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A COMPARATIVE STUDY OF THE PITUITARY OF SOME FRESH-WATER TELEOSTS

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(With 3 Plates)

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I—INTRODUCTION

The pituitary of Teleosts has been studied by various workers (Herring, 1908, 1913 ; Stendell, 1914 ; Tilney, 1911 ; de Beer, 1926 ; Florentine and Weiss, 1931 ; Bell, 1938 ; Levenstein, 1939 ; Woodman, 1939 ; Kerr, 1942 ; Miller, 1944 ; Atz, 1953 ; and Stolk, 1950-57). Seasonal histological changes in the pituitary of Teleosts is described by Bock (1928), Matthews (1936), Lee (1942), and others. The work of Bretschneider and de Wit (1947), Scruggs (1951), Olivereau (1954) and Pickford and Atz (1957) are exhaustive. It is generally observed that the "Übergangsteil" is the component which exhibits marked seasonal changes. Several authors have homologised the components of the teleostean pituitary to that of the higher vertebrates and the terminology involved is very extensive. Charipper (1937) observed variations in the placement of the various components of the teleostean pituitary. Scruggs (1939) did not record a *pars anterior* in *Esox niger*. Butcher (1936) reported the absence of well-defined lobes in the pituitary of *Fundulus*. Stolk (1955) recorded abnormal distribution of the lobes in *Xiphophorus helleri*. In the salmon, Woodman (1939) described the "Übergangsteil" to be of transitional nature, as described by Stendell (1914). Kerr (1942) has classified the teleostean pituitary into two types : *Type A* : Comprises of forms having no distinct pituitary stalk - *Type B* : Includes those having a definite stalk. The terms platybasic and leptobasic of Bretschneider and de Wit (1947) denote types A and B of Kerr (1942).

Studies on the pituitary of Indian species are meagre and confined to limited aspects, and to a few species such as *Chanos chanos* (Tampi 1951, 1953), *Barbus stigma*, *Ophicephalus punctatus*, *Chela bacaila*, *Cirrhitina reba*, *Mystus seenghala* (Sathyanesan 1957-60), *Hilsa ilisha*, *Engraulis telara* and *Gadusia chapra* (Misra and Sathyanesan, 1958).

It has been observed by the workers that in the teleosts the arrangement and organisation of the component parts of the pituitary gland widely varies in different species (Stendell 1914, de Beer 1926, Matthews 1937, Hoar 1957), has many structural and histological features peculiar to itself and seems to have evolved in its own way (Kerr 1942*a* or *b*). This work is an attempt to further our knowledge of the morphology, histology and the variable features of the pituitary of teleosts inhabiting the tropical fresh-waters.

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II—MATERIAL AND METHODS

Specimens for this study were collected from the river Ganges at Varanasi (U.P.). They were decapitated and the pituitary and a portion of the gonads were fixed in the appropriate fixatives immediately. In cases where the dissection of the pituitary was difficult, it was initially fixed along with a part of the attached bone and connective tissue. Dawson Friedgood's formol-sublimate, Bouin's fluid, Heidenhain's azan stain and Anderson's modified Mallory's triple stain were the fixatives and the stains used in the routine work. Paraffin sections were cut at 4 and 6 μ thickness. Since the pituitary-gonad interrelationship is well established, the growth phases of the gonads in relation to the pituitary was also recorded. The gonads were fixed in Bouin's fluid and stained in Ehrlich's haematoxylin.

III—OBSERVATIONS

1. General features of the teleostean pituitary

The pituitary is attached to the infundibulum. The infundibular stalk, when present, may be moderately long and slender or short and thick. In forms where a definite stalk is wanting the pituitary is closely applied to the infundibulum. The pituitary is divided into two parts : (i) The *pars glandularis* or the *adenohypophysis* comprising of three components, the *pars anterior*, the *Übergangsteil* and the *pars intermedia*, and (ii) The *pars nervosa* or the *neurohypophysis* which is the extension of the pituitary stalk or the floor of the infundibulum into all the components of the *pars glandularis*. The main nervosal trunk ramifies profusely in the *pars intermedia*. The occurrence of the nervosal branches in all the constituents of the *adenohypophysis* is reported to be a secondary development. The most primitive condition is shown by *Acipenser* and *Lepidosteus* (Kerr, 1949) having the *pars nervosa* and the *pars intermedia* only. In several fishes the infundibular cavity extends into the *pars nervosa* as funnels or recesses which are lined by ependymal cells of varied shape. The *pars nervosa* is fibrocellular in its composition. The fibres are loosely arranged, and the neuroglia nuclei are scattered in their interstices. Blood vessels, colloid-like bodies and sometimes glandular cells are seen in the *pars nervosa*. The components of the *pars glandularis* are distinguished by their distinct cell-types. The basophils, acidophils and chromophobes are the basic

cell-types of the pars glandularis. The pituitary is covered by a vascular meninges of connective tissue from which the blood vessels of varying size enter into its substance.

2. *Description of individual species*

Since the pituitary gland is highly variable, depending on its secretory activity, the structure described here denotes the condition of the gland during the particular time of the year mentioned herein. The differential staining of the glandular cells obtained is specific for the fixatives and stains used. The general classification of fishes adopted in this paper is that proposed by Regan (1929).

Order ISOSPONDYLI

Suborder *CLUPEOIDEA*

Family *CLUPEIDAE*

(i) *Hilsa ilisha* (Ham.)

(Collected during September, when this species migrates upstream with mature gonads.)

The pituitary is attached to the infundibulum by a stalk and is lodged in a distinct *sella turcica* as that of *Polypterus* (de Beer, 1926) and *Epiplatys* (Griffiths, 1938). In this differs from the other species, reported here in the presence of a well defined *sella turcica*. The components of the pars glandularis are arranged along an antero-posterior axis (Pl. 20, Fig. 1). The pars nervosa ramifies extensively in the pars intermedia but has only a few branches in the other components. In some specimens the pars nervosa has abundant chromophilic colloid-like substances which are in the form of streaks among the fibres (Pl. 22, Fig. 1). The existence of the oro-hypophysial duct is reported in *Hilsa ilisha* (Misra and Sathyanesan, 1958). This duct is continued into the pars anterior and its diverticula spread all over the component. Thus, in a section the pars anterior looks as though it is made up of tubular structures. The lumina of these tubules are a part of the hypophysial cavity which, in turn, is the cavity of the oro-hypophysial canal. The tubules are lined by acidophils and chromophobes. The pars nervosal branches and blood-capillaries are seen in between contiguous tubules.

The "Übergangsteil" is made up of basophils, acidophils and chromophobes. The chromophobes are very few and ill-defined. The basophils are in a state of degranulation and many of them lack a distinct cell-boundary. The pars intermedia consists of acidophils, chromophobes and a few basophils. Some of the acidophils possess intracellular acidophilic globules (Pl. 22, Fig. 3). These bear resemblance to the 'sphere cells' of *Perca fluviatilis* (Kerr, 1942). Such acidophilic globules, of a varying size, are extruded in the pars nervosa. The pars intermedia is abundantly supplied with blood vessels.

(ii) *Gadusia chapra* (Ham.)

(Collected during September, with ripe gonads.)

The pituitary is structurally similar to that of *Hilsa ilisha*. In *Gadusia* the evidence of the oro-hypophysial duct is less manifest and the *sella turcica* is less prominent. The presence of colloid-like contents in the

pars nervosa is much less marked. Groups of neuroglia nuclei and few disintegrating chromophils are generally present in the *pars nervosa*.

The glandular components are arranged in an antero-posterior axis as in *Hilsa ilisha*. The hypophysial cavity in the *pars anterior* is homologous to that of *Hilsa*. A large cavity occupies three-fourths of the *pars anterior* (Pl. 20, Fig. 2), which may contain basophilic matter. These tubules have acidophils and chromophobes as their cellular constituents (Pl. 22, Fig. 2), with traversing blood-capillaries. The continuity of the oro-hypophysial duct into the *pars anterior* is lost, but some times this may be indicated by the prolonged tip of the *pars anterior* (Pl. 20, Fig. 2). Acidophils, basophils and chromophobes are present in the "Übergangsteil". The basophils are larger than the acidophils and some are vacuolated. Many of them lack distinct cell-limits and are in a state of degranulation. This lobe is fairly well supplied with blood vessels. The *pars intermedia* is predominantly acidophilic, with scattered chromophobes.

Family ENGRAULIDAE

(iii) *Engraulis telara* (Ham.)

(Specimens collected during October, with 'spent' gonads.)

The pituitary of *Engraulis telara* resembles that of *Gadusia chapra*. The *pars nervosa* has a prominent infundibular cavity lined with ependymal cells and are completely cut off from the main infundibular cavity (Pl. 20, Fig. 3). The hypophysial cavity in the *pars anterior* is tubular, but no single tubule is outstandingly large as in *Gadusia*. The basophils of the "Übergangsteil" show total degranulation and many of them lack a cellular limit.

Suborder NOTOPTEROIDEA

Family NOTOPTERIDAE

(iv) *Notopterus chitala* (Ham.)

(Collected during April, with the gonads in the resting condition.)

The pituitary is closely applied to the brain and is without a distinct stalk and sella turcica. The infundibular cavity is wide (Pl. 21, Fig. 4). The extension of the infundibular cavity in the *pars nervosa* is in the form of a long narrow channel lined by ependymal cells (Pl. 22, Fig. 6). The *pars nervosa* is intimately related with the thin floor of the infundibulum and arborisation is largely restricted to the *pars intermedia*. Colloid-like material and scattered chromophils are present in the *pars nervosa*. The glandular components are arranged in a regular sequence along the antero-posterior axis.

The *pars anterior* has acidophils and chromophobes. The acidophils are densely granulated, but sparsely granulated ones are also not uncommon. Chromophobes are few. The Übergangsteil has acidophils, basophils and chromophobes, in that order of their abundance. The *pars intermedia* is richly vascularised and contains acidophils and

chromophobes. The acidophils are densely granulated and some emigrant ones are in a state of disintegration in the pars nervosa.

Order OSTARIOPHYSI

Suborder *SILUROIDEA*

Family CLARIIDAE

(v) *Clarias batrachus* (Linn.)

(Collected during August, with the gonads fully ripe.)

The pituitary is attached to the infundibulum by a short thick stalk (Pl. 20, Fig. 6). The pars nervosa arborises into all the components of the pars glandularis but the main trunk penetrates the pars intermedia. The pars nervosa may contain a few chromophils belonging to the pars glandularis. Colloid-like material is very scanty and only seen in the main nervosal trunk.

The components of the pars glandularis are arranged in a dorso-ventral sequence. The pars anterior is situated dorsally proximal to the stalk. The pars intermedia is ventral and distal and the Übergangsteil is wedged in between. The pars anterior is made up of acidophils, chromophobes and basophils. The basophils are scattered and few. The acidophils show varying degrees of granulation. Two types of chromophobes are apparent—some are larger with sufficient cytoplasm and a distinct cell-boundary; others lack a definite cell-wall and, with their meagre cytoplasm, look like naked nuclei. Acidophils, basophils and chromophobes occur in the Übergangsteil. The acidophils are heavily granulated and are deeply stained. A large percentage of basophils lack definition and are in different stages of degranulation. The chromophobes resemble groups of nuclei. The pars intermedia is composed of chromophobes, acidophils and dull basophils. The acidophils are smaller than those of the Übergangsteil and some have basophilic inclusions in their cytoplasm. The chromophobes have very little cytoplasm and their rounded nuclei exhibit a distinct nucleolus. Some of the blood-vessels entering the pars intermedia from the vascular envelop are outstandingly large and extend up to the pars anterior dorsally (Pl. 20, Fig. 6).

Family HETEROPNEUSTIDAE

(vi) *Heteropneustes fossilis* (Bloch)

(Collected in August, with fully mature gonads.)

The pituitary resembles that of *Clarias batrachus* in its external morphology and relationship with the brain (Pl. 29, Fig. 5). The colloid-like material resembling that found in the pars nervosa is present in the infundibular cavity. Neuron cells, which are often found in the floor of the infundibulum, are occasionally present in the main trunk of the pars nervosa. A few disintegrating chromophils also occur in the component. The pars anterior has acidophils, and chromophobes. The former is predominant and sparsely granulated. The chromophobes

have a well-defined cell-boundary. Basophils, acidophils and chromophobes are present in the Übergangsteil. The basophils are strikingly larger than the acidophils and are heavily granulated ; many of them are vacuolated. These vacuoles contain varying quantities of acidophilic granules or globules (Pl. 22, Fig. 7). The larger blood sinuses of the Übergangsteil contain chromophilic colloid-like matter. The cell-wall of some of the basophils lying closer to the sinuses gives way to liberate their contents into the sinuses (Pl. 22, Fig. 8). This phenomenon is comparable to the observation made by de Beer (1926) in the mammalian pituitary where the acidophils burst to pour out their granular contents into the sinusoids. Some of the sinuses contain disintegrating basophils (Pl. 22, Fig. 5). The acidophils are intensely granulated and are smaller than the basophils. Chromophobes are few and are devoid of distinct cell limits.

The pars intermedia resembles that of *Clarias*, but acidophils seem to lack the basophilic contents. In *Heteropneustes* smaller blood-vessels penetrate into the pars intermedia from outside.

Family SISORIDAE

(vii) *Bagarius bagarius* (Ham.)

(Collected in June after spawning, with the gonads in a depleted state.)

The pituitary is attached to the infundibulum by a distinct stalk. The infundibular cavity extends into the pars nervosa. The arrangement of the components of the pars glandularis is slightly different from those described earlier. In this species though the Übergangsteil is placed in between the pars anterior and the pars intermedia, the former is in continuation with the latter towards the stalk (Pl. 20, Fig. 4).

Many of pars nervosal branches penetrate the pars intermedia and the pars anterior. The chromophils and the colloid-like substances are scarce in the pars nervosa. Acidophils and chromophobes are found in the pars anterior. A rosette-like disposition of acidophils around the blood vessel and nervosal branches is noticeable. The acidophils lying around the blood-vessels are more densely granulated than those occurring around the pars nervosal branches.

The Übergangsteil is the smallest component of the pars glandularis (Pl. 20, Fig. 4.) and is made up of acidophils, basophils, violet-coloured amphiphils and chromophobes. The acidophils outnumber the other cell-types ; they are oval or round and copiously granulated. The amphiphils resemble the acidophils, with a distinct violet tinge. The basophils are much less in number and some of them have a prominent vacuole which may contain few scattered acidophilic granules. The chromophobes are few in number which may or may not have distinct cell boundaries. The pars intermedia contains light blue basophils heavily granulated acidophils and chromophobes. Deeply staining

acidophilic granules and globules occur in this part. These bodies appear to take their origin from the granulated acidophils.

Family SILURIDAE

(viii) **Wallago attu** (Bl. & Schn.)

(Collected in June, the fish is in the spawning and partly spent condition.)

The pituitary is ovoidal in shape and has an infundibular stalk. The Übergangsteil has a peripheral disposition in the ventro-lateral aspect of the gland and may cover up peripherally nearly three-fourths of the pars intermedia which is situated towards the centre (Pl. 21, Fig. 6). The pars intermedia is in contact with the pars anterior dorsally.

The main trunk of the pars nervosa arborises in the pars intermedia leaving smaller branches into the other components. The chromophils and colloid-like material are scanty in the pars nervosa. A large blood vessel entering the pars intermedia from the vascular connective tissue envelop vascularises the pars nervosa and extends upto the stalk. The pars anterior is formed of sparsely granulated, reddish brown acidophils and chromophobes. The cells lining the pars nervosal branches of the pars anterior are chromophobic, but in specimens collected during May they take up an amphiphilic hue. The Übergangsteil consists of acidophils, basophils and chromophobes. The basophils exhibit different degrees of degranulation ; some possess a prominent vacuole and others lack definition. The chromophobes occasionally look like groups of nuclei. A homogeneous basophilic substance is found in relation with the blood-sinuses penetrating the pars intermedia and the Übergangsteil. Light reddish brown chromophobes and acidophils are present in the pars intermedia.

Family BAGRIDAE

(ix) **Rita rita** (Ham.)

(Collected in November, when the gonads are in the resting stage.)

The pituitary is stalked and the surface of the pars anterior is indented as in *Esox lucius* and *Salmo trutta* (Kerr, 1942). The groove on the surface of the gland demarcates the boundary of the pars anterior from the rest of the gland. The main trunk of the pars nervosa contains the prominent infundibular cavity which is lined by elongated ependymal cells (Pl. 21, Fig. 2), as in *Notopterus chitala* and *Engraulis telara*. Chromophils and colloid-like substances are rare in the pars nervosa. The disposition of the components of the pars glandularis is dorso-ventral, as in *Clarias* and *Heteropneustes*. The pars anterior is situated proximal to the stalk dorsally, and the pars intermedia is distal and ventral, having the Übergangsteil in between them.

The pars anterior has chromophobes and differentially granulated acidophils. The Übergangsteil is made up of acidophils, basophils and chromophobes. The acidophils are densely granulated and form

the principal cell-type. Some of the basophils are vacuolated. The pars intermedia contain acidophils and chromophobes.

In the pituitary of the specimens collected during July, when the gonads are in the spawning stage, the Übergangsteil is appreciably enlarged and the basophils preponderate. A large number of basophils have acidophilic granules and globules in their vacuoles. Some basophils exhibit degranulation which render them chromophobic.

Suborder *CYPRINOIDEA*

Family CYPRINIDAE

(x) *Rohtee cotio* (Ham.)

(Collected in June, with the gonads fully distended)

The pituitary is attached by a short, thick stalk to the infundibulum (Pl. 21, Fig. 3). Since the stalk passes through a shelf made of bone and connective tissue, removal of the pituitary with the brain is difficult. The glandular components are arranged along the dorso-ventral axis. Chromophils are rare but droplets of colloid-like bodies are present in the pars nervosa. The pars anterior consists of deeply staining acidophils and chromophobes. The chromophobes lack a well defined cell-wall. Acidophils, basophils and chromophobes are present in the Übergangsteil. The basophils are the most numerous; some are vacuolated (Pl. 22, Fig. 4) but may or may not contain secretory matter. The acidophils are varied in shape and much smaller than the basophils. The chromophobes are few and lack definition. The pars nervosa occupies one-half of the pars intermedia. The chromophobes are the principal cell-type. The acidophils are few in number.

Notable differences are detected in the Übergangsteil of specimens collected during November, when the gonads are in the resting phase. There is conspicuous reduction in the size and number of the basophils and those with secretory matter are rare.

Order PECCOMORPHI

Suborder, *OPHICEPHALOIDEA*

Family OPHICEPHALIDAE

(xi) *Ophicephalus punctatus* Bloch

(Collected during July, with the gonads partly depleted.)

The pituitary is closely applied to the brain, and a definite stalk is wanting (Pl. 21, Fig. 5). Narrow extensions of the infundibular cavity are present in the pars nervosa. The pars nervosa contains small colloid-like patches and a few scattered chromophils. The pars anterior contains chromophobes and sparsely granulated acidophils. This component is adequately supplied with blood-vessels. The chief cell-

type of the Übergangsteil is degranulated. The degranulating basophils render this region frothy, a condition which is comparable to the net-like appearance recorded in *Xiphias gladius* (Lee, 1942), *Fundulus* (Matthews, 1936), *Cirrhinus reba* and *Mystus seenghala* (Sathyanesan, 1958 and 1960). The acidophils of the Übergangsteil look like islands in a reticulum. The granulated basophils are rendered chromophobic to stains. The greater part of the pars intermedia is occupied by the ramification of the pars nervosa. Chromophobes of a light brownish tint form the principal cell-type. Acidophils and basophils are few in number.

In March, when the gonads are in an enlarged condition (pre-spawning phase), the Übergangsteil is compact and with granulated basophils. Degranulation of the basophils is not noticed but cytoplasmic vacuoles do occur in some.

Order OPISTHOMI

Family MASTACEMBELIDAE

(xii) *Mastacembelus armatus* (Lacep.)

(Collected during September, with the gonads distended with eggs.)

The pituitary is applied close to the brain and a distinct stalk is lacking, as in *Ophicephalus* and *Notopterus*. The glandular components are arranged in the antero-posterior direction, as in *Notopterus chitala* (Pl. 21, Fig. I). The pars nervosa sends extensive branches into the pars intermedia, and small ramifications in the other components. The pars anterior is the smallest component of the gland and is composed of acidophils, chromophobes and basophils. The basophils are few and resemble those in the Übergangsteil. The Übergangsteil is made up of acidophils, basophils and chromophobes. The acidophils are arranged in a lobular pattern along the dorsal margin, while the basophils lie in the ventral zone. Such an arrangement of the chromophils has been reported in *Zoarcetes* (Kerr, 1942) and *Centrarchids* (Scruggs, 1939). Groups of brightly coloured acidophilic globules are found among the acidophils of the Übergangsteil and in the pars nervosa. These acidophils which contain in these globules seem to resemble the sphere cells of *Perca fluviatilis* (Kerr, 1942). The pars intermedia is the largest component having lightly stained basophils as its chief cell-type. The chromophobes are much fewer and are scattered among the basophils. The course of the blood-vessels entering the pars intermedia from outside are indicated by the indented nature of its surface.

IV—DISCUSSION

The pituitary of the Teleosts described here can be broadly divided into two types as classified by Kerr (1942). *Type A* : Comprising glands without a definite infundibular stalk ; *Type B* : Including those having a distinct stalk. Pituitaries without a stalk and with a short stalk are closely applied to the brain and can be easily removed in tact with the brain. In species like *Rohtee cotio* a shelf of bony and connective tissue element is formed between the pituitary and the floor of the

infundibulum, which renders the removal of the gland with the brain difficult. Teleosts in general lack a well-defined sella turcica as occurs in the higher vertebrates (Bell, 1938). But in *Hilsa ilisha* a distinct sella turcica is present which was reported earlier by Misra and Sathyanesan (1958). All the species studied have a glandular and nervosal component typical of the teleosts. The surface of the pituitary is in some cases rough. The surface of the pars anterior of *Rita rita* and pars intermedia of *Wallago attu* and *Mastacembelus* are markedly indented. This may be due to the entry of blood vessels from outside.

Three types of arrangements of the various components of the pars glandularis in relation to each other are recorded in this study, as, follows :—(1) The glandular components are arranged one behind the other in a dorso-ventral axis. The pars anterior is dorsal and proximal to the infundibulum, while the pars intermedia is ventral and distal, and the Übergangsteil lies in between, as in *Rita rita* and *Rohtee cotio*. (2) The disposition of the glandular components is along the antero-posterior axis. The Übergangsteil is wedged in between the pars anterior and pars intermedia, as in *Mastacembelus*, *Notopterus chitala* and *Hilsa ilisha*. This arrangement is a little less pronounced in *Ophicephalus punctatus*. (3) The pars intermedia forms the core, and the Übergangsteil and pars anterior are partly peripheral in their arrangement as seen in *Wallago attu* where the pars anterior is in continuation with the pars intermedia dorsally. This tendency is apparently foreshadowed in *Bagarius bagarius*. Type 3, appears to be intermediate between Types 1 and 2. Bell (1938) observed that certain changes in the orientation of various lobes have taken place as a result of the development of the pituitary stalk. Charipper (1937) remarked that a generalisation about the position of the Übergangsteil could not be hazarded because it is central in *Gasterosteus* and *Cyprinus*, while in *Fundulus* it is peripheral.

The extension of the infundibulum into the pars nervosa was recorded by Tilney (1911) and Kerr (1949) in the Ganoids. Kerr (1949) reported that the tubular extensions are present in a reduced condition in the primitive Teleosts such as the eel, but in the great majority of these fishes they have become obliterated by the development of the solid pars nervosa and the stalk. In *Hexanchus* and *Heptanchus* the extension of the infundibular is in the form of an open tube (Charipper, 1937). Such extensions have been observed in *Polypterus* (Gerard and Cordier, 1936), *Aguilla* and *Mugil* (Charipper, 1937) and *Epiplatodus* (Griffiths, 1938).

In *Protopterus aethiopicus*, Dawson (1940) observed irregular and slender outgrowths of the infundibular cavity which he compared to the so-called sinuses of *Lepidosiren* (Kerr, 1943). These infundibular cavities are distinguished from the empty blood sinuses by their ependymal lining. According to Tilney (1911) these channels form the pathway of conduction of the secretory products of the pituitary into the third ventricle. Kerr (1943) cited the absence of such a channel in the higher vertebrates as an argument against the view of Tilney (1911).

In *Engraulis* and *Rita rita* the infundibular cavities appear as prominent closed vesicles in the pars nervosa, completely cut away from the

infundibular cavity. In *Mastacembelus* and *Ophicephalus* the cavities are in the form of funnels in the pars nervosa, having open connection with the infundibular cavity. In *Notopterus chitala* it is in the form of a choked duct, reminding of the condition obtained in the Ganoids (Kerr, 1949).

The pars anterior is very variable in teleosts. In *Esox niger* the pars anterior is absent (Scruggs, 1939). However, Stendell (1914) recorded a pars anterior in *Esox indicus*. Butcher (1936) could not detect the several lobes in the pituitary of *Fundulus*. Scruggs (1939) remarked that the glandular components are less distinctly defined in *Fundulus* than in other fishes. The homology between the pars anterior of fishes and the pars tuberalis of mammals has been suggested (Charipper, 1937 ; and Bell, 1938). Kerr (1949) stated that such a homology can not be accepted on the structural and histological grounds since the pars anterior is not formed from the lateral lobe during development. Bock (1928) pointed out that no exact homology could be established between the two. A tongue-like prolongation of the pars anterior has been compared with the pars tuberalis of the higher vertebrates by Potts (1942). Scruggs (1939) inferred that the pars anterior of the Teleosts shows much more selective activity than the tuberalis of the higher vertebrates and hence may not form an exact homologue. The pars anterior of the various fishes described here indicate their variable nature from species to species. In the Clupeids, namely, *Hilsa ilishā*, *Gadusia chapra* and *Engraulis telara*, the pars anterior contains tubular structures which are the diverticula of the hypophysial cavity. The presence of such cavities is considered to be a primitive feature, and is characteristic of the pars anterior of *Acipenser*, *Lepidosteus*, *Amia*, the eel and the trout (Kerr, 1949, 1942). Recently, such a cavity has been reported in *Pangasius pangasius* (Sathyanesan, 1960).

The cellular differentiation and their seasonal variations in the Übergangsteil have a close resemblance to the pars anterior of the higher vertebrates. Such a correspondence between the Übergangsteil of Teleosts and the pars anterior of the higher vertebrates have been emphasised earlier by Charipper (1937), Bell (1938), Levenstein (1939), Hoar, (1957) and others. Stolk (1950, 1957) and Bretschneider and de Wit (1947) have used the term "lobus tuberalis" as synonymous with pars anterior. In view of the difference of opinion regarding the homology of this component, Olivereau (1954) and Hoar (1957) have rightly suggested that such homologies should await until more is known about their physiology.

In the review of the vascular supply of the pituitary gland in fishes, Levenstein (1939) stated that the blood supply of the pituitary is intimately connected with the pars nervosa and no sizable vessels are found entering the glands from its surface. A similar condition was reported by Stendell (1914) and Bock (1928) for the many forms which they

studied. Bell (1938) stated that no large blood-vessels were found entering the pituitary body in the goldfish. Further, he found the pars anterior to be the most vascular lobe. In the present work in all cases blood-vessels are detected penetrating the pituitary from the vascular capsular covering, and in some forms like *Clarias batrachus* and *Wallago attu* the vessels are outstandingly large.

Colloid-like materials are present in the pars nervosa and pars glandularis in many forms. They are formed as intracellular granules or globules in the chromophils. Sometimes the chromophils disintegrate as a whole to form such bodies as reported by Stendell (1914), Potts (1942) and Sathyanesan (1960). In *Hilsa ilisha* the colloid-like bodies are seen in large quantities in the main trunk of the pars nervosa and towards the stalk, which suggests their transportation to the infundibulum through the pars nervosa and the pituitary stalk. The chromophils emptying their contents into the blood sinuses and the disintegration of these cells as a whole in the sinuses, as evidenced in *Heteropneustes*, are suggestive of the direct entrance of the secretory products into the circulation. The possible pathways of the secretory products in the higher vertebrates is reviewed by Popjak (1940).

V—SUMMARY

The pituitaries of fresh water fishes described here belong to type A, and type B, as defined by Kerr (1942). In the former the pituitary stalk is absent and the infundibular cavity is wide, whereas in the latter the pituitary stalk is present and the infundibular cavity is reduced.

In species like *Rohtee cotio* the presence of an incomplete shelf between the gland and the brain renders the dissection difficult.

In general the teleosts lack a well defined sella turcica, but in *Hilsa ilisha* it is prominent and may be comparable to that of higher vertebrates.

The pituitary stalk ramifies in the glandular components as the pars nervosa. The main trunk is in association with the pars intermedia. The relative disposition of the components of the pars glandularis may be one of the three types described in the text.

The extension of the infundibular cavity into the pars nervosa is very varied and these cavities are readily recognizable by their ependymal lining.

Acidophils, basophils and chromophobes are the basic cell types present in the pars glandularis. In pars glandularis intracellular granules, globules or liquefied matter may be present. Such bodies are also extruded from the cells. In some cases disintegration of migrated chromophils takes place in the pars nervosa. In *Heteropneustes fossilis*

the disintegrating glandular cells are seen in the blood sinuses. These suggest the secretory activity and the possible methods of absorption of secretory products into the general system.

Although small capillaries are seen in the pituitary stalk, the entrance of the prominent blood vessels from the covering meninges into the glands suggests the main blood supply to the pituitary is not through the brain connection or stalk as opined by Kerr (1942).

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PLATE 20

- FIG. 1.—Median sagittal section of the pituitary of *Hilsa ilisha*, showing the arrangement of the glandular and nervous components. The hypophysial cavity and the extension of the oro-hypophysial duct into the pars anterior may be seen. X 20.
- FIG. 2.—M. S. section of the pituitary of *Gadusia chapra*. Outstandingly large solitary hypophysial cavity may be noted. X 48.
- FIG. 3.—M. S. section of the pituitary of *Engraulis telara*. Enclosed infundibular cavity in the pars nervosa may be noted. X 88.
- FIG. 4.—M. S. section of the pituitary of *Bagarius bagarius*, showing the disposition of its various components. X 24.
- FIG. 5.—M. S. section of the pituitary of *Heteropneustes fossilis*. X 36.
- FIG. 6.—M. S. section of the pituitary of *Clarias batrachus* a prominent blood vessel penetrating the pars intermedia may be seen. X 24.

Lettering :

acl., acidophil.
bas., basophil.
bl.c., blood corpuscles.
bl. ves., blood vessel.
bl.s., blood sinus.
chrb., chromophobe.
clb.by., colloid-like body.
ep.c., ependymal cell.
gr., granule.
hyp. cav., hypophysial cavity.

inf. cav., infundibular cavity.
M.S., "Median-sagittal" (for sections)
o.hyp.dct., oro-hypophysial duct.
p.a., pars anterior.
p.i., pars intermedia.
pit. st., pituitary stalk.
p.n., pars nervosa.
ubg., übergangsteil.
vac., vacuole.

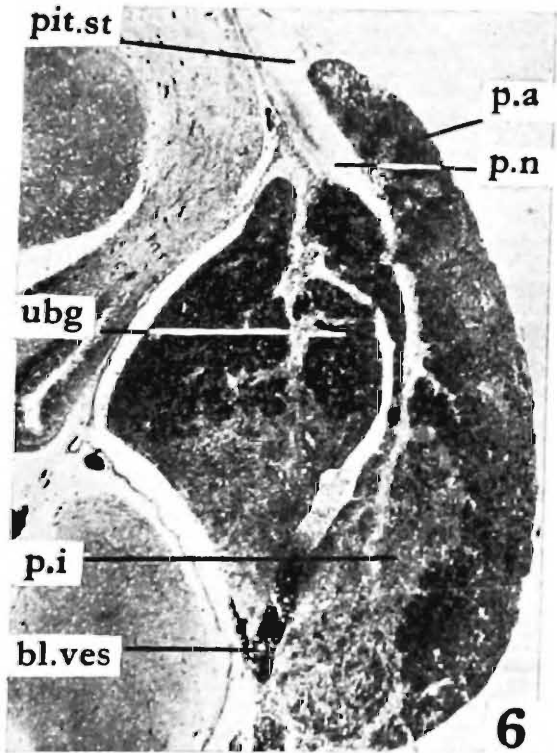
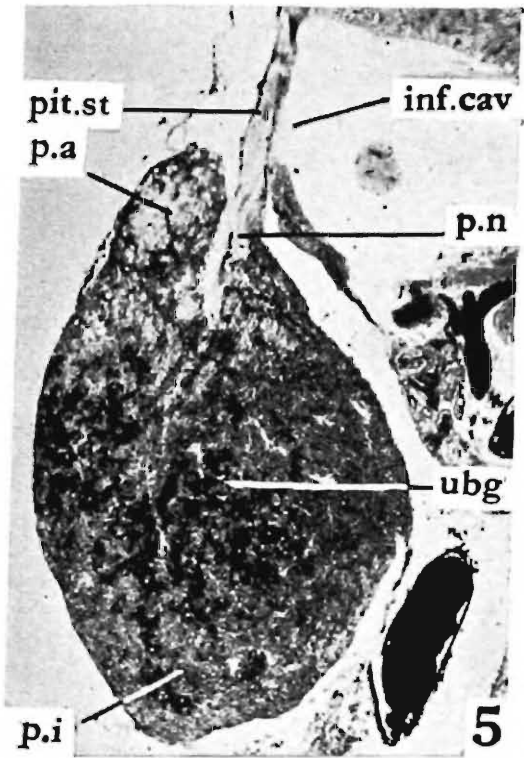
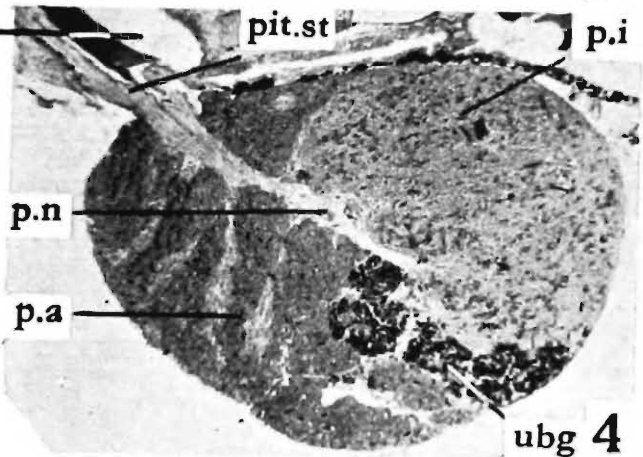
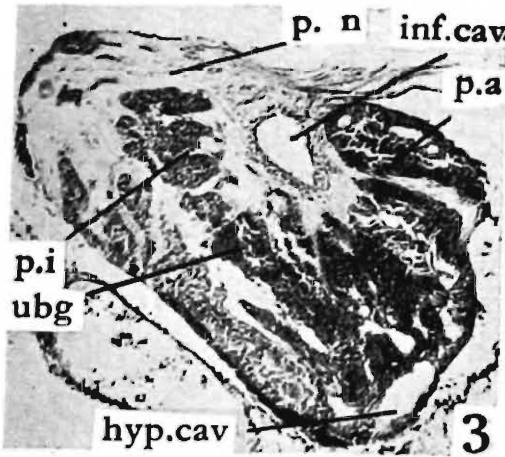
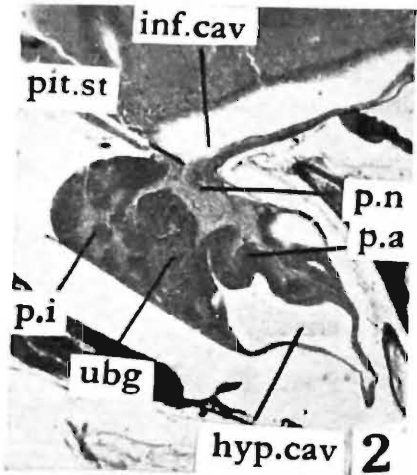
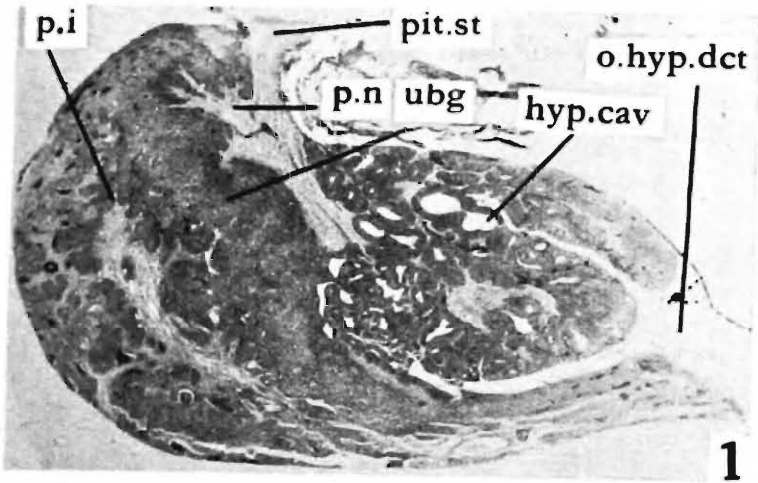


PLATE 21

- FIG. 1.—Median sagittal section of the pituitary of *Mastacembelus armatus*, showing the absence of a definite stalk and the presence of extensive infundibular cavity. X 64.
- FIG. 2.—M. S. section of the pituitary of *Rita rita*, showing the infundibular cavity in the pars nervosa and the external demarcation differentiating the pars anterior from the rest of the components. X 28.
- FIG. 3.—M. S. section of the pituitary of *Rohtee cotio*. X 64.
- FIG. 4.—M. S. section of the pituitary of *Notopterus chitala*, showing the antero-posterior serial arrangement of the glandular components, the want of a definite stalk, and the wide infundibular cavity. X 24.
- FIG. 5.—M. S. section of the pituitary of *Ophicephalus punctatus*. X 64.
- FIG. 6.—M. S. section of the pituitary of *Wallago attu*, showing the arrangement of its various components. A large blood-vessel entering the pars intermedia may be noted. X 20.

Lettering :

ac.l., acidophil.
bas., basophil.
bl.c., blood corpuscles.
bl.ves., blood vessel.
bl.s., blood sinus.
chrb., chromophobe.
clb. by., colloid-like body.
ep.c., ependymal cell.
gr., granule.
hyp.ph.cav., hypophysial cavity.

inf.cav., infundibular cavity.
M.S., "Median-sagittal" (for sections)
o.hyp.dct., oro-hypophysial duct.
p.a., pars anterior.
p.i., pars intermedia.
pit.st., pituitary stalk.
p.n., pars nervosa.
ubg., übergangsteil
vac., vacuole.

