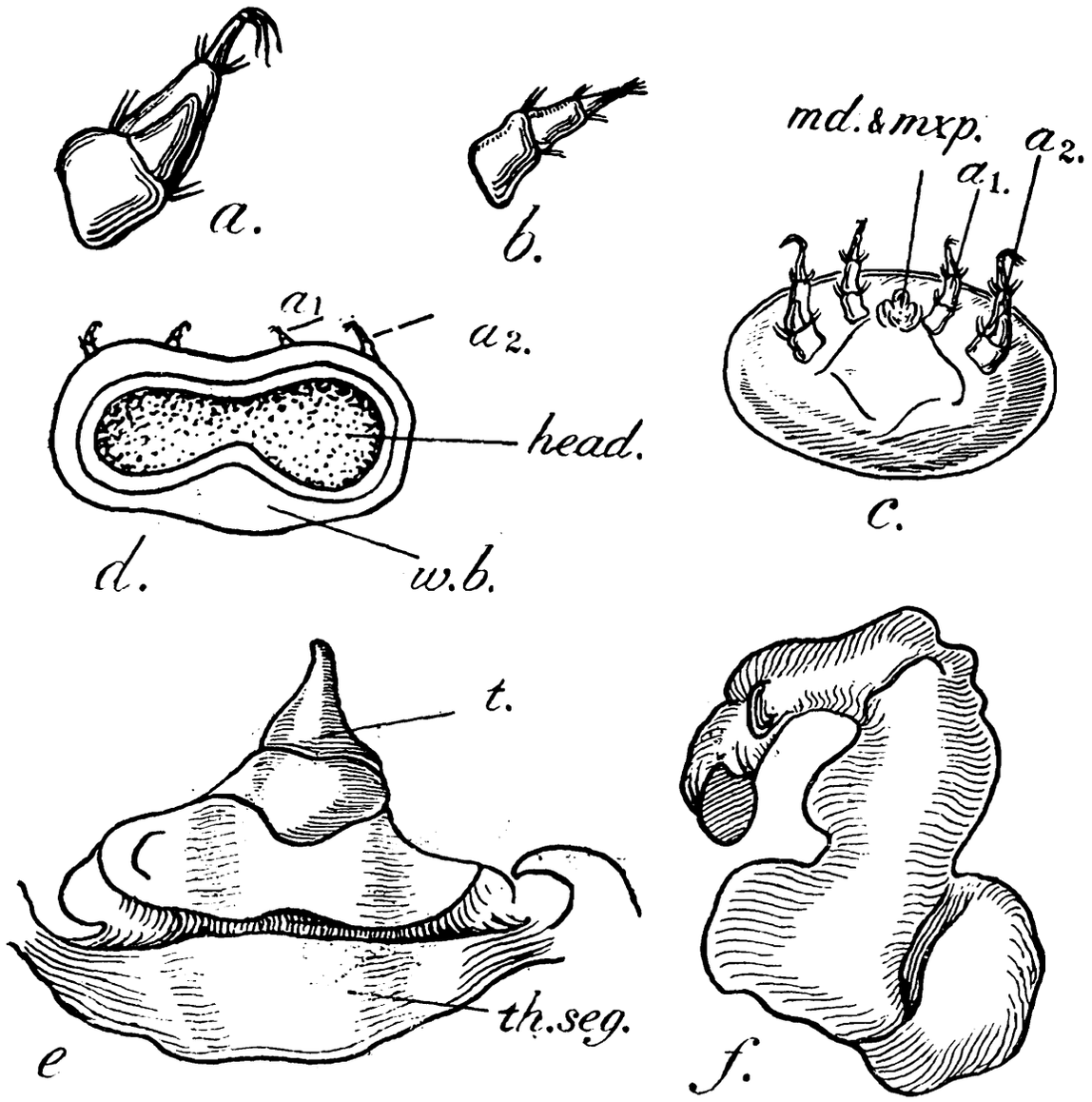
The following measurements were taken :—

Total length	16 mm.
Length of the animal from the frontal border to the first abdominal segment	9 mm.
Greatest width of the thorax	8·5 mm.
Length of the head	2 mm.
Length of the Uropod	4·5 mm.
Length of a typical digitate appendage	3 mm.

The Head.—The head (Text-fig. 2 *d*) is dumbell-shaped with a wavy border, which is prominent on its posterior side. The thorax being very much larger in size, its first segment completely envelops the head.

The antennules (Text-fig. 2 *b*) are very small and are three-jointed. The first segment of the antennule is massive, while the last ends in tuft of hairs. The antennae (Text-fig. 2 *a*) are more prominent and each is five-jointed. The first article is consolidated with the head and the second is the largest in size, with a deep groove in it; the rest of the segments are slender. All the segments of the antennae show tufts of hairs at the base of each segment. The mandibles together with the

maxillipedes (Text-fig. 2 *c*) give a spoon-like appearance when viewed from the ventral side.



TEXT-FIG. 2.—*Megacepon choprai*, gen. *et.* sp. nov. *a.* second antenna; *b.* first antenna; *c.* ventral view of the head; *d.* dorsal view of the head; *e.* tubercle with the last thoracic segment; *f.* typical (4th) thoracic appendage; *a*1., first antenna; *a*2., second antenna; *md.*, mandible; *mxp.*, maxillipede *th. seg.*, thorasic segment; *w.b.*, wavy border.

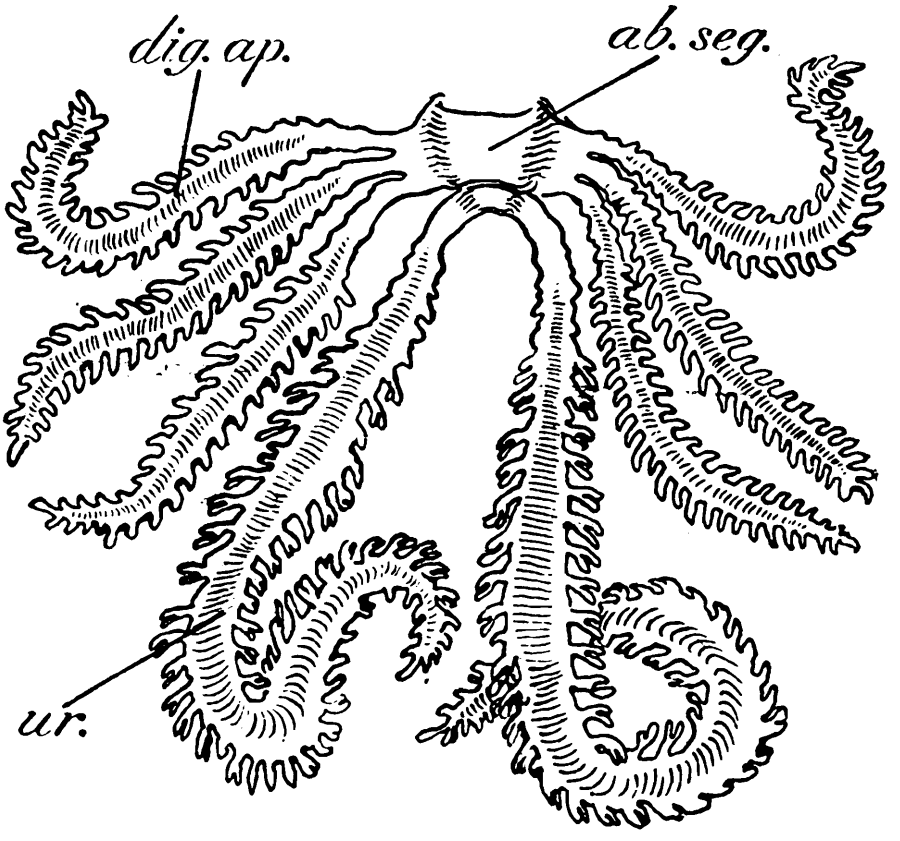
The Thorax.—The thorax forms the major part of the body of the animal and the entire globular form is brought about by the modification of the thoracic segments and the oostegites. There are seven thoracic segments, and all of them are in the form of cushions. These cushions are milky-white in colour, and are largest in size in the middle and taper towards the lateral regions, which are rose-red in colour in the living specimen. The third and fourth cushions show a groove in the middle, while the seventh bears a median dorsal tubercle, which is very prominent (Text-fig. 2 *e*).