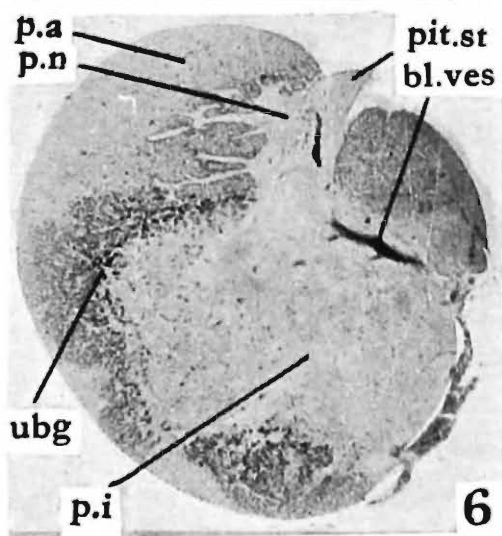
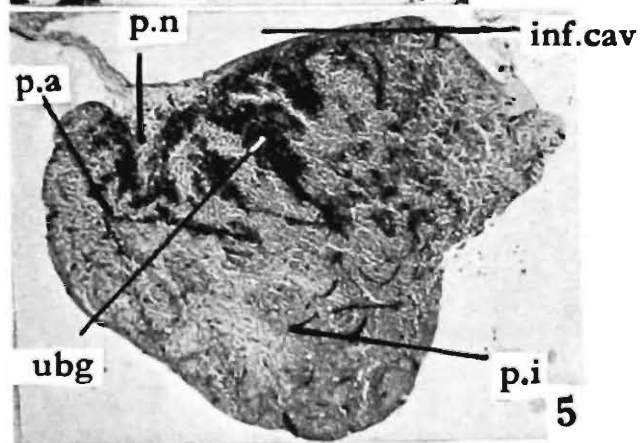
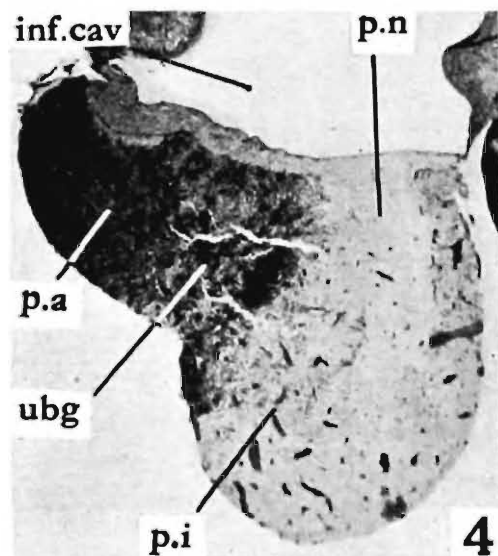
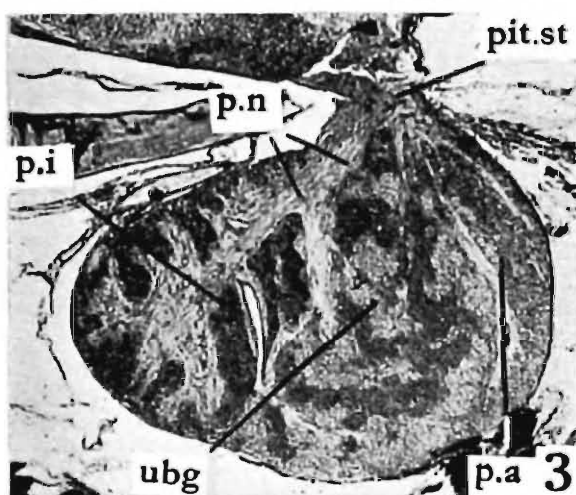
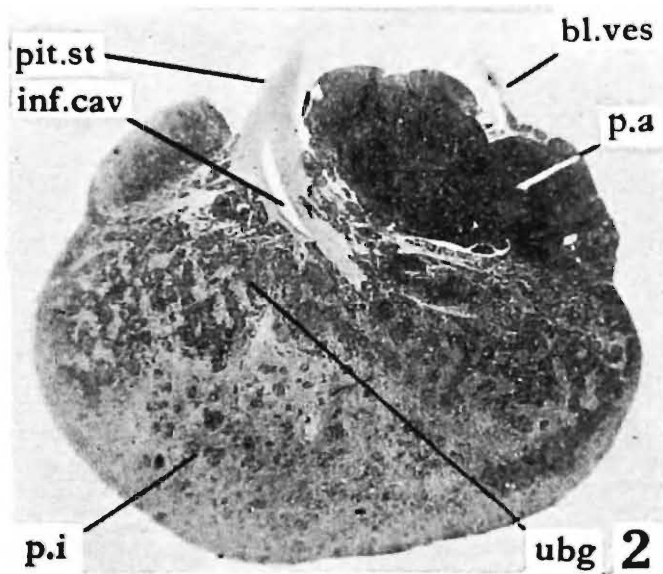
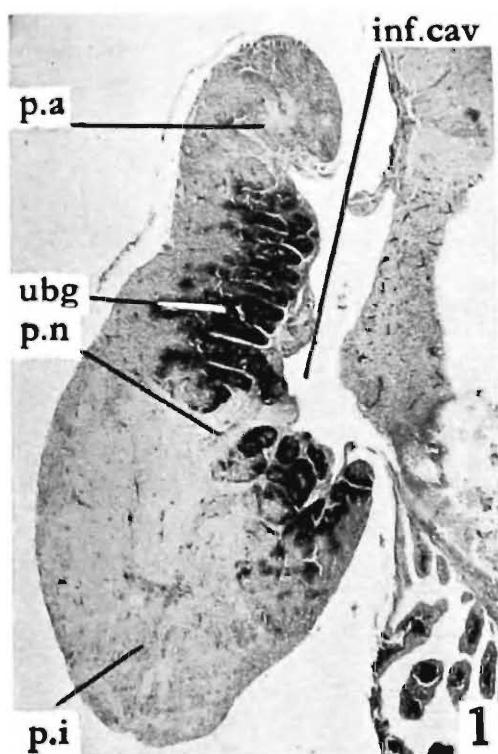


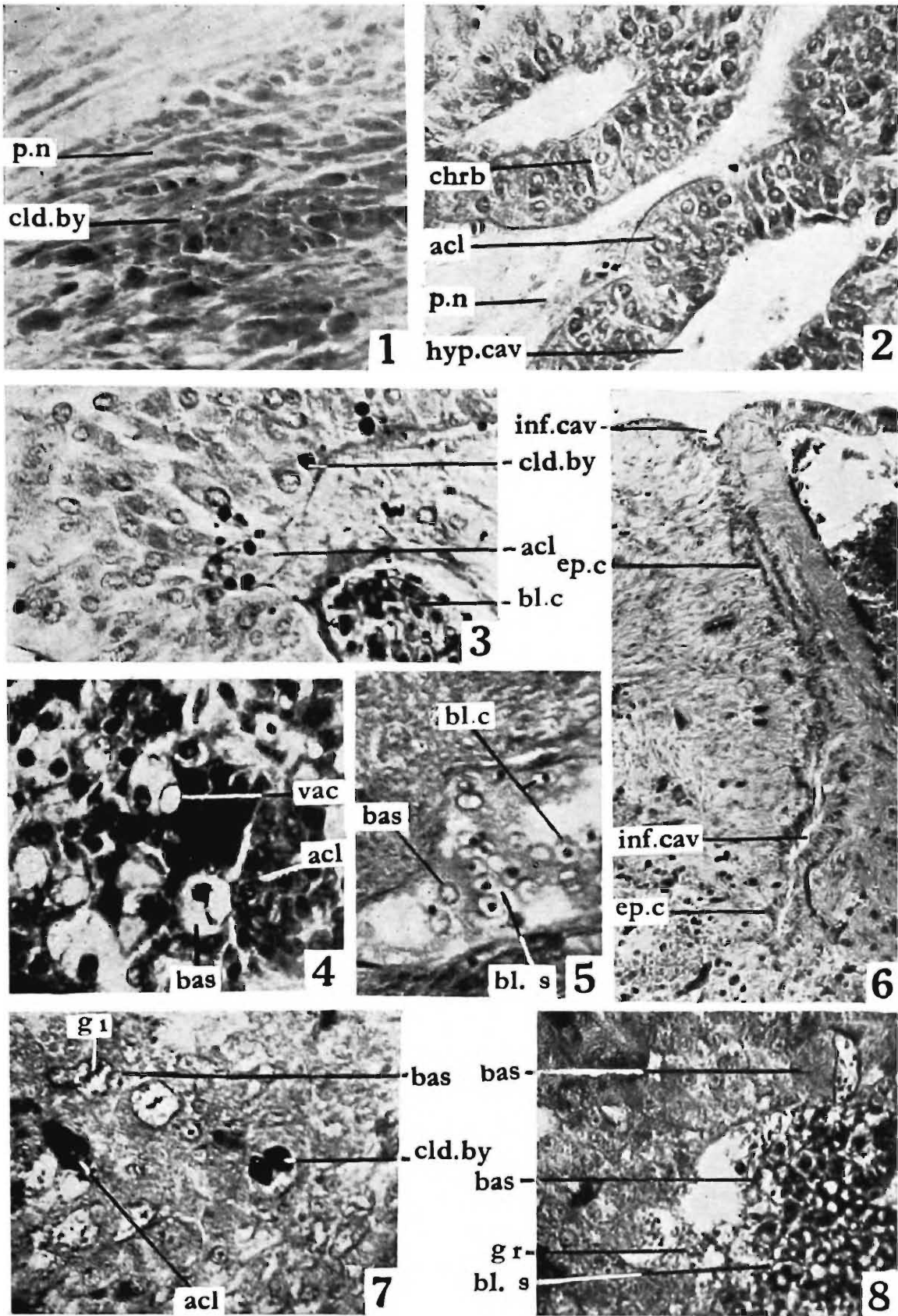
PLATE 22

- FIG. 1.—Photograph, showing the pars nervosa with streaks of colloid-like matter in *Hilsa ilisha*. X 360.
- FIG. 2.—Photograph, showing the tubular nature of the pars anterior in *Gadusia chapra*. X 416.
- FIG. 3.—Photograph, showing the structure of the Übergangsteil in *Hilsa ilisha*, secretory globules may be noted. X 360.
- FIG. 4.—Photograph of the Übergangsteil in *Rohitee cotio*, showing the vacuolated basophils and granulated acidophils. X 64.
- FIG. 5.—Photograph, showing the basophils and their cytoplasmic granules in the blood sinuses in *Heteropneustes fossilis*. X 368.
(Also see Fig. 8).
- FIG. 6.—Photograph, showing the choked infundibular canal in the pars nervosa of *Notopterus chitala*. X 112.
- FIG. 7.—Photograph, showing the acidophilic globules and granules in the vacuolated basophils of the Übergangsteil in *Heteropneustes fossilis*. X 400.
- FIG. 8.—Same species as Fig. 5, and showing same parts. X 352.

Lettering :

acl., acidophil.
bas., basophil.
bl.c., blood corpuscles.
bl.ves., blood vessel.
bl.s., blood sinus.
chrb., chromophobe.
clb. by., colloid-like body.
ep.c., ependymal cell.
gr., granule.
hyp cav., hypophysial cavity

inf.cav., infundibular cavity.
M.S., "Median-sagittal" (for sections).
o.hyp.dct, oro-hypophysial duct.
p.a., pars anterior.
p.i., pars intermedia.
pit.st., pituitary stalk.
p.n., pars nervosa.
ubg., Übergangsteil.
vac., vacuole.



OBSERVATIONS ON SKULLS OF FOUR-HORNED DOMESTIC SHEEP

By

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(With 1 Table and 1 Plate)

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I—INTRODUCTION

The occurrence of four-horned sheep in domestic breeds is not uncommon. Such abnormal individuals may be produced due to some primary disturbances in the early embryonic development. The causes of such disturbances resulting in structural disharmony may be either genetic or environmental. There are grounds to believe that the four-horned condition in domestic sheep is genetic. Thus, Shortt (1885) describes how a four-horned sheep imported to Madras raised its own distinctive breed of many members in the course of a few generations. Several such breeds are reported to occur in Africa, China and other countries.

The three four-horned skulls of domestic sheep present in the Osteological Collections of Zoological Survey of India facilitated certain interesting observations especially with regard to morpho-craniological alterations as related to the excess of horn. This is pertinent especially in the light of earlier reports that the multiplication of horn is associated with lengthening of the wool, rendering the breed commercially more valuable. The structural implications of the abnormality and its effect on the related organisation of the skull are noted and discussed in this paper.

II—OBSERVATIONS

The appearance of a pair of secondary horns has modified the primaries. While the latter retain their predominance in size, they show a tendency in all three cases to deviate from the usual plane of horn curvature. In one specimen, the primary pair has curved towards the facial portion, the remote end then reflecting back again, almost threatening to pierce the left eye. This end of the horn has apparently been cut

[321]

in the living state to offset this possibility. In another specimen, the horns on the right side originate and proceed to some distance so closely that it appears to be a case of mere splitting of the primary horn. In the third specimen, both primaries and secondaries are less haphazard in the plane of growth, the primary one symmetrically diverging outwards and forming a half-loop. All the horns are transversally ringed. The secondary horns in all three cases originate from the lateral vertex immediately behind the orbit and below the primaries and their further development is antero-lateral.

A notable change in the cranium is the great expansion of the frontal bone. This is most manifest at the post-horn cranial portion where it has pushed the parietal bones further down. Caught between the supraoccipital and the invading frontal, the parietals have become proportionately much smaller.

It is evident (Table 1) that while all the three abnormal skulls show marked reduction in the parietal length as compared to the normal skull, the one which has the greatest total length but has the heaviest of horns has the shortest parietal length.

TABLE 1.—*Measurements in mm. of abnormal (four-horned) and normal skulls of domestic sheep in the Zoological Survey of India.*

Material	Total length	*Frontal length (f)	*Parietal length (p)	% Of p to f.
Abnormal (four horned) skull No. 1.	240	112	16	14.3%
Abnormal (four-horned) skull No. 2.	230	96	22	23%
Abnormal (four-horned) skull No. 3.	? (broken premaxilla)	93	25	26.8%
Normal (two-horned) skull	? (broken premaxilla)	88	32	36.3%

Another noteworthy feature is the extremely poor development of the tympanic bullae. But though the bullae proper are meagrely developed, its styloid processes are well developed. In the absence of complete data on the labels, it is difficult to say whether this represents a true variational character of the race. The frontal sinuses extend into the second pair of horn core also. But the supraorbital foramina are not at all duplicate.

III—CONCLUSIONS

The horn duplication in all three cases shows similarity in the following respects : (i) The primary horns are always the more prominent. (ii) The points of origin of both types of horns are fixed, the secondaries invariably originating immediately behind the orbit and below the primaries. Since the chief brunt of the changes due to the growth of secondaries has to be borne by the frontal bone, a correspondingly greater

*Straight line length along median line.

development of that bone is noticed. The corresponding reduction in the size of the parietals may also thus be perhaps correlated with the weight the frontal bone has to sustain. This is borne out by the fact that in the two skulls of the same size the parietal reduction was more manifest in the one which has the heavier pairs of horns.

IV—REMARKS

A commonly held view is that the four-horned condition is arrived at by the splitting of the first pair, the division taking place in the basic core and not externally (Cornel 1955). In this connection, Dove's experiments are of interest. He could produce a six-horned goat by transplanting split sections of dermis and connective tissue from both horn buds, giving ground to the conclusion that the horn core is the result of a separate centre of ossification originating in the connective tissue and dermis. A mutation occurring in the gene which controls this ossification process can conceivably cause a split development in the horn core, producing outwardly more than one horn. Extension of frontal sinuses into both pairs of horns and their close and fixed origin may be viewed as points favouring this view.

V—SUMMARY

1. Three specimens of four-horned skulls are examined to study the structural implications of the abnormality.
2. The study revealed the following factors :
 - (a) The primary horns are always more prominent and the points of origin of primary as well as the secondary horns are fixed and not varying.
 - (b) Since the additional weight due to duplication of horns is to be borne by the frontal, there is a correspondingly greater development of that bone.
 - (c) Frontal expansion is made at the expense of the parietal bone which is reduced inversely to the weight of the horns.
3. The phenomenon is discussed and a plausible cause suggested.

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PLATE 23

Skulls of four-horned domestic sheep.

Fig. 1. Front view of a skull.

Figs. 2-4 Posterior views of the skulls, showing the relative reduction in the size of parietal bone.



Skulls of four-horned domestic sheep.

A NEW FROG, *PHILAUTUS GHERRAPUNJIAE* (FAMILY
RANIDAE) FROM ASSAM, INDIA, WITH FIELD OBSERVA-
TION ON ITS BEHAVIOUR AND METAMORPHOSIS

By

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(With 1 Text-figure and 2 Plates)

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III—Description of the tadpole	329
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I—INTRODUCTION

In early May, 1959, one of us (M. L. R.)* collected some tadpoles and young frogs from the vicinity of the Circuit House near Cherrapunji (the Khasi-Jaintia Hills District, Assam, eastern India) and made some field observations on their behaviour and metamorphosis. On closer examination, the frog proved to be new to science and is described below, together with a description of the tadpole stage. Some field observations on the frogs and the tadpoles are also recorded. A second collection, of tadpoles only, was made in June, 1959, by Shri J. K. Sen, Zoological Assistant.

II—DESCRIPTION OF THE NEW FROG

(a) *Material*

All from vicinity of Cherrapunji (Khasi-Jaintia Hills District, Assam), Lat. 25°15'N. and Long. 91°44'E., altitude above mean sea-level 4369 ft. or *ca.* 1330 metres.

LOT (A).—Several young frogs and tadpoles, coll. *M. L. Roonwal* and *A. P. Kapur*, 7th May, 1959, from pools of water and from grass.

*Thanks are due to Dr. A. P. Kapur, Deputy Director, for kindly assisting in the collection of the material.

etc., near the Circuit House, about 3 km. from Cherrapunji town, as follows :—

Field Coll. No. R1/7.5.59.—Several young, recently metamorphosed frogs (head-and-body, excluding legs, *ca.* 13 mm. long).

No. R2/7.5.59.—Several tadpoles : From pools of water below Circuit House.

Lot (B).—Field Coll. No. A22, Several tadpoles, coll. *J. K. Sen*, 27th June, 1959, *ca.* 2 km. south of Circuit House, in a small pool, by the side of road connecting Cherrapunji bazar with Mablang village.

(b) Description

Family RANIDAE

Genus *Philautus* Gistel

1848. *Philautus*, J. von. N. F. X. Gistel, *Naturg. Thierr.*, Stuttgart, p. 10.

***Philautus cherrapunjiae* sp. nov.**

(Plates 24 and 25 ; and Table 1)

The following description is based on young, recently metamorphosed frogs ; older specimens were not available.

General : Colour (in alcohol) : Dorsally varying from grey to dark brownish, rather uniform and with no markings ; limbs paler. Ventrally, body slightly grey ; throat somewhat paler ; limbs paler and creamish. Skin above smooth, with few folds ; a weak fold from eye to shoulder present ; ventrally with coarse granulations on abdomen. Natural colour (in living specimens) Body : Dorsum : Dirty grass green, eyes blackish ; portion of head below eyes whitish. Venter : Chin and lower jaw whitish, chest and abdomen dusky grey. Arms and legs : Dorsally dirty white with pale green tinge, ventrally similar but paler. Some specimens much darker, almost dark grey dorsally and grey ventrally. Size small (head-and-body about 12-13 mm. long). Body depressed : constricted at the waist.

Head : Rather depressed ; broader than long ; snout short and truncate, a little shorter than the maximum diameter of eye ; canthus rostralis indistinct ; loreal region slightly concave. Nostrils closer to the tip of snout than to the anterior corner of eye. Eyes prominent, directed forwards and upwards, and with a rounded pupil ; upper eyelids broad ; minimum interorbital space about one-and-a-half times broader than the width of the upper eyelid and a little broader than the internarial space. Tympanum hidden. Tongue small, free, deeply notched behind and without a papilla. Vomerine teeth absent.

Forelimbs : Moderately long. Fingers half-webbed, moderately long and somewhat flattened dorso-ventrally : first finger shorter than second ; third longest ; fourth shorter than third but slightly longer than second ; tips of each finger dilated into a subround disk, that of the third the largest ; subarticular tubercles prominent ; no tubercles present on palm.

Hindlimbs : Moderately long ; tibio-tarsal articulation reaching between anterior corner of eye and tip of snout. Toes three-fourths webbed and somewhat flattened fourth toe the longest, third and

fifth subequal, nearly reaching the distal subarticular tubercle of fourth; second shorter than third and nearly reaching the distal subarticular tubercle of the latter ; first shortest and stopping far below the base of the disk of second ; tips of each toe dilated into a subround disk ; sub-articular tubercles moderately developed ; with a fold of skin on the outer side of fifth toe ; no metatarsal tubercle present.

Sexes not distinguishable externally in young frogs.

Measurements.—See Table 1.

TABLE 1.

Body-measurements in mm. of young, recently metamorphosed frogs (holotype and paratypes) of Philautus cherrapunjiae Roonwal and Kripalani, from Cherrapunji, Assam.

Body-parts	Holo- type	Paratypes				
	1	2	3	4	5	6
1. Length of head-and-body (from tip of snout to vent)	12	12.1	13	12	12.6	12.5
2. Length of head (from tip of snout to angle of jaws)	4.5	4.5	4.6	4.5	4.3	4.5
3. Width of head (at angle of jaw)	5	5	5.1	5	5	5
4. Length of snout (from tip of snout to anterior corner of eyes)	2.4	2.4	2.5	2.4	2.5	2.4
5. Max. length of eye (from anterior to posterior corner)	2.6	2.6	2.7	2.6	2.7	3.6
6. Min. interorbital distance	3	3	3	3.1	3	3.1
7. Distance between anterior edge of nostril to tip of snout	0.4	0.4	0.5	0.4	0.5	0.4
8. Distance between anterior edge of nostril and anterior corner of eye of its side	2	2	2	2	2	2
9. Length of arm (from proximal end of junction of arm with the body to tip of longest finger)	11.5	11.5	11.5	11.6	11.5	11.6
10. Length of hand (from base of palm to tip of longest finger)	4.5	4.5	4.5	4.6	4.5	4.6
11. Max. diameter of disc of 3rd finger	0.56	0.5	0.5	0.5	0.5	0.5

Body parts	Holo- type		Paratypes			
	1	2	3	4	5	6
12. Length of 1st finger	1	1	1	1.1	1	1.1
13. Length of 2nd finger	2	2	2	2	2	2
14. Length of 3rd finger	3	3	3	3	3	3
15. Length of 4th finger	2	2	2	2	2	2
16. Length of leg (from midventral line of attachment of leg with body to tip of longest toe)	19	19.5	20	19	19	19
17. Length of tibia (from knee to tibio-tarsal joint)	6	6	6	6.1	6	6
18. Length of foot (from base of foot to tip of longest toe)	7	7	7	7	7	7
19. Max. diameter of disc of 4th toe	0.6	0.5	0.5	0.6	0.6	0.5
20. Length of 1st toe	2	2	2	2	2	2
21. Length of 2nd toe	3	3	3	3	3	3
22. Length of 3rd toe	4	4	4	4	4	4
23. Length of 4th toe	5	5.1	5	5	5	5
24. Length of 5th toe	4	4	4	4	4	4

(c) *Type-specimens*

All type-specimens are deposited with the Zoological Survey of India, Calcutta.

Holotype.—A young, recently metamorphosed frog, Z.S.I. Reg. No. 20806, in spirit in a vial, Cherrapunji, Assam (from LOT "A", No. R1/7.5.59, in "Material" above), coll. *M. L. Roonwal & A. P. Kapur*, 7th May, 1959.

Paratypes.—Six young frogs, with the same data as the holotype; Z.S.I. Reg. Nos. 20807-20812.

(d) *Type-locality*

INDIA : Near Circuit House, *ca.* 3 km. from Cherrapunji town (Khasi-Jaintia Hills District, Assam), alt. *ca.* 1330 metres above mean sea-level.

(e) *Geographical Distribution*

INDIA : Assam : Cherrapunji and immediate vicinity (Khasi-Jaintia Hills District), altitude *ca.* 1330 metres.

(f) *Comparisons*

Philautus cherrapunjiae Roonwal & Kripalani is close to

P. vittatus (Boulenger) from Upper Burma, Thailand and Cochin China, but differs from the latter as follows :—

(a) FROG :

(i) Snout truncated (*vs.* pointed in *vittatus*). (ii) Fingers half-webbed (*vs.* with only rudiments of webs). (iii) Metatarsal tubercles absent (a feeble inner metatarsal tubercle present in *vittatus*). (iv) Tibiotarsal articulation almost reaching the snout, *i.e.*, midway between anterior corner of eye and tip of snout (*vs.* stopping short at the eye in *vittatus*). (v) Colour above a uniform greyish to dark blackish brown, without a pattern and without any yellow (in *vittatus*, yellowish and closely speckled with brown, the latter forming a band on either side of head; above this a lateral yellowish band continued forward as a narrow line above the edge of upper eyelid).

(b) TADPOLE :

With the labial tooth row formula :

$$\begin{array}{ccc} \frac{1}{4-4} & & \frac{1}{3-3} \\ \frac{1-1}{2} & \text{(versus)} & \frac{3}{3} \text{ in } \textit{vittatus}. \end{array}$$

III—DESCRIPTION OF THE TADPOLE

(Plate 25 and Table 2)

The tadpoles collected were well developed. In some specimens the spiracle was still present and functional, and the forelegs had not yet emerged (Pl. 25, Fig. 1), while others were about to metamorphose (Pl. 25, Fig. 2) (and, in fact, some did metamorphose into frogs the day after the collection); in the latter the forelegs had emerged and the spiracle had disappeared. The description given below is based on the former stage—*i.e.*, with the tadpoles having the spiracle still present and functional and with no forelegs :—

General : Natural colour (in living specimens) : Blackish all over dorsum, dusky below ; tail blackish. Colour (in alcohol-preserved specimens) : Dorsum and tail dark grey ; below paler. Size : Moderate ; total length with tail (in spirit-preserved specimens) *ca.* 34-36 mm.

Head and body : Oval, slightly flattened, with the ventral surface moderately convex. Tip of snout bluntly rounded. Nostrils lying nearer the anterior corner of eye than to the tip of snout, and directed upwards and outwards ; the internarial distance less than the interorbital distance (*ca.* 1.5 mm. *vs.* 2.4 mm.). The paired eyes directed forwards and upwards and placed dorso-laterally on the snout ; lying about one-third the distance between the tip of snout and the distal end of base of hindlimbs, and about midway between the tip of snout and the spiracle. With a single spiracle which is sinistral, lateral, tubular and pointing upward and backward and lying somewhat nearer the base of the tail than to the tip of the snout ; opening of spiracle subround to oval, with the maximum diameter *ca.* 1 mm. Vent situated dextrally.

Mouth disc : Small, directed downwards and a little backwards. Anterior lip edged by two rows of lateral papillae. Posterior lip edged throughout by two rows of papillae. Beak well developed, with the

edges broadly blackened, lower part stout and V-shaped, both upper and lower parts finely serrated. Labial tooth row formula :

$$\begin{array}{c} 1 \\ 4 - 4 \\ \hline 1 - 1 \\ 2 \end{array}$$

Legs : Forelegs not yet emerged from body, except in tadpoles nearing metamorphosis. Hindlegs moderately long, but much shorter than tail, with 5 toes; each toe with a prominent, subround disc at the tip; intermetatarsal tubercles present.

Tail : About one-and-a-half times as long as head-and-body; gradually tapering distally to a blunt point. Tail membrane deeper dorsally than ventrally; both the dorsal and the ventral membranes arising a little behind the base of the hindlimbs; muscular portion of tail well developed and tapering distally to a point.

Measurements.—See Table 2.

TABLE 2.

Measurements in mm. of well-developed tadpoles (Plate 25, Fig.1) of Philautus cherrapunjiae Roonwal and Kripalani with the forelimbs not yet emerged and the spiracle still present.

Body-part	Measurements (in mm.)
1. Total length, with tail.	34-36
2. Length of head-and-body (from tip of snout to the anterior base of hind leg).	12-13
3. Maximum width of head-and-body	8-9
4. Length of tail (from vent to tip of tail)	20-21
5. Maximum height of tail	4.5-4.6

IV—FIELD OBSERVATIONS

(a) *General (climate, etc.)*

(Table 3)

Owing to its altitude (4309 ft. or *ca.* 1330 metres), Cherrapunji (Lat. 25°15'N. and Long 91°44'E.) is a relatively cool place. The monthly means of daily maximum temperatures varied from 60.3°F. (in January) to 72.5°F. (in August), and of the daily minimum temperatures from 46.1°F. (in January) to 65.3°F. (in July and August). The highest temperature recorded during the 35-year period (1906-40) was 85°F. (on 4th October, 1938) and the lowest 33°F. (on 19th February, 1938 and 27th March, 1912).

Cherrapunji is a very humid place and also the wettest on earth. The mean fortnightly relative humidity varies from 61% (March) to 93% (July), the most humid months being May to September (mean fortnightly R.H., 82-93%). The mean monthly rainfall (data for 35 years, 1906-40) varies from 0.49 inches (in December) to 106 inches

(in June), the annual average being 425.23 inches. The bulk of this rainfall (*ca.* 323 inches) is received during the four monsoon months, May-August. The five driest months are from November to March when little or no rainfall is received, the figures, in inches, being as follow :—November 2.70; December 0.49; January 0.75; February 2.11 and March 7.27. Even the grass is said to dry up in March and April.

The place is also very misty, low clouds constantly hovering about the place, particularly during the monsoon months.

The day when the young frogs were collected (7th May, 1959) was cloudy, with the sun peeping out occasionally and there was an intermittent drizzle throughout the day.

TABLE 3.

Summary of weather of Cherrapunji, Assam (meteorological observatory at Lat. 25°15'N. and Long. 91°44'E. ; altitude above mean sea-level, 4309 ft. or ca. 1330 metres). [Data based on 35 years record (1906-1940) of the Meteorological Department.]

Item	Range	Annual Total or Mean
1. Atmospheric pressure		
(a) First fortnight of month	863.0 mb. (July)—871.8 mb. (Dec.)	Mean : 868.3 mb.
(b) Second fortnight of month.	860.8 mb. (July)—869.5 mb. (Dec.).	Mean : 865.9 mb
2. Mean monthly temperature (degrees F.)		
(a) Daily Maximum	60.3 (Jan.)—72.5 (Aug.)	Mean : 68.9 F.
(b) Daily Minimum	46.1 (Jan.)—65.3 (July & Aug.).	Mean : 57.6°F.
3. Relative Humidity		
(a) First fortnight of month	61% (Mar.)—93% (July)	Mean : 76%
(b) Second fortnight of month.	62% (Mar.)—92% (July)	Mean : 80%
4. Mean monthly rainfall (in inches)	0.49 (Dec.)—106 (June)	Total : 425.23 inches

(b) *Behaviour of tadpoles and young frogs*
(Text-fig. 1)

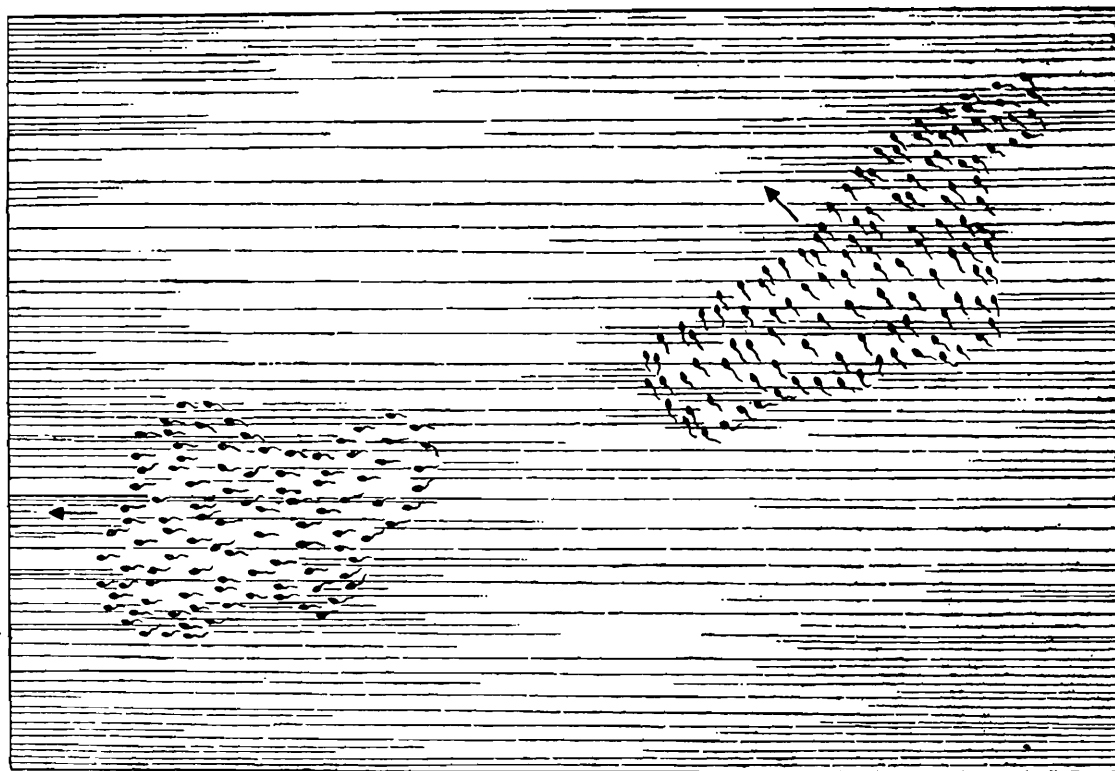
The following observations were made on the behaviour of tadpoles and young, freshly metamorphosed adults, in the field and in the laboratory.

(i) *Tadpoles :*

Just below the Circuit House of Cherrapunji, about 30 metres from the main gate, there were, on 7th May, 1959, two stagnant and apparently

permanent pools of water, one *ca.* 10×20 metres and the second somewhat smaller. The pools had low grass growing all round and also inside the pools, and were probably about 3-4 metres deep.

The tadpoles showed gregariousness and were found swimming in compact, irregularly-shaped schools (Text-fig. 1) of about 100-200 individuals in each, usually just below (*ca.* 10 cm.) the surface of water. These schools could be seen as dark patches on the water. Five such schools were seen, but there must have been more. When disturbed by means of a stick, the school temporarily broke up and the individuals swarm about separately, but within a few minutes they regrouped themselves into a school.



TEXT-FIG. 1.—Diagrammatic view of a pool of water below Circuit House, Cherrapunji (Assam) to show two schools of tadpoles, of *Philautus cherrapunjiæ* Roonwal & Kripalani as seen on 7th May, 1959.

(ii) *Young frogs :*

In the grass and elsewhere near the pools of water mentioned above, the young, freshly metamorphosed, frogs were found sitting singly or in groups of twos and threes. Their favourite place appeared to be the masonry gate pillars, about 2 metres high, of the Circuit House compound, and they gave the impression as if they were drying themselves, although the weather throughout the day was very cloudy and misty, with intermittent drizzles of rain. Some of these frogs still carried the remnant of the tadpole tail, about 5-8 mm. long.

(c) *Metamorphosis*

About 40 tadpoles which were collected at Cherrapunji on the 7th May, 1959, were brought to Shillong the same night, and kept in a basin of tap-water. (When collected at Cherrapunji, none of the tadpoles had any trace of external foreleg, but a pair of functional and well developed hindlegs was present the tail was long.) Next morning

(8.5.59) it was found that several of them were dead. A number of others which were metamorphosed into frogs during the night, had jumped out of the basin and were found in various parts of the floor of the room. Many of the remainder were now with a pair of forelegs emerged out of the tadpole body, and the tail was still long ; these individuals did not wish to stay in the water they were constantly trying to climb the sides of the basin and jump out. Some of these latter individuals which were trying to jump out were transferred to a bamboo basket with some green grass leaves at the bottom, but next morning (9.5.59) all these individuals were found dead and shrivelled up ; some tadpoles were still swimming actively in the basin on the 9th May.

V—SUMMARY

1. A new frog, *Philautus cherrapunjiae* Roonwal and Kripalani, from Cherrapunji (Assam, eastern India), is described.

2. It is allied to *P. vittatus* Boulenger (from Upper Burma, Thailand and Cochin China, but differs from the latter in having (in the frog) the fingers half-webbed (vs. with only rudiments of webs), metatarsal tubercles absent (vs. present), tibio-tarsal articulation almost reaching the snout (vs. stopping short at the eye), body-colour uniform grey (vs. with a yellow and brown pattern). In the tadpole, the labial tooth row formula is :

$$\begin{array}{ccc} 1 & & 1 \\ 4-4 & (vs. & 3-3 \\ 1-1 & & \\ 2 & & 3 \end{array} \text{ in } vittatus).$$

3. The tadpole is described.

4. Field observations on the tadpoles and young frogs are recorded. The tadpoles are gregarious and swim in schools of 100-200 individuals. When disturbed, a school breaks up temporarily, but soon the individuals regroup themselves into a school.

5. The young, freshly metamorphosed frogs have the habit of perching themselves on high places such as gate pillars, as if for sunning.

6. The tadpoles were observed to metamorphose into frogs in early May.

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PLATE 24

Philautus cherrapuniae sp. nov.

The young frog. (From the holotype specimen)

FIG. 1.—Whole frog, in dorsal view.

FIG. 2.—Whole frog, in ventral view.

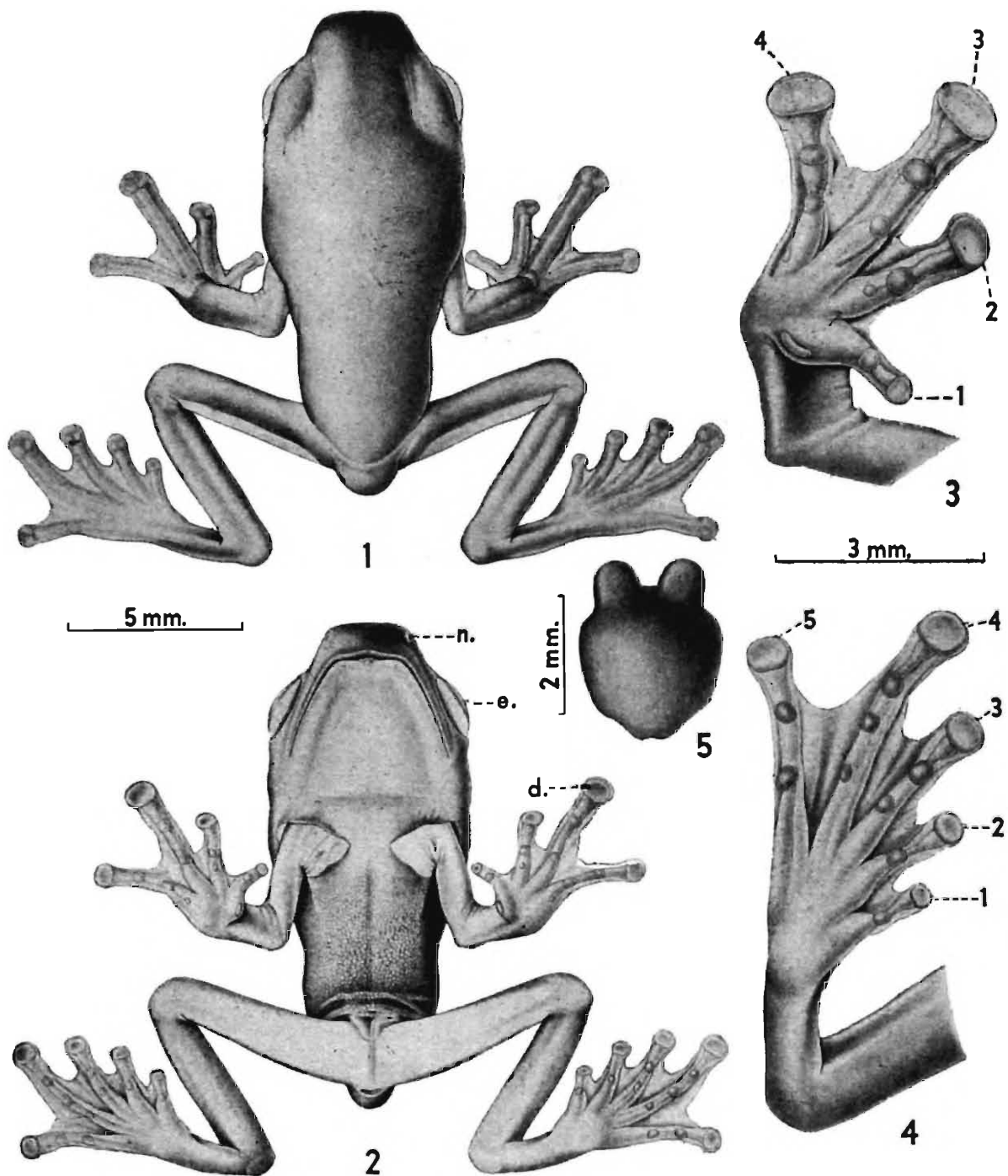
FIG. 3.—Hand, in ventral view.

FIG. 4.—Foot, in ventral view.

FIG. 5.—Tongue, in dorsal view.

Lettering :

d., disc ; *e.*, eye ; *n* , nose ; 1—5, digit numbers of hand and foot.



Philautus cherrapunjiae sp. nov.

PLATE 25

Tadpoles of *Plilautus cherrapunjiae* sp. nov.

FIG. 1. —Lateral view of a tadpole with only hindlimbs present.

FIG. 2.—Mouth of the above tadpole.

FIG. 3.—Lateral view of a tadpole with both the fore-and hindlimbs present

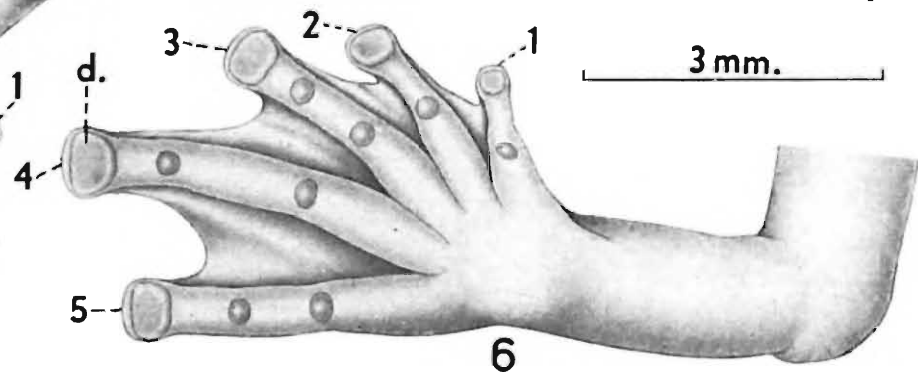
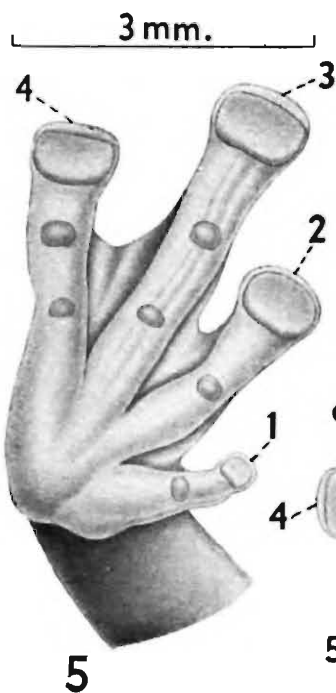
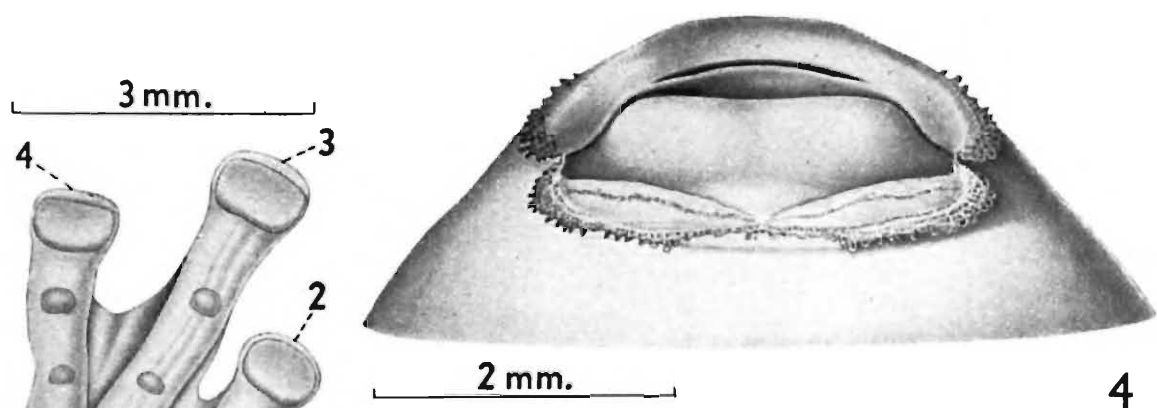
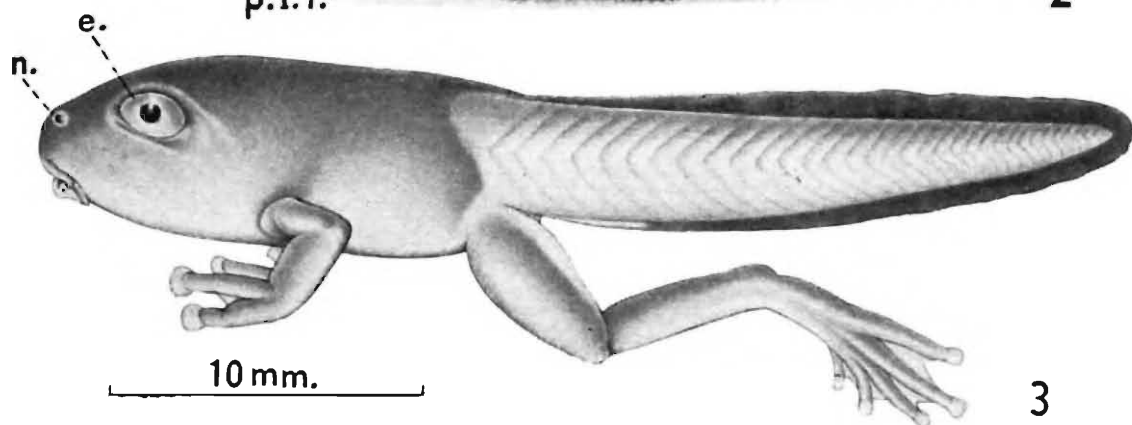
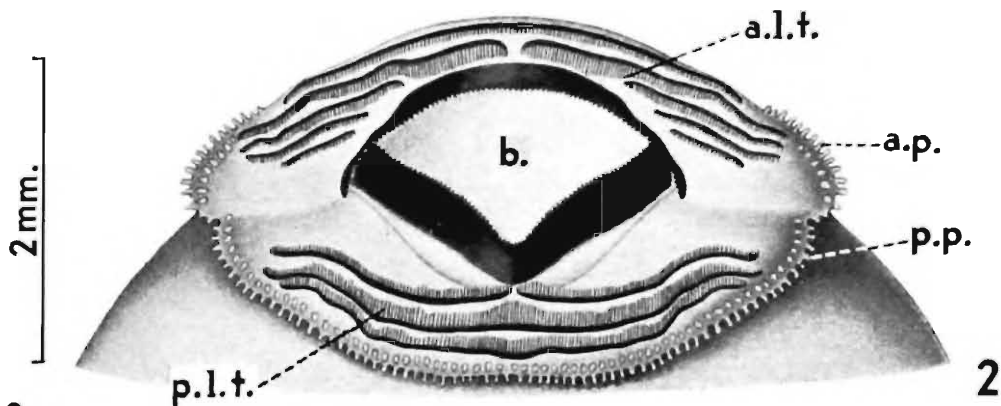
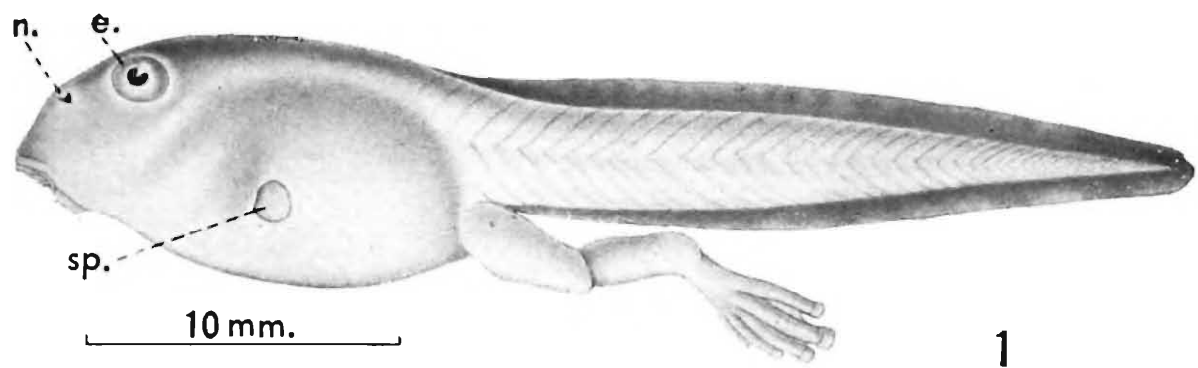
FIG. 4.—Mouth of the tadpole in Fig. 3.

FIG. 5.—Ventral view of hand of the tadpole in Fig. 3.

FIG. 6.—Ventral view of foot of the tadpole in Fig. 3.

Lettering :

a.l.t., anterior labial teeth ; *a.p.*, anterior papillae ; *p.l.t.*, posterior labial teeth ;
p.p., posterior papillae ; *sp.*, spiracle ; 1-5, digit numbers of hand and foot.



Tadpoles of *Philautus cherrapunjiae* sp. nov.

ANIMALS OF PREHISTORIC INDIA AND THEIR AFFINITIES WITH THOSE OF THE WESTERN ASIATIC COUNTRIES

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(With 1 Text-figure and 7 Plates)

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I—INTRODUCTION

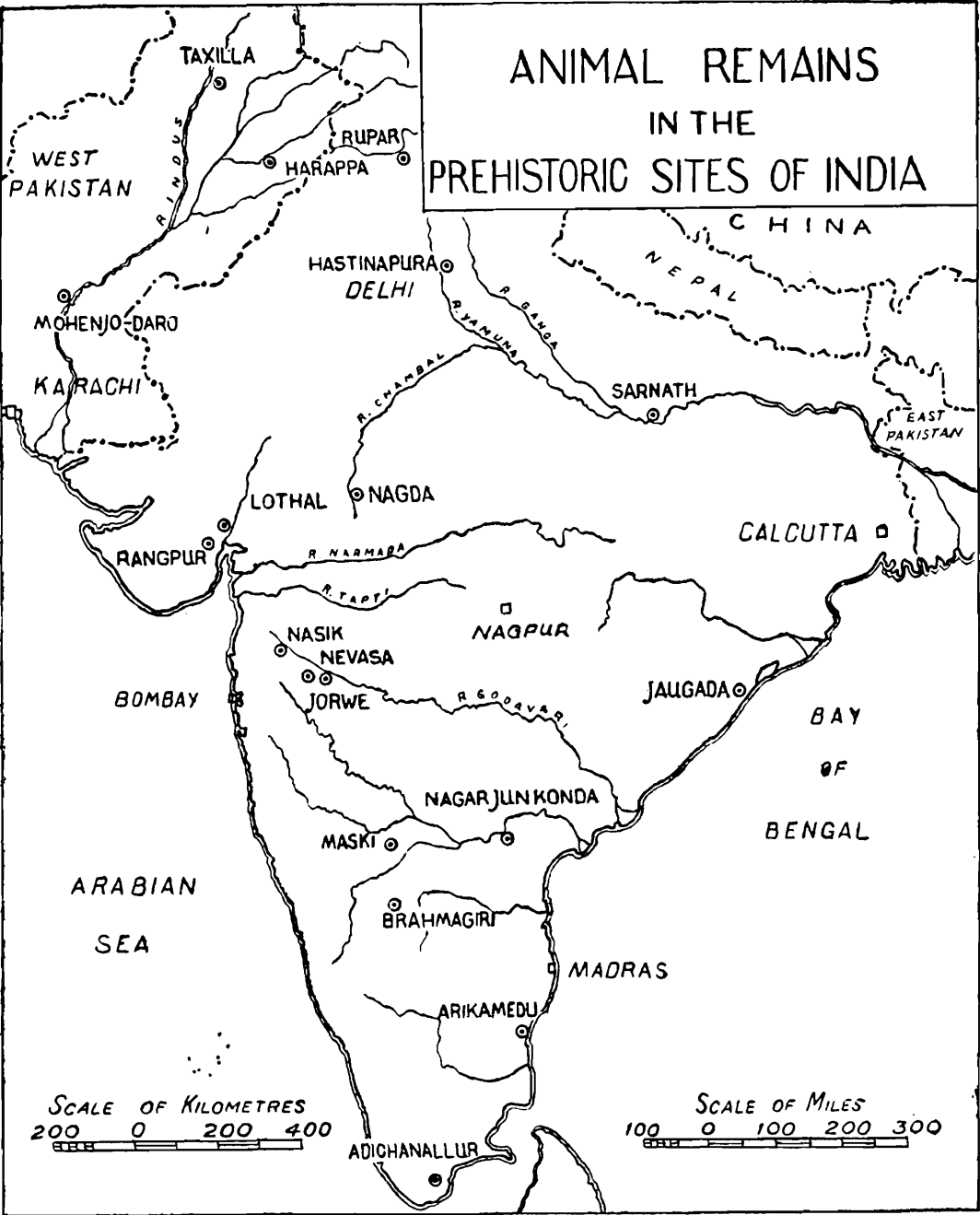
The history of the early appearances of human civilization is closely connected with the notion of food production which, in the real sense, implies an effective agriculture (including, in the Old World, animal husbandry) and a settled village type of existence. Civilization cannot make its appearance until effective food production based on farming of plants and animals had come into existence. Sometime around 8,000 years ago, in the Western Asia, traces of a new economic stage in food-production came into existence. In the reconstruction of prehistoric farming, both animal and plant remains have played an important role. The primary documentation for understanding of the beginnings of early culture and civilization, the archaeological excavations, through the media of the faunal and floral remains found along with other excavated materials, not only reveal to us the social and material culture of the people but also help us to know geographical, topographical and climatic conditions and other environmental complex together with economic aspects of the bygone periods. The history of the various types of animals, is revealed through the art and paintings of the prehistoric people and from actual bony remains found in the excavations. This paper deals with the animal skeletal remains excavated in the different ancient sites of India, and their affinities and correlations with those of the Western Asiatic countries, together with a brief account of the ancestry of the animals concerned. Below is given the names of the various excavated archaeological sites of India, mentioned in the text, in a chronological order.

- (1) 2,500 B. C.—1,500 B. C. *Mohenjodaro*—(In the Larkana district, Sind). Now in West Pakistan.
- (2) 2,500 B. C.—1,500 B.C. *Harappa*—(In the Montgomery district, Punjab). Now in West Pakistan.
- (3) 2,100 B. C.—1,500 B. C. *Rana Ghundai*. (In North Baluchistan, West Pakistan).
- (4) 2,000 B. C.—200 B. C. *Rupar*. (In Ambala district, Punjab).
- (5) 2,000 B. C.—800 B. C. *Rangpur*. (In Ahmedabad district, Gujarat).
- (6) 1,000 B. C.—3rd Century B. C. *Hastinapur*. (In Meerut district, Uttar Pradesh).
- (7) 1,000 B. C.—1st Century A. D. *Maski*. (In Raichur district, Mysore State).
- (8) Mid 1st Century B. C.—2nd Century A. D. *Taxilla*. (22 miles N. of Rawalpindi, N.W.F. Province. Now in West Pakistan).
- (9) 1,000 B. C.—1st Century A. D. *Brahmagiri*. (In Chitaldrug district, Mysore State).
- (10) 200 B. C.—300 A. D. *Nasik*. (In Nasik district, Maharashtra).
- (11) 20 A. D.—50 A. D. *Arikamedu* (Pondicherry, S. India).

Unfortunately, the sites which yielded animal remains are geologically not very old, hence we do not know much about the predomestic condition of these animals in India. The above mentioned sites show a

mature stage of civilization and domestication of animals, with the few exception of the wild species of Harappa, such as the rhinoceros and the tiger, etc. The earliest known culture of India is the Harappan culture or the Indus Valley Civilization. This culture is probably an offshoot of a larger culture which manifested itself along the Afro-Asian belt or Western Persia, Mesopotamia (Iraq) and Egypt in the calcolithic age. According to archaeologists (Wheeler 1953, p. 4) the dating of the Harappan civilization is established between 2,500 B.C. to 1,500 B.C. Recent excavations show the wide extension of the Harappan civilization up to Gujarat. This culture extended from the north-western part of old India, comprising Baluchistan, Makran and Sind, Punjab along the courses of the R. Indus and its tributaries eastward to Rupar (district Ambala, Punjab) and Bikaner (Rajasthan) and Bahawalpur (Punjab) and in the south of Sind up to Rangpur and Lothal in Gujarat.

The accompanying map (Text-fig. 1) gives the sites of the Indus Valley Civilization along with other Indian prehistoric sites.



TEXT-FIG. 1.—Map, showing sites of the Indus Valley Civilization and other pre-historic sites in India.

The excavations reveal that the people of the Indus Civilization had contact with the civilization of the Western Asia and Egypt. This civilization covers the largest area than any other pre-classical civilization of India.

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II—DESCRIPTION OF THE ANIMAL REMAINS OBTAINED FROM THE VARIOUS PREHISTORIC SITES OF INDIA

(1) Mohenjodaro (2,500 B.C.—1,500 B.C.)

The first report on the animal remains of the Indus Civilization was from Mohenjodaro and was studied by Sewell and Guha (1931) and it represented 38 species as follows :—

(a) Invertebrates

Phylum MOLLUSCA

1. *Lamellidens marginalis* (Lamarck)
(A Freshwater Mussel)
2. *Arca granosa* Linn.
(The Marine Ark Shell)
3. *Arabica arabica* (Linn.)—(Syn. *Cypraea arabica* Linn.)
(A Cowry)
4. *Erosaria ocillata* (Linn.)—(Syn. *Cypraea ocillata* Linn.)
(A Cowry)
5. *Babylonia spirata* (Linn.)—(Syn. *Eburna spirata* Lamarck)
(A Marine Gastropod Shell)
6. *Fasciolaria (Pleuroploca) trapezium* (Linn.)—(Syn. *Fasciolaria trapezium* Linn.)
(A Marine Gastropod Shell)
7. *Xancus pyrum* (Linn.) var. *acuta* Hornell—(Syn. *Turbinella pyrum* Linn.) and var. *fuscus* Sowerby.
(The Shank Shell)
8. *Viviparus bengalensis* (Lamarck)
(The Banded Pond Snail)

9. *Indoplanorbis exustus* (Deshayes)
(A Freshwater Snail)

10. *Parreyssia favidens* (Benson)
(A Bivalve Mollusc)

Phylum COELENTERATE

11. *Favia fabus* (Forskal)
(A Coral)

(b) *Vertebrates*

Class PISCES (Fish)

- (1) *Rita rita* (Ham. Buch.)
(A River Fish)
- (2) *Wallago* sp.
(A River Fish)
- (3) *Arius* sp.
(A Siluroid Fish)
- (4) A Carp Remains

Class REPTILIA

- (1) *Gavialis gangeticus* (Gmelin)
(The Gharial)
- (2) *Trionyx gangeticus* Cuvier
(A River Turtle)
- (3) *Chitra indica* (Gray)
(A River Turtle)
- (4) *Lissemys punctata* (Bonnaterre)—(Syn. *Emyda granosa* Gray) (A River Turtle)
- (5) *Testudo elegans* Schoepff.
(The Common Land Tortoise)
- (6) *Geoclemys hamiltoni* (Gray)—(Syn. *Damonia hamiltoni* Gray)
(A Freshwater Tortoise)

- (7) *Baragur baska* (Gray)
(A River Turtle)

Class AVES (Birds)

- (1) *Gallus* sp.
(The Fowl)

Class MAMMALIA

Order INSECTIVORA

1. *Suncus stoliczkanus* Anderson—(Syn. *Crocidura bidiana* Anderson).
(The Anderson's Shrew)

Order CARNIVORA

1. *Herpestes auropunctatus* (Hodgson)
(The Small Indian Mongoose)
2. *Canis familiaris* Linn.
(The Domestic Dog)

Order PROBOSCIDEA

1. *Elephas maximus* Linn.
(The Indian Elephant)

Order PERISSODACTYLA

- 1 *Equus caballus* Linn.
(The Horse)

Order ARTIODACTYLA

1. *Bos indicus* Linn.
(The Indian Humped Cattle)

2. *Bos bubalis* Linn.
(The Indian Buffalo)
3. *Ovis* sp.
(The Sheep)
4. *Rusa unicolor* (Kerr.)—(Syn. *Cervus unicolor* Kerr.)
(The Sambar)
5. *Axis (Hyalaphus) porcinus* (Zimm.)—(Syn. *Cervus porcinus* Zimm.)
(The Hog Deer)
6. *Cervus hanglu* (Wagner)—(Syn. *Cervus cashmerianus* Falconer)
(The Kashmir Stag or Hangul)
7. *Axis axis* (Erxl.)—(Syn. *Cervus axis* Erxl.)
(The Chital or Spotted Deer)
8. *Camelus dromedarius* Linn.
(The One-humped Camel)
9. *Sus scrofa cristatus* Wagner
(The Indian Pig)

Order RODENTIA

1. *Rattus rattus* (Linn.)—(Syn. *Mus rattus* Linn.)
(The Common Indian Rat)

General remarks.—The above-mentioned animals can be classified into five categories as follows :—

(i) Amongst the remains as listed above the following animals were probably maintained in a state of domestication.

Bos indicus Linn. (The Indian Humped Cattle) ; *Bos bubalis* Linn. (The Indian Buffalo) ; *Ovis* sp. (The Sheep) ; *Canis familiaris* Linn.

(The Domestic Dog) ; *Sus cristatus* Wagner (The Indian Pig) ; *Camelus dromedarius* Linn. (The One-humped Camel) ; *Elephas maximus* Linn. (The Indian Elephant) ; and *Gallus* sp. (The fowl), and at a later period *Equus caballus* Linn. (The Horse).

The presence of a considerable number of bones belonging to young individuals of *Bos indicus* Linn. and *Sus cristatus* Wagner, show that the people practised a full-fledged domestication of these animals.

(ii) The animals which were probably not actually domesticated but which frequently lived in the vicinity of human habitation and semi-domesticated were as follows :—

Herpestes auropunctatus (Hodgson) (The Common Indian Little Mongoose) ; *Suncus stoliczkanus* Anderson (The Anderson's Shrew) ; *Rattus rattus* Linn. (The Common Rat).

(iii) Animals that were caught and utilized as food were as follows :—

Gavialis gangeticus (Gmelin) (The Gharial) ; *Trionyx gangeticus* Cuvier (A River Turtle) ; *Chitra indica* (Gray) (A River Turtle) ; *Lissemys punctata* (Bonnaterre) (A River Turtle) ; *Geoclemys hamiltoni* (Gray) (A Freshwater Tortoise) ; *Batagur baska* (Gray) (A River Turtle) ; *Rita rita* (Ham. Buch.) (A River Fish) ; *Wallago* sp. (A River Fish) ; The Carp ; *Arius* sp. (Sea and estuarine Fish).

With the exception of the carp (Family—Cyprinidae) all remains of fish belong to the family Siluridae ; of the 3 genera represented, two viz., *Rita* and *Wallago* are at present the common inhabitants of the large rivers of India. In the case of *Arius* the distribution given by Day (*Fauna Brit. India, Pisces*, p. 70) is the seas and estuaries of tropical regions ascending to within tidal influence and even entering freshwater. All the three fishes, viz. *Rita rita* (Ham. Buch.), *Wallago* sp., and the carp bones with cut marks on them signify that they were used as food.

The presence of the remains of a number of other aquatic animals such as the gharial, and turtles, in burnt condition indicate that such animals in those early times were also used as food by the inhabitants.

(iv) The remains of shells imported for use as ornaments and for other purposes are follows :—

Lamellidens marginalis (Lamarck) (A Freshwater Mussel) ; *Arca granosa* Linn. (The Marine Ark Shell) ; *Arabica arabica* (Linn.) (A Cowry) ; *Babylonia spirata* (Linn.) (A Marine Gastropod mollusc) ; *Fasciolaria trapezium* Linn. (A Marine Gastropod mollusc) ; and *Xancus pyrum* var. *acuta* Hornell and var. *fuscus* Sowerby (The Shank Shell).

Apart from any food value it is certain that the shells were used for ornaments. Except *Lamellidens marginalis* (Lamarck), all other species without any doubt can be said to have been brought from the sea coast which indicates that a regular trade was carried on between Mohenjodaro and the sea coast by the people. As Hornell (1916, p. 71) pointed out “ at the present time, apart from the Gulf of Mannar and Palk Bay, the coast of Kathiawar is the only considerable source of shank shells ; in the early times shank shell cutting centres existed in the Southern Deccan in Kathiawar and Gujarat ” In addition to the bangles or fragments of bangles that have been excavated, the presence of a number of cores from which bangles have been sawn, shows clearly that in the time past Mohenjodaro was a centre of the bangle-making industry.

(v) The following deer species were imported for medical purposes according to Sewell and Guha (1931, p. 672).

Cervus hanglu (Wagner) The Kashmir Stag or Hangul ; *Rusa unicorn* (Kerr.) The Sambar ; *Axis axis* (Erxl.) The Chital or Spotted Deer ; and *Axis (Hyalaphus) porcinus* (Zimm.) The Hog Deer.

Among the remains of the four different species of deer only one, namely, *Axis (Hyalaphus) porcinus* (Zimm.) is at the present day an inhabitant of Sind. All are horns and no skeletal remains are found which makes Sewell (1931, p. 672) to think that they were imported from outside for medicinal purposes.

The find of a number of avian bones doubtfully referred to *Gallus* sp., excavated at Mohenjodaro, does not according to Sewell (1931, p. 662) give any idea whether any or all belong to domestic poultry or to wild birds. As regards size, they are considerably larger than the present-day fowl. It is, therefore, doubtful whether the inhabitants of Mohenjodaro were acquainted with the domestic fowl.

(2) *Harappa Site (2,500 B. C.—1,500 B. C.)*

The animal remains of another important prehistoric site of the Indus Civilization is Harappa. This was worked out by Prashad (1936), and 30 species were represented in the collection. In general the bones excavated resemble those described by Sewell from Mohenjodaro (1931). Several of the species in the two collections are identical, while some like the shrew, *Suncus stoliczkanus* Anderson, and a number of stags and deer are not represented in the collection from Harappa. On the other hand, the monitor lizard (*Varanus* sp.), the cat (*Felis ocreata* Gmelin, race *domestica*), the jackal (*Canis aureus* Linn.), the wolf (*Canis lupus* Linn.), and the domestic ass (*Equus asinus* Linn.), the rhinoceros (*Rhinoceros unicornis* Linn.), the goat (*Capra hircus aegagrus* Erxl.), found at Harappa, were not represented in the Mohenjodaro collection.

The climatic conditions of Punjab at that time were different from that of the present time which is evidently proved by the presence of the rhinoceros (*Rhinoceros unicornis* Linn.), the water buffalo (*Bos bubalis* Linn.), the wolf (*Canis lupus* Linn.), which live in marshy land mixed with forests.

The presence of a number of other aquatic animals such as the gharial and some turtles, i.e., *Geoclemys hamiltoni* (Gray), *Kachuga tectum* Gray, *Lissemys punctata* (Bonnaterre), *Chitra indica* (Gray), *Trionyx gangeticus* Cuvier, which were also likewise recorded at Mohenjodaro (1931) indicate that they were probably an ingredient of the food of the inhabitants.

The remains of the jackal (*Canis aureus* Linn.), and the wolf (*Canis lupus* Linn.) were found not far from the edges of town ; rats (*Rattus* Linn.) and gerbills (*Tatera indica* Hardwicke), the mongoose (*Herpestes auropunctatus* (Hodgson), the lizards (*Varanus* sp.) and the tortoises must have been familiar in the streets and courtyards in Harappa. The river nearby supplied the carps and also *Rita rita* (Ham. Buch.), a freshwater fish, as food.

The farming economy is greatly responsible for the prosperity of Harappa which is evident from the various domestic animals such as *Bos indicus* Linn. (The Humped Cattle of India), *Bos bubalis* Linn.

(The Buffalo); *Capra hircus aegagrus* Erxl. (The Domestic Goat), *Ovis vignei* Blyth, race *domesticus* (The Domestic Sheep), and *Sus cristatus* Wagner race *domesticus* (The Domestic Pig).

The goats appear to belong to same group as those of Kashmir which produce the superb wool from which the famous shawls are made. Possibly the goat wool served the same purpose in Harappa. The long-legged and long-tailed sheep of Harappa, were probably domesticated from the wild Urial Stock (*Ovis vignei* Blyth) from which modern Indian sheep are believed to have been derived, which includes various wool producing forms.

The pig (*Sus cristatus* var. *domesticus*) at Harappa belongs to the lean brisk, bristly species known in India even today.

There is also evidence of the dog from the earliest days of the Harappan culture. The bony remains from Harappa show at least two types of domesticated dog : one akin to the modern pariah dog and the other to the mastiff type. The former (*Canis tenggeranus* Kohlb., race *harappensis* Prashad) comes close to the original ancestral type of dog derived from some of medium sized wolf in the oriental region in South-east Asia or Western Asia or Europe.

The remains of the cat were not recorded at Mohenjodaro but were found at Harappa. At Chano—daro a brick is found over which the characteristic foot-prints of a dog are identified (Piggot, 1950, p. 156 and Wheeler 1953, p. 63). The cat from Harappa (*Felis ocreata* Gmelin, race *domestica* Brisson) seems to have closely resembled the ordinary European domestic cat in appearance (Piggot *l.c.*).

Only a few camel bones of the Indian one-humped race (*Camelus dromedarius* Linn.) have been found at Mohenjodaro and Harappa. This species has not so far been discovered in a wild state and is known only in domesticated form. It is, according to Sclatter (1891, p. 192), found domesticated in India, Afghanistan, and Western Asia and also in Northern Africa.

Prashad (1936, p. 28) recorded the remains of Domestic Ass, *Equus asinus* Linn., at Harappa. The horse bone recorded at Mohenjodaro (1931, p. 653) by Sewell was not, however, known at Harappa uptill now. Nath (1954) recorded a fairly large collection of true horse remains from Harappa, which like Mohenjodaro, appeared at a late period from the upper layer of the turmoil region of area G, Harappa. The remains suggest comparison with the Indian "country bred" animal.

Finally, the elephant (*Elephas maximus* Linn.) should be included amongst those animals almost certainly domesticated by the Harappa people, and, as Piggot (1950, p. 157) says, it is possible that the representation on the seals show the two breeds recognised today in India, viz., (i) the Komooria Dhundia breed with its flat back, square head and stout legs, and (ii) the inferior Meergha breed which is less heavily built and has a sloping back.

A few bony fragments of the domestic fowl (*Gallus* sp.) have been obtained at Harappa which show close resemblance with the bones of domestic fowl found at present. Regarding the size they are slightly bigger in size than the present day race of fowl. The Mohenjodaro find of avian bones, however, far exceeds in size than those of Harappa and the modern species of the fowl.

(3) *Rupar Site (2,000 B.C.—200 B.C.)*

Another site of Harappan culture recently excavated is Rupar in the district of Ambala, East Punjab. The number of species of animals represented in this collection is 18 as follows :—

(a) *Invertebrates*

Phylum MOLLUSCA

1. *Viviparus bengalensis* (Lamarck)
(The Freshwater Mussel)

(b) *Vertebrates*

Class REPTILIA

1. *Varanus flavescens* (Gray)
(The Monitor Lizard)
2. *Chitra indica* (Gray)
(A Soft-shelled River Turtle)
3. *Trionyx gangeticus* Cuvier
(The Ganges Soft-shelled Turtle)

Class AVES (Birds)

1. *Gallus* sp.
(The Domestic Fowl)
2. *Francolinus francolinus* (Linn.)
(The Black Partridge)

Class MAMMALIA

Order CARNIVORA

1. *Canis familiaris* Linn.
(The Domestic Dog)
- Order RODENTIA

1. *Bandicota bengalensis* Gray and Hardw
(The Indian Mole Rat)
2. *Rattus rattus* (Linn.)
(The Common Rat)

Order PROBOSCIDEA

1. *Elephas maximus* Linn.
(The Indian Elephant)
- Order PERISSODACTYLA

1. *Equus asinus* Linn.
(The Domestic Ass)
2. *Equus caballus* Linn.
(The Horse)

Order ARTIODACTYLA

1. *Bos indicus* Linn.
(The Indian Humped Cattle)
2. *Bos (Bubalus) bubalis* Linn.
(The Indian Buffalo)
3. *Capra hircus aegagrus* Erxl.
(The Indian Domestic Goat)

4. *Ovis vignei* Blyth, race *domesticus*
(The Domestic Sheep)
5. *Axis axis* (Erxl.)
(The Chital or Spotted Deer)
6. *Sus scrofa cristatus* Wagner
(The Domestic Pig)

All the species of animals, referred above, are identical with those of Harappa (1936) and Mohenjodaro (1931) with the exception of two viz, (i) *Francolinus francolinus* (Linn.)—the black partridge, and (ii) *Bandicota bengalensis* Gray & Hardw.—the Indian mole-rat, which were not recorded at Harappa and Mohenjodaro, are reported now from Rupar.

A few cut marks on the bones, particularly of *Bos indicus* Linn., *Bos (Bubalus) bubalis* Linn., *Ovis vignei* Blyth, *Capra hircus aegagrus* Erxl. and *Sus scrofa cristatus* Wagner, indicates the probable use of these animals as food.

The find of the black partridge, *Francolinus francolinus* (Linn.) besides that of the fowl (*Gallus* sp.) indicates that the inhabitants were well acquainted with these birds. The animal remains from Rupar closely resemble in their species with those of Mohenjodaro (1931) and Harappa (1936).

(4) Rangpur Site (2000 B.C.—800 B.C.)

The recent excavations of the sites of Rangpur and Lothal in Saurashtra, by the Department of Archaeology, has brought into light the large extension of the Harappan Culture. A large number of bones were excavated from Rangpur; Nath (1958) has recently worked out this collection and it represents 10 species as follows :—

- (a) *Invertebrates*
Phylum MOLLUSCA
- (1) *Xancus pyrum* (Linn.)
(The Shank Shell)
- (b) *Vertebrates*
Class REPTILIA
- (1) *Chitra indica* (Gray)
(A River Turtle)
- Class MAMMALIA
Order CARNIVORA
- (1) *Canis familiaris* Linn.
(The Domestic Dog)
Order PERISSODACTYLA
- (1) *Equus asinus* Linn.
(The Domestic Ass)
Order ARTIODACTYLA
- (1) *Bos indicus* Linn.
(The Indian Humped Cattle)
- (2) *Bos (Bubalus) bubalis* Linn.
(The Indian Buffalo)

- (3) *Capra hircus aegagrus* Erxl.
(The Domestic Goat)
- (4) *Ovis vignei* Blyth, race *domesticus*
(The Domestic Sheep)
- (5) *Cervus duvauceli* Cuvier
(The Barasingha)
- (6) *Sus scrofa cristatus* Wagner
(The Domestic Pig)

All the remains are of the domestic animals, which resemble in their species with the other Harappan culture animal species.

(5) *Rana Ghundai Site* (2,100 B.C.—1,500 B.C.)

Another prehistoric site in Western India is Rana Ghundai, in N. Baluchistan, which is now in West Pakistan, and is more or less contemporary with Harappan culture. Piggot (1950, p. 121) described the animal remains of the following species from that site :—

Equus asinus Linn. (The Domestic Ass); *Equus caballus* Linn. (The Horse) ; *Bos indicus* Linn. (The Indian Humped Cattle) ; *Ovis vignei* Blyth (The Domestic Sheep).

Piggot (1950, p. 121) says “The Nomadic, horse-riding herdsmen used the site R G I as a camping ground” According to Piggot (1950, p. 157) horse, *Equus caballus* Linn., was already known to the first inhabitants of Rana Ghundai of North Baluchistan, while it appeared at a later period at Harappa (1954) and Mohenjodaro (1931).

(6) *Taxilla Site* (Mid 1st Century B.C.—2nd Century A.D.)

Excavations carried out in 1944-45 in the north-west India, at Taxilla, 22 miles north of Rawalpindi, brought into light a wealth of materials of historical and semi-historical associations. The date assigned to the finds of this site is from mid First Century B.C. to Second Century A.D. A small collection of animal remains excavated from this site, which Nath (1957) has recently worked out, show the following species represented in the collection of Taxilla :—

Equus asinus Linn. (The Domestic Ass) ; *Equus ? caballus* Linn. (The Horse) ; *Bos indicus* Linn. (The Indian Humped Cattle); *Bos (Bubalus) bubalis* Linn. (The Indian Domestic Buffalo) ; and *Sus scrofa cristatus* Wagner (Indian Domestic Pig).

The remains of the above-mentioned animals resemble with those of Harappa (1936) as well as Rupar (1958).

(7) *Hastinapura Site* (1,000 B.C.—3rd Century B.C.)

The most notable excavation carried out during the year 1954-1955 in the northern India was Hastinapura, in the district of Meerut, U.P., a site which is also mentioned in the earliest great Indian Epic Mahabharata. The date assigned to the animal remains of this site is from 1,000 B.C. to 3rd Century B.C. The animal remains from Hastinapura were worked out by Nath (1951, pp. 107-120). The number of species represented in the collection from Hastinapura is 12.

Vertebrates

Class PISCES

- (i) Remains of Carp.

Class REPTILIA

- (1) *Lissemys punctata* (Bonnat.)
(A River Turtle)
- (2) *Chitra indica* (Gray)
(A River Turtle)
- (3) *Trionyx gangeticus* Cuvier
(The Ganges Soft-shelled Turtle)

Class MAMMALIA

Order PERISSODACTYLA

- (1) *Equus caballus* Linn.
(The Horse)

Order PROBOSCIDEA

- (1) *Elephas maximus* Linn.
(The Indian Elephant)

Order ARTIODACTYLA

- (1) *Bos indicus* Linn.
(The Indian Humped Cattle)
- (2) *Bos (Bubalus) bubalis* Linn.
(The Indian Buffalo)
- (3) *Ovis vignei* Blyth race *domesticus* Prashad
(The Domestic Sheep)
- (4) *Capra hircus aegagrus* Erxl.
(The Indian Domestic Goat)
- (5) *Sus cristatus* Wagner var. *domesticus* Rolleston
- (6) *Cervus duvaucelli* Cuvier
(The Barasingha)

The Hastinapura collection of animal remains yielded a large number of bones which belong to young ones. A number of bones of *Bos indicus* Linn., *Bos (Bubalus) bubalis* Linn., *Ovis vignei* Blyth, and *Sus cristatus* Wagner have definite marks of cut by sharp instruments which indicate that the inhabitants probably used these animals for food.

Uptill now, we dealt with the animal remains obtained from the various prehistoric sites of the Northern India. Now I will deal with the animal remains excavated from the prehistoric sites of South India. The animal remains excavated at the South Indian prehistoric sites are reported from Maski (1957), Brahmagiri (1958) and Arikamedu (1946).

(8) *Maski Site (1,000 B.C.—100 A.D.)*

The prehistoric site of Maski is in the Raichur district of the present Mysore State, about 75 miles from the Raichur town. The dating of this culture is 1,000 B.C. to First Century A.D. The excavation made here during the field season of 1954 yielded a good collection of animal

remains which has been worked out by Nath (1957, pp.121-129). The following species of animals are represented in the collection from Maski :—

(a) *Invertebrates*

Phylum MOLLUSCA

- (1) *Viviparus bengalensis* (Lamarck)
(The Banded Pond-Snail)

- (2) *Parreyssia* sp.
(A Freshwater-Mussel)

(b) *Vertebrates*

Class MAMMALIA

Order RODENTIA

- (1) *Rattus rattus* Linn.
(The Common Rat)
Order PERISSODACTYLA

- (1) *Equus asinus* Linn.
(The Domestic Ass)
Order ARTIODACTYLA

- (1) *Bos indicus* Linn.
(The Indian Humped Cattle)
(2) *Bos (Bubalus) bubalis* Linn.
(The Indian Domestic Buffalo)
(3) *Ovis vignei* Blyth, race *domesticus*
(The Domestic Sheep)
(4) *Capra hircus aegagrus* Erxl.
(The Domestic Goat)

The animal remains from Maski resemble closely those of Harappa (1936) and Hastinapura (1955).

The animal remains excavated from the sites at Brahmagiri, Sanur and Arikamedu are mostly those of Megalithic Culture which is dated from 200 B.C. to the first century A.D.

(9) *Brahmagiri Site (1,000 B.C.—100 A.D.)*

The prehistoric site of Brahmagiri is situated in the Chitaldrug district of Mysore State, which was excavated during the field season of 1947. A large number of animal remains was excavated from this site. Recently Nath (unpublished report) has worked out the collection of animal remains from Brahmagiri. The animal remains of the prehistoric site of Brahmagiri belong to the three different cultural periods as follows :—

I. *Brahmagiri Stone Axe Culture* : Early first millennium B.C. to the beginning of 2nd century B.C., which has been subdivided into two sub-cultures, e.g., 1A (Early Stone Axe Culture) and 1B (Late Stone Axe Culture).

II. *Megalithic Culture* : After Ca 200 B.C. to the middle of the first century A.D. overlapping the Andhra Culture.

III. *Andhra Culture* : About the middle of the 1st century A.D. to the third century.

The following species are represented in the Sub-phase 1A (Earlier) of Brahmagiri Stone Axe Culture : *Equus* sp. (Wild Ass) ; *Lepus nigricollis* Cuvier (The Indian Hare) , *Bos indicus* (The Indian Domestic Humped Cattle); and *Ovis vignei* Blyth, race *domesticus* (The Domestic Sheep).

The following species are represented in the Sub-phase 1B (Later) of the Brahmagiri Stone Axe Culture : *Canis familiaris* Linn. (The Domestic Dog) , *Equus asinus* Linn. (The Domestic Ass) , *Bos indicus* Linn. (The Indian Domestic Humped Cattle) ; *Bos (Bubalus) bubalis* Linn. (The Indian Domestic Buffalo) ; *Ovis vignei* Blyth race *domesticus* (The Domestic Sheep) ; *Capra hircus aegagrus* Erxl. (The Domestic Goat) ; *Axis axis* Erxl. (The Spotted Deer or Chital) ; and *Sus scrofa cristatus* Wagner (The Indian Pig).

The following species are represented in the Brahmagiri Megalithic Culture : *Bos indicus* Linn. (The Indian Domestic Humped Cattle) ; *Capra hircus aegagrus* Erxl. (The Domestic Goat) ; *Axis axis* Erxl. (The Chital or Spotted Deer) ; and *Gallus* sp. (The Domestic Fowl).

The following species are represented in the Brahmagiri Āndhra Culture : *Bos indicus* Linn. (The Indian Domestic Humped Cattle) ; *Bos (Bubalus) bubalis* Linn. (The Indian Domestic Buffalo) ; *Ovis vignei* Blyth, race *domesticus* (The Domestic Sheep) ; *Capra hircus aegagrus* Erxl. (The Domestic Goat) ; *Lepus nigricollis* Cuvier (The Indian Hare) ; and *Pila globosa* (Swainson) (The Freshwater Apple-snail).

Except *Axis axis* Erxl., all the remains are those of domesticated animals maintained by the inhabitants of the above mentioned Brahmagiri cultural periods.

(10) Arikamedu Site (20 A.D.—50 A.D.)

The excavation of the site of Arikamedu dating 20 A.D.—50 A.D., near Pondicherry, Madras made during the field season of 1945, yielded the following species of animals :—

Vertebrates

Class REPTILIA

- (1) *Lissemys punctata* (Bonnaterre)
(A River Turtle)

Class AVES (birds)

- (1) *Gallus* sp.
(The Domestic Fowl)

Class MAMMALIA

Order ARTIODACTYLA

- (1) *Bos indicus* Linn.
(The Indian Humped Cattle)
- (2) *Sus cristatus* Wagner
(The Indian Domestic Pig)

(11) *Nasik Site (200 B.C.—300 A.D.)*

Recently the identification of animal remains, excavated at Nasik (Bombay Province) in 1950-51, by George (1955, pp.142-43) have brought into light the following species of animals from Nasik :—

Trionyx sp. (River Turtle) ; *Bos indicus* Linn. (Ox) ; *Bos bubalis* Linn. (Buffalo) ; *Ovis* sp. (Sheep) ; *Capra* sp. (Goat) ; *Sus cristatus* Wagner (Domestic Pig) ; *Boselaphus tragocamelus* Pall. (Nilgai) ; *Cervus unicolor* Kerr. (Sambar) , *Axis axis* (Erxl.) (Chital or Spotted Deer) ; *Tetraceros quadricornis* (Blainv.) (Four-horned Antelope) ; *Rattus rattus* (Linn.) (The Common Rat) ; and *Semnopithecus* sp. (Common Langur).