The tubercle is cone-shaped and projects from the seventh cushion-like elevation.

On the ventral side, the thorax is covered by the oostegites, which are five in number on each side (Text-fig. 1 *b*). They are white in colour and are attached only by their posterior ends, and each oostegite is overlapped by the one behind it. The seven pairs of thoracic legs are well developed. They are massive, five-jointed and clawed at the

tips (Text-fig. 2 *f*). The incubatory lamellae mask the basal part of the legs. . The penultimate segment of each thoracic leg has a few strong hairs at its base. The exopodites, though present, are short and stumpy.

The Abdomen.—The abdomen is comparatively slender and segmentation is more marked on the ventral side. The segments are



TEXT-FIG. 3.—Uropod with the last abdominal segment and pleopods of *Megacepon choprai.*
ab. seg., abdominal segment; *dig. ap.*, digitate appendage; *ur.*, uropod.

more or less hidden from view by the overlapping of the digitate appendages. There are five pairs of pleopods. The pleura of the abdominal segments are modified into prolongations, and are digitate. The external as well as the internal rami of the pleopods are also modified into long digitate appendages. The abdomen is short and slightly bent towards one side. The uropods also consist of two long digitate processes, like those of the pleopods or the modified pleura of the abdominal segments (Text-fig. 3). The uropods are one and a half times longer than any one of the feathery appendages, which are more or less of the same length. There are sixteen digitate appendages on each side. Each abdominal segment has three processes, *viz.*, the exopodite, the endopodite and the pleural prolongation on each side. The digitate appendages have a pinnate appearance and the borders of the appendages are very transparent.

Type-specimen.—No. C 2480/1, Zoological Survey of India.

Effect of Parasitism.—The effect of parasitism on the host is also worth mentioning. The chelipeds were more or less disabled, and the walking legs were feebler in the parasitised crab than those in a healthy specimen. The gills on which the parasite was seen were of a greyish

Table showing generic characters of Megacepon and allied genera.

Generic Name.	Average Size.	Thorax.	Thoracic Appendages.	Abdomen.	Abdominal Appendages.	Uropod.	Host.
Megacepon	16 mm.	A median dorsal tubercle in the last thoracic segment; all segments raised as "cushions".	Thoracic legs well developed; short & stumpy exopodite.	Long & slender, segmentation well marked; pleura modified to form long digitate prolongations.	Exopodite & endopodite modified to form digitate appendages similar to pleural prolongations.	1½ times longer than abdominal appendages; feathery and pinnate.	*Sesarma tetragonum.*
Grapsicepon	1·9 mm.	Two dorsal tubercles in the last two thoracic segments; first four segments raised as "cushions".	Thoracic legs ill-developed; exopodites absent.	Long & slender; pleura modified to form long digitate appendages.	Expodite alone modified to form digitate appendage; endopodite in the form of tubercles.	Uropod of same length as digitate appendages.	
Trapezicepon	Less than 5 mm.	Dorsal tubercle absent.	....	Pleura unmodified.	Pleopods fleshy and in the form of digitate appendages but rudimentary.	Uropod digitate and fleshy.	Trapezid crab.
Portunicepon	6 mm.	Dorsal tubercle absent	....	Pleura ill developed	Exopodites and endopodites developed but former smaller in length.	Uropod digitate and nearly equal in length to abdominal appendages.	*Portunus arcuatus.*

tinge and under the microscope, the lamellae showed signs of degeneration.

The present species is allied to some of the bopyrid parasites described in the Monographs on Isopod parasites by J. Bonnier (1900) and Miss H. Richardson (1905). The genera which are closely related to *Megacepon* are : *Grapsicepon* Giard and Bonnier (1887), *Trapezicepon* Bonnier (1900), and *Portunicepon* Bonnier 1900. It may be mentioned that Stebbing (1906) has described a bopyrid from crabs of the Indian region under the name *Tylokepon bonnieri* ; this is sharply demarcated from the above genera in the possession of two median tubercles of which one is trifid, of pleopods with unequal rami, and of a head " formed as it were of two short stout cylinders " The principal characters of the closely allied genera, so far as females are concerned, are given on page 389 in a tabular form.

Acknowledgement.

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