The presence of the remains of deers viz., *Cervus unicolor* (Kerr.) and *Axis axis* (Erxl.), as well as of the four-horned Antelope, *Tetraceros quadricornis* (Blainv.), and the Nilgai, *Boselaphus tragocamelus* Pall., at the prehistoric site of Nasik, shows that in its proximity there might have been undulating jungle area covered with grass. The presence of the bony remains of a primate viz., *Semnopithecus* (The Common Langur) is also noteworthy as the skeletal remains of this animal have not been so far recorded from any prehistoric sites of India.

III. AFFINITIES AND CORRELATIONS OF THE PREHISTORIC DOMESTIC ANIMALS OF INDIA WITH THOSE OF THE WESTERN ASIATIC COUNTRIES

(1) *General*

Having dealt with the animals of the prehistoric India, now I shall attempt to correlate these animals with those of the Western Asiatic countries. There is much confusion regarding the term 'Near' and 'Middle' East owing of the variety of classificatory, administrative and military reasons. Therefore, in this paper the term Western Asiatic countries has been used in place of 'Near' and 'Middle' East, and is applied to the area that stretches from Aegean to Indus river and from north flank of Caucasus to the Sudan. This is an area of great extremes of climate and topography, having high mountains grassy uplands, fertile valley, dry alluvial plains, scorching deserts and lush coastal stripes. Fortunately we have got the accounts of the prehistoric animals from Mesopotamia, Persia, Syria and Egypt, and therefore it has become possible to correlate the prehistoric animal remains of India with the above mentioned Western Asiatic countries. Pumpelly excavation at Anau (1908) in Turkestan, Hilzheimer's report on the animals of Mesopotamia (1941), Paton's report on the animals of ancient Egypt (1925), and Gejvall (1938-1939) report on the fauna of successive settlements of Troy, and the reports of the animal remains from the excavations at Alishar Huyuk (Van der Osten 1937), Shah Tepe (Amischler 1939) and that of Sialk (Ghirshman 1938-39), have brought into light a great variety of the prehistoric animals which show close relationship with those of the animals of the Prehistoric India. The animal groups which show resemblance between the Prehistoric India and Western Asiatic countries are : *Bos* (Cattle) ; *Ovis* (Sheep) ; *Capra* (Goat) ; *Sus* (Pig) ; *Equus* (Ass and Horse) ; *Camelus* (Camels) ; *Canis* (Dog) ; *Felis* (Cat) , and *Gallus* (Fowl).

(2) *Bos* (The oxen)

(Plate 26, Figs. 1, 2 ; Plate 30, Figs. 1-6)

The bovids of the genus *Bos* consist of two types of cattles, one larger massive form and long-horned and the other small form with short

horns. The earlier naturalists divided the domestic cattles into two main divisions : the humped type or Zebu inhabiting the tropical countries and to which the name *Bos indicus* was given by Linnaeus (1758, pp. 71-72) ; and the non-humped cattle for which he proposed *Bos taurus*.

Long-horned cattle, which descended from the European Urus, *Bos primigenius* Boj., and its Asiatic relative, *Bos namadicus* Falc. which is virtually indistinguishable according to some authors (Dyson 1953 and Duerst 1908), are the most widespread of cattle in earliest times from Egypt to Indus and from Neolithic to modern times. Duerst (1908, p. 359) recorded from Anau, remains of *Bos namadicus* Falc., of which he considered *B. macroceros* Duerst, to be synonym, and recorded further remains of domestic cattle under the name *Bos taurus macroceros* (1908, p. 364). This domestic race according to Duerst (1908, p. 369) had originated from the wild *B. namadicus* Falc., and "is absolutely the same ox that was possessed by Egyptians" Duerst (1908, p. 359) describes that long-horned form cattle, *Bos primigenius* Boj., was already present in the time of ancient Babylonian civilization about 4000 to 5000 B.C. in Mesopotamia, as appears on a cylinder seal of those times. Long-horned cattle, *B. primigenius* Boj., is reported in the Halaf period at Tell Aswad in Syria (Mallowan 1946, p. 124). At Sialk (Ghirshman 1938, p. 197) also the long-horned ox, *Bos taurus* Linn. has been reported and at Shah Tepe (Amschler 1939, p. 95) it has been recorded under the name *Bos taurus brachyceros* Amschler. It is now known that smaller forms also existed in Europe (Reynolds 1939, p. 28) and North Africa (Roamer 1928, p. 111 ; 1938, pp. 170-171, 183) side by side with huge beast of *primigenius* race. Thus two types of cattles of long-horned forms and short-horned forms are reported to be found in prehistoric sites of Europe and North Africa.

According to Rutimeyer (1862, pp. 149 and 222) the humped cattle—*Bos indicus* Linn., inhabiting the tropical countries, is a very distinct species. From very ancient times it is almost the sole type of domestic cattle of Asia and Africa and has undergone much less structural modification than the European forms. It is unknown in a wild or fossil state and was believed by Blyth (1931, p. 658) and Friederichs (1933) to have originated outside India. It has been identified at Harappa (Prashad 1936, pp. 8 & 34), Mohenjodaro (Marshall 1931, p. 28, 29, 654), Hastinapur (Nath 1955, pp. 110-114), Maski (Nath 1957, pp. 123-125), Rupar (Nath 1957) and at Rangpur (Nath 1958) and all other prehistoric sites of India. Van Buren (1939, pp. 74-76) states that a humped bull with spreading horns are frequently found in figurines and other arts of Halaf and Ubaid Periods of southern Iraq. Humped cattle are known in Egypt by the XVIII Dynasty (16th Century B.C.) but the time of their introduction is unknown (Dyson 1953, p. 664).

The presence of short-horned cattle also presents a problem. Prashad (1936, p.37) has also distinguished two distinct forms of humped cattle, *Bos indicus* Linn., from Harappa : (i) A large massive form probably of the type of long-horned humped cattle. (ii) A small form with short-horns which probably represents the humpless variety. Such distinctions of two forms i.e., the long-horned cattle and the short-horned cattle have also been found as mentioned above, from the prehistoric sites of Europe and North Africa. Duerst (1908, p. 364) and Prashad (1936,

pp. 8, 9 and 32) agree that *Bos namadicus* Falc. cannot be the ancestral form, because the osteological differences between it and the domestic short-horn are too great. Both agree that short-horned variety originated as a result of "decline of cattle-breeding" and does not represent a distinct species. Amschler (1945, pp. 325-326) identifies a wild short-horn *Bos brachyceros arnei* Amsch., from Shah Tepe III D & E in Iran as progenitor of the domestic type present in the level dating to the end of 4th millennium. Other short-horns are reported of the same date at Alishar Huyuk (Von der Osten 1937, p. 294) and somewhat later at Mohenjodaro (1931) and Harappa (1936). Van Buren (1939, pp. 69-74) notes that the more primitive type had short horns but there was also a long-horned type at an early date in Mesopotamia.

The general evidence does not commend any definite conclusion, except to the effect that large and small, humped and humpless, long and short horned individuals are all known in the Fertile Crescent area, Western Asia, during the Neolithic period.

(3) *Bos (Bubalus) bubalis* Linn.

(The Indian Domestic Buffalo)

(Plate 26, Fig. 3 ; Plate 30, Figs. 7-9)

The Indian buffalo—*Bos (Bubalus) bubalis* Linn., the remains of which have been identified at Harappa (Prashad 1936, pp. 43-46), Mohenjodaro (Sewell 1931, p. 659), Hastinapura (Nath 1955, p. 115), Maski (Nath 1957, p. 126) and recently Nath has identified the remains of similar animal at Rangpur, Rupar, Taxilla, which show clearly its presence at the prehistoric sites of India. Though the skeletal remains of this animal are not found in the Prehistoric Period of the Western Asiatic countries, Hilzheimer (1920, p. 312) believes that the Indian buffalo, which is confined to the Oriental Region, had a much more extensive range in the West about the beginning of our era. This view, according to author, is supported by the skeletal remains of the buffalo which have been found in some parts of Europe. Its representation in the Old Mesopotamian relief and in Egypt shows clearly that the animal was known to those places. According to Duerst (1908, p. 361-362), its best representation is found "on the cylinder seal of Surgon, King of Accad, who reigned B.C. 3800 to 3750"

It is also represented on a vessel spout from Hittite level Alishar Huyuk (Van der Osten 1937, p. 295).

(4) *Ovis* (The Sheep)

(Plate 26, Figs. 4, 5 ; Plate 31, Figs. 6-13)

The other important animal of prehistoric period was sheep. It is now generally accepted that the three species of wild sheep exist in Asia, viz., (I) *Ovis musimon* Pallas, which inhabits the high lands of Hither Asia from Anatolia to the Elburz and the Zagros and is also found north of Mediterranean in Corsica and Sardinia, (II) *Ovis vignei* Blyth, (the Asiatic Urial) the home of which is the northern slope of Elburz, Turkestan, Afghanistan, Baluchistan and Punjab, and (III) the Argal, *O. ammon* Linn., living to the east of the Ural, all of which have given rise to breeds of domestic sheep. The remains of Asiatic Urial (*Ovis vignei* Blyth) have been identified at Harappa Prashad 1936, pp. 49-51). Rana Ghundai (Piggot 1950, p. 121), Hastinapur (Nath 1955, p. 116) and Maski (Nath 1957, p. 127). Recently Nath has also reported it

from Rupa, Rangpur, and Brahmagiri sites of India. Remains of sheep were also recorded from Mohenjodaro (Sewell 1931, p. 659), but no specific name was given there. In Western Asia we find exactly the same species at Shah Tepe III D & E (Arne 1945, p. 325), Sialk I (Ghirshman 1938, p. 196) in Iran, and at Anau I (where *O. vignei* Blyth comprises 22 per cent of the bones in Period I, and *O. A. palustris* Rutim. 25 per cent of II ; (Pumpelly 1908, pp. 341-342). In identifying the Anau sheep Duerst (Pumpelly 1908, p. 374) pointed out the presence of intermediate forms linking the turbary sheep, *O. aries palustris* Rutim., with the osteologically wild *O. vignei* Blyth, of Period Ia. On this he proved the derivation of *O. aries palustris* Rutim, from *O. vignei* Blyth. Pilgrim (1947) on the other hand expresses the opinion that the turbary sheep was probably descended from *O. orientalis* Brandt & Ratzeburg, and also remarks that there is reason to believe that some of the prehistoric sheep of Turkestan has originated from *Ovis vignei* Blyth. Childe states (1952, p. 26) that the oldest domesticated sheep found in the Swiss Lake-dwelling and other deposits in Central and Western Europe, *Ovis palustris* Rutim., is the domesticated descendant of the Asiatic Urial (*Ovis vignei*), a long-tailed sheep. Hilzheimer (1931, p. 195) and Keimer (1936, p. 297) agree that the oldest Egyptian sheep, *Ovis longipes* Wagner belongs to the same Urial stock. It is thus evident that the Asiatic Urial (*Ovis vignei* Blyth) was introduced into Africa and Europe from East. The earliest widely bred sheep in the Near East appear to be a primitive hairy type found in Mesopotamia and Egypt (Hilzheimer 1936, p. 195 ; Mond 1937, p. 256). Dyson (1953, p. 665) states that the art of the late fourth Millennium (Jamdet—Nasr Period) in southern Iraq reveals both woolly and fat-tailed sheep. The former reaching Egypt during the New Kingdom and the latter imported in Negro Africa. It is thus quite evident that the earliest domestic sheep appears to be of West Asiatic origin.

(5) *Capra* (The Goat)

(Plate 26, Fig. 6 ; Plate 31, Figs. 1-5)

Next to sheep the other most basically important animal to the development of culture in the Prehistoric Period of the Old World was goat. The selection of a name for the Domestic Indian Goat has been a matter of difficulty. Goats have been identified at Harappa (Prashad 1936, pp. 47-49) as *Capra aegagrus* Gmelin, race *indicus*. Nath (1955, p. 177) however, designated *Capra hircus aegagrus* Erxl. to the similar remains of goat from Hastinapura and proposed to redesignate all the Indian Domestic Goats as *Capra hircus aegagrus* Erxl. Prashad (1936, p. 48) as well as Blanford (1891, p. 503) regard *Capra aegagrus* Gmelin, as parent form from which all the domestic races of goats are derived. Linnaeus (1758, p. 68) however, used the name *Capra hircus* Linn., for the domestic goat and regarded it as principal species from which domestic races were derived. Pocock (1946, p. 681) also referred to *Capra hircus* Linn. as the parent species of domestic races of goat. Coon (1950, p. 130) is also of opinion that the parent of domestic goat is the so called bezoar—goat, *Capra hircus* Linn. of Turkestan and Afghanistan. Both Lydekker (1913, pp. 156-57) as well as Blanford (Prashad 1936, p. 48) adopted the name *Capra hircus aegagrus* for the Persian Wild Goat, implies that *C. aegagrus* Gmelin is derived

from *C. hircus* Linn. However, Blanford (1891) in the *Fauna of British India : Mammalia* gave *aegagrus* Gmelin the status of a full species and considered that all the Indian Domestic Goats were derived from *Capra aegagrus* Gmelin, and Prashad (1936, p. 48) followed him. However, as regards the authorship of the *aegagrus*, it may be pointed out that the name of Gmelin 1788, as the author of *aegagrus*, referred above, has wrongly been used by Blanford (1891, p. 502) as also by Prashad (1936, p. 47) and other workers, since there is no reference of it by Gmelin (1788) on p. 193 in the *Systema Naturae*, Vol. 1. The original real author of *aegagrus* is Erxleben (1777, p. 260) and not Gmelin, and the name of the same author has also recently been referred to *aegagrus* by Ellerman & Morrison-Scott (1952, p. 404). Recently Ellerman and Morrison-Scott (loc. cit.) instead of considering the *aegagrus* as a full species regarded *aegagrus* Erxl., as a race of *Capra hircus* Linn., whose distribution in wild form occurs at the present time in Greek Islands, Caucasus, Southern Turkmania in Russia, Turkestan, Asia Minor, Persia to Baluchistan and Western India, and introduced the name *Capra hircus aegagrus* Erxl. for all the wild and domestic goats including even the domestic goats of India.

From the above discussion it is evident to classify the domestic goat by the name *Capra hircus aegagrus* Erxl., and accordingly Nath (1955, p. 117) proposed to redesignate all the Indian domestic goats under the same name. Pilgrim (1947, p. 286) has further suggested that the Persian wild goat—*Capra aegagrus* Erxl., the Central Asiatic goat *Capra falconeri* Wagn., and the Pleistocene goat, *C. prisca* Adam. and Niez., are all ancestral to the domestic goat, *Capra hircus* Linn. Acceptance of the monospecific origin of goat from *C. aegagrus* Erxl. resulted in the classification of the latter as a subspecies of *hircus* Linn.

Goats have been recorded at Harappa (Prashad 1936, p. 47), Hastinapura (Nath 1955, p. 117), and Maski (Nath 1957, p. 129). Nath has also recorded them from Rupar, Rangpur, and Brahmagiri sites of India. In Western Asia we find the same species of goat (*Capra hircus* Linn.) at Shah Tepe (Amschler 1939, pp. 39 & 89), Sialk (Ghirshman 1938, p. 196) in Iran, and at Anau II under the name *Capra hircus rutimeyeri* Duerst (Pumpelly 1938, p. 380), and at Alishar Huyuk (Van der Osten 1937, p. 298). Bones of the goat have been reported from Hassuna (Childe 1952, p. 105) in Assyria, West of Tigris, which presumably belong to domestic stock. At Jarmo in Iraq, the bones of domesticable goats have also been found (Childe 1952, p. 104).

In the Late Uruk Period of Mesopotamia Childe (1952, p. 129) reported goats (*Capra hircus* Linn.). At Jericho, along Yamuq river in North Palestine, the actual finds of goats and sheep attest their breeding (Childe 1952, p. 127). According to Dyson (1953) the early Mamber goat possibly present at Tell Mefesh (Mallowan 1946, p. 128) in the Halaf Period, in Mesopotamia, is thought to have originated in Syria. It also reported from Egyptian Predynastic at Foukh (Guy 1938, p. 21). Thus we find that the so called bezoar goat—*Capra hircus* Linn. of Turkestan and Afghanistan was widely spread in the prehistoric periods of the Old World.

(6) *Sus* (The Pig)

(Plate 26, Fig. 7)

Pig constituted one of the most important animal to the development of Culture in the Prehistoric Period of the Old World. Pig remains, have been identified from India, at Harappa (Prashad 1936, pp. 54-57), Mohenjodaro (Sewell 1931, pp. 660-61) and Hastinapura (Nath 1955, pp. 118-119). Nath (1958, Unpublished reports) has also recorded it from Rupar, Rangpur, Taxilla and Brahmagiri sites of India. The nomenclature of the pigs is very confused due to the difficulty in differentiating the North Eurasian *Sus scrofa* Linn., from the Asiatic variety, the Indian type commonly identified as *Sus cristatus* Wagner, and various other types in South-east Asia which are sometimes grouped as *Sus vittatus* Mull. & Schleg. The relationship between the three is not clear. Kloss (1931) makes *cristatus* Wagner a subspecies of *scrofa* Linn., and considered the Indian pigs as belonging to the Eurasian species *scrofa* Linn. Earlier De Blainville (1864, p. 129) and Gray (1852, p. 130) also confirmed this view in so far as the osteology of the two forms, viz., *scrofa* Linn., and *cristatus* Wagner are concerned where they could not find any difference of morphological importance between the two. But Chasen (1940) and others group *cristatus* Wagner with *vittatus* Mull. & Schleg. or regard it a race of the latter. Recently Elierman and Morrison-Scott (1952, p. 404) have treated all the wild pigs of the Palaearctic and Indian regions as belonging to a single species *Sus scrofa* Linn., which has a wide range of distribution. Accordingly the Indian pigs are now classed as *Sus scrofa*, making *cristatus* as the subspecies or race of *scrofa* (thus *Sus scrofa cristatus* Wagner) and the same name is now used for all the domestic pigs of India.

In the Western Asiatic countries the only available statistical data of pigs are from Iraq, where preliminary field count indicated 1 per cent of bone at Karim Shahr, and 10 per cent at Jarmo (Braidwood, 1952, pp. 26 and 30) were pigs. At Anau (Pumpelly 1908, pp. 355-358) the pig was nearly absent in Period I, but made up 12 per cent to 15 per cent of the bones from Period II & III. The type of pig at Anau was designated as *Sus scrofa palustris* Rutim. The Mesopotamian data are of interest in the light of Hilzheimer's (1941) conclusion that sheep and swine were two most important Sumerian animals. Interesting also is the large quantity of pigs found at Merimde (Mond 1937, p. 258), and at Maadi (Menghin 1932, p. 52) in lower Egypt in the Pre-dynastic period, in contrast to their rarity in later times when the pig was considered unclean (Dyson 1953, p. 665). According to Paton (1925, pp. 17 & 29) pigs were still in use during Dynasty III & IV in Egypt, probably in association with God Set, and their subsequent disuse possibly may be associated with the ascendancy of God Horus over Set.

Pig bones (of *scrofa* type) have been identified at Alishar Huyuk (Von der Osten 1937, pp. 302-308), while at Shah Tepe Amschler (1939, pp. 36, 45, 66, 73) identifies two forms of pigs, viz., *Sus scrofa attila* Thomas and *Sus scrofa palustris* Rutim. At Sialk (Ghirshman 1939, p. 198) pig bones were also identified but no specific name was given to them. All of the early eastern pigs including India also, as mentioned above, are now classed as *Sus scrofa* Linn. Thus, it is evident that the

Indian pigs are closely associated Western Asiatic pigs, and their affinity and distribution with them are very close and interesting.

The most basic important four animals (Cattle/sheep/goat/pig) to the development of Culture in the Prehistoric Period of the Old World were often accompanied by an equid of the onager group (donkey). In Prehistoric times this animal facilitated transportation.

(7) *Equus* (The Ass, Donkey, Horse, etc.)

(i) *Equus asinus* Linn.

(The Domestic Ass)

(Plate 26, Fig. 8 ; Plate 32, Figs. 7-11)

In early Bronze age transportation was facilitated by the domestication of donkey and the invention of wheeled-vehicles (Coon 1953, p. 227). In the Egyptian civilization of the early Bronze age ploughing required oxen, while threshing and burden carrying needed donkeys. The earliest wheeled-vehicles found are four-wheeled carts and a two-wheeled chariot that Sir Leonard Woolley found in 1927 in the royal Tomb of Ur, dating from the earliest sumerian times, between 3000 & 2700 B. C. The animals that pulled the wheeled-vehicles of the late Uruk and Jamdet Nasr Periods was the Onager (Falkenstein 1936, p. 56 ; Frankfort 1939, p. 22 ; Speiser 1935, pp. 73-74) in Mesopotamia. In the Aegean area the ass appears in Troy IV and the true horse not until Troy VI (Gejvall 1938, 1939). Childe (1952, p. 65) states that in north Africa in the Nile proper, people were dependent on the use of ass for transport and bones of these beasts were found intact in the settlement near Armant. In Pharaoh's time Childe (1952, p. 87) states that even the provincial magnates were accompanied in death by a few humans together with asses. Amschler (1939, p. 63) have reported the occurrence of ass—*Equus asinus* Linn., from Shah Tepe in Iran. In Western India the people of Rana Ghundai (Piggot 1950, p. 121) bred asses and probably even horse. Asses have been identified from Harappa (Prashad 1936, p. 28) and Maski (Nath 1957, p. 122), and Nath (1958) has recorded them from Rupar, Rangpur, Brahmagiri and Taxilla sites of India. The appearance of ass is late in the Harappa civilization. According to Coon (1952, p. 231) the asses are available for transport by the end of Bronze-age. During the Palaeolithic & Mesolithic of Palestine at least one large onager, *Equus hemionus* Pallas, is present at Shukbah cave (Bate 1928, p. 20), Wadi Dhobai (Bate 1938, pp. 293-94), Qumm Qatafa (Nellville 1931, p. 256) and Mugharet el Kebarah (Bate 1932, pp. 277-78). The Recent equids in this area (Harper 1945) have included the African Ass, *Equus asinus* Linn., the Syrian onager, *Equus hemionus hemippus* Geoffroy, and the large true onager of Iran and further east, *E. hemionus hemionus* Pallas. Equids have been identified from Harappa (1936, pp. 8 and 28), Mohenjodaro (Marshall 1931, pp. 654, 666), Rana Ghundai (Piggot 1950, p. 121), Maski (1957, p. 122), Anau I (Pumpelly 1908, pp. 38, 42, 341-42), Shah Tepe III (Arne 1945, p. 325), Sialk II (Ghirshman 1938, p. 195), Belt cave Level (Coon 1951, p. 44), Jarmo (Braidwood 1952, Fig. 14) ; Tell Mafesh (Mallowan 1946, p. 128) in the Ubaid Period of Iraq, Megiddo (Guy and Engburg 1938, p. 210) in the Chalcolithic Palestine, and at Maadi (Mond 1937, p. 255) in the Predynastic Egypt. The taxonomy used by most of the workers being

inconsistent, most of the Equids are identified now as asses or onager and not true horse. Lundholm (1949) and recently Nath (1954) reviewing these remains identified as true horse, *Equus caballus* Linn., at Anau, Sialk and Shah Tepe, show conclusively that they belong to the onager group and not to the true horse. Lundholm (1949), Hilzheimer (1935), Van Buren (1939), Friederichs (1933) and Slawkowsky (1940) all agree that there is no evidence for the true horse in the Western Asiatic countries before 2000 B.C. Consequently it was onager and not the horse in Mesopotamia which pulled the wheeled vehicles. In Egypt the true horse is not found until the 15th Century B.C. (Chard 1937, p. 317), although war chariots were known between 1580 and 1557 B.C. (Clark 1941, p. 57) one or two generations after the Hykos invasion. Accordingly Dobson (1953, p. 667) states that onager/ass were in use by the late 4th millennium, while the true horse, *Equus caballus* Linn., was introduced later on in the early 2nd millennium B.C.

(ii) *Equus caballus* Linn.

(The Horse)

(Plate 26, Fig. 9 ; Plate 27, Fig. 1)

According to Piggot (1950, p. 267) the horse appears to have been domesticated in South Russia by middle Kuban times (between 2000 to 1500 B.C.) and representations of Przewalski's horse appear on a silver bowl from earlier Maikop tomb. Horse remains again appear in Baluchistan at Rana Ghundai I (Piggot 1950, p. 121), Mohenjodaro (Sewell 1931, p. 653) and Harappa, where Nath (1962) has recently identified the remains of True horse, *Equus caballus* Linn., from the turmoil area G, probably at the end of Harappa civilization. Recently Nath recorded it from Hastinapura (1955, p. 109) and Rupar (1957). Horse was the characteristic domesticated animal of the Aryans (Piggot 1950, p. 266) who used it with light two-wheeled chariot for sport or warfare. Military cavalry was known to the Assyrians and Achæmenids in 800 B.C., and the invention of stirrup (Piggot 1950, p. 266) must be an ancient oriental contribution to horsemanship. In Bronze Age chariot-horses were really ponies (Coon 1953, p. 272). Large, saddle-sized horse like the one we ride was first bred (Coon 1953, p. 272) by the Medes of the Western Iran, near Hamadan. From there was exported the famous Nisean horse of antiquity. According to Coon (1953, p. 272) in later times horse was used for postal services by Persians and Romans.

It is thus clear that horse appeared much later than the ass or onager and came into light later in the matured phase of prehistoric human civilization of the Old World.

(8) *Camelus* (The Camel)

(Plate 27, Figs. 2, 3 , Plate 32, Figs. 1-4)

Camel, popularly known as ship of desert, was an animal in Prehistoric Periods which facilitated transportation. It appeared later than ass but earlier than the horse in the prehistoric times.

Its early history of domestication is curiously obscure. It was extensively used by the Assyrians from the 9th Century B. C. onwards

(Piggot 1950, p. 156). To-day no wild variety exists. Both one-humped and two-humped species are being domesticated at the present day.

There is remarkable lack of early representation (Piggot 1950, p. 157) of this animal in the Ancient East. However, a few camel bones of the Indian one-humped species (*Camelus dromedarius* Linn.) were found at Mohenjodaro (Sewell 1931, p. 660) and at Harappa (Prashad 1936, pp. 58-59), and they have also been found at Anau (Duerst 1908, p. 383) in Turkestan. The bony remains found in the neolithic Tripolye Culture of South Russia (Piggot 1950, p. 157) are likely to be approximately contemporary with Harappan Culture (Piggot, 1950, p. 157). Piggot (loc. cit.) states that one of the rarest representation of a camel in prehistoric Western Asia comes from a site probably of the second millennium B. C. just over the border of Baluchistan in Persian Makran, at Khurab, where it is modelled in relief on a bronze object. Camels have also been identified at Shah Tepe (Amschler 1939, p. 77) where the species reported belongs to the two-humped race, *Camelus bactrianus* Erxl. The earliest representation of the two-humped camel, *Camelus bactrianus* Erxl. are those on monuments of Achaemenian Age in Iran, dating from 5th Century B.C. (Coon 1955, p. 334). *Camelus dromedarius* Linn. is now reported from Palestine in the Pleistocene (Yeivin 1952, p. 41 ; Neuville 1951, p. 214), and in the Neolithic at Sha 'a ha Golan (Stekelis 1951, pp. 5 & 17) and at Warka in Southern Iraq where Hilzheimer identifies it amongst the figurines of the Ubaid Period (Van Buren 1939, p. 36). This animal has also been reported from the Palaeolithic sites of North Africa (Roamer, 1928, 1938). According to Free (1944, p. 191), *Camelus dromedarius* Linn. may have been domesticated in the Near East quite early for carrying the loads, if not ridden by people before the late second millennium B. C.

The introduction of the camel at the beginning of the iron age in 5th Century B. C. by Persians (Coon 1955, p. 270) in Egypt, permitted merchants to cross previously impassable deserts with large caravans. The caravans stimulated international trade between regions separated by deserts.

(9) *Elephas* (The Elephant)

(Plate 27, Fig. 4)

For transportation and haulage of heavy material the elephant played a great part in the prehistoric times. Besides, elephant ivory was used fairly in prehistoric times, and, as at present, ivory trade was a significant feature in those days. In Egypt ivory was in great use and we find carved ladles, ivory combs, ivory base and harpoons of Amratian 4000 B.C. and spoon of Gerzean cultures at Nile (Childe 1952, p. 56). In North Africa pictures of elephants, engraved, pecked or painted on rocks show that the people were well acquainted with this animal.

The skeletal remains of the elephants are however, well represented in the prehistoric sites of India. Only the tusk of *Elephas maximus* Linn., has been recorded from Mohenjodaro and it makes Sewell (1931, p. 653) think that probably the people did not have the animal but imported ivory from other places. Prashad (1936) did not record the remains of Indian Elephant, *Elephas maximus* Linn., at Harappa. Nath (1954) has however identified the bony remains of Indian elephant from Harappa

which also corroborate with the representation of Elephants on the seals obtained at Harappa. Thus, we can say that the knowledge of domestication of this animal was known to people of Harappa.

Skeletal remains of Indian elephant, *Elephas maximus* Linn., has also been recorded from Hastinapur (Nath 1955, p. 109) and Rupar (1957). The find of an Indian elephant tusk at Lothal has recently been identified by Nath (1958).

(10) *Canis* (The Dog)

(Plate 27, Figs. 5-7; Plate 29, Figs. 6, 6a, 6b, 7, 8, 8a, 8b)

The earliest known animal was dog. It is evidently proved that this animal was first domesticated in stone age. This animal was domesticated in Europe for hunting in post glacial mesolithic times (8000 B.C. or so). The domestic species, *Canis familiaris* Linn., first appeared during the Neolithic Period (Zittel 1925, p. 67).

From the old records supplied by Chaldaean and Egyptian monuments, it is manifested that several distinct varieties, which resembled modern breeds, have been developed 4000 to 5000 years ago. Slender dog of Greyhound type and a short-legged breed like a smooth Aberdeen are depicted in Egypt. The Assyrians had mastiff like hounds near about 600 B.C. The actual remains of dog have been recorded from Jericho (Childe 1952, p. 104) in Iraq. The Nile dwellers in the Nile Valley as Childe (1952, p. 54) states forced the dog to accompany his master in death and buried with him in the tomb. The dogs in the Pharaoh's time (Childe 1952, p. 79) are unlike older Egyptian greyhound and resemble rather Mesopotamian hounds. Thus a new breed of dog appeared in that time. The Anau dog recorded by Duerst (1908, p. 348) was designated as *Canis familiaris matris optimae* Jeitteles, which shows strong resemblance and affinity with the Dingo and Pariah dogs of the East. The remains of domestic dog, *C. familiaris* Linn., have been recorded from Sialk (Ghirshman 1938, p. 196) as well as from Shah Tepe (Amschler 1939, pp. 36 & 53) in Iran. The domestic dogs have also been identified at Alishar Huyuk (Von der Osten 1937, p. 293) where both the varieties of marsh dogs of Swiss Lake-dwellers, viz., the *palustris lodogensis* type and *inostranzewi* type are represented. In India the domestic dogs have been recorded from Mohenjodaro (Sewell 1931, p. 650) where they show strong resemblance with the Dingo and the Indian Pariah and have been designated as *C. familiaris* var. *dingo* Blum. But Indian Pariah is not conspecific with Dingo as Sewell (1931, p. 652) surmised and evidently Mohenjodaro dog does not represent with Australian Dingo, *C. dingo* Blum. The Mohenjodaro dog also shows strong affinity with the Anau dog. At Harappa (Prashad 1936, pp. 8 & 22) there is evidence of the domestication of dog from the earliest days of their culture. The evidence of bones and representations from Harappa show at least two types of dog, one akin to the modern pariah and the other a mastiff type. The Harappa dog resembling with the former comes near to the original ancestral type of dog found in the Oriental Region in diluvial times and has been designated by Prashad (1936, pp. 8 & 22) as *Canis tenggeranus* race *harappensis* Prashad. This dog also shows close resemblance and affinity with Anau dog—*C. familiaris matris optimae* Jeitteles and the shepherd dog.

The greyhound as shown from ancient Egyptian monuments existed several thousand years B. C. and has come down to us with very little structural change. From ancient Babylonian monuments it is evident that the mastiff type is a very old breed and continuing up to the present time without any change (Pocock 1932, *Encyclopedia Britannica*, 7, pp. 495-496).

Nath has recorded the remains of the domestic dog, *C. familiaris* Linn., from Rupar (1957), Rangpur and Brahmagiri (Nath, Unpublished reports) which show strong resemblance with the modern pariah.

From the above discussion, it is thus evident that the domestic dogs, *C. familiaris* Linn., obtained from Prehistoric sites of India show strong resemblance and affinity with those of the Near-East.

(11) *Felis* (The Cat)

(Plate 27, Fig. 8 ; Plate 28, Figs. 1, 1a, 2, 2a)

The cat, a member of the Family Felidae, was domesticated in prehistoric periods. It is well known that ancient Egyptians domesticated the Egyptian race of African wild cat, *Felis ocreata maniculata* Cretzschmar. These Egyptian cats are generally believed to have had a large share in the parentage of the domesticated cats of Europe and the Western Asia, by their crossing with the indigenous wild species.

Tame cats from Egypt were probably imported at an early date. 609, B.C. into Etruria by the Phoenician traders ; there is decisive evidence that they were established in Italy long before the Christian era. There is very interesting evidence of domesticated cat bones from Harappa (1936, p. 15) and Chanuhudaro (Piggot 1950, p. 156). The cat bones from Harappa are the only finds representing the Domestic Cat. According to Piggot (1950, p. 156) the Harappa cat, *Felis ocreata* race *domestica*, seems to have resemblance with the ordinary European domestic cat in appearance.

(12) *Gallus* sp.

(The Domestic Fowl)

In addition to these animals, a chicken, *Gallus* sp., has been reported at Harappa (Prashad 1936, p. 15). The identification of fowl at Mohenjodaro (Sewell 1931, p. 662) is questioned. This has now been identified at Rupar (Nath 1958). Coon (1950, p. 90) identified it at Belt cave of Iran where one spur from Neolithic is said to be of *Gallus*. The etymology of the akkadian word for this bird indicates that it was known in Mesopotamia before the second millennium B. C. (Carter 1923, pp. 2-3). Childe (1952, p. 76) thinks that the fowls were domesticated at Harappa.

(13) *Rhinoceros unicornis* Linn.

(The One-horned Indian Rhinoceros)

(Plate 27, Fig. 9 ; Plate 32, Figs. 5, 6)

The remains of a one-horned rhinoceros, *Rhinoceros unicornis* Linn., from Harappa (1936, p. 30) are rather very interesting as this animal is no longer found there to-day. Formerly this animal was extensively

distributed in the Indian Peninsula. It was common in the Punjab as far as Peshawar in the time of Emperor Babus (Prashad 1936, p. 30). The fossilized bone of this animal has recently been reported to be associated with microlith in Gujrat (Sankalia & Karve 1949, p. 28).

From the above discussion, it is thus evident that the finds of the various species of animals from the Prehistoric sites of India resemble and compare well with those of the Western Asiatic countries and thereby show close affinities with each other.

IV—A BRIEF ACCOUNT OF THE ANCESTRY OF THE DOMESTICATED ANIMALS OF INDIA

With reference to the origin of the various Indian domestic animals, I agree with Prashad (1936, p. 6) that several of them are descendants of the very rich mammalian Siwalik Fauna of the Indian Tertiaries. The Indian buffalo, the camel and elephant are so closely allied to Siwalik forms that their ancestry cannot be doubted. It is generally agreed by all that the Indian Humped cattle are to be derived from the Siwalik Nerbuddah ox, *Bos namadicus* Falc.

Cat.—There is general concensus of opinion that the ancestor of the Domestic Cat was the African *Felis ocreata* Gmelin ; Indian Domestic Cat is also derived from this ancestral form.

Ass.—In view of the close relationship of the Indian ass with the African species, *Equus asinus* Linn., it is considered that this animal was imported to India from Africa, probably along Jacobi Arabian and Persian Region of dispersal (Prashad 1936, p. 7).

Ox.—Both the types viz., the large-horned humped cattle and small-horned, humpless cattle are represented from Harappa and Mohenjodaro. Duerst (1908) and Prashad (1936) agree that short-horned type originated as a result of the "decline of cattle breeding" and is not to be considered as a new race. This long-horned humped cattle is considered to be the descendant of the Siwalik Nerbuddah ox—*Bos namadicus* Falconer.

Goat.—The so called bezoar-goat, *Capra hircus* Linn., of Turkestan and Afghanistan whose remains have been recorded from all over the Near East is the likeliest candidate for the title of parenthood of the Indian Goat.—*Capra hircus aegagrus* Erxl.

Sheep.—It is now generally accepted that three wild sheep exist in Asia, viz., (I) *Ovis musimon* Pallas, which inhabits the highlands of Hither Asia from Anatolia to Elburz and the Zagros and also found North of Mediterranean in Corsica and Sardinia, (II) *Ovis vignei* Blyth, (the Asiatic Urial) the home of which is the northern slope of Elburz, Turkestan, Afghanistan, Baluchistan and the Punjab, and (III) the Argal, *O. ammon* Linn., living to the East of Ural, all of which have given rise to breeds of domestic sheep. The Urial sheep, *Ovis vignei* Blyth, the range of which extends to the Indus Valley is now, acknowledged the ancestor of Indian Domestic Sheep.

Pig.—According to most recent authorities (Kloss 1931 ; Ellerman and Morrison-Scott (1952, p. 404) there is no specific difference of morphological importance between *cristatus* Wagner (Indian pig) and *scrofa* Linn. (European pig) and accordingly Indian pig is classed as

Sus scrofa Linn. with a wide range of distribution in the Palaearctic and Indian regions. The Indian domestic pig is the domesticated form of the wild *Sus scrofa* Linn.

Camel.—I agree with Prashad (1936, p. 9) that the Indian one-humped camel is undoubtedly the descendant of the Siwalik form, *C. sivalensis* Falc. & Cautley, and its domestication was first brought about in India probably in the Indus Valley.

Dog.—Two distinct types of dogs domesticated in India are recognisable by the representations of bony finds from Harappa and Mohenjodaro : (I) a type akin to Pariah, and (II) a mastiff type. I agree with Prashad (1936, pp. 8, 25-26) that Indian domesticated dogs have descended from *Canis tenggeranus* Kohlbrugge of the Oriental Region in the South-east Asia in the Diluvial times and from it were derived the Pariah, the Greyhound and the Tibet Dog. This ancestral form, *C. tenggeranus* Kohlbr., according to Prashad (1936, p. 26) after migration into Australia with aborigines was transformed into the True Dingo—*C. dingo* Blum.

Buffalo.—There is general concensus of opinion that Indian Buffalo is the direct lineal descendant of the gigantic *Bubalus palaeindicus* Falconer of Siwalik hills.

Elephant.—Indian Elephants are considered to be descendants of *Stegodon ganesha* Falc. & Cautley of the Siwalik hills.

Horse.—The true horse is the descendant of the domesticated form of the wild horses of the Central Asia or Eastern Europe.

V—SUMMARY

1. This paper reviews the skeletal animal remains obtained from the various prehistoric sites of India, such as Mohenjodaro (2500 B.C.—1500 B.C.), Harappa (2500 B.C.—1500 B.C.), Rana Ghundai (2100 B.C.—1500 B.C.), Rupar (2000 B.C.—200 B.C.), Rangpur (2000 B.C.—800 B.C.), Hastinapura (2000 B.C.—3rd Century B.C.), Maski (1000 B.C.—1st century A.D.), Taxilla (mid 1st century B.C.—to 2nd century A.D.), Brahmagiri (200 B.C.—1st century A.D.), Nasik (200 B.C.—300 A.D.), Arikamedu (20 A.D.—50 A.D.). These remains have been classified into six categories as follows :—

(a) The remains of animals probably maintained in a state of domestication in the prehistoric times are as follows.—*Bos indicus* Linn. ; *Bos (Bubalus) bubalis* Linn. ; *Ovis vignei* Blyth, race *domesticus* ; *Capra hircus aegagrus* Erxl. ; *Canis familiaris* Linn. ; *Canis tenggeranus* Kohlbr., race *harappensis* Prashad ; *Sus scrofa cristatus* Wagner ; *Camelus dromedarius* Linn. ; *Elephas maximus* Linn. ; *Gallus* sp. ; *Francolinus francolinus* (Linn.)—The Black Partridge ; *Equus asinus* Linn. ; and at a later date *Equus caballus* Linn.

(b) The remains of animals which lived in the vicinity of human habitation and probably semi-domesticated in the prehistoric times are as follows.—*Herpestes auropunctatus* (Hodgson) ; *Suncus stoliczkanus* Anderson ; *Rattus rattus* Linn. ; *Tatera indica* (Hardwicke).

(c) The remains of animals probably utilized as food were as follows.—*Gavialis gangeticus* (Gmelin) ; *Trionyx gangeticus* Cuvier ; *Chitra indica*

(Gray) ; *Lissemys punctata* (Bonnaterre) ; *Geoclemys hamiltoni* (Gray) ; *Batagur baska* (Gray) ; *Rita rita* (Ham. Buch.)—A river fish ; *Wallago* sp. (A river fish) , and The Carp *Arius* sp. (Sea and Estuarine fish).

(d) The remains of deer species which were obtained from the prehistoric sites are as follows.—*Cervus hanglu* (Wagner) ; *Rusa unicolor* (Kerr.) , *Axis axis* (Erxl.) ; *Axis* (*Hyelaphus*) *porcinus* (Zimm.) ; and *Tetraceros quadricornis* (Blainv.).

(e) The skeletal remains of the wild animals which were obtained not far away from the prehistoric sites are as follows.—*Canis aureus* Linn. ; *Canis lupus* Linn. ; *Rhinoceros unicornis* Linn. ; and *Bos bubalis* Linn.

(f) The remains of molluscan shells imported for use as ornaments and other purposes are as follows.—*Lamellidens marginalis* (Lamarck) ; *Arca granosa* (Linn.) ; *Arabica arabica* (Linn.) ; *Babylonia spirata* (Linn.) ; and *Xancus pyrum* var. *acuta* Hornell and var. *fuscus* Sowerby.

2. The significant role played by various species of animals, obtained from the prehistoric sites of India, in the cultural life of people is discussed.

3. An attempt has been made to correlate and compare the prehistoric finds of various domestic animal groups of India, such as *Bos* (oxen & buffalo) ; *Ovis* (sheep) ; *Capra* (goat) ; *Sus* (pig) ; *Equus* (Ass, horse, etc.) ; *Camelus* (camels) , *Elephas* (elephant) ; *Canis* (dogs) ; *Felis* (cats) ; *Gallus* sp. (fowl), etc., with those of the prehistoric animal remains of the Western Asiatic countries such as Mesopotamia (Iraq), Syria, Persia (Iran), Palestine and North Africa. The study reveals that the prehistoric domestic animals of India had strong affinities and resemblances with those of the Western Asiatic countries.

4. Brief account is given of the ancestral forms from which the various domesticated animals such as cat, ass, ox, goat, sheep, pig, camel, dog, buffalo, elephant and horse were derived.

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PLATE 26

Sketches of some of the domestic and wild animals of India and other countries.

FIG. 1.—The Zebu or domestic humped cattle of India, *Bos indicus* Linn.

FIG. 2.—The unhumped European cattle, *Bos taurus* Linn.

FIG. 3.—The Indian domestic buffalo, *Bos (Bubalus) bubalis* Linn.

FIG. 4.—The Mouflon ram, *Ovis musimon* Pallas.

FIG. 5.—The Urial or Punjab wild sheep, *Ovis vignei* Blyth.

FIG. 6.—The Bezoar or wild goat, *Capra hircus* Linn.

FIG. 7.—The Indian wild boar, *Sus scrofa cristatus* Wagner.

FIG. 8.—The wild ass, *Equus asinus* Linn.

FIG. 9.—The Mongolian wild horse, *Equus caballus przewalskii* Poliakov.

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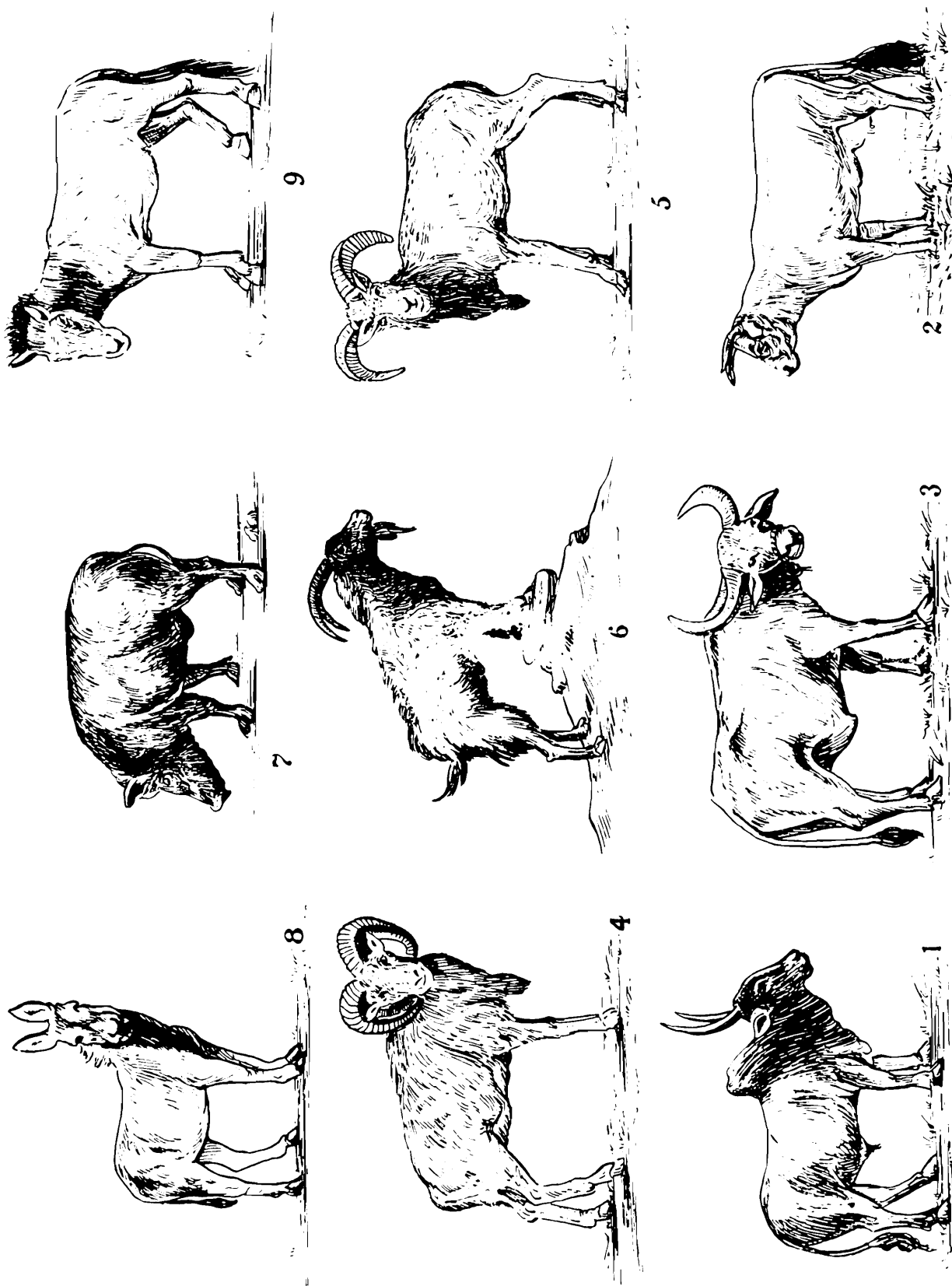


PLATE 27

Sketches of some of the domestic and wild animals of India and other countries (continued).

FIG. 1.—The Arabian Horse, *Equus caballus* Linn.

FIG. 2.—The Dromedary or one-humped Camel, *Camelus dromedarius* Linn.

FIG. 3.—The Bactrian or Two-humped Camel, *Camelus bacterianus* Linn.

FIG. 4.—The Indian Elephant, *Elephas maximus* Linn.

FIG. 5.—Dog (Greyhound).

FIG. 6.—Dog (Mastiff).

FIG. 7.—The Australian Dingo Dog, *Canis familiaris dingo* Blum.

FIG. 8.—The domestic cat, *Felis domestica* Linn.

FIG. 9.—The Indian One-horned Rhinoceros, *Rhinoceros unicornis* Linn.

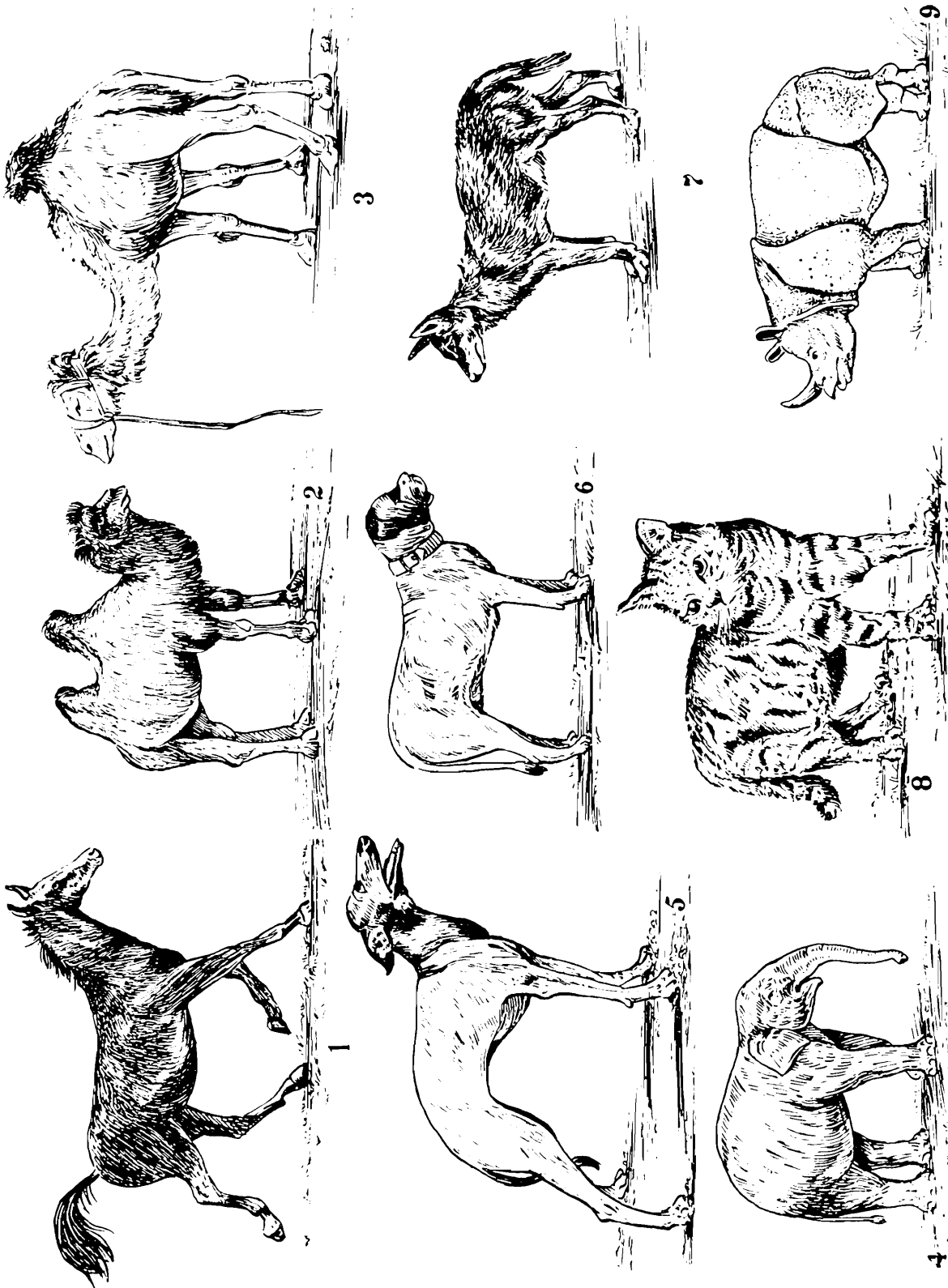


PLATE 28

Skeletal remains of some animals from the Harappa Excavation (ca. 2500 B.C.—1500 B.C.) together with skeletons of recent forms in the collection of Zoological Survey of India. (After B. Prashad 1936, *Mem. Archaeol. Surv. India*, No. 51, Pl. II). All figs. 1/3 Nat. size.

(a) *Felis ocreata* Gmelin race *domestica* Brisson

FIG. 1.—Dorsal view of a skull, in Zoological Survey of India collection.

FIG. 1a.—Lateral view of the same skull as 1.

FIG. 2.—Dorsal view of the skull excavated from Mound F, No. 1202, Harappa.

FIG. 2a.—Lateral view of the same skull as 2.

(b) *Herpestes auropunctatus* (Hodgson)

FIG. 3.—Lateral view of a skull excavated from Mound F, Harappa, No. 7783e.

FIG. 4.—Lower jaw from the same site as 3.

FIG. 5.—Lower jaw of a specimen in the Zoological Survey of India collection.

FIG. 6.—Atlas vertebra from the same site as 3.

FIG. 7.—Axis vertebra from the same site as 3.

FIG. 8.—Right scapula from the same site as 3.

FIG. 9.—Right humerus from the same site as 3.

FIG. 10.—Right tibia, incomplete, from the same site as 3.

FIG. 11.—Right half of the pelvic girdle from the same site as 3.

(c) *Canis aureus* Linn.

FIG. 12.—Lateral view of a skull excavated from Area G, Harappa.

FIG. 13.—Lateral view of a skull from the old A. S. B. collection in the Zoological Survey of India.

FIG. 14.—Left ramus of the lower jaw from Area G, Harappa.

FIG. 15.—Left ramus of the lower jaw in the Zoological Survey of India collection.

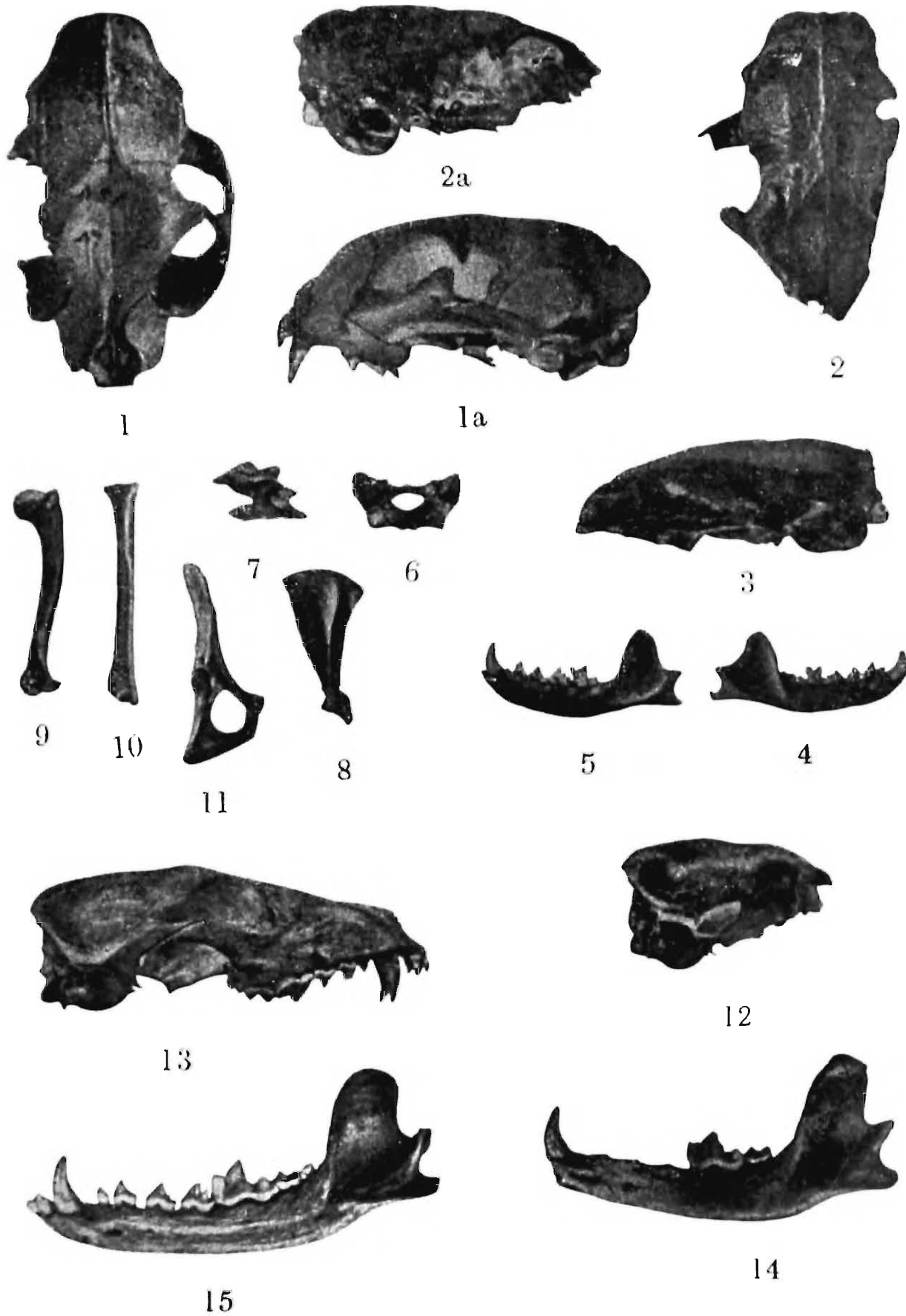


PLATE 29

Skeletal remains of some animals from the Harappa Excavation (*ca.* 2500 B.C.—1500 B.C.) together with skeletons of recent forms in the collection of the Zoological Survey of India. (*After* B. Prashad 1936, *Mem. Archaeol. Surv. India*, No. 51, Pl. III). All figs. 1/3 Nat. size.

(*a*) *Canis lupus* Linn.

FIGS. 1, 1*a*.—Lateral & ventral views of a skull. No. 10797(*d*), excavated at Harappa.

FIGS. 2, 2*a*.—Lateral & ventral views of a skull in the Zoological Survey of India collection.

FIG. 3.—Right ramus of a lower jaw. No. 10797(*d*) excavated at Harappa.

FIG. 4.—Left femur. No. G. 289, excavated at Harappa.

FIG. 5.—Left calcaneum. No. 10797(*d*) excavated.

(*b*) *Canis tenggeranus* Kohl., race *harappensis* Prashad

FIGS. 6, 6*a*, 6*b*.—Lateral, ventral and dorsal views of a skull from Mound AB, Harappa.

FIG. 7.—Left ramus of lower jaw from the same site as 6.

(*c*) *Indian Pariah Dog*

FIGS. 8, 8*a*, 8*b*.—Lateral, ventral and dorsal views of a skull in the Zoological Survey of India collection.

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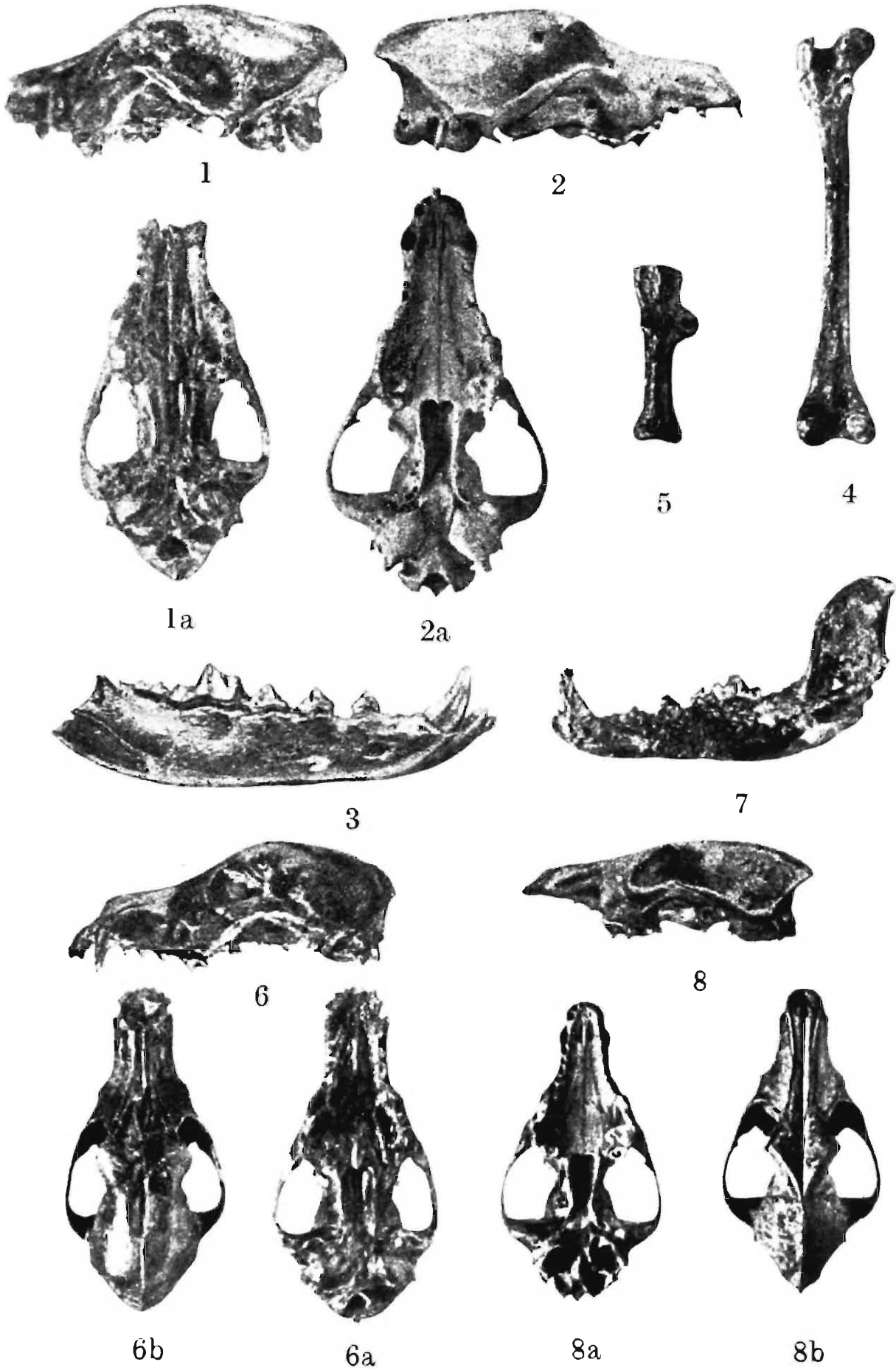


PLATE 30

Skeletal remains of some animals from the Harappa Excavation (ca. 2500 B.C.—1500 B.C.) together with skeletons of recent forms in the collection of the Zoological Survey of India. (After B. Prashad 1936, *Mem. Archaeol. Surv. India*, No. 51, Pl. V). All figs. 1/3 Nat. size.

(a) *Bos indicus* Linn.

FIG. 1.—Left 3rd—4th metacarpal of an animal of the short-horned race. No. H/C Cemetery site, Harappa.

FIG. 2.—Right femur of an animal of the long-horned race. No. 10212, Harappa.

FIGS. 3, 4.—Complete and distal fragment of 3rd—4th metatarsal of the short-and long-horned races. No. 10212 and from Mound F, Trench VI, respectively, Harappa.

FIGS. 5, 6.—1st, 2nd phalanges of the short-and long-horned races. No. 10212 and from Mound F, Trench VI respectively, Harappa.

(b) *Bos (Bubalus) bubalis* Linn.

FIG. 7.—Palatal part of a specimen. No. G311/27 Harappa.

FIG. 8.—Fragment of a right horn from Mound G Trench II square AM 40/21, Harappa.

FIG. 9.—Fragment of left ramus of lower jaw. No. 5440a, b, c, Harappa

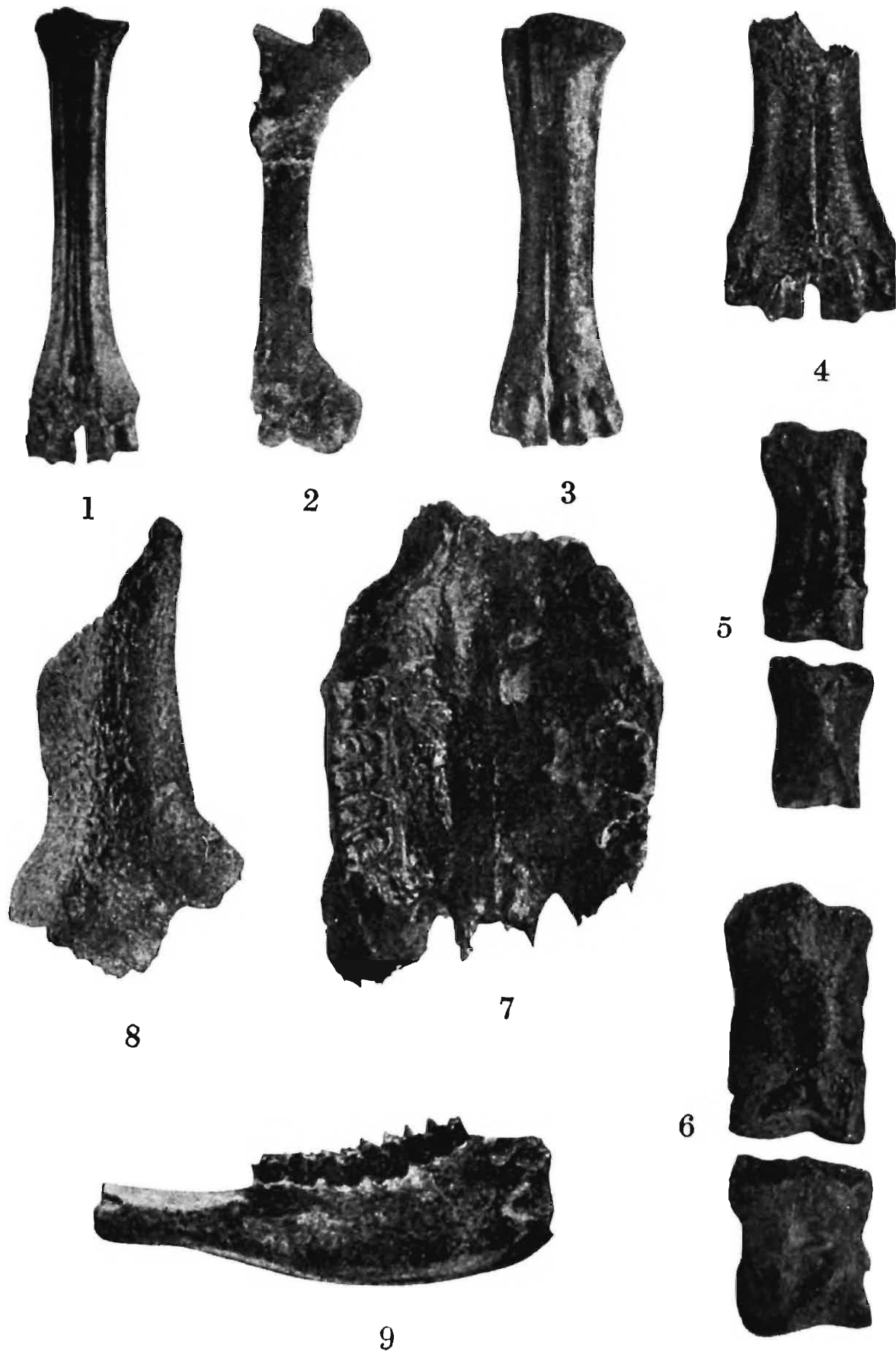


PLATE 31

Skeletal remains of some animals from the Harappa Excavation (ca. 2500 B.C.—1500 B.C.) together with skeletons of recent forms in the collection of the Zoological Survey of India. (After B. Prashad 1936 *Mem. Archaeol. Surv. India*, No. 51, Pl. VI). All figs. 1/3 Nat. size.

(a) *Capra hircus aegagrus* Erxl.

FIG. 1.—Lateral view of fragment of right ramus of lower jaw. No. H. 507, Harappa.

FIG. 2.—Distal end of left humerus. No. H. 307b, Harappa.

FIG. 3.—Distal half of right 3rd—4th metacarpal. No. 7846a. Harappa.

FIG. 4.—Distal fragment of right 3rd—4th metatarsal. No. 3687. Harappa.

FIG. 5.—Left horn-core fragment (No. D. S. 18), Harappa.

(b) *Ovis vignei* Blyth, race *domesticus*

FIGS. 6, 7.—Lateral & posterior views of skull. No. H. 501 f, Harappa.

FIGS. 8, 9.—Two horn-cores, No. 3905, Harappa.

FIG. 10.—Fragment of right ramus of lower jaw. No. 4989a, Harappa.

FIG. 11.—Distal fragment of left humerus. No. G. 10212, Harappa.

FIG. 12.—Distal fragment of right 3rd—4th metacarpal. No. (D.S. 27), Harappa.

FIG. 13.—Distal fragment of left femur. No. G. 10212, Harappa.



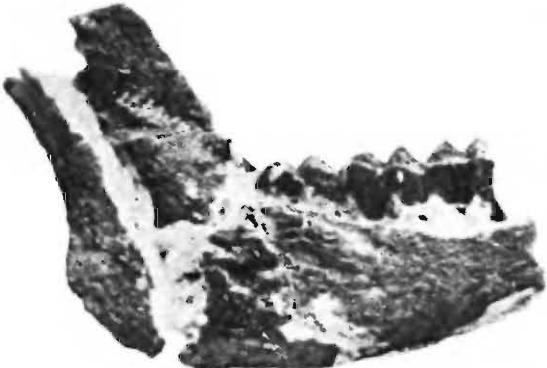
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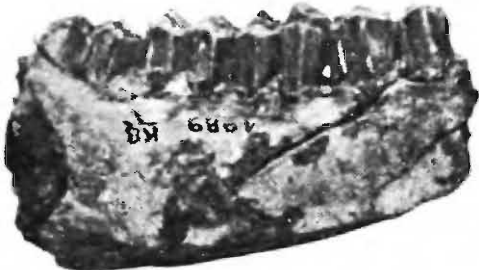
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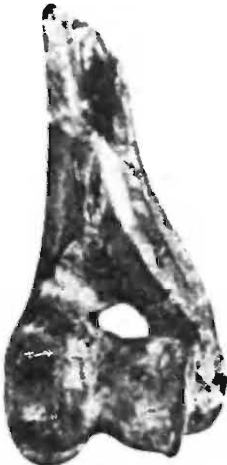
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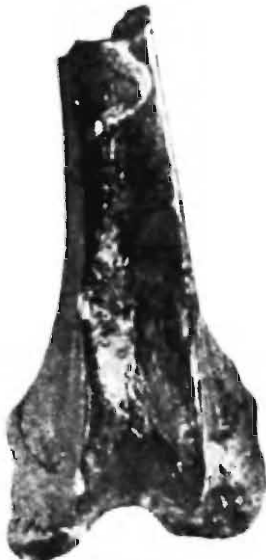
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PLATE 32

Skeletal remains of some animals from the Harappa Excavation (ca. 2500 B.C.—1500 B.C.) together with skeletons of recent forms in the collection of the Zoological Survey of India. (After B. Prashad 1936, *Mem. Archaeol. Surv. India*, No. 56, Pl. VII). All figs. 1/3 Nat. size.

(a) *Camelus dromedarius* Linn.

FIG. 1.—Left scapula No. 954, fragmentary, Harappa.

FIG. 2.—Left scapula of a recent specimen in the collection of the Zoological Survey of India.

FIG. 3.—Left radio-ulnar shaft from Mound AB, excavated from a depth of 5' 9", Harappa.

FIG. 4.—Left radio-ulna of a recent specimen in the collection of the Zoological Survey of India.

(b) *Rhinoceros unicornis* Linn.

FIG. 5.—Fragmentary right scapula from Mound F, excavated from a depth of 8' 7" —11' 10", Harappa.

FIG. 6.—Right scapula of a specimen in the collection of the Zoological Survey of India.

(c) *Equus asinus* Linn.

FIG. 7.—Maxillary portion of palate with 4th premolar and 1-3 molars ; No. 954. Harappa.

FIGS. 8, 9.—3rd right metacarpals. No. 954. Harappa.

FIGS. 10, 11.—Two specimens of 2nd phalanx of right hind-leg and right fore-leg of different sizes (D. R. S. colln.). No. D. S. 40 & 29 respectively, Harappa.



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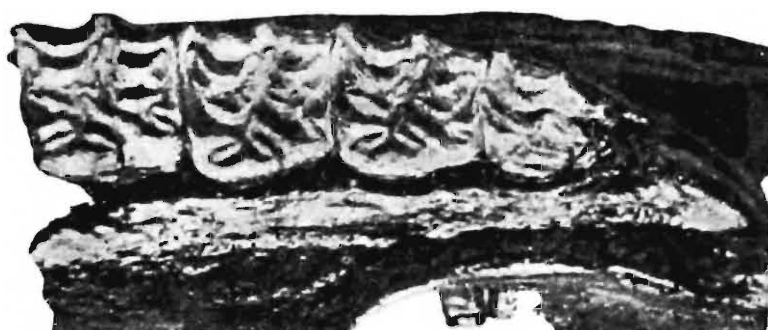
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9

ON A COLLECTION OF FISH FROM THE COROMANDEL COAST OF INDIA INCLUDING PONDICHERRY AND KARAIKKAL AREAS

By

A. G. K. MENON

Zoological Survey of India, Calcutta

(With 1 Plate)

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I—INTRODUCTION

During the years 1956-58, the Zoological Survey of India carried out two intensive surveys of the Coromandel Coast of India, including the Pondicherry and Karaikkal areas. Pondicherry and Karaikkal, the former French possessions and the intervening strip of the Coromandel Coast are of special interest for in the past many European zoologists had made collections there and described many new and interesting species. The main purpose of the survey of this area was, therefore, to procure the topotype material of the various species described from there.

The chief rivers of the area surveyed are the Ginghee, the Ponnaiyar, the Gadilam, the Uppanar, the Vellar and the Arasalar ; all these rivers flow in almost parallel courses to the east into the Bay of Bengal. Of these, excluding the Ginghee and the Ponnaiyar in which collections were made both at places away from the tidal limits as well as at the mouth of the river, the survey was done only at their mouths. The backwaters at Cuddalore and the Killi backwaters at Porto Novo were specially surveyed.

The following is the list of collecting stations with the dates of collection :—

1. Pondicherry—20-xii-56.

2. Veerampatnam, about 3 miles south of Pondicherry—20-xii-56, 21-xii-56 & 22-xii-56.
3. Manikaranthope, about 3 miles south-west of Veerampatnam.—23-xii-56.
4. Sunnambar river, branch of the Gingee, off Nonankuppam, about 5 miles south of Pondicherry—24-xii-56.
5. Usteri Tank, about 8 miles north-west of Pondicherry—26-xii-56, 28-xii-56, 11-ii-58 & 12-ii-58.
6. Vaithikuppam, about 2 miles north of Pondicherry—27-xii-56, 8-ii-58.
7. Sunnambukalawa, about a mile west of Pondicherry—14-ii-58.
8. Ariyankuppam, about 4 miles south of Pondicherry—15-ii-58.
9. Madukkarai, about 21 miles south-west of Pondicherry—3-i-57, 13-ii-58.
10. Ponnaiyar river, near Rampakam, about 6 miles south of Madukkarai—3-i-57.
11. Panayadikuppam, about 6 miles south-east of Madukkarai—5-i-57.
12. Madakardipet, about 41 miles north of Madukkarai—6-i-57, 9-ii-58.
13. Cuddalore, South Arcot Dist., Madras—10-i-57, 17-ii-58.
14. Kuddikadu backwaters, about 2 miles south-west of Cuddalore 11-i-57, 21-ii-58.
15. Ponnaiyar river, near Periyaganankuppam, about 5 miles north-west of Cuddalore—12-i-57, 19-ii-58.
16. Sonakuppam, 2 miles south of Cuddalore—11-i-57, 12-i-57, 15-i-57.
17. Thannikoil, about 7 miles north-west of Cuddalore—14-i-57.
18. Bahur, about 10 miles north-west of Cuddalore—15-i-57.
19. Gadilam river, Cuddalore—17-i-58, 20-ii-58.
20. Kunjampetta, about 31 miles south of Cuddalore—22-ii-58.
21. Veeranam Lake, about 38 miles south-west of Cuddalore—26-ii-58, 27-ii-58.
22. Porto-Novo, South-Arcot Dist., Madras—19-i-57, 20-i-57.
23. Vellar river, Porto Novo—21-i-57.
24. Pudupet, about $2\frac{1}{2}$ miles north of Porto Novo—22-i-57.
25. Killi backwaters, about 4 miles south-west of Porto-Novo—24-i-57.
26. Pichavaram backwaters, about 10 miles south of Porto-Novo—25-i-57.
27. Tranquebar, Tanjore Dist., Madras—29-i-57, 3-iii-58.
28. Poraiyar, about 2 miles south of Tranquebar—30-i-57.
29. Sattankudi, about 2 miles north of Tranquebar, 31-i-57, 1-ii-57, 4-iii-58.
30. Karaikkal, Pondicherry State—4-ii-57, 6-iii-58.
31. Mouth of the Arasalar river, Karaikkal—5-ii-57, 9-ii-57, 10-iii-58.

32. Kilingimedu coast, about $3\frac{1}{2}$ miles north of Karaikkal—6-ii-57, 9-ii-57, 10-ii-57 & 9-iii-58.
33. Kakamurihe, about $3\frac{1}{2}$ miles south-west of Karaikkal—7-iii-58.
34. Keechankuppam, about 3 miles south of Nagapatnam—8-ii-57.
35. Mariamangalam, about $3\frac{1}{2}$ miles west of Karaikkal—7-iii-58.
36. Ammankulum, about 8 miles north of Karaikkal—9-iii-58.
37. Mananpetta, about 11 miles north-west of Karaikkal—11-iii-58.

In all there are 175 species in the present collection including two new species, one a Ophichthyid eel, *Eascanichthys deraniyagalai* Menon, and another a pipe-fish, *Doryichthys* sp., the descriptions of which are being published separately in the *Journal of the Zoological Society of India*. Topotype specimens of the following fifteen species were obtained :—*Carcharhinus sorrah* (Müller & Henle), *Narcine timlei* (Bloch & Schn.), *Narke dipterygia* (Bloch & Schn.), *Therapon puta* Cuv. & Val., *Sphyræna obtusata* Cuv. & Val., *Polydactylus sextarius* (Bloch & Schn.), *Lactarius lactarius* (Bloch & Schn.), *Atropus atropus* (Bloch & Schn.), *Caranx* (*Carangoides*) *malabaricus* (Bloch & Schn.), *Mene maculata* (Bloch & Schn.), *Johnius carutta* Bloch, *Otolithes ruber* (Bloch & Schn.), *Scomberomorus guttatus* (Bloch & Schn.), *Psettodes erumei* (Bloch & Schn.) and *Trichiurus savala* Cuvier. They are indicated under the respective species. A systematic account of the collection with the number of specimens and their size ranges under each species according to the localities and their geographical distribution is given in the paper. Except where otherwise stated, the measurements given indicate the "total length" of the fish from the tip of the snout to the far end of the tail fin. A brief zoogeographical discussion on the marine fishes in the collection is also attempted. The study of the marine fishes in the collection points out to the conclusion that the Malay Archipelago is the main centre of evolution of the marine shore-fishes of the Indo-West Pacific Region, and India obtained its shore-fish fauna from this centre of distribution.

II—ACKNOWLEDGMENTS

I take this opportunity to express my sincerest thanks to the authorities of the Pondicherry State, especially to Sri Venkatasubba Reddiar, Councillor for Public Works and Fisheries, and to Sri E. K. Madhavan, the Director of Fisheries, for the great interest they took in my work and the help they rendered in the collection of fishes. To Dr. M. L. Roonwal, the Director of the Zoological Survey of India, I am deeply indebted for affording me the opportunity to survey the Coromandel Coast and the interest he showed in my study.

III—SYSTEMATIC ACCOUNT

Class I. ELASMORBANCHII

Order 1. LAMNIFORMES

Family 1. ORECTOLOBIDAE

1. *Chiloscyllium griseum* Müller & Henle

1841. *Chiloscyllium griseum* Müller & Henle, *Syst. Besch. Plagiostomen*, Berlin, p. 19. (India ; Japan.)

1, 450.0 mm., Kilingimedu, Karaikkal.

Distribution.—From the Red Sea, South Africa, and India to the Malay Peninsula, China and Japan.

Family 2. CARCHARHINIDAE

2. *Scoliodon sorrakowah* (Cuvier).

1829. *Carcharias sorrakowah* Cuvier, *Règne Animal*, Paris, 2 (ed. 2), p. 388.
(Based on description of *sorrah kowah*, in Russell 1803, *Fish. Coromandel*, 1, p. 9, pl. 15. Vizagapatam.)

3, 286.6—545.5 mm. Sonakuppam, Cuddalore.

Distribution.—From Mekran, India, and Ceylon to Burma, Malaya, Siam, Indo-China, Java, Philippines and Japan.

3. *Carcharhinus sorrah* Müller & Henle

1841. *Carcharias (Prionodon) sorrah* Müller & Henle, *Syst. Besch. Plagiostomen*, Berlin, p. 45, pl. 16. (Pondicherry ; Java ; Madagascar.)

3, 325.5—690.2 mm., Pondicherry (*topotypes*).

Distribution.—From the Red Sea, Madagascar and India to Malaya, Indo-China, China, Malay Archipelago, Melanesia and Hawaii.

4. *Galeocerdo cuvieri* (Le Sueur)

1822. *Squalus cuvier* Le Sueur, *J. Acad. nat. Sci. Philadelphia*, Philadelphia, 2, p. 351. (North-west coast of New Holland.)

1, 115.5 mm., Karaikkal.

Distribution.—Widely distributed in all the warm seas of the world.

Order 2. RAJIFORMES

Family 1. RHINOBATIDAE

5. *Rhinobatos granulatus* Cuvier

1829. *Rhinobatus granulatus* Cuvier, *Règne Animal*, Paris, 2 (ed. 2), p. 396.
(Pondicherry.)

1, 500.0 mm., Karaikkal.

Distribution.—From the coasts of India, Ceylon, and Andamans to Burma, Malaya, Malay Archipelago, Thailand, Cochin China and China.

Family 2. TRYGONIDAE

6. *Dasyatis (Himantura) uarnak* (Forskål)

1665. *Raja uarnak* Forskål, *Descript. Animal* ; Hauniae, pp. viii, 18. (Arabia.)
2, 200.0 & 220.5 mm. wide, Pondicherry.

Distribution.—Widespread from the Red Sea and east coast of Africa to Malay Archipelago, Melanesia and Polynesia.

7. *Dasyatis (Amphotistius) zugei* Müller & Henle

1841. *Trygon zugei* Müller & Henle, *Syst. Besch. Plagiostomen*, Berlin p. 165, pl. 54. (Japan ; China ; Pondicherry ; India.)

2, about 102.0 mm. wide each, Tranquebar ; one, 165.0 mm. wide, Cuddalore.

Distribution.—From the coasts of India and Ceylon to Malaya, Cochin China, Java, Philippines and Japan.

8. *Gymnura (Gymnura) micrura* (Schneider)

1801. *Raja micrura* Schneider, *Syst. Ichth.*, Berlin, p. 360. (Surinam, Dutch Guiana.)

2, 216.0 and 251.5 mm. wide ; Kilingimedu, and Karaikkal.

Distribution.—From the coasts of India and Ceylon to Malaya, Siam, Indo-China and Malay Archipelago.

9. *Gymnura (Gymnura) poecilura* (Shaw)

1804. *Raja poecilura* Shaw, *General Zoology*, London, 5, p. 291. (Based on 'tenkee kunsul', Russell, 1803, *Fish. Coromandel*, 1, p. 4, pl. 6. (Vizagapatam.)

1, 225.0 mm wide, mouth of R. Arasalar, Karaikkal.

Distribution.—From the Red Sea, India and Ceylon to the Malay Peninsula, Thailand, China, the Malay Archipelago, Philippines and Japan.

Family 3. MYLIOBATIDAE**10. *Aetobatus flagellum* (Bloch & Schn.)**

1801. *Raja flagellum* Bloch & Schneider, *Syst. Ichth.*, Berlin, p. 361, pl. 73. (Coromandel)

1, 300.0 mm. wide, Kilingimedu, Karaikkal.

Distribution.—Red sea, Madagascar, India, Burma and the Malay Archipelago.

Order 3. TORPEDINIFORMES**Family 1. TORPEDINIDAE****11. *Narcine brunnea* Annandale**

1909. *Narcine brunnea* Annandale, *Mem. Indian Mus.*, Calcutta, 2, p. 45, pl. 3a, fig. 2, 2a. (Hooghly river mouth.)

1, 165.5mm., Sonakuppam, Cuddalore ; 4, 150.0—196.5 mm., Pondicherry.

Distribution.—Coasts of India and Ceylon and Philippines.

12. *Narcine timlei* (Bloch & Schn.)

1801. *Raja timlei* Bloch & Schneider, *Syst. Ichth.*, Berlin, p. 359. (Tranquebar.)

1, 235.5 mm., Kilingimedu, Karaikkal ; 8, 100.0 to 150.0 mm., Tranquebar (*topotypes*).

Distribution.—From the coasts of India and Ceylon to Malay Archipelago, China and Japan.

13. *Narke dipterygia* (Bloch & Schn.)

1801. *Raja dipterygia* Bloch & Schneider, *Syst. Ichth.*, Berlin, p. 359. (Tranquebar.)

2, about 165.0 mm. each, Tranquebar (*topotypes*) ; 2, 138.0 & 160.3 mm., Kilingimedu, Karaikkal.

Distribution.—From the coasts of India and Ceylon to Malaya, Indo-China, China, Philippines and Japan

Class II. TELEOSTOMI

Order 4. CLUPEIFORMES

Family 1. CLUPEIDAE

14. *Dussumieria acuta* Cuv. & Val.

1847. *Dussumieria acuta* Cuvier & Valenciennes, *Hist. Nat. Poiss.*, Paris, 20, p. 467, pl. 606. (Bombay ; Coromandel coast.)

7, 129·0 to 156·0 mm., Tranquebar, six, 144·5 to 138·5 mm., Pondicherry ; three, 148·5 to 178·5 mm., Kilingimedu, Karaikkal.

Distribution.—From the south coast of Arabia, India and Ceylon, Malaya, Malay Archipelago, China, Philippines and Australia (Coastal waters).

15. *Dussumieria hasselti* Bleeker

1851. *Dussumieria hasselti* Bleeker, *Nat. Tijds. Ned. Ind.*, Batavia, 1, p. 422. (Batavia ; Cheribon ; Samarang ; Surabaya.)

1, 159·5 mm., Tranquebar.

Distribution.—From India to Burma, Malaya, Malay Archipelago, Formosa and Queensland (Coastal waters).

16. *Sardinella fimbriata* (Cuv. & Val.)

1847. *Spratella fimbriata* Cuvier and Valenciennes, *Hist. Nat. Poiss.*, Paris, 20, p. 359, pl. dc. (Malabar.)

2, 116·0 and 151·5 mm., Kilingimedu, Karaikkal.

Distribution.—From India and Ceylon to Burma, Malaya, Malay Archipelago, Thailand, Indo-China and China (Coastal waters).

17. *Sardinella melanura* (Cuvier)

1829. *Clupea melanura* Cuvier, *Régne Animal*, Paris, 2, fed. 2, p. 318. (Based on *Clupanodon sinensis* (part) Lacepede, 1803, *Hist. Nat. Poiss.*, Paris, 5, pp. 468, 471, pl. 11, fig. 3, Asia.)

2, 135·0 mm., each Kilingimedu, Karaikkal.

Distribution.—From the east of Africa and Madagascar, India, Ceylon, Andamans to Malay Archipelago, Hainan, China, Micronesia and Polynesia. (Coastal waters.)

18. *Sardinella sindensis* (Day)

1878, *Clupea sindensis* Day, *Fish. India*, London, 1, p. 638, pl. 163, fig. 2. (Karachi.)

4, 108·5—115·5 mm., Pondicherry ; 2, ca. 145·0 mm. each Tranquebar.

Distribution.—From Seychelles and India to Malaya, Philippines, Formosa and to Ambonia. (Coastal waters.)

19. *Sardinella sirm* (Walbaum)

1792. *Clupea sirm* Walbaum, *Artedi Pisc.*, 3, p. 38 (on Forskål, 1775, *Descript. Animal.*, Hauniae, 17, Arabia.)

4, 156.0—169.8 mm., Pondicherry.

Distribution.—From the Red Sea, Arabia, east coast of Africa, India and Ceylon to Malay Archipelago, China, Micronesia and Polynesia (Coastal waters).

20. *Hilsa ilisha* (Ham.)

1822. *Clupanodon ilisha* Hamilton, *Fish Ganges*, Edinburgh, p. 243, pl. 19, Fig. 75. (Ganges estuaries ; Patna ; Goyalpara ; Calcutta ; Dacca.)

1, 180.0 mm., Mariamangalam, $3\frac{1}{2}$ miles west of Karaikkal ; 1, 117.5 mm., Sonakuppam, Cuddalore.

Distribution.—From the Persian Gulf, India and Ceylon to Burma and Philippines. (Coastal waters, entering rivers.)

21. *Pellona ditchela* (Cuv. & Val.)

1847. *Pellona ditchela* Cuvier & Valenciennes, *Hist. Nat. Poiss.*, Paris, 22, p. 314. (Based on *Ditchelee* Russell, 1803, *Fish. Coromandel*, 2, p. 72, pl. 188, Vizagapatam.)

2, about 160.0 mm. each, Kilingimedu, Karaikkal.

Distribution.—From the east coast of Africa, Madagascar, India and Ceylon to Burma, Malaya, Malay Archipelago and also Queensland (Coastal waters).

22. *Opisthopterus tardoore* (Cuvier)

1829. *Pristigaster tardoore* Cuvier, *Règne Animal* ed. 2, Paris, 2, p. 321. (Based on *Tartoore* Russell, 1803, *Fish. Coromandel*, 11, p. 74, pl. 193. (Vizagapatam.)

4, 165.0 mm.—182.0 mm., Sonakuppam, Cuddalore, & 146.0—205.0 mm. ; Porto-Novo ; 2, 180.0 mm., Tranquebar ; 1, 160.0 mm., Veerampatnam, Pondicherry.

Distribution.—From India and Ceylon to Burma, Malaya, Malay Archipelago, Thailand and China (Coastal waters).

23. *Anodontostoma chacunda* (Hamilton)

1882. *Clupanodon chacunda* Hamilton, *Fish Ganges*, Edinburgh, pp. 246-383. (Gangetic estuaries.)

1, 190.0 mm., Sonakuppam, Cuddalore ; 2, about 770.0 mm. each, Kilingimedu, Karaikkal.

Distribution.—From India to Burma, Malaya, Thailand, Malay Archipelago, Philippines and Melanesia (Coastal waters).

Family 2. ENGRAULIDAE**24. *Setipinna taty* (Cuv. & Val.)**

1848. *Engraulis taty* Cuvier & Valenciennes, *Hist. Nat. Poiss.*, Paris, 21, p. 60. (Pondicherry ; Malacca.)

1, 119.0 mm., Porto Novo ; 1, 133.0 mm., mouth of R. Arasalar, Karaikkal.

Distribution.—From the coasts of India and Ceylon to Burma, Malaya, Malay Archipelago, Thailand and China. (Coastal waters, entering rivers.)

25. *Anchoviella commersonii* (Lacépède.)

1801. *Stolephorus commersonii* Lacépède, *Hist. Nat. Poiss.*, Paris, 5, pp. 381, 382, pl. 12, fig. 1. (Type-locality not given.)

15, 48.0—77.5 mm., Porto Novo ; 10, 62.5—65.0 mm., Tranquebar.

Distribution.—From the east coast of Africa, Mauritius, India and Ceylon to Malaya, Malay Archipelago, China, Philippines and Polynesia (Coastal waters).

26. *Anchoviella indica* (van Hasselt)

1823. *Engraulis indica* van Hasselt, *Algern. Konst. Letterbode*, p. 329. (Java.)
6, 60.0—74.5 mm., Kilingimedu, Karaikkal.

Distribution.—From the east coast of Africa and India to Malaya, Malay Archipelago, Philippines, Thailand, China, Melanesia and Polynesia (Coastal waters).

27. *Anchoviella tri* (Bleeker)

1852. *Engraulis tri* Bleeker, *Verh. Bat. Gen.*, Batavia, 24, p. 40. (Batavia)
1, 132.0 mm., Sonakuppam, Cuddalore.

Distribution.—From India to Malaya, Malay Archipelago and Philippines (Coastal waters).

28. *Thrissocles dussumieri* (Cuv. & Val.)

1848. *Engraulis dussumieri* Cuvier and Valenciennes, *Hist. Nat. Poiss.*, Paris, 21, p. 69. (Type-locality not given.)

1, 140.0 mm., Porto Novo ; Two, 112.0 & 113.0 mm., Veerampatnam, Pondicherry.

Distribution.—From India to Malaya, Malay Archipelago and China (Coastal waters).

29. *Thrissocles malabaricus* (Bloch)

1795. *Clupea malabaricus* Bloch, *Naturng. Ausland. Fische*, Berlin, 9, p. 115, pl. 432. (Tranquebar.)

4, 75.0 mm.—93.0 mm., Vaithikuppam, Pondicherry.

Distribution.—East coast of Africa, India, Celebes and Philippines (Coastal waters).

30. *Thrissocles mystax* (Bloch & Schn.)

1801. *Clupea mystax* Bloch & Schneider, *Syst. Ichth.*, Berlin, p. 426, pl. 183. (Malabar.)

2, *ca.*, 130.5 mm. each, Pondicherry ; three, 130.0—186.0 mm., Tranquebar ; four, 55.0—132.0 mm., Kilingimedu, Karaikkal.

Distribution.—From India and Ceylon to Malaya, Malay Archipelago, Thailand, China and also Queensland (Coastal waters).

31. *Thrissocles purava* (Hamilton)

1822. *Clupea purava* Hamilton, *Fish. Ganges*, Edinburgh, pp. 238, 382. (Gangetic estuaries.)

1, 112.0 mm., R. Sunnambar at Nonankuppam, Pondicherry.

Distribution.—India to Malay Archipelago (Coastal and estuarine waters).

32. *Thrissocles setirostris* (Brousonet)

1682. *Clupea setisostis* Broussonet, *Ichth.*, London, 1, pl. 2. (Tanna ; New Hebrides.)

2, 129.5 & 135.0 mm., Sunnambar river at Nonankuppam, Pondicherry.

Distribution.—Widely distributed in the warm waters of the Indo-West Pacific, ranging from the Red Sea and east coast of Africa to Queensland and Polynesia (Coastal waters).

Family 3. CHIROCENTRIDAE

33. *Chirocentrus dorab* (Forskâl)

1775. *Clupea dorab* Forskâl, *Descript. Anim.*, Hauniae, pp. XII, 72. (Djedda, Red Sea.)

1, 401.5 mm., Pondicherry ; 1, 460.5 mm., Karaikkal.

Distribution.—Widely distributed in the warm waters of the Indo-west Pacific ranging from the Red Sea and east coast of Africa to Australia and Melanesia (Coastal waters).

Family 4. CHANIDAE

34. *Chanos chanos* (Forskâl)

1775. *Mugil chanos* Forskal, *Descript. Anim.*, Hauniae, pp. XIV, 74. (Djedda, Red Sea.)

3, 87.0—95.0 mm., Kilingimedu, Karaikkal.

Distribution.—Widely distributed in the warm waters of the Indo-west Pacific ranging from the Red Sea to Japan, Australia, Melanesia and Polynesia (Coastal waters including lagoons).

Order 5. SCOPELIFORMES

Family 1. SYNODIDAE

35. *Harpodon nehereus* (Ham.)

1822. *Osmerus? nehereus* Hamilton, *Fish. Ganges*, Edinburgh, pp. 209, 380. (Ganges mouth.)

4, 162.0—205.5 mm., Tranquebar.

Distribution.—Widely distributed from the east coast of Africa to China and Australia (Coastal and estuarine waters, entering rivers).

36. *Saurida tumbil* (Bloch)

1395. *Salmo tumbil*, Bloch, *Naturl. Ausland. Fische*, Berlin, 9, p. 112, pl. 430. (Type-locality not given.)

2, 240.0 & 300.0 mm., Veerampatnam, Pondicherry ; 1, 173.0 mm. Kilingimedu, Karaikkal.

Distribution.—Widely distributed in the warm waters of the Indo-West Pacific, ranging from the east coast of Africa to Australia, Japan and Hawaii (Coastal waters).

Order 6. CYPRINIFORMES

Family 1. CYPRINIDAE

37. *Chela clupeoides* (Bloch)

1797. *Cyprinus clupeoides* Bloch, *Ichthyol. Hist. Nat.*, Paris, 12, p. 49, pl. 408, fig. 2. (Tranquebar.)

11, 79.0—105.0 mm., Ponnaiyar River, S. E. of Madukkarai ; 3, 97.5—126.0 mm., Kakamurihe, Karaikkal ; 2, 72.0—81.5 mm., Bahur, 10 miles N. W. of Cuddalore ; 4, 95.5—120 mm., Usteri Tank ; 5, 70.0—92.5 mm., Ponnaiyar River, Cuddalore.

Distribution.—India (Cutch, Peninsular India and the Satpura mountains.). In Rivers, streams, ponds and tanks.

38. *Chela laubuca* (Hamilton)

1882. *Cyprinus laubuca* Hamilton, *Fish. Ganges*, Edinburgh, p. 260. (Northern Bengal.)

9, 27.0—34.5 mm. Ammankulam, Karaikkal.

Distribution.—Ceylon, India, Burma, Thailand & Sumatra (Rivers, Streams, ponds and tanks).

39. *Esomus barbatus* (Jerdon)

1849. *Leuciscus barbatus* Jerdon, *Madras J. Lit. Sci.*, Madras, 15, p. 322. (Mysore.)

16, 62.5—83.5 mm., Ponnaiyar R. Madukkarai , 46, 40.0—51.5 mm., Sunnambukalava, Pondicherry ; 15, 40.0—54.0 mm., Mariamangalam, Karaikkal ; 58.0 mm. Bahur, 10 miles north west of Cuddalore ; 20, 38.0—52.6 mm., Ammankulam, Karaikkal , 34, 25.0—51.0 mm., Manampetta, 11 miles north west of Karaikkal , 7, 32.5—46.5 mm., Madukkarai, Pondicherry ; 10, 28.5—56.0 mm. Usteri Tank.

Distribution.—Peninsular India, (Rivers, streams, ponds, tanks and ditches).

40. *Rasbora daniconius* (Hamilton)

1882. *Cyprinus daniconius* Hamilton, *Fish. Ganges*, Edinburgh, pp. 327, 329, 391, pl. 15, f. 89. (Southern Bengal.)

28, 27.0—39.0 mm., Usteri Tank , two, 32.0 & 45.0 mm., Ponnaiyar River, Cuddalore.

Distribution.—Ceylon, India and Burma. (Rivers, streams, ponds and tanks.)

41. *Labeo calbasu* (Hamilton)

1822. *Cyprinus calbasu* Hamilton, *Fish. Ganges*, Edinburgh, pp. 297, 387, pl. 2, fig. 33. (Bengal.)

1, 151.0 mm., Ponnaiyar River, Madukkarai.

Distribution.—India and Burma. Also known from Thailand and China. (Deep pools in clear sluggish streams.)

42. *Labeo boga* (Hamilton)

1882. *Cyprinus boga* Hamilton, *Fish. Ganges*, Edinburgh, pp. 286, 386, pl. 28, fig. 80. (Brahmaputra river.)

6, 70.0 to 99.0 mm., Ponnaiyar River, Cuddalore., 5, 82.0 to 99.5 mm., Bahur, 10 miles N.W. of Cuddalore.

Distribution.—India and Burma. Rivers.)

43. *Labeo kontius* (Jerdon)

1849. *Cyprinus kontius* Jerdon, *Mad. J. Lit. Sci.*, Madras, **15**, p. 302, (Cauvery river.)

1, 169.0 mm. Veeranam Lake, Lalpet.

Distribution.—Peninsular India. (Rivers.)

44. *Puntius chola* (Hamilton)

1882. *Cyprinus, chola* Hamilton, *Fish. Ganges*, Edinburgh, pp. 312, 389. (Bengal.)

1, 67.5 mm., Usteri tank ; 1, 54.0 mm., Madukkarai, Pondicherry ; 1, 67.0 mm., Ammankulam, Karaikkal ; 5, 47.0—91.5 mm., Bahur, 10 miles N. W. of Cuddalore ; 17, 58.0—75.0 mm., Ponnaiyar River, Madukkarai.

Distribution.—India and Burma. (Rivers, streams, lakes and tanks.)

45. *Puntius dorsalis* (Jerdon)

1849. *Systemus dorsalis* Jerdon, *Madras J. Lit. Sci.*, Madras, **15**, p. 314. (Madras.)

15, 58.5—91.5 mm., Usteri Tank., 5, 54.0—61.0 mm., Kakamurihe, Karaikkal ; 5, 120.0—159.5 mm., Veeranam Lake, Lalpet ; 1, 69 mm., Ponnaiyar River, Madukkarai.

Distribution.—Peninsular India and Ceylon. (Rivers, streams, lakes and ponds.)

46. *Puntius filamentosus* (Cuv. & Val.)

1844. *Leuciscus filamentosus* Cuvier and Valenciennes, *Hist. Nat. Poiss.*, Paris, **17**, p. 96, pl. 492. (Alleppey.)

1, 65.0 mm., Usteri Tank ; 1, 132.0 mm., Veeranam Lake, Lalpet.

Distribution.—Ceylon and Peninsular India. (Rivers, streams, lakes and tanks.)

47. *Puntius sarana* (Hamilton)

1822. *Cyprinus sarana* Hamilton, *Fish. Ganges*, Edinburgh, pp. 307, 308. (Bengal.)

2, 109.0 to 119.0 mm., mouth of R. Gadilam, Cuddalore ; 3, 121.5—133.0 mm., Kakamurihe, Karaikkal ; 3, 93.0 to 129.5 mm., Usteri Tank ; 1, 207.0 mm., Veeranam Lake, Lalpet.

Distribution.—Ceylon, India & Burma. (Rivers, streams, ponds lakes and tanks.)

48. *Puntius (sarana) pinnauratus* Day

1865. *Cyclocheilichthys pinnauratus* Day, *Fish. Malabar*, London, p. 209, pl. 15, fig. 2. (Cochin.)

2, 121.5 and 126.0 mm., Usteri Tank.

Distribution.—Ceylon, India, Burma and Malaya. (Rivers, streams, Ponds, lakes and tanks.)

49. **Puntius sophore** (Hamilton)

1822. *Cyprinus sophore* Hamilton, *Fish. Ganges*, Edinburgh, pp. 310, 389. (Bengal.)

96, 26.5—79.5 mm., Usteri Tank ; 38, 43.0—68.0 mm., Ponnaiyar River, Madukkarai ; 7, 42.0—55.0 mm., Madakardipet, $4\frac{1}{2}$ miles north of Madukkarai ; 4, 53.5—79.0 mm., Ponnaiyar River, Cuddalore ; 2, 50.0 and 56.0 mm., Gadilam River, Cuddalore ; 16, 45.5—67.5 mm., Madukkarai, Pondicherry.

Distribution.—India, Burma and Yunnan. (Rivers, streams, lakes, ponds and tanks.)

Family 2. COBITIDAE

50. **Lepidocephalus thermalis** (Cuv. & Val.)

1846. *Cobitis thermalis* Cuvier & Valenciennes, *Hist. Nat. Poiss.*, Paris, 18, p. 78. (Ceylon.)

1, 41.5 mm., Bahur, 10 miles north-west of Cuddalore ; 2, 31.0 and 35.0 mm., Usteri Tank ; 3, 30.0—40.0 mm., Manampetta, Karaikkal.

Distribution.—Ceylon and Peninsular India. (Streams, lakes, tanks and pools.)

Family 3. ARIIDAE

51. **Osteogobius militaris** (Linnaeus)

1758. *Silurus militaris* Linnaeus, *Syst. Nat.* (ed. 10), London, p. 505. (Asia.)
2, ca. 200.0 mm. each, Tranquebar.

Distribution.—From the coasts of India to the Malay Archipelago. (Sea, estuaries and tidal rivers.)

52. **Tachysurus jella** (Day)

1878. *Arius jella* Day, *Fish. India*, p. 467, Pl. 106, fig. 3. (Coromandel coast.)

2, 35 mm. each, mouth of the Arasalar River, Karaikkal.

Distribution.—Along the east coast of India and Ceylon through the mouth of the Ganges eastwards as far as Burma (Sea, estuaries and tidal rivers).

Family 4. BAGRIDAE

53. **Mystus (Mystus) gulio** (Hamilton)

1822. *Pimelodus gulio* Hamilton, *Fish. Ganges*, Edinburgh, pp. 201, 379, pl. 23, fig. 66. (Gangetic estuaries.)

14, 65.5—85.0 mm., Poraiyar, Tranquebar, 45, 54.0—100.0 mm., Ponnaiyar River, Madukkarai.

Distribution.—From the coasts of India, Pakistan and Ceylon to the Malay Archipelago. (Estuaries and tidal rivers.)

54. *Mystus (Mystus) vittatus* (Bloch)

1797. *Silurus vittatus* Bloch, *Ichthyol. Hist. nat.*, Paris, 11, p. 40, 371, fig. 2. (Tranquebar.)

45, 63.5—96.5 mm., Ponnaiyar River, Madukkarai ; 3, 79.0—86.0 mm., Usteri Tank.

Distribution.—Ceylon, India, Burma, and Siam. (Fresh water ponds and streams.)

Family 5. SCHILBEIDAE

55. *Pseudeutropius atherinoides* (Bloch)

1794. *Silurus atherinoides*, Bloch, *Naturg. Ausland. Fische*, Berlin, 8, p. 48, pl. 371, fig. 1. (Tranquebar.)

2, 49.0 and 66.0 mm., Usteri Tank.

Distribution.—India and Burma. (Larger rivers.)

Order 7. ANGUILLIFORMES

Family 1. ANGUILLIDAE

56. *Anguilla bengalensis* (Gray and Hardw)

1822. *Muraena anguilla* Hamilton, *Fish. Ganges*, Edinburgh, p. 22. (Bengal.)

1, 465.0 mm. Backwaters of Pichavaram, Porto Novo.

Distribution.—India, Ceylon, Burma, Java and Celebes. (Catadromous, inhabiting fresh waters and spawning at sea.)

57. *Anguilla bicolor* McClelland

1845. *Anguilla bicolor* McClelland, *Calcutta J. nat. Hist.*, Calcutta, 5, p. 178, t. 6, fig. 1. (Sandoway on the Malay coast.)

25, 47.5—120.0 mm., mouth of R. Gadilam Cuddalore ; 4, 66.0—119.0 mm., R. Ponnaiyar, Cuddalore.

Distribution.—Ceylon, India and Burma. (Catadromus, inhabiting fresh waters of coastal plains and spawning at sea.)

Family 2. MURAENIDAE

58. *Gymnothorax pseudothyrsoides* (Bleeker)

1852. *Muraena pseudothyrsoides* Bleeker, *Nat. Tijds. Ned. Ind.*, Batavia 3, p. 778. (Macassar, Celebes.)

1, 600.0 mm., Sonakuppam, Cuddalore.

Distribution.—From Zanzibar, Muscat, Seychelles, Chagos Archipelagos and India to Malay Archipelago, and Darnley Island. (Coastal waters.)

59. *Gymnothorax punctata* (Bloch & Schn.)

1801. *Muraena punctatus* Bloch & Schneider, *Syst. Ichth.*, Berlin, p. 526. (Tranquebar.)

1, 46.0 mm., Sunnambar river at Nonankuppam, Pondicherry.

Distribution.—India (Bay of Bengal) and Ceylon to the Malay Archipelago. (Coastal and estuarine waters, entering fresh water.)

Family 3. MURAENESOCIDAE

60. *Muraenesox arabicus* (Bloch & Schn.)

1801. *Muraena arabica* Bloch & Schneider, *Syst. Ichth.*, Berlin, p. 488.
(Based on *Muraena cinerea* Forskål, *Descript. Animal.*, pp. x, 22,
Arabia, pre-occupied by Bonnaterra 1788, ex Gronow, from Guinea.)

1, 600.0 mm., Keechankuppam, Nagapatnam.

Distribution.—From the Red Sea, east coast of Africa, and India to Malaya, Malay Archipelago, China, Japan, Philippines and Australia. (Shallow coastal inlets, brackish and salt water lagoons.)

Family 4. OPHICHTHYIDAE

61. *Bascanichthys deraniyagalai* Menon

1961. *Bascanichthys deraniyagalai* Menon, *J. zool. Soc. India*, Calcutta, 13, (1), p. 13. (Arasalar river.)

5, 188.0—600.0 mm., mouth of R. Arasalar, Karaikkal.

Distribution.—Karaikkal, Coromandel Coast, India. (Estuarine waters.)

Order 8. BELONIFORMES

Family 1. BELONIDAE

62. *Xenentodon cancila* (Hamilton)

1822. *Esox cancila* Hamilton, *Fish Ganges*, Edinburgh, pp. 213, 380, pl. 27, fig. 70. (Gangetic provinces.)

1889. *Belone cancila*, Day, *Faun. Brit. Ind. Fish*, 1, p. 420, fig. 136.

7, 190.0—210.0 mm., Usteri Tank.

Distribution.—From India, Ceylon and Burma through Thailand to Malay. (Coastal fresh waters.)

63. *Strongylura strongylura* (van Hasselt)

1823. *Belone strongylura* van Hasselt, *Algem. Konst. Letterbode*, 1, p. 131. (Batavia, Java.)

2, ca. 200.0 mm. each, Usteri Tank.

Distribution.—From the coasts of Iran, India and Ceylon to Burma, China, Cochin China, Formosa, Malay Archipelago and N. Australia. (Marine, entering estuaries.)

Family 2. HEMIRHAMPHIDAE

64. *Hyporhamphus gaimardi* (Cuv. & Val.)

1846. *Hemirhamphus gaimardi* Cuvier and Valenciennes, *Hist. Nat. Poiss.*, Paris, 19, p. 36. (Moluccas : Amboina ; New Guinea ; Port Jackson.)

4, 129.0 mm. each, Vellar River, Porto Novo ; 2, 154.0 mm. each, Kudikadu backwaters, Cuddalore ; 2, ca. 280.5 mm. each, Kilingimedu, Karaikkal ; 1, 168.0 mm., Vainthikuppam, Pondicherry.

Distribution.—From Iran, India and Burma to Malay Archipelago, Philippines, Amboina, New Guinea and Australia. (Sea and estuaries.)

Order 9. SYNGNATHIFORMES

Family 1. SYNGNATHIDAE

65. *Ichthyocampus carce* (Hamilton)

1822. *Syngnathus carce* Hamilton, *Fish. Ganges*, Edinburgh, p. 13. (Gangetic tide-ways.)

4, 73.5—85.5 mm., mouth of R. Gadilam, Cuddalore.

Distribution.—From India and Ceylon to Malaya and Malay Archipelago. (Sea and estuaries entering fresh waters.)

66. *Microphis brachyurus* Bleeker

1853. *Syngnathus brachyurus* Bleeker, *Verh. Bat. Genootsch.*, **25**, *Troskieuwige Visschen*, Batavia, p. 16. (East Indian Archipelago.)

1, 99.0 mm., R. Ponnaiyar, Cuddalore.

Distribution.—Widely distributed in the Indo-West Pacific ranging from east coast of Africa to Japan and Polynesia. (Fresh water rivers, and brackish and salt water estuaries.)

67. *Doryichthys cunculus* (Hamilton)

1822. *Doryichthys cunculus* Hamilton, *Fish. Ganges*, Edinburgh, pp. 12, 362. (Estuaries near Calcutta.)

1, 120.0 mm., R. Ponnaiyar, Cuddalore ; 1, 157.5 mm., mouth of R. Gadilam, Cuddalore.

Distribution.—India. (Estuaries and tidal rivers.)

*68. *Doryichthys* sp.

1, 72.0 mm., R. Gadilam, Cuddalore.

Distribution.—Cuddalore, Coromandel coast, India. (Estuarine waters.)

Order 10. CYPRINODONTIFORMES

Family 1. CYPRINODONTIDAE

69. *Aplocheilus panchax* (Hamilton)

1822. *Esox panchax* Hamilton, *Fish. Ganges*, Edinburgh, pp. 211, 380, pl. 3, fig. 69. (Bengal.)

50, 10.0—31.0 mm., Panayadikuppam, Madukkarai ; 22, 19.0—23.0 mm., Usteri Tank.

Distribution.—India, Burma, Malaya, Thailand and Malay Archipelago. (Fresh and brackish waters.)

70. *Oryzias melastigma* (McClelland)

1839. *Aplocheious melastigmus* McClelland, *Asiatic Res.*, Calcutta, **19**, pp. 301, 427, pl. 42, fig. 3. (Calcutta.)

23, 15.5—27.0 mm., Sunnambukalawa, Pondicherry ; 234, 22.5—34.0 mm., R. Ponnaiyar, Cuddalore ; 55, 14.0—33.5 mm., Kudikadu back waters, Cuddalore.

Distribution.—From coasts of Ceylon and Peninsular India through Lower Bengal to Burma. (Brackish waters and estuaries.)

*This is apparently new and is being described elsewhere.

Order 11. MUGILIFORMES

Family 1. SPHYRAENOIDAE

71. *Sphyraena jello* (Cuv. & Val.)

1829. *Sphyraena jello* Cuvier & Valenciennes, *Hist. Nat. Poiss.*, Paris, 3, p. 349. (Based on *jellow* Russel, 1803, *Fish. Coromandel*, 2, p. 59, pl. 174, Vizagapatam.)

2, *ca.* 300.0 mm., Pondicherry ; 1, 380.0 mm., Kilingimedu, Karaikkal.

Distribution.—Widely distributed in the Indo-West Pacific, ranging from the Red Sea and east coast of Africa to Riu Kiu Islands and to New Caledonia and Fiji Islands. (Sea and brackish waters.)

72. *Sphyraena obtusata* (Cuv. & Val.)

1829. *Sphyraena obtusata* Cuvier and Valenciennes, *Hist. Nat. Poiss.*, Paris, 6, p. 350. (Pondicherry ; Bourbon ; Malabar ; Port Jackson.)

1, 242.0 mm., Tranquebar Coast ; 2, *ca.* 245.0 mm., Veerampatnam, Pondicherry (*topotypes*) ; 1, 230.0 mm., Kilingimedu, Karaikkal.

Distribution.—From the Red Sea and east coast of Africa to Riu Kiu Island, Philippines, Australia, New Zealand and Fiji Islands. (Coastal waters.)

Family 2. MUGILIDAE

73. *Chelon vaiensis* (Quoy & Gaimard)

1824. *Mugil vaiensis* Quoy & Gaimard, *Voyage de "l'Uranie" et "La Physicienne" par Freycinet*, Zool., Paris, p. 337, pl. 59, fig. 2. (Waigiou.)

3, 105.0—177 mm., Kudekadu back waters, Cuddalore.

Distribution.—Widely distributed in the Indo-West Pacific, ranging from the Red Sea and the east coast of Africa to Australia and Polynesia. (Coastal, estuaries and fresh waters.)

74. *Mugil cephalus* (Linnaeus)

1758. *Mugil cephalus* Linnaeus, *Syst. Nat.*, (ed. 10), London, pl. 1, p. 316. ("Oceano Europaea".)

1, 195.0 mm., Kudikadu back waters, Cuddalore.

Distribution.—Widely distributed in the tropical and temperate waters of the Indian, S. Atlantic and S. Pacific Oceans. (Common in estuaries, entering fresh water.)

75. *Mugil parsia* (Hamilton)

1822. *Mugil parsia* Hamilton, *Fish. Ganges*, Edinburgh, p. 215, pl. 17, fig. 71. (Hooghly river.)

3, 104.0—133.5 mm., Kudikadu backwaters, Cuddalore ; 90, 33.5—94.0 mm., R. Gadilam, Cuddalore ; 3, 80.5—100.4 mm., Veerampatnam, Pondicherry ; 2, 90.0 mm., and 95.0 mm., Ponnaiyar R., Cuddalore ; 11, 65.0 mm.—165.0 mm., Vellar R., Porto Novo.

Distribution.—India and Ceylon to Malaya, Thailand, Malay Archipelago, Philippines, Gauam, New Guinea and Australia. (Coastal, entering estuaries.)

76. *Mugil speigleri* Bleeker

1858. *Mugil speigleri* Bleeker, *Nat. Tyds. Ned. Ind.*, Batavia, 16, p. 386. (Batavia.)

1, 170.0 mm., Potro Novo.

Distribution.—From Baluchistan and coast of India to Malaya and Malay Archipelago. (Coastal waters.)

77. *Mugil tade* Forskål

1775. *Mugil tade* Forskal, *Descr. Anim.*, Hauniae, pp. 14, 74. (Arabia.)

1, 274.0 mm., Poraiyar, Tranquebar ; 4, 122.0—150.0 mm., Gadilam R., Cuddalore.

Distribution.—From the Red Sea, Sokotra, India and Ceylon to Malaya, Malay Archipelago, China, Philippines, Marianas, Guam and Australia. (Coastal and estuarine waters and tidal rivers.)

Order 12. POLYNEMIFORMES**Family 1. POLYNEMIDAE****78. *polynemus heptadactylus* Cuv. & Val.**

1829. *Polynemus heptadactylus* Cuvier and Valenciennes, *Hist. Nat. Poiss.*, Paris, 3, p. 300. (Batavia.)

1, 116.0 mm., Tranquebar.

Distribution.—From coast of India and Ceylon to Malaya and Malay Archipelago. (Coastal and brackish waters.)

79. *Polydactylus sextarius* (Bloch & Schn.)

1801. *Polynemus sextarius* Bloch & Schneider, *Syst. Ichth.*, Berlin, p. 18, pl. 4. (Tranquebar.)

1, 154.0 mm., Keechankuppam, Nagapatnam ; 7, 124 to 177.0 mm., Tranquebar (*topotypes*) ; 1, 142.0 mm., Veerampatnam, Pondicherry ; 1, 151.5 mm., Kilingimedu, Karaikkal.

Distribution.—From east coast of Africa, India and Ceylon to Malaya, Malay Archipelago, Thailand and China. (Coastal waters.)

80. *Polydactylus indicus* (Shaw)

1804. *Polynemus indicus* Shaw, *General Zool.*, London, 5, (1), p. 155. (Vizagapatnam.)

1, 220.0 mm., Sonakuppam, Cuddalore ; 2, *ca.* 300 mm., Kudikadu back waters, Cuddalore ; 1, 225.0 mm., Keechankuppam, Nagapatnam.

Distribution.—From east coast of Africa, Madagascar, Mauritius, India and Ceylon to Burma, Malaya, Malay Archipelago and Australia. (Coastal waters and rivers.)

Order 13. OPHIOCEPHALIFORMES**Family 1. CHANNIDAE****82. *Channa gachua* (Hamilton)**

1822. *Ophiocephalus gachua* Hamilton, *Fish. Ganges*, Edinburgh, pp. 68, 367, pl. 21, fig. 21. (Bengal.)

2, 80.0 and 31.5 mm., Usteri Tank ; 2, 62.0 and 93.0 mm., Gadilam R., Cuddalore ; 7, 32.0—83.5 mm., Ponnaiyar R., Cuddalore ; 1, 153.0 mm., Ponnaiyar R., Mudukkarai.

Distribution.—From Baluchistan and Afghanistan, India and Andamans to Burma, Malaya, Malay Archipelago, Indo-China and Thailand. (Fresh water streams and stagnant pools of coastal plains.)

83. *Channa leucopunctata* (Sykes)

1841. *Ophiocephalus leucopunctatus* Sykes, *Trans. Zool. Soc. Lond.*, London, 2, p. 352, pl. 60, fig. 3. ("Goreh river, Dukhan".)

1, 264·0 mm., Kakakurughi, Karaikkal ; 2, 240·0 and 250·0 mm., Thannikoil, Cuddalore.

Distribution.—Peninsular India and Deccan. (Rivers, large tanks and lakes.)

84. *Channa punctata* (Bloch)

1793. *Ophicephalus punctatus* Bloch, *Naturng. ausland. Fische*, Berlin, 7, p. 139, pl. 358. (Malabar.)

5, 65·0—119·0 mm., Madakardipet, 4½ miles north of Madukkarai; 77·0—94·5 mm., Usteri tank ; 11, 80·0—142·0 mm., Ponnaiyar R., Madukkarai.

Distribution.—Ceylon, India, Burma and Malaya. (Large fresh water tanks and ponds ; rarely rivers.)

85. *Channa striata* (Bloch)

1793. *Ophicephalus striatus* Bloch, *Naturng. ausland. Fische*, Berlin, 10 p. 141, pl. 359. (Malabar.)

1, 181·5 mm., Usteri tank.

Distribution.—From India and Ceylon to Malay, Malaya Archipelago, Thailand, China and Philippines. (Rivers, canals, lakes, ponds and marshes.)

Order 14. PERCIFORMES**Family 1. AMBASSIDÆ****86. *Ambassis commersoni* Cuv. & Val.**

1828. *Ambassis commersonii* Cuvier & Valenciennes, *Hist. Nat. Poiss.*, Paris, 2, p. 176. (Bourbon Island, Mediterranean ; Pondicherry ; Mahe ; Java.)

7, 61·5—94·0 mm., Gadilam R., Cuddalore ; 18, 44·5—99·0 mm., Kudikadu back waters, Cuddalore ; 1, 90·0 mm., Veerampatnam, 3 miles south of Pondicherry, 3, 90·0—135·0 mm., Keechankuppam, Nagapatnam.

Distribution.—From Red Sea, east coast of Africa, Madagascar, Mauritius, Seychelles, coasts of India and Ceylon to Thailand, Malay Archipelago, Philippines and Australia. (Estuaries, ascending rivers.)

87. *Ambassis gymnocephalus* (Lacépède)

1802. *Lutjanus gymnocephalus* Lacépède, *Hist. nat. Poiss.*, Paris, pp. 181, 216. (Indo-Pacific.)

2, 53·5 mm. each, Kudikadu backwaters, Cuddalore ; 24, 22·0—42·0 mm., Ponnaiyar R., Cuddalore ; 14, 50·0—75·5 mm., Sunnambar R. at Nononkuppam, Pondicherry.

Distribution.—From coasts of east Africa, India and Ceylon to Malaya, Malay Archipelago, Thailand, China, Philippines and Australia. (Estuarine, entering rivers.)

88. *Ambassis ranga* (Hamilton)

1822. *Ambassis ranga* Hamilton, *Fish. Ganges*, Edinburgh, pp. 113, 371, pl. 16, fig. 38. (Gangetic Provinces.)

1, 35·0 mm., Usteri Tank.

Distribution.—India, Burma and Thailand. (Fresh water streams, lakes, tanks and ponds.)

Family 2. EPINEPHELIDAE

89. *Epinephelus tauvina* (Forskāl)

1775. *Percatauvina* Forskal, *Descript. Animal.*, Hauniae, 11, p. 39. (Djedda, Red Sea.)

2, 202.0 and 218.0 mm. Tranquebar coast.

Distribution.—Widely distributed from the coast of Africa to Hawaii Islands and to Australia, northwards as far as south China. (Coastal waters.)

Family 3. THERAPONIDAE

90. *Therapon jarbua* (Forskāl)

1775. *Seiaena jarbua* Forskal, *Descript. Animal.*, Hauniae, 12, p. 50. (Djedda, Red Sea.)

2, 51.0 and 84.0 mm., Ponnaiyar R., Cuddalore ; 1, 148.5 mm., Kudikadu, Cuddalore ; 7, 54.0—141.5 mm., Veerampatnam, Pondicherry ; 1, 127.5 mm., brackish waters near Manikaran-thope, Pondicherry ; 1, 166.0 mm., Kilingimedu, Karaikkal ; 1, 71.5 mm., Poraiyar, Tranquebar.

Distribution.—Widely distributed in the Indo-West Pacific ranging from the Red Sea and east coast of Africa to Japan and to Australia and to Polynesia. (Coastal waters and estuaries.)

91. *Therapon puta* Cuv. & Val.

1829. *Therapon puta* Cuvier and Valenciennes, *Hist. nat. Poiss.*, Paris, 3, p. 131. (Pondicherry, Mahe.)

6, 80.5—112.0 mm., Veerampatnam, Pondicherry (*topotypes*) ; 5, 117.0—148.0 mm., Kilingimedu, Karaikkal.

Distribution.—Indo-West Pacific, ranging from the Red Sea and the east coast of Africa to New Britain (Bismarck Archipelago), and Queensland. (Coastal and brackish waters.)

92. *Pelates quadrilineatus* (Bloch)

1790. *Holocentrus quadrilineatus* Bloch, *Naturg. ausland. Fische*, Berlin, 4, p. 82, pl. 238. ("The Orient".)

2, 137.5 and 145.0 mm., Kilingimedu, Karaikkal ; 1, 109.0 mm. back waters near Manikaran-thope, Pondicherry.

Distribution.—Widespread in the Indo-West Pacific, extending from Red Sea and east coast of Africa through Malay Archipelago to North Australia. (Coastal and brackish waters.)

Family 4. SILLAGINIDAE

93. *Sillago sihama* (Forskāl)

1775. *Atherina sihama* Forskal, *Descr. Animal.*, Hauniae, pp. 13, 70. (Lohaja, Red Sea.)

5, 88.5—150.0 mm., Veerampatnam, Pondicherry ; 2, 147.0 and 204.0 mm. ; 1, 195.0 mm., Sonakuppam, Cuddalore.

Distribution.—Widely distributed from the Red Sea and east coast of Africa to Australia, Japan and Polynesia. (Coastal waters and estuaries.)

Family 5. LACTARIIDAE

94. *Lactarius lactarius* (Bloch & Schn.)

1801. *Scomber lactarius* Bloch & Schneider, *Syst. Ichth.*, Berlin, p. 31. (Tranquebar.)

1, 158.0 mm., Tranquebar, (*topotype*) ; 3, 160.0 mm., Veerampatnam, Pondicherry ; 1, 173.0 mm., Porto Novo coast ; 3, 155.0—200.0 mm., Kilingimedu, Karaikkal.

Distribution.—Widely distributed from the Red Sea and east coast of Africa to Japan, Australia and Polynesia. (Coastal waters.)

Family 6. RACHYCENTRIDAE

95. *Rachycentron canadus* (Linnaeus)

1766. *Gasterosteus canadus* Linnaeus, *Syst. Nat.* (ed. 12), London, 1, p. 491. (Carolina.)

1 460.0 mm., Pondicherry ; 1, 287.0 mm., Tranquebar.

Distribution.—In all warm seas, except the west coast of America. (Pelagic in coastal waters.)

Family 7. CARANGIDAE

96. *Alectis indica* (Rüppell)

1828. *Scyris indicus* Rüppell, *Atlas Fische Roth. Meer.*, Frankfurt, p. 128, pl. 33, fig. 1. (Djedda, Red Sea.)

1, 120.0 mm., Cuddalore.

Distribution.—Widely distributed in the Indo-West Pacific, ranging from the Red Sea and Delagoa Bay to Hawaii Islands. (Coastal waters.)

97. *Atropus atropus* (Bloch & Schn.)

1801. *Brama atropos* Bloch & Schneider, *Syst. Ichth.*, Berlin, p. 98. (Tranquebar.)

3, 150.0—190.5 mm., Tranquebar (*topotypes*) ; 3, 128.0—175.0 mm., Kilingimedu, Karaikkal.

Distribution.—Widespread in the warmer Indo-West Pacific, ranging from east coast of Africa to China and Polynesia. (Coastal waters.)

98. *Caranx* (*Caranx*) *carangus* (Bloch)

1793. *Oscomber carangus* Bloch, *Naturg. ausland. Fische*, Berlin, 7, p. 69. (Antilles.)

1, 198.0 mm., Sonakuppam, Cuddalore ; 1, 80.0 mm., Pondicherry ; 1, 119.0 mm., Sunnambar R., at Nonamkuppam, Pondicherry ; 2, 171.0 and 190.0 mm., Kilingimedu, Karaikkal.

Distribution.—Widely distributed in the Indo-West Pacific, ranging from the Red Sea and east coast of Africa to Hawaii Islands and probably also Atlantic coast of tropical America. (Coastal waters.)

99. *Caranx* (*Carangoides*) *malabaricus* (Bloch & Schn.)

1801. *Scomber malabaricus* Bloch & Schneider, *Syst. Ichth.*, Berlin, p. 31. (Tranquebar.)

2, 163.0 and 170.0 mm., Tranquebar (*topotypes*).

Distribution.—Widespread, ranging from Red Sea and east and south coast of Africa to Australia, Philippines and Japan. (Coastal waters.)

100. *Caranx* (Selar) *kalla* (Cuv. & Val.)

1833. *Caranx kalla* Cuvier and Valenciennes *Hist. nat. Poiss.*, Paris, 9, p. 49. (Malabar ; Mahe ; Red Sea.)

1889. *Caranx kalla*, Day, *Faun. Brit. Ind., Fish*, 2, p. 160.

1, 130.0 mm., Tranquebar.

Distribution.—Widely distributed from the Red Sea and east coast of Africa to Australia and Japan. (Coastal, shallow and deeper waters.)

101. *Caranx* (Selaroides) *leptolepis* (Cuv. & Val.)

1883. *Caranx leptolepis* Cuvier and Valenciennes, *Hist. nat. Poiss.*, Paris, 9, p. 63. (Java.)

1, 148.0 mm., Cuddalore.

Distribution.—From the coast of Arabia, India and Ceylon to China, Riu Kiu, Formosa, Philippines and Queensland. (Coastal waters.)

102. *Megalaspis cordyla* (Linnaeus)

1758. *Scomber cordyla* Linnaeus, *Syst. Nat.* (ed. 10), London, Pt. 1, p. 298. (East Indies.)

2, 265.0 mm. each, Kilingimedu, Karaikkal ; 1, 216.0 mm., Tranquebar.

Distribution.—Widely distributed in the Indo-West Pacific, ranging from the Red Sea and east coast of Africa to Polynesia and Hawaii. (Coastal waters.)

103. *Chorinemus sancti-petri* Cuv. & Val.

1831. *Chorinemus sancti-petri* Cuvier and Valenciennes, *Hist. nat. Poiss.*, Paris, 8, p. 279. (Malacca.)

2, 290.0 mm., each, Kilingimedu, Karaikkal ; 1, 300.0 mm., Tranquebar ; 1, 131.5 mm., Veerampatnam, Pondicherry.

Distribution.—Widely distributed in the Indo-West Pacific, ranging from the Red Sea and east coast of Africa to Polynesia and Hawaii. (Coastal waters.)

104. *Chorinemus lysan* (Forsk.)

1775. *Scomber lysan* Forskal, *Descr. Animal.*, Hauniae, p. 54. (Djedda ; Lohaja.)

1, 325.0 mm., Pondicherry.

Distribution.—Widespread in the Indo-West Pacific, extending from Red Sea and east coast of Africa to Japan, Australia, Melanesia and Polynesia. (Coastal waters.)

105. *Chorinemus tala* Cuv. & Val.

1831. *Chorinemus tala* Cuvier & Valenciennes, *Hist. nat. Poiss.*, Paris, 8, p. 317. (Malabar.)

6, 160.0 to 250.0 mm., Pondicherry.

Distribution.—From the Red Sea and east coast of Africa to Australia, Thailand and the Philippines. (Coastal waters.)

Family 8. MENIDAE

106. *Mene maculata* (Bloch & Schn.)

1801. *Zeus maculatus* Bloch & Schenider, *Syst. Ichth.*, Berlin, p. 95. (Tranquebar.)
5, ca. 200 mm. each, Tranquebar (*topotypes*).

Distribution.—Widespread from east coast of Africa to Queensland and Japan. (Coastal waters.)

Family 9, LUTJANIDAE

107. *Lutjanus argentimaculatus* (Forskål)

1775. *Sciaena argentimaculatus* Forskål, *Descr. Animal.*, Hauniae, pp. 11, 47. (Arabia.)

10, 56·0-95·0 mm., Sunnambar R. at Nonamkuppam, Pondicherry.

Distribution.—Widespread in the Indo-West Pacific, ranging from the Red Sea and east coast of Africa to Riu Kiu Islands, Australia and Polynesia. (Coastal entering estuaries.)

108. *Lutjanus johnii* (Bloch)

1792. *Anthias johnii* Bloch, *Naturg. ausland. Fische*, Berlin, 6, p. 113, pl. 318, (Suratta.)

2, 180·0 and 191·0 mm., mouth of Arasalar R., Karaikkal.

Distribution.—Widespread from the east coast of Africa to Philippines, China, Australia and Polynesia. (Coastal waters.)

Family 10. NEMIPTERIDAE

109. *Nemipterus japonicus* (Bloch)

1791. *Sparus japonicus* Bloch, *Naturg. ausland. Fische*, Berlin, 5, p. 110, pl. 227, fig. 1. (Type-locality not given.)

1, 200·0 mm., Veerampatnam, Pondicherry ; 2, 165·0 mm. each, Porto Novo.

Distribution.—Widespread from the Red Sea and east coast of Africa to China and the Philippines. (Coastal waters.)

Family 11 LEIOGNATHIDAE

110. *Leiognathus dussumieri* (Cuv. & Val.)

1835. *Equula dussumieri* Cuvier & Valenciennes, *Hist. nat. Poiss.*, Paris, 10, p. 56, pl. 283. (Coromandel coast.)

1, 133·5 mm., Sonakuppam, Cuddalore.

Distribution.—From Madagascar and coasts of India, Ceylon and Andamans to Australia and Polynesia. (Coastal waters.)

111. *Leiognathus equulus* (Forskål)

1775. *Scomber equula* Forskal, *Descr. Animal.*, Hauniae, pp. 12, 58. (Arabia.)

3, 133·0 mm.—240·0 mm., Sunnambar R. at Nonankuppam, Pondicherry ; 3, 105·0—220·0 mm., Sonakuppam, Cuddalore ; 1, 114·5 mm.

Veerampatnam, Pondicherry.

Distribution.—Widespread in the Indo-West Pacific, ranging from Red Sea and east coast of Africa to Philippines, Japan, Australia and Polynesia. (Coastal water, ascending rivers.)

112. *Leiognathus fasciatus* (Lacépède)

1803. *Clupea fasciata* Lacépède, *Hist. nat. Poiss.*, Paris, 5, pp. 425, 460. (Mauritius.)

4, 32.0-55.5 mm., Sonnambar R., at Nonankuppam, Pondicherry; 1, 61.5 mm., Kudikadu backwaters, Cuddalore.

Distribution.—Widespread from Red Sea Zanzibar, Madagascar, India and Ceylon to Philippines, Australia and Polynesia. (Coastal waters.)

113. *Leiognathus insidiator* (Bloch)

1787. *Zeus insidiator* Bloch, *Naturl. ausland. Fische*, Berlin, 3, p. 41, pl. 191, figs. 2-3. (Suratte.)

1889. *Equula insidiatrix* Day, *Faun. Brit. Ind., Fish*, 2, p. 191.

3, 100.0—110.0 mm., Sonakuppam, Cuddalore ; 3, 86.0—100.0 mm., Kilingimedu, Karaikkal ; 1, 106.0 mm., Pondicherry ; 6, 50.0—60.0 mm., Porto Novo ; 1, 49.5 mm., Veerampatnam, Pondicherry.

Distribution.—Widespread from the east coast of Africa to China, Philippines and Polynesia. (Coastal and estuarine waters.)

114. *Leiognathus lineolatus* (Cuv. & Val.)

1835. *Equula lineolata*, Cuvier & Valenciennes, *Hist. Nat. Poiss.*, Paris, 10, p. 86. (Java ; Anjer.)

2, ca, 116.0 mm. each, Sonakuppam, Cuddalore., 1, 134.0 mm. Veerampatnam, Pondicherry.

Distribution.—From Madagascar, India and Ceylon to Malaya, Malay Archipelago, Japan and Queensland. (Coastal waters.)

115. *Leiognathus ruconius* (Hamilton)

1822. *Chanda ruconius* Hamilton, *Fish. Ganges*, Edinburgh, pp. 106, 371, pl. 12, fig. 35. (Ganges estuaries.)

1, 40.0 mm., Veerampatnam, Pondicherry.

Distribution.—Widespread in the Indo-west Pacific, ranging from South Africa to Australia, Philippines and Formosa. (Shallow coastal and estuarine waters.)

116. *Leiognathus splendens* (Cuvier)

1829. *Equula splendens*, Cuvier, *Règne Animal* (ed. 2), Paris, 2, p. 212. (Based on *Gomorah korah* Russell, 1803, *Fish. Coromandel*, 1, p. 48, fig. 61, Vizagapatam.)

1, 124.0 mm., Kilingimedu, Karaikkal ; 4, 90.0-120.0 mm., Veerampatnam, Pondicherry ; 2, 105.5 mm. each, Sonakuppam, Cuddalore.

Distribution.—From Red Sea, Madagascar, Mauritius, Coasts of India and Ceylon to Malay, Malaya Archipelago, Thailand, China, Formosa, Philippines, Queensland and Polynesia. (Coastal waters.)

117. *Gazza minuta* (Bloch)

1797. *Scomber minuta* Bloch, *Syst. Ichth.*, Berlin, p. 110, pl. 429, fig. 2. (Malabar.)

4, 87·0—128·0 mm., Kilingimedu, Karaikkal ; 1, 103·5 mm., Pondicherry ; 2, 135·0 and 154·5 mm., Porto Novo ; 1, 124·5 mm., Sonakuppam, Cuddalore.

Distribution.—Widespread in the Indo-West Pacific, ranging from the Red Sea and east Coast of Africa to Philippines, Formosa, Queensland and Polynesia. (Coastal waters.)

Family 12. GERRIDAE

118. *Gerres filamentosus* (Cuvier)

1829. *Gerres filamentosus* Cuvier, *Règne Animal* (ed. 2), Paris, 2, p. 188. (Vizagapatnam.)

1, 130·0 mm., Kilingimedu, Karaikkal ; 1, 191·5 mm., Veerampatnam, Pondicherry—2, ca. 115·0 mm. each, Kudikadu backwaters, Cuddalore ; 1, 200·0 mm., Tranquebar

Distribution.—Widespread from the Red Sea and east Coast of Africa to Philippines, Japan, Queensland and Melanesia. (Coastal and estuarine waters.)

119. *Gerres setifer* (Hamilton)

1822. *Chanda setifer* Hamilton, *Fish. Ganges*, Edinburgh, pp. 105, 370. (Ganges estuaries.)

1, 85·0 mm., Tranquebar.

Distribution.—Coasts of India, Ceylon, Burma, Malaya, Thailand and Hongkong. (Coastal and estuarine waters.)

Family 13. SCIAENIDAE

120. *Johnius carutta* (Bloch)

1793. *Johnius carutta* Bloch, *Naturg. ausland. Fische*, Berlin, 7, p. 133, pl. 536. (Tranquebar.)

3, 43·5 to 114·0 mm., Tranquebar (*topotypes*) ; 1, 146·0 mm., Sonakuppam, Cuddalore.

Distribution.—India, Ceylon, Malaya, Malay Archipelago, Thailand and South China. (Coastal waters.)

121. *Johnius maculatus* (Bloch & Schn.)

1801. *Johnius maculatus* Bloch & Schneider, *Syst. Ichth.*, Berlin, p. 75. (Tranquebar.)

1, 148·0 mm., Keechankuppam, Nagapatnam ; 5, 117·0-159·0 mm., Kilingimedu, Karaikkal.

Distribution.—Coasts of India and Ceylon. (Coastal waters.)

122. *Otolithes ruber* (Bloch & Schn.)

1801. *Johnius ruber* Bloch & Schneider, *Syst. Ichth.*, Berlin, p. 75, pl. 17. (Tranquebar.)

1, 203·5 mm., Tranquebar (*topotype*).

Distribution.—East coasts of Africa, India, Ceylon and Malaya. (Coastal waters.)

123. **Otolithes argenteus** Cuv. & Val.

1830. *Otolithus argenteus* Cuvier and Valenciennes, *Hist. nat. Poiss.*, Paris, 5, p. 62. (Batavia ; Malabar ; Malacca.)

1, 129·0 mm., Kilingimedu, Karaikkal ; 3, 200·0—238·0 mm., Sonakuppam, Cuddalore.

Distribution.—Widely distributed from the east coast of Africa to southern China, Philippines and Queensland. (Coastal and estuarine waters.)

124. **Pseudosciaena aneus** (Bloch)

1793. *Johnius aneus* Bloch, *Naturg. ausland. Fische*, Berlin, 7, p. 135. (Malabar.)

1, 234·0 mm., Proto Novo.

Distribution.—Coasts of India, Ceylon and Andamans to South China, Malay Archipelago and Philippines. (Coastal waters and mouths of rivers.)

125. **Pseudosciaena diacanthus** (Lacépède)

1802. *Lutjanus diacanthus* Lacépède, *Hist. nat. Poiss.*, Paris, 4, pp. 195, 240 (Type-locality not given.)

5, 90·0—193·0 mm., Keechankuppam, Nagapatnam ; 3, 230·0—300·0 mm., Cuddalore.

Distribution.—Coasts of India, Ceylon, Burma, Malaya, Malay Archipelago, Thailand, South China and Philippines. (Coastal and estuarine waters.)

126. **Pseudosciaena coibor** (Hamilton)

1822. *Bola coibor* Hamilton, *Fish. Ganges*, Edinburgh, pp. 78, 362. (Ganges River as far as Kanpur ; Jamna River to Agra.)

1, 169·0 mm., Sunnambar R. at Nonankuppam, Pondicherry ; 248·0 mm., Tranquebar.

Distribution.—Seas around India, Ceylon, Malaya, Malay Archipelago and Australia. (Coastal waters and estuaries.)

127. **Pseudosciaena axillaris** (Cuv. & Val.)

1830. *Corvina axillaris* Cuvier and Valenciennes, *Hist. nat. Poiss.*, Paris, 5, p. 112. (Malabar.)

1, 180·0 mm., Sonakuppam, Cuddalore.

Distribution.—Coasts of India, Ceylon, Malay Archipelago, Thailand, South China, Philippines, Queensland and Melanesia. (Coastal waters and mouth of rivers.)

128. **Sciaena dussumieri** (Cuv. & Val.)

1833. *Umbrina dussumieri* Cuvier & Valenciennes, *Hist. nat. Poiss.*, Paris, 9, p. 481. (Coromandel coasts.)

2, 150·0 and 160·0 mm., Veerampatnam, Pondicherry ; 1, 225·0 mm., Kilingimedu, Karaikkal ; 1, 119·0 mm., Porto Novo.

Distribution.—East coast of Africa, Madagascar, India, Ceylon, Malaya, Malay Archipelago, Indo-China, S. China, Formosa and Philippines. (Coastal waters.)

129. *Sciaena macroptera* (Bleeker)

1853. *Umbrina macropterus* Bleeker, *Nat. Tijds. ned. Ind.*, Batavia, 4, p. 254. (Sumatra.)

1, 203·0 mm., Tranquebar.

Distribution.—Natal, India, Ceylon, and Malay Archipelago. (Coastal waters.)

Family 14. LETHRINIDAE

130. *Lethrinus nebulosus* (Forskål)

1775. *Sciaena nebulosa* Forskal, *Descr. Animal*, Hauniae, pp. 12, 52. (Arabia.)

1, 265·0 mm., Sonakuppam, Cuddalore.

Distribution.—Widespread from the Red Sea and east coast of Africa to China, Philippines, Australia and Polynesia. (Coastal waters.)

Family 15. MULLIDAE

131. *Upeneus vittatus* (Forskål)

1775. *Mullus vittatus* Forskal, *Descr. Animal*, Hauniae, pp. 10, 31. (Djedda, Red Sea.)

1, 68·0 mm., Sunnambar R. at Nonankuppam, Pondicherry ; 1, 65·5 mm., Veerampatnam, Pondicherry ; 2, ca. 149·5 mm. each, Kilingimedu, Karaikkal.

Distribution.—Widespread in the Indo-West Pacific, ranging from Red Sea and east coast of Africa to Japan, Philippines, Australia and Polynesia. (Shallow coastal waters.)

Family 16. KYPHOSIDAE

132. *Kyphosus cinerascens* (Forskål)

1775. *Sciaena cineras* Forskål, *Descr. Animal*, Hauniae, pp. 12, 53. (Arabia.)

1, 169·0 mm., Pondicherry.

Distribution.—Widespread from Red Sea and east Coast of Africa to Japan, Australia and Malanesia. (Coastal waters.)

Family 17. EPHIPPIDAE

133. *Ephippus orbis* (Bloch)

1787. *Chaetodon orbis* Bloch, *Naturg. ausland. Fische*, Berlin, 3, p. 81, pl. 202, fig. 1. (East Indies.)

1, 172·0 mm., Pondicherry.

Distribution.—From the east coast of Africa to China, Formosa and the Philippines. (Coastal waters.)

Family 18. DREPANIDAE

134. *Drepane punctata* (Linnaeus)

1758. *Chaetodon punctatus* Linnaeus, *Syst. Nat.*, (ed. 10.) London, Pt. 1, p. 273. (Asia.)

1, 92·0 mm., Pondicherry ; 1, 85·5 mm., Kilingimedu, Karaikkal.

Distribution.—Red Sea and east coast of Africa to Australia, China, Philippines and Polynesia. (Coastal and estuarine waters.)

Family 19. SCATOPHAGIDAE**135. *Scatophagus argus* (Linnaeus)**

1766. *Chaetodon argus* Linnaeus, *Syst. Nat.*, (ed. 12), London, 1, p. 464. (India.)
1, 200 mm., Poraiyar, Tranquebar ; 2, 83·5 & 88·5 mm.,
Gadilam R., Cuddalore.

Distribution.—Coasts of India, Ceylon, Burma, Malaya, Malay Archipelago, Thailand, China, Formosa, Philippines, Australia Melanesia and Polynesia. (Coastal waters, entering estuaries and fresh water of rivers and lakes.)

Family 20. CICHLIDAE**136. *Eetroplus maculatus* (Bloch)**

1785. *Chaetodon maculatus* Bloch, *Ichth. Hist. nat.*, Paris, pl. 427, fig. 2. (type-locality not given.)

22, 41·0—71·5 mm., Usteri Tank ; 4, 55·5 65·5 mm., Vellar R., Porto Novo ; 28, 14·0—39·5 mm., Ponnaiyar R., Cuddalore.

Distribution.—Ceylon and Peninsular India. (Coastal fresh waters.)

137. *Eetroplus suratensis* (Bloch)

1785. *Chaetodon suratensis* Bloch, *Ichth. Hist. nat.*, Paris, pl. 217. (Surat.)

2, 185·0 and 218·0 mm., Pondicherry.

Distribution.—Ceylon, Peninsular India and Deccan. (Coastal fresh and brackish waters.)

Family 21. CEPOLIDAE**138. *Acanthocephala abbreviata* (Cuv. & Val.)**

1835. *Cepola abbreviata* Cuvier & Valenciennes, *Hist. nat. Poiss.*, Paris, 10, p. 403. (Anjer Strait, near Java.)

1, 176·5 mm., Porto Novo.

Distribution.—Coasts of India, Malaya, Malay Archipelago, and Philippines. (Coastal waters.)

Family 22. URANOSCOPIDAE**139. *Ichthyoscopus lebeck* (Bloch & Schn.)**

1801. *Uranoscopus lebeck* Bloch & Schneider, *Syst. Ichth.*, Berlin, p. 47. (Tranquebar.)

1, 220·0 mm., Porto Novo.

Distribution.—Coasts of India and Ceylon, Malay Archipelago, Australia and Japan. (Coastal waters.)

140. *Uranoscopus guttatus* Cuvier

1829. *Uranoscopus guttatus* Cuvier, *Hist. nat. Poiss.*, Paris, 3, p. 305. (Pondicherry.)

2, 103·0 and 128·0 mm., Porto Novo.

Distribution.—India. (Coastal waters.)

Family 23. SIGANIDAE

141. *Siganus oramin* (Bloch & Schn.)

1801. *Amphacanthus guttatus* var. *oramin* Bloch & Schneider, *Syst. Ichth.*, Berlin, p. 207, pl. 48. (Tranquebar.)

2, 169.0 mm. each, Kilingimedu, Karaikkal.

Distribution.—Widespread in Indo-West Pacific, ranging from east coast of Africa to Japan, Australia, Melanesia, Micronesia, and Polynesia. (Coastal waters.)

Family 24. TRICHIURIDAE

142. *Trichiurus savala* Cuvier

1829. *Trichiurus savala* Cuvier, *Règne Animal* (2 ed.), Paris, 11, p. 219.

1831. *Trichiurus savala* Cuvier, *Hist. nat. Poiss.*, Paris, 8, p. 251, pl. 224. (Pondicherry ; China ; Malacca.)

8, 300.0 to 460.0 mm., Veerampatnam, Pondicherry (*topotypes*)
1, 390.0 Kilingimedu, Karaikkal.

Distribution.—From India and Ceylon to Malaya, Malay Archipelago, Thailand, China, Japan, Philippines and Queensland. (Coastal waters and estuaries.)

Family 25. SCOMBRIDAE

143. *Rastrelliger kanagurta* (Cuvier)

1817. *Scomber kanagurta* Cuvier, *Règne Animal*, Paris, 2, Op. 313, footnote. (Based on *kanagurta* Russell, 1803, *Fish Coromandel*, 11, p. 28, fig. 136, Vizagapatam.)

3, 215.0—230.0 mm., Sonakuppam, Cuddalore; 1, 240.0 mm., Veerampatnam, Pondicherry ; 2, 225.0 mm., & 230.0 mm., Tranquebar ; 1, 90.0 mm., Kilingimedu, Karaikkal.

Distribution.—Widespread in Indo-West Pacific, ranging from Red Sea and east coast of Africa to Japan, Australia, Melanesia, Micronesia and Polynesia. (Open sea and coastal waters.)

Family 25. CIBIIDAE

144. *Scomberomorus commersoni* (Lacépède)

1800. *Scomber commerson* Lacépède, *Hist. nat. Poiss.*, Paris, 2, pp. 598, 600, pl. 20, fig. 1. (Type-locality not given.)

1, 360.0 mm., Tranquebar.

Distribution.—Widespread in Indo-West Pacific, ranging from Red Sea and east and south coast of Africa to Japan, Australia, Melanesia and Polynesia. (Coastal and brackish waters.)

145. *Scomberomorus guttatus* (Bloch & Schn.)

1801. *Scomber guttatus* Bloch & Schneider, *Syst. Ichth.*, Berlin, p. 23, fig. 5. (Tranquebar.)

2, 340.5 mm., and 400.0 mm., Tranquebar (*topotypes*).

Distribution.—From Persian Gulf through India, and Ceylon to Malaya, Malay Archipelago, Thailand, China, Formosa and Philippines. Open sea and coastal waters, entering rivers.)

Family 27. STROMATEIDAE

146. *Pampus chinensis* (Euphrasen)

1788. *Stromateus chinensis* Euphrasen, *Kongl. Vete. Acad. Handl. Stockholm*, Stockholm, 9, p. 53. (Channel between Canton & Hong Kong along Chinese coast.)

2, 205.0 mm. each Veerampatnam, Pondicherry.

Distribution.—From India and Ceylon to Malaya, Malay Archipelago, Thailand, Indo-China and China. (Coastal waters.)

147. *Parastromateus niger* (Bloch)

1795. *Stromateus niger* Bloch, *Naturg. ausland. Fische*, Berlin, 6, p. 93, pl. 422 (Malaya.)

1, 239.0 mm., Sattankudi, Tranquebar.

Distribution.—Widespread from Persian Gulf and east coast of Africa to Japan and Philippines. (Coastal waters.)

Family 28. ANABANTIDAE

148. *Anabas testudineus* (Bloch)

1792. *Anabas testudineus* Bloch, *Naturg. ausland. Fische*, Berlin, 6, p. 121, pl. 322. (East Indies.)

8, 31.0—95.0 mm., Kakamurughe village, near Karaikkal ; 7, 19.0—35.0 mm., Thannikoil, Cuddalore.

Distribution.—India, Ceylon, Burma, Malaya, Malay Archipelago, Thailand, Indo-China, South China and Philippines. (Rivers, lakes, ponds, marshes and ditches ; also estuaries. Both fresh and brackish waters.)

Family 29. ELEOTRIDAE

149. *Eleotris fusca* (Bloch & Schn.)

1801. *Poecilia fusca* Bloch & Schneider, *Syst. Ichth.*, Berlin, p. 453. (New Hebrides.)

6, 35.0—55.0 mm., Ponnaiyar R., Cuddalore.

Distribution.—From the east coast of Africa to the Philippines, Guam and through Polynesia to the Marquesas (Brackish to fresh waters.)

Family 30. GOBIIDAE

150. *Glossogobius giuris* (Hamilton)

1822. *Gobius giuris* Hamilton, *Fish Ganges*, Edinburgh, p. 51, pl. 33, fig. 15. (Gangetic Provinces.)

7, 35.0—144.0 mm., Ponnaiyar R., Cuddalore ; 223, 45.0—52.0 mm., Kudikadu backwaters, Cuddalore ; 23, 30.0—52.5 mm., Madukkarai, Pondicherry ; 8, 27.5—44.0 mm., Gadilam R., Cuddalore ; 1, 99.0 mm., Kakamurihe, Karaikkal ; 2, 43.5 mm., each, Kunjampetta, Cuddalore ; 1, 145.0 mm., Sunnambar R., at Nonankuppam, Pondicherry ; 3, 70.0—195.0 mm., Poraiyar, Tranquebar.

Distribution.—From east coast of Africa to Australia and New Caledonia, Philippines, China and Japan. (Fresh and salt waters.)

Family 31. PERIOPHTHALMIDAE

151. *Boleophthalmus boddarti* (Pallas)

1770. *Gobius boddarti* Pallas, *Spicilegia*, Berlin, 8, p. 11, pl. figs. 4-5. (Indian Ocean.)

7, 96.5—160.0 mm., Vellar R., Porto Novo ; 2, 100.0 & 133.0 mm., mouth of Arasalar R., Karaikkal ; 2, 112.0 & 149.0 mm., Kunjampetta, Cuddalore ; 1, 67.5 mm., Gadilam R., Cuddalore ; 38, 80.0—128.0 mm., Tranquebar.

Distribution : India, Malaya, Malay Archipelago and Thailand. (Salt and brackish waters, entering tidal rivers.)

Family 32. SCORPAENIDAE

152. *Minous monodactylus* (Bloch & Schn.)

1801 *Scorpaena monodactyla* Bloch & Schneider *Syst. Ichth.*, Berlin, p. 194. (Type-locality not given.)

3, 103.5-116.0 mm., Sonakuppam, Cuddalore.

Distribution.—Seas of India to China. (Coastal waters.)

153. *Sebastichthys strongia* (Cuv. & Val.)

1829. *Scorpaena strongia* Cuvier & Valenciennes, *Hist. nat. Poiss.* Paris, 4, p. 323. (Caroline Islands.)

4, 68.5—116.5 mm., Porto Novo.

Distribution.—From India and Ceylon to Polynesia and Hawaii. (Coastal waters.)

Family 33. PLATYCEPHALIDAE

154. *Platycephalus indicus* (Linnaeus)

1758. *Callionymus indicus* Linnaeus, *Syst. Nat.* (ed. 10), London, 1, p. 250. (Asia.)

1, 96.0 mm., Kilingimedu, Karaikkal ; 1, ca. 122.0 mm., Kudikadu backwaters, Cuddalore.

Distribution.—Widespread, ranging from Red Sea and east coast of Africa to Australia, Japan and Melanesia. (Coastal waters and estuaries.)

155. *Platycephalus macracanthus* (Bleeker)

1869. *Platycephalus macracanthus* Bleeker, *Akad. Wet. Amsterdam Verslag.*, Amsterdam, 3 (2), p. 253. (Amboina.)

1, 151.5 mm., Porto Novo.

Distribution.—India to the Malay Archipelago and Amboina. (Coastal waters.)

156. *Platycephalus scaber* (Linnaeus)

1758. *Cottus scaber* Linnaeus, *Syst. Nat.* (ed. 10), London, Pt. 1, p. 451. (East Indies.)

2, 118.0 mm. and 161.0 mm., Porto Novo ; 3, 220.0—225.0 mm., Kilingimedu, Karaikkal ; 1, 205.0 mm., Sonakuppam, Cuddalore.

Distribution.—Seas of India to Malay Archipelago and Amboina. (Coastal waters.)

Order 15. PLEURONECTIFORMES

Family 1. PSETTODIDAE

157. *Psettodes erumei* (Bloch & Schn.)

1801. *Pleuronectes erumei* Bloch & Schneider, *Syst. Ichth.*, Berlin, p. 150. (Tranquebar.)

1, 187.0 mm., Tranquebar (*topotype*).

Distribution.—Widespread, from Red Sea and east coast of Africa to Australia, Philippines and Japan. (Coastal waters down to 50 fathoms.)

Family 2. BOTHIDAE

158. *Pseudorhombus javanicus* (Bleeker)

1853. *Rhombus javanicus* Bleeker, *Nat. Tyds. ned. Indie*, Batavia, 4, p. 502. (Batavia.)

1, 169.0 mm., Porto Novo.

Distribution.—Widespread, from east coast of India and Ceylon to Malaya, Malay Archipelago, Thailand, Indo-China, China and Philippines. (Coastal waters.)

159. *Pseudorhombus triocellatus* (Bloch & Schn.)

1801. *Pleuronectes triocellatus* Bloch & Schneider, *Syst. Ichth.*, Berlin, p. 145. (East Indian seas.)

1, 118.5 mm., Pondicherry ; 2, 110.5 and 124.5 mm., Kilingimedu, Karaikkal ; 1, 123.0 mm., Keechamkuppam, Nagapatnam ; 1, 100 mm., Porto Novo.

Distribution.—Widespread from east coast of India and Ceylon to Malay Archipelago and Polynesia. (Coastal waters.)

Family 3. CYNOGLOSSIDAE

160. *Aesopia cornuta* (Kaup)

1858. *Aesopia cornuta* Kaup, *Arch. Naturg.*, Berlin, 24, p. 98 (India).

2, 104.5 and 128.5 mm., Pondicherry

Distribution.—India and Ceylon. (Coastal waters.)

161. *Brachirus orientalis* (Bloch & Schn.)

1801. *Pleuronectes orientalis* Bloch & Schneider, *Syst. Ichth.*, Berlin, p. 157. (Tranquebar.)

2, 110.0 and 121.5 mm., Vellar R., Porto Novo.

Distribution.—From India and Ceylon to China and Australia. (Coastal waters.)

162. *Cynoglossus lida* (Bleeker)

1851. *Plagusia lida* Bleeker, *Nat. Tyds. ned. Indie*, Batavia, 1, p. 413. (Batavia.)

1, 127.0 mm., Tranquebar ; 1, 120.0 mm., Kilingimedu, Karaikkal ; 2, 190.0 mm. each, Sonakuppam, Cuddalore.

Distribution.—From east coast of Africa to Malaya and Malay Archipelago. (Coastal shallow waters.)

163. *Cynoglossus lingua* (Hamilton)

1822. *Cynoglossus lingua* Hamilton, *Fish. Ganges*, Edinburgh, pp. 32, 365. (Salt estuaries of Calcutta.)

1, 77.5 mm., month of Arasalar R. Karaikkal ; 1, 161.5 mm., Tranquebar.

Distribution.—East coast of India and Ceylon, Malaya, Malay Archipelago and Thailand. (Coastal waters and estuaries.)

164. *Cynoglossus macrolepidotus* (Bleeker)

1850. *Plagusia macrolepidota* Bleeker, *Nat. Tyds. ned. Indie*, Batavia, 1, p. 415. (Batavia).

1, 189.5 mm., Tranquebar ; 1, 210.0 mm., Pondicherry ; 2, *ca.* 340.0 mm., each, Keechankuppam, Nagapatnam ; 2, 187.0 and 222.0 mm., Sonakuppam, Cuddalore ; 1, 227.5 mm., Veerampatnam, Pondicherry.

Distribution.—From Persian Gulf, coasts of India and Ceylon to Philippines. (Coastal waters.)

165. *Synaptura commersoniana* (Lacépède)

1802. *Pleuronectes commersonnii* Lacépède, *Hist. nat. Poiss.*, Paris, 3, pl. 12, fig. 2. (Mauritius.)

1, 82.0 mm., Sonakuppam, Cuddalore ; 1, 217.0 mm., Kilingimedu, Karaikkal.

Distribution.—India and Ceylon to Malaya and Malay Archipelago. (Coastal waters.)

166. *Zebrias quagga* (Kaup)

1858. *Aesopia quagga* Kaup, *Arch. Naturg.*, 1, Berlin, p. 98. (Bombay.)

1, 112.5 mm., Veerampatnam, Pondicherry.

Distribution.—From Iran, India and Ceylon to Japan and Australia. (Coastal waters.)

Order 16. MASTACEMBELIFORMES

Family 1. MASTACEMBELIDAE

167. *Macrognathus aculeatum* (Bloch)

1795. *Ophidium aculeatum* Bloch, *Naturg. ausland. Fische*, Berlin, pl. 159, fig. 2. (Type-locality not given.)

4, 124.0–150.0 mm., Usteri Tank ; 2, 140.0 mm., each, Bahur, 10 miles north-west of Cuddalore ; 1, 190.0 mm., Madakardipet, Madukkarai ; 2, 120.0 and 169.0 mm., Madukkarai, Pondicherry.

Distribution.—India, Ceylon, Burma, Malaya, Malay Archipelago, Thailand, Indo-China and China. (Fresh and brackish waters.)

Order 17. ECHENEIFORMES

Family 1. ECHENEIDAE

168. *Echeneis neucrates* Linnaeus

1758. *Echeneis neucrates* Linnaeus, *Syst. Nat.*, (ed. 10.) London, pt. 1, p. 261. ("In Pelago Indico".)

1, 600.0 mm., Pondicherry.

Distribution.— In all warmer seas of the world. (On large sharks as host.)

Order 18. TETRODONTIFORMES

Family 1. TRIACANTHIDAE

169. *Triacanthus indicus* Regan

1903. *Triacanthus indicus* Regan, *Proc. zool. Soc. Lond.*, London, p. 184. (Based on Russell, 1803, *Indian Fishes*, p. 14, pl. 21, coasts of India.)

2, 119.5 mm., and 200.0 mm., Tranquebar ; 1, 120.0 mm., Pondicherry; 83.5 mm., Kilingimedu, Karaikkal.

Distribution.— From India and Ceylon to Penang. (Coastal waters.)

Family 2. TETRAODONTIDAE

170. *Arothron stellatus* (Bloch and Schn.)

1801. *Tetrodon Lugocephalus* var. *stellatus* Bloch & Schneider. *Syst. Ichth.* Berlin, p. 503. (Mauritius.)

1, 350.0 mm., Keechankuppam, Nagapatnam ; 1, 360.0 mm., Pondicherry.

Distribution.— Widespread in Indo-West Pacific, ranging from East Africa to Australia and Polynesia. (Coastal waters.)

171. *Chelonodon fluviatilis* (Hamilton)

1822. *Tetrodon fluviatilis* Hamilton, *Fish, Ganges*, Edinburgh, pp. 6, 362, pl. 30, fig. 1. (Lower Bengal.)

2, about 110.0 mm. each, Sunnamber river at Nonankuppam ; Pondicherry ; 1, 118.0 mm., Tranquebar.

Distribution.— From India and Ceylon to the Philippines. (Coastal waters entering rivers and lagoons.)

172. *Chelonodon patoca* (Hamilton)

1822. *Tetrodon patoca* Hamilton, *Fish Ganges*, Edinburgh, pp. 7, 362, pl. 18, fig. 2. (Ganges estuaries.)

2, 111.0 and 131.0 mm., Sonakuppam, Cuddalore ; 1, 140.0 mm., Tranquebar.

Distribution.— Widespread in the Indo-West Pacific, ranging from East Africa to the Philippines. (Coastal waters, estuaries and lagoons.)

173. *Gastrophysus lunaris* (Bloch and Schn.)

1801. *Tetrodon lunaris* Bloch & Schneider, *Syst. nat. Bloch.*, Berlin, p. 505. (Malabar.)

1, 131.5 mm., porto Novo ; 14, 70.0—152.0 mm., Ariyamkuppam, Pondicherry ; 4, 100.0—181.5 mm., Kilingimedu, Karaikkal ; 1, 111.5 mm., Veerampatnam, Pondicherry ; 4, 102.2—167.0 mm., Tranquebar.

Distribution.—Widespread in Indo-West Pacific, ranging from East Africa to the Philippines. (Coastal waters.)

174. *Lagocephalus inermis* (Temm. & Schleg.)

1847. *Tetrodon inermis* Temm. & Schleg., *Faun. Japon Poiss.*, Paris, p. 278, t. 122, fig. 2. (Japan.)

2, ca. 110.0 mm. each, Sunnambar R. at Nonankuppam, Pondicherry ; 1, 118.0 mm., Tranquebar.

Distribution.—Widespread in the Indo-West Pacific, ranging from east Africa to Japan. (Coastal waters.)

175. *Troquigener oblongus* (Bloch)

1786. *Tetrodon oblongus* Bloch, *Naturg. ausland. Fische*, Berlin, 2, p. 6., pl. 145, fig. 1. (East Indies.)

2, 85.5 and 113.0 mm., Kilingimedu, Karaikkal ; 1, 235.0 mm., Keechankuppam, Nagapatnam ; 1, 270.5 mm., Pondicherry.

Distribution.—Widespread in Indo-West Pacific, ranging from East Africa to Japan. (Coastal waters.)

IV—ZOOGEOGRAPHICAL REMARKS

Of the 175 species of fishes in the collection under report, *Chela clupeoides* (Bloch), *C. laubuca* (Ham.), *Esomus barbatus* (Jerdon), *Rasbora daniconius* (Ham.), *Labeo calbasu* (Ham.), *L. boga* (Ham.), *L. kontius* (Jerdon.), *Puntius chola* (Ham.), *P. dorsalis* (Jerdon), *P. filmaentosus* (Val.), *P. sarana* (Ham.), *Puntius (sarana) pinnauratus* Day and *P. sophore* (Ham.) (Cyprinidae), *Lepidocephalus thermalis* (Val.) (Cobitidae), *Mystus vittatus* (Bloch) (Bagridae), *Pseudeutropius atherinoides* (Bloch) (Schilbeidae), *Channa gachua* (Ham.), *C. leucopunctata* (Sykes), *C. punctata* (Bloch) and *C. striata* (Bloch) of the family Channidae according to the classification of Myers (1938) may be considered as the "Primary Fresh-water Group" Because of their physiological intolerance to salt water, the migration of these fishes to Peninsular India had to be accomplished by means of fresh water migration routes (Menon, 1955). *Aplocheilichthys panchax* (Ham.) (Cyprinodontidae), *Xenentodon cancila* (Ham.) (Belontiidae), *Ambassis ranga* (Ham.) (Ambassidae), *Epiplatys maculatus* (Bloch) and *E. suratensis* (Bloch) (Cichlidae), *Anabas testudineus* (Bloch) (Anabantidae), *Eleotris fusca* (Bloch and Schn.) (Eleotridae), *Glossogobius aureus* (Ham.) (Gobiidae) and *Macrognathus aculeatus* (Bloch) (Mastacembelidae) may be considered "Secondary" rather than "Primary" fresh water fishes. These fishes have a fairly well-developed salt tolerance and may have been able to colonise Peninsular India by crossing salt water barriers. Leaving out the "Primary" and "Secondary" fresh water fishes, the rest are either marine shore fishes or euryhaline fishes which are adapted to considerable variations in salinity. The euryhaline fishes

show a marine type of distribution similar to those of the shore fishes, and they are, therefore, considered here along with the shore fishes for the purpose of the zoogeographical discussion.

The range of each species in the collection has been carefully investigated and analysed in order to give some idea of the zoogeographical affinities of this fauna. Of the 146 species of shore fishes in the collection, *Galeocerdo cuvieri* (Le Sueur), *Mugil cephalus* Linnaeus and *Echeneis neucrates* Linnaeus, forming 2.0 per cent, are circumtropical in distribution. Two species, *Rachycentron canadus* Linnaeus and *Caranx carangus* (Bloch), forming 1.4 per cent, are also widespread in all warm seas of the world except the west coast of America. *Tachysurus jella* Day, *Anguilla bicolor* McClell., *Bascanichthys deraniyagalai* Menon, *Doryichthys* Sp. *Oryzias melastigma* (McClell.), *Doryichthys cuncalus* (Ham.), *Johnius maculatus* Bloch and Schn. *Uranoscopus guttatus* Cuvier, and *Aesopia cornuta* (Kaup), 9 species, or 6.2 per cent, are endemic to the Indian area. Fourteen species, or 9.6 per cent, are distributed throughout the Indo-West Pacific region, ranging from the East African area to the Polynesian, including the Japanese and the North Australian areas. Sixty-five species, or 44.5 per cent, are spread from the East African area (Red Sea, Arabia, South Africa or Seychelles) to the Malay area including the Japanese or the North Australian or the Polynesian or in the case of a few species, more than one area of the east. Twenty-four species, or 16.4 per cent, are common to the Indian and the Malay areas including one or more areas (Japanese, N. Australian or Polynesian) of the east. Twenty-nine species, or 19.9 per cent, are found in the Indian and the Malay areas only. Thus, it will be seen that excluding the endemic forms there is not a single species which is not found in the Malay area, *i.e.*, about 94.0 per cent of the species of shore fishes in the collection are also found in the Malay area.

The Malay area, with the world's greatest Archipelago containing large areas with a depth of less than 200 m., is the richest in animal life, no region in the world being so rich in species (Ekman, 1953). The present study indicates that the Malay area is the centre and focus of evolution of the marine shore fish fauna of the Indo-West Pacific region and India undoubtedly derived its shore fish fauna from this centre of distribution.

V—SUMMARY

The Coromandel Coast, including Pondicherry and Karaikkal areas, was surveyed during 1956-58 and a systematic account of the fish collections is given. In all 175 species of fish are listed including two recently described species. Topotype specimens of 15 species are present in the collections. A brief zoogeographical discussion of the shore fishes in the collection is also included in the paper.

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3465, pp. 339-364.

PLATE 33

Map of the Coromandel Coast, including Pondicherry and Karaikkal areas, showing the localities where fishes were collected.

ON THE DISTRIBUTION OF THE FISHES (ORDERS CLUPEI—
FORMES, BATHYCLUPEIFORMES, GALAXIIFORMES, SCO-
PELIFORMES AND ATELEOPIIFORMES) OF THE INDIAN RE-
GION IN RELATION TO THE MEAN ANNUAL ISOTHERMS

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(With 1 plate and 1 Text-fig.)

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I—INTRODUCTION

In a previous paper by us (Misra and Menon, 1958) the distributional pattern of the Elasmobranchs and Chimaeras of the Indian region with particular reference to the mean annual isotherms was indicated. The present paper is a similar study regarding the distribution of the fishes of the Orders Clupeiformes, Bathyclupeiformes, Galaxiiformes, Scopeliformes and Ateleopiformes of the Indian region in relation to the mean annual isotherms of 6°, 12° and 20°C.

In the Check-List of these orders by Misra (1947), 171 species were listed from within the limits of the Indian region, *i.e.*, on the west, the Gulf of Oman and then from Ras-el-Haad southwards along Long. 60°E.; on the south, from Lat. 1°S., where it meets Long. 60°E., eastwards to the coast of Sumatra ; on the East, the coast of Burma.

In addition to these, 4 more species, viz., *Sardinella perforata* (Cantor), *Pellona hoevenii* Blkr., *Platyroctogen mirus* Lloyd and *Chirocentrus nudus* Swns., have been added in this paper at the same time relegating two species, *Notopterus osmani* Rahimullah and Das and *Stomias valdiviae* Br. to the synonymy of *Notopterus notopterus* (Pallas) and *Stomias affinis* Gthr. respectively. Thus the total number of species dealt with here is 173 (including 4 subspecies), consisting of 85 littoral, 3 land-locked and exotic, and 85 bathypelagic species.

The mean annual isotherms of 6°, 12° and 30°C. are shown by dotted lines in the accompanying map (Plate 34). The limits of these three isotherms were defined in the previous paper (Misra and Menon, 1958, p. 73) ; and in the classified list of the 173 species given in the end are shown their mean annual isotherms, latitudinal and longitudinal ranges, vertical ranges, distribution, habitat or depths in metres and bottom temperatures wherever available.

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II—DISTRIBUTION OF SPECIES

A detailed and specific study of the distributional ranges of the fishes in relation to the three isotherms reveals the following :—

1. *Littoral or semipelagic, land-locked and bathypelagic species.*—Out of the total 173 species, 85 are littoral, 3 exotic and land-locked, and 85 bathypelagic. All the littoral or semipelagic species are in the 20°C. isotherm. Out of 85 bathypelagic species, 52 are in 20°C. and 21 in both 20° and 12°C. isotherms. Of the remaining 12 species, one species, *Nansenia graenlandicus* (Reinhardt) is restricted to 20°C. isotherm and beyond 6°C. isotherm in the Arctic zone ; five species, viz., *Myctophum coccoi* (Cocco), *Malacosteus niger* Ayres, *Argyropelecus hemigymnus* Cocco, *Argyropeletus aculeatus* V and *Sternoptyx diaphana* Herm. are distributed in 20°, 12° and 6°C. isotherms, while two species, *Cyclothone acclinidens* Garman and *Idiacanthus fasciola* Ptrs. have been recorded in 20° and 12°C. isotherms and beyond 6°C. isotherm in the Antarctic zone ; two species, *Cyclothone signata signata* Garman and *Argyropelecus olfersi* (C.) are distributed in 20°, 12° and 6°C. isotherms and beyond 6°C. isotherm in the Arctic zone ; *Argyropelecus sladeni* Regan is restricted to 20°C. isotherm and beyond 6°C. in the Antarctic zone, while *Cyclothone microdon microdon* Gthr. is remarkable in having been recorded from 20°, 12° and 6°C. isotherms and beyond 6°C. both in the Arctic and Antarctic zones. The 3 land-locked species are exotic and freshwater, viz., *Salmo gairdnerii gairdnerii* Richardson, *Salmo leuvenensis* Walker and *Salmo trutta fario* L. These

have, since a long time, been introduced into the cold climates of the "Indian region" and are known to breed successfully, subject to snow-fall, at altitudes ranging from 8000-9000 ft. above the sea level and never below it.

2. *Endemic species*.—Out of the total 170 littoral and bathypelagic species, 33 are endemic to the "Indian region", the rest 137 occurring beyond the "Indian region". All the endemic species are in the 20°C. isotherm. Of the 33 endemic species, 16 are littoral, viz., *Ehirava fluviatilis* Deraniyagala, *Stolephorus malabaricus* (Day), *Gudusia variegata* (Day), *Ilisha leschenaulti* (V.), *Ilisha motius* (Ham.), *Ilisha sladeni* (V.), *Gonialosa manmina* (Ham.), *Gonialosa modestus* (Day), *Setipinna phasa* (Ham.), *Coilia cantoris* Blkr., *Coilia quadragesimalis* V., *Coilia ramcarati* (Ham.), *Thrissocles annandalei* (Chaudhuri), *Thrissocles kempfi* (Chaudhuri), *Thrissocles rambhae* (Chaudhuri) and *Galaxias indicus* Day. The remaining 17 of the endemic species are bathypelagic, or abyssal having been recorded from depths ranging between 272-2395 metres with bottom temperatures varying from 11.1° to 2.3°C. They are *Alepocephalus edentulus* Alc., *Alepocephalus longiceps* Lloyd, *Alepocephalus macrops* Lloyd, *Narcetes erimelas* Alc., *Xenodermichthys squamilaterus* Alc., *Leptoderma affinis* Alc., *Tauredophidium hextii* Alc., *Platyroctogen mirus* Lloyd, *Aulostomatomorpha phospherops* Alc., *Triplophos hemingi* (Mc Ardle), *Bathyclupea hoskynii* Alc., *Harpodon squamosus* Alc., *Scopelarchus guentheri* Alc., *Bathypterois* (*Bathypterois*) *atricolor* Alc., *Bathypterois* (*Hemipteroids*) *guentheri* Alc., *Myctophum indicus* Day and *Lampanyctus pyrsobolus* (Alc.).

3. *Species extending beyond the "Indian region"*.—Out of the 137 species distributed beyond the "Indian region", 68 are bathypelagic or abyssal and 69 littoral. In the 69 littoral species, 10 species, viz., *Macrura ilisha* (Ham.), *Gudusia chapra* (Ham.), *Corica soborna* (Ham.), *Ilisha filigera* (V.), *Raconda russelliana* Gray, *Setipinna breviceps* (Cantor), *Coilia reynaldi* V., *Thrissocles purava* (Ham.), *Xenengraulis spinidens* J. and S. and *Saurida longimanus* Norman, are restricted to the north of Equator, their range of distribution being 0°—35°N., 48°—142°E., while the remaining 59 species extend their range both to north and south of Equator. Out of the remaining 59 species, 16 species, viz., *Elops saurus* L., *Megalops cyprinoides* (Brouss.), *Albula vulpes* (L.), *Harengula vittata* (V.), *Sardinella jussieu* Lac., *Sardinella melanura* (C.), *Sardinella perforata* (Cantor), *Sardinella sirm* (Walbaum), *Kowala coval* (C.), *Clupa nodon punctatus* (Schgl.), *Anchoviella indica* (v. Hass.), *Thrissocles baelama* (Forsk.), *Chanos chanos* (Forsk.), *Saurida gracilis* (Q. and G.), *Saurida japonicus* (Houttuyn) and *Trachinocephalus myops* (Schn.), are remarkably cosmopolitan extending from the east coast of Africa eastwards through the Indo-Pacific to the islands of Polynesia beyond 180°E., with a distributional range 35°N.—35°S., 18°E.—149°W. Of the remaining 43 littoral species, 12 species, viz., *Sardinella dayi* Regan, *Harengula ovalis* (Bennett), *Hilsa kelee* (C.), *Pellona ditchela* V., *Nematalosa nasus* (Bl.), *Anchoviella commersoni* Lac., *Thrissocles malabaricus* (Bl.), *Thrissocles setirostris* (Brouss.), *Chirocentrus dorab* (Forsk.), *Chirocentrus nudus* Swns., *Saurida tumbil* (Bl.), and *Synodus indicus* (Day) occur 20°S.

or below 20°S. , but do not extend eastwards beyond 180°E. , thus showing a distributional range $35^{\circ}\text{N.}—33^{\circ}\text{S.}$, $27^{\circ}—180^{\circ}\text{E.}$ Out of the remaining 31 littoral species, four species, viz., *Dussumieria hasseltii* Blkr., *Anchoviella heterolobus* (Rupp.), *Thrissocles hamiltoni* (Gray) and *Thrissocles mystax* (Schn.), restrict their range between 13°S. and 18°S. of the Equator, with the distributional range $35^{\circ}\text{N.}—18^{\circ}\text{S.}$, $39^{\circ}—180^{\circ}\text{E.}$ The remaining 27 littoral species, viz., *Dussumieria acuta* V., *Sardinella albella* (V.), *Sardinella clupeioides* (Blkr.), *Sardinella fimbriata* (V.), *Sardinella longiceps* V., *Sardinella sindensis* (Day.), *Hilsa sinensis* (L.), *Ilisha brachysoma* (Blkr.), *Ilisha elongata* (Benn.), *Ilisha indica* (Swns.), *Ilisha kampani* (Web. de Bfrt.), *Ilisha melastoma* (C.), *Ilisha novacula* (V.), *Opisthopterus. tardoore* (C.), *Clupanodon thrissa* (L.), *Anodontostoma chacunda* (Ham.), *Setipinna taty* (V.), *Coilia borneensis* (Blkr.), *Coilia dussumieri* (V.), *Anchoviella tri* (Blkr.), *Thrissocles dussumieri* (V.), *Pellona hoevenii* Blkr., *Thrissocles kammalensis* (Blkr.), *Thrissocles valenciennesi* (Blkr.), *Notopterus chitala* (Ham.), *Notopterus notopterus* (Pallas) and *Harpodon nehereus* (Ham.), extend their distribution between 2°S. and 10°S. of the Equator, not occurring beyond 150°E. , within the range $35^{\circ}\text{N.}—7^{\circ}\text{S.}$, $38^{\circ}—140^{\circ}\text{E.}$

4. *Deep-sea species restricted to the Indo-Pacific region.*—Out of the non-endemic bathypelagic species, 22 species, viz., *Alepocephalus bicolor* Alc., *Alepocephalus blanfordi* Alc., *Alepocephalus microlepis* Lloyd, *Bathytroctes microlepis* Gthr., *Bathytroctes squamosus* Alc., *Narcetes affinis* Lloyd, *Xenodermichthys guentheri* Alc., *Xenodermichthys nudus* (Br.), *Xenodermichthys lividis* Br., *Yarrella corythaeolum* (Alc.), *Stomias nebulosus* Alc., *Chauliodus pammelas* Alc., *Saurida undosquamis* Rich., *Evermanella atratus* (Alc.), *Melanostomias valdiviae* Br., *Bathypterois* (*Bathypterois*) *insularum* Alc., *Myctophum fibulatum* G. and C., *Myctophum pterotus* Alc., *Lampanyctus macropterus* Br., *Diaphus caeruleus* (Klunz.), *Scopelengys tristis* Alc. and *Ateleopus indicus* (Wood-Mason and Alc.) have been recorded only from the Indo-Pacific region from the Cape of Good Hope to the western coasts of Central America within the distributional range $35^{\circ}\text{N.}—35^{\circ}\text{S.}$, $18^{\circ}\text{E.}—80^{\circ}\text{W.}$, at depths varying from 343—3931 m., in bottom temperatures 13.3° to 2.1°C. Out of these species 6 species, viz., *Alepocephalus microlepis* Lloyd, *Xenodermichthys guentheri* Alc., *Narcetes affinis* Lloyd, *Melanostomias valdiviae* Br., *Myctophum fibulatum* G. and C. and *Scopelengys tristis* Alc., are restricted to the north of the Equator, their range of distribution being $0^{\circ}—23^{\circ}\text{N.}$, $53^{\circ}\text{E.}—80^{\circ}\text{W.}$, at depths varying from 343—3279m., in bottom temperatures 17.20° to 2.1°C. Of the remaining 16 Indo-Pacific species, *Xenodermichthys lividis* (Br.), and *Xenodermichthys nudus* (Br.), have been recorded only from within the range $0^{\circ}31'—0^{\circ}39'\text{S.}$, $98^{\circ}—101^{\circ}\text{E.}$, in depths 750—903m., just below south of the Equator, while 5 species, viz., *Yarrella corythaeolum* (Alc.), *Saurida undosquamis* Rich., *Bathypterois insularum* Alc., *Myctophum pterotus* Alc., and *Diaphus caeruleus* (Klunz.) extend their range beyond 28° south of the Equator, in depths varying from 457—2084m. and temperatures 13.3° to 3.18°C. ; and 9 species, viz., *Alepocephalus blanfordi* Alc., *Alepocephalus bicolor* Alc., *Bathytroctes macrolepis* Gthr., *Bathytroctes squamosus* Alc., *Stomias nebulosus* Alc., *Chauliodus pammelas* Alc., *Lampanyctus macropterus* Br., *Evermanella atratus* Alc. and *Ateleopus indicus* (Wood-Mason and Alcock) restrict their range between $2^{\circ}—10^{\circ}$ south of the

Equator in depths varying from 430—1650 m. and bottom temperatures 12.12° to 2.2°C.

5. *Deep-sea species common to the Indo-Pacific and Atlantic.*—Nine species, viz., *Vinciguerria nimbarius* J. W., *Bathytroctes microlepis* Gthr., *Platytrectes apus* Gthr., *Photostomias guerni* Collet, *Astronesthes marh, tensii* Klunz., *Bathylchnus cyaneus* Br., *Melanostomias melanops* Br., *Lampanyctus gemmifer* G. and B., and *Diaphus garmani* Gilbert, occur north of the Equator both in the Indo-Pacific and Atlantic Oceans, their range in the Indian Ocean being 4°–24°N., 39°–94°E., and in the Atlantic 0°–39°N., 7°–13°W.

Four species, viz., *Gonostoma elongatum* Gthr., *Polyipnus spinosus* Gthr., *Lampanyctus longipes* Br., and *Neoscopelus macrolepidotus* Johnson have been recorded north and south of the Equator in the Indo-Pacific region and north of the Equator in the Atlantic Ocean within the ranges 33°N.—35°S., 18°E.—178°W. and 0°–41°N., 7°E.—80°W respectively ; one species, *Chlorophthalmus agassizi* Bonap. has been recorded north and south of the Indo-Pacific and the Mediterranean with the distributional range 20°N.—35°S., 18°E.—155°W and 38°13'N., 15°13'E. respectively.

One species, *Diaphus splendidum* (Br.) shows a distributional range 35°N.—20°S., 42°–135°E. north and south of Equator in the Indo-Pacific and 3°–9°S., 7°–9°E. south of the Equator in the Atlantic.

One species *Stomias affinis* Gthr., has been found north of the Equator in the Indo-Pacific and north and south of the Equator in the Atlantic within the range 0°–15°N., 41°–98°E. and 30°N.—5°S., 11°E.—87°W. respectively.

One species *Lampanyctus micropteuum* (Alc.) presents a distributional range 0°–6°S., 58°–99°E. in the Indo-Pacific occurring only to the south of the Equator and 3°N.—9°S., 7°E.—9°W in the Atlantic occurring both to the south and north of the Equator.

Of the remaining 29 species, 14 species, viz., *Bathytroctes rostratus* Gthr., *Cyclothone microdon pallida* Br., *Cyclothone obscura* Br., *Valencienellus stellatus* Garman, *Cyclothone signata alba* Br., *Vinciguerria lucetius* Garman, *Argyropelecus affinis* Garman. *Astronesthes indicus* Br., *Myctophum laternatum* Garman, *Myctophum reinhardti* (Lutken), *Myctophum spinosus* (Steind.), *Myctophum valdiviae* Br., *Diaphus dumerili* (Blkr.) and *Diaphus lutkeni* Br. occur both to the south and north of the Equator in the Indo-Pacific as well as in the Atlantic, their range of distribution respectively, being 34°N.—40°S., 18°E.—74°W. and 44°N.—37°S., 16°E.—87°W., three species, viz., *Chauliodus sloani* Schn. *Lestidium (Bathysudis) speciosus* Bellotti and *Diaphus rafines quei* Cocco.

occur both to the south and north of the Equator in the Indo-Pacific, and the Atlantic within the ranges $35^{\circ}\text{N.}—29^{\circ}\text{S.}$, $30^{\circ}\text{E.}—140^{\circ}\text{W}$ and $37^{\circ}\text{N.}—40^{\circ}\text{S.}$, $16^{\circ}\text{E.}—87^{\circ}\text{W}$ respectively, and also in the Mediterranean $36^{\circ}—38^{\circ}\text{N.}$, $14^{\circ}—15^{\circ}\text{E.}$

Out of the remaining 12 species, *Nasenai graenlandicus* (Reinhard) has been recorded from north and south of the Equator in the Indian Ocean and north of the Equator in the Atlantic sector of the Arctic Ocean within the ranges $4^{\circ}\text{N.}—29^{\circ}\text{S.}$, $30^{\circ}—73^{\circ}\text{E.}$ and 72°N. , 40°W. , respectively ; *Cyclothone accilinidens* Garman has been recorded from north and south of the Equator in the Indian Ocean and Atlantic and also from the Atlantic sector of the Antarctic within the ranges $24^{\circ}\text{N.}—26^{\circ}\text{S.}$, $41^{\circ}—97^{\circ}\text{E.}$, $37^{\circ}\text{N.}—28^{\circ}\text{S.}$, $9^{\circ}\text{E.}—21^{\circ}\text{W}$ and $56^{\circ}31'\text{S.}$, $14^{\circ}29'\text{E.}$ respectively ; *Cyclothone microdon-microdon* Gthr., has been recorded from north and south of the Equator both in the Indo-Pacific and the Atlantic, from the Atlantic sector of the Arctic in the ranges $11^{\circ}\text{N.}—50^{\circ}\text{S.}$, $18^{\circ}\text{E.}—90^{\circ}\text{W.}$, $40^{\circ}\text{N.}—50^{\circ}\text{S.}$, $18^{\circ}\text{E.}—88^{\circ}\text{W.}$, $65^{\circ}—67^{\circ}\text{N.}$, $30^{\circ}—58^{\circ}\text{W.}$, $53^{\circ}—62^{\circ}\text{S.}$, $95^{\circ}\text{E.}—57^{\circ}\text{W.}$, respectively ; *Cyclothone signata signata* Garman has been recorded from the north and south of Equator both in the Indian and Atlantic Oceans and also from the Atlantic sector, of the Arctic Ocean within the ranges $13^{\circ}\text{N.}—30^{\circ}\text{S.}$, $48^{\circ}—97^{\circ}\text{E.}$ and $31^{\circ}\text{N.}—37^{\circ}\text{S.}$, $18^{\circ}\text{E.}—21^{\circ}\text{W.}$, $61^{\circ}21'\text{N.}$, $80^{\circ}41'\text{W.}$, respectively ; *Sternoptyx diaphana* Garm. has been recorded from north and south of the Equator both in the Indo-Pacific and Atlantic and also from the subarctic sector of the Atlantic in the ranges $35^{\circ}\text{N.}—47^{\circ}\text{S.}$, $18^{\circ}\text{E.}—115^{\circ}\text{W.}$, $46^{\circ}\text{N.}—35^{\circ}\text{S.}$, $16^{\circ}\text{E.}—87^{\circ}\text{W.}$, and 46°N. , 56°W. , respectively , *Argyrolepecus aculeatus* V has been recorded north and south of the Equator both in the Indian Ocean and Atlantic Oceans and also from the coast of Norway in the subarctic sector of the Atlantic within the ranges of $20^{\circ}\text{N.}—32^{\circ}\text{S.}$, $39^{\circ}—99^{\circ}\text{E.}$, $32^{\circ}\text{N.}—35^{\circ}\text{S.}$, $16^{\circ}\text{E.}—87^{\circ}\text{W.}$, and 10°E. , 70°N. , respectively *Argyrolepecus hemigymnus* Cocco has been recorded north and south of the Equator both in the Indian and Atlantic Oceans and also from the Mediterranean and the subarctic sector of the Atlantic in ranges $12^{\circ}\text{N.}—30^{\circ}\text{S.}$, $51^{\circ}—97^{\circ}\text{E.}$, $39^{\circ}\text{N.}—35^{\circ}\text{S.}$, $27^{\circ}—87^{\circ}\text{W.}$, 38°N. , 15°E. and $60^{\circ}—64^{\circ}\text{N.}$, $1^{\circ}—7^{\circ}\text{W.}$,—respectively ; *Argyrolepecus olforsti* (C.) has been recorded north and south of the Equator both in the Indian and Atlantic Oceans from the subarctic sector of the Atlantic and also from the Arctic Ocean within the ranges $9^{\circ}\text{N.}—35^{\circ}\text{S.}$, $18^{\circ}\text{E.}—79^{\circ}\text{W.}$, $63^{\circ}\text{N.}—3^{\circ}\text{S.}$, $7^{\circ}\text{E.}—74^{\circ}\text{W.}$ and 71°N. , 25°E. , respectively ; *Argynolepecus sladeni* Regan has been recorded from north and south of the Equator both in the Indian and Atlantic Oceans and also from the Atlantic sector of the Antarctic within the ranges $12^{\circ}\text{N.}—5^{\circ}\text{S.}$, $41^{\circ}—65^{\circ}\text{E.}$, $12^{\circ}\text{N.}—12^{\circ}\text{S.}$, $11^{\circ}\text{E.}—20^{\circ}\text{W}$ and $61^{\circ}25'30^{\circ}\text{S.}$, $53^{\circ}46'\text{W.}$, respectively ; *Malacosteus niger* Ayres has been recorded north and south of the Equator both in the Indian and Atlantic Oceans and also from the subarctic sector of the Atlantic within the ranges $13^{\circ}\text{N.}—10^{\circ}\text{S.}$, $46^{\circ}—97^{\circ}\text{E.}$, $42^{\circ}\text{N.}—33^{\circ}\text{S.}$, 15°E. , 70°N. , respectively ; *Idiacanthus fasciola* Ptrs. has been recorded from north and south of the Equator in the Indian and Atlantic Oceans and the subantarctic sector of the Atlantic within the ranges $7^{\circ}\text{N.}—5^{\circ}\text{S.}$, $48^{\circ}—85^{\circ}\text{E.}$, $40^{\circ}\text{N.}—36^{\circ}\text{S.}$, $17^{\circ}\text{E.}—80^{\circ}\text{W.}$, and $55^{\circ}\text{S.}—56^{\circ}\text{S.}$, $14^{\circ}—16^{\circ}\text{E.}$, respectively ; *Myctophum coccoi* Cocco has been recorded from north and south of the Equator both in the Indo-Pacific and Atlantic from the subarctic sector

of the Atlantic and also from the Mediterranean within the ranges $34^{\circ}\text{N}.$ — $39^{\circ}\text{S}.$, $18^{\circ}\text{E}.$ — $71^{\circ}\text{W}.$, $46^{\circ}\text{N}.$ — $38^{\circ}\text{S}.$, $2^{\circ}\text{E}.$ — 70°W and $37^{\circ}35'\text{N}.$, $14^{\circ}10'\text{E}.$, respectively.

6. *Vertical distribution of the species.*—Littoral or semipelagic species occur in waters within the Continental shelf in depths less than 200 metres. Bathypelagic species inhabit waters beyond the Continental shelf in depths below 200 metres. Abyssal species occur in waters beyond the Continental slope in depths below 2000 metres. Out of the total 85 bathypelagic species 35 have been recorded both from the bathypelagic and abyssal zones, 2 from the abyssal zone and 48 from the bathypelagic 200—2000 m. The bathypelagic species are, thus, found to have a wide vertical range being capable of migrating upwards and downwards.

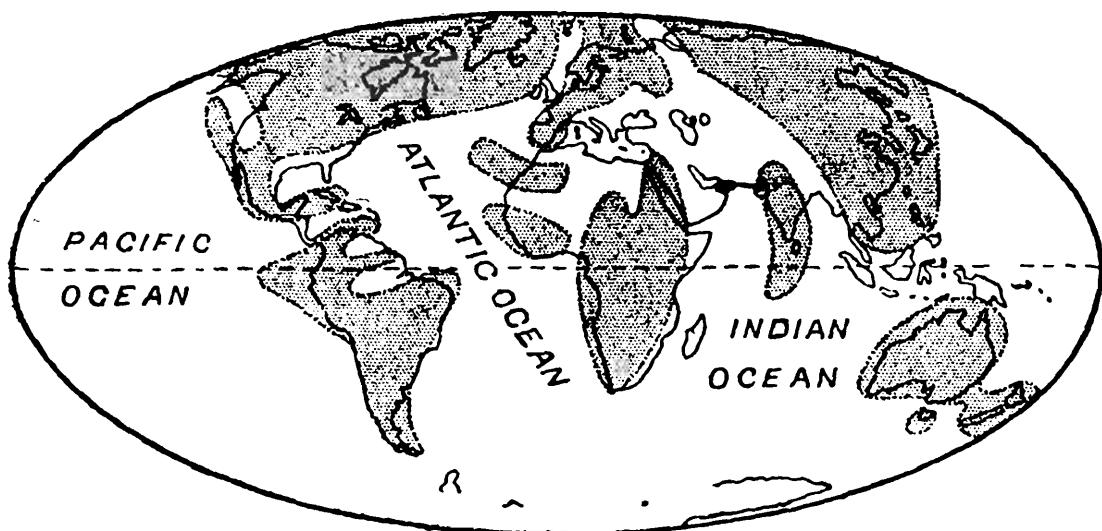
III—CONCLUSIONS

In the total 173 species of fishes of the Orders Clupeiformes, Bathyclupeiformes, Galaxiiformes, Scopeliformes and Ateleopiformes of the “Indian regions” 85 are littoral or semipelagic 3 land-locked and exotic, and 85 are bathypelagic or abyssal. The Order Clupeiformes consists of 76 littoral, 3 exotic and land-locked and 53 bathypelagic species. The Orders Bathyclupeiformes and Galaxiiformes are represented by a single species in each, of which the former is bathypelagic and the latter littoral. In the Order Scopeliformes 7 species are littoral and 29 bathypelagic or abyssal. The Order Ateleopiformes is represented by a single bathypelagic species. In other words, out of the total 173 species dealt with here, 133 belong to the Order Clupeiformes, 57 to the Order Scopeliformes and one each of the Orders Bathyclupeiformes, Galaxiiformes and Ateleopiformes. Thus the Order Clupeiformes and Scopeliformes together consist of 170 species, out of which 83 are bathypelagic and 87 littoral. Of the 83 bathypelagic species 16 are endemic to the “Indian region”, while 67 species have been recorded from the Indo-Pacific, Atlantic, Arctic and Antarctic regions. Out of the 87 littoral species 3 are exotic, 16 are endemic and the remaining 68 species have a restricted range in the Indo-Pacific and tropoical Atlantic. *Bathyclupea hoskynii* Alc., the single species representing the Order Bathyclupeiformes and *Galaxias indicus* Day, the single representative of the Order Galaxiiformes are confined to the Bay of Bengal, and the littoral district of Madras, W Bengal and E. Pakistan respectively, while the sole species *Ateleopus indicus* Wood-Mason and Alcock, of the Order Ateleopiformes has been recorded only from the Arabian Sea, Bay of Bengal and the Philippine seas.

While the bathypelagic species are not affected by such physical barriers as the isotherms and a few of them extend their distribution in all the five oceans, the littoral species evince a distributional pattern quite characteristic of them, by not penetrating into the cold waters

of the Atlantic west of the Cape of Good Hope. The littoral and semi-pelagic species of the "Indian region" extend their range from the Red Sea and the east coast of Africa, through the Indo-Pacific eastwards even as far as to the east coast of tropical North and South America, but their range towards the west is restricted beyond the west of the Cape of Good Hope. This is due to the fact that the 12°C isotherm (Plate 34) bordering the south-west coast of Africa beyond west of the Cape of Good Hope and extending upto 22°S. latitude, serves as a physical barrier for the free intermingling of the fishes of the Atlantic with those of the Indian region. However, it is probable that some of the species occurring in 20°C isotherm may often extend their range to 12°C isotherm in the Mediterranean and temperate Atlantic as and when surface temperature conditions there become favourable during the summer months of the year.

Among the 16 littoral, semipelagic species extending their range eastwards beyond 180°E., *Albula vulpes* (L.), with its type-locality in



TEXT-FIG. 1.—Map showing land distribution in the Eocene. (After Norman).

the Bahama Is., Atlantic, is singular in its occurrence in the Indo-Pacific region. The occurrence of some Mediterranean and tropical Atlantic species in the Indo-Pacific and some Indo-Pacific species in the tropical Atlantic and the Mediterranean may be explained (Günther, 188° ; Alcock, 1899 ; Norman, 1931) by the configuration of the Land masses during the Eocene period when the Mediterranean sea extended eastwards and opened into the Indian Ocean, and the isthmus of Panama was submerged under sea and the Atlantic and Pacific Oceans were continuous (Text-fig. 1), thus making it possible for an intermingling of the species. Smith (1953) has suggested that species common to the Indo-Pacific and the tropical Atlantic and the Mediterranean may be "relics of intermingling, for not very long ago in geological time conditions were different and there was almost certainly a warm water connection between the Indian and Atlantic Oceans" Besides, the recent and artificially constructed Panama and Suez canals may have to some extent served as a connecting passage for a free dispersal of species in certain cases.

IV—SYSTEMATIC LIST* OF THE FISHES SHOWING THE LATITUDINAL AND LONGITUDINAL RANGES, HABITAT OR DEPTHS IN METRES AND DISTRIBUTION

Species	Range in latitudes and longitudes	Range of depth in metres.	Distribution
Series Pisces Class Teleostomi Subclass Actinopterygii Order Clupeiformes (Isospondyli, Malacopterygii S. Str., Thrissomorphi). Suborder Clupeoidei Superfamily Elopoidae Family Elopidae			
Family ELOPIDAE			
1. <i>Elops saurus</i> L.			
In 20°C. isotherm	35°N.—35°S., 18°E.—155°W.	Littoral ; euryha- line.	Red Sea, Arabia, east and south coasts of Africa, Cape of Good Hope, Madagascar, Mauritius Pakistan, India, Ceylon, Malay Peninsula, Indo- nesia, Philippines, China, Korea, Japan, New South Wales, Hawaii.
Family MEGALOPIDAE			
2. <i>Negalops cyprinoides</i> (Brouss.)—			
In 20°C. isotherm	35°N.—34°S., 26°E.—170°W.	Do.	East and south coasts of Africa, Natal, Zanzibar, Madagascar, Mauritius, India, Pakistan, Ceylon, Burma, Malay Peninsula, Indonesia, Siam, Philippi- nes, China, Formosa, Fusan, Queensland, Mela- nesia, Micronesia, Poly- nesia, Tahiti.
Superfamily Albuloidae			
Family ALBULIDAE			
3. <i>Albula vulpes</i> L.			
In 20°C. isotherm	35°N.—29°S., 30°E.—149°W ; 18°—23°N., 74°W.	Littoral	Red Sea, Natal, South Africa, Zanzibar, Mauri- tius, India, Ceylon, Pakistan, Malay Penin- sula, Indonesia, Cochin, China, Philippines, Korea, Japan, Queensland, New South Wales, Melanesia, Micronesia Polynesia, Hawaii, Brazil, Antilles.
Superfamily Clupeoidae			
Family CLUPEIDAE			
Subfamily Dussumieriini			
4. <i>Dussumieria acuta</i> V.			
In 20°C. isotherm	25°N.—7°S., 45°—140°E.	Do.	South Arabia, Pakistan, India, Ceylon, Malay Peninsula, Singapore, Indonesia, Siam, China, Philippines, Melanesia.

* Certain nomenclatorial errors and omissions occurring in the "Check List of the Fishes of India, Burma and Ceylon II. Clupeiformes, Bathyclupeiformes, Galaxiiformes, Scopeliformes and Ateleop-
formes", *Rec. India Mus.*, 45, pp. 377-431 (1947), have been rectified.

Species	Range in latitudes and longitudes	Range of depth in metres	Distribution
5. <i>Dussumieria hasseltii</i> Blkr. In 20°C. isotherm	22°N.—13°S., 75°—140°E.	Littoral	India, Ceylon, Burma, Malaya Peninsula, Singa- pore, Indonesia, Siam, Cochin China, Philippines, Formosa, China, Queens- land.
6. <i>Ehirava fluviatilis</i> Deraniyagala In 20°C. isotherm	6°—7°N., 79°50' E.	Littoral; euryhal- line.	Ceylon.
7. <i>Stolephorus malabaricus</i> (Day) Subfamily Clupeini	11°N., 76°E.	Do.	India.
8. <i>Harengula ovalis</i> (Bennett) =[<i>Harengula punctata</i> (Rupp.)] In 20°C. isotherm	35°N.—29°S., 30°—180°E.	Littoral	Suez Canal, Red Sea, Arabia, South Africa, Natal, Seychelles, India, Ceylon, Pakistan, Indo- nesia, Philippines, China, Japan, Melanesia, Micro- nesia, Polynesia.
9. <i>Harengula vittata</i> (V.) In 20°C. isotherm	25°N.—29°S., 30°E.—170°W.	Littoral	South Africa, Zanzibar, Indonesia, Siam, Melan- esia, Polynesia.
10. <i>Sardinella albella</i> (V.) In 20°C. isotherm	24°N.—7°S., 38°—123°E.	Do.	East coast of Africa, Paki- stan, India-Indonesia, Siam, Hongkong, Phil- ippines.
11. <i>Sardinella clupeioides</i> (Blkr.) In 20°C. isotherm	26°N.—7°S., 80°—127°E.	Do.	Ceylon, Malaya, Indonesia, Philippines, Japan.
12. <i>Sardinella dayi</i> Regan In 20°C. isotherm	14°N.—20°S., 57°—74°E.	Do.	India, Mauritius.
13. <i>Sardinella fimbriata</i> (V.) In 20°C. isotherm	25°N.—7°S., 62°—123°E.	Do.	Pakistan, India, Ceylon, Burma, Singapore, Indo- nesia, Siam, Tonkin, China, Philippines.
14. <i>Sardinella jusieu</i> Lac. [<i>Sardinella gibbosa</i> (Blkr.)] In 20°C. isotherm	34°N.—29°S., 30°E.—170°W.	Do.	Natal, Durban, Mauritius, Bourbon, Madagascar, India, Ceylon, Malaya, Indonesia, Shanghai, Hongkong, Philippines, Queensland, Micronesia, Polynesia, Fiji, Samoa.
15. <i>Sardinella longiceps</i> V. In 20°C. isotherm	25°N.—7°S., 39°—123°E.	Do.	Mombasa, Arabia, Sey- chelles, Pakistan, India, Ceylon, Indonesia, Co- chin China, Philippines.
16. <i>Sardinella melanura</i> (C.) In 20°C. isotherm	34°N.—25°S., 32°E.—149°W.	Do.	East coast of Africa, Mauritius, Madagascar, Pakistan, India, Ceylon, Malaya, Singapore, Indo- nesia, Siam, Philippines, Japan, Micronesia, Polynesia.

Species	Range in latitudes and longitudes	Range of depth in metres	Distribution
17. <i>Sardinella perforata</i> (Cantor)			
In 20°C. isotherm	27°N.—12°S., 51°—170°E.	Littoral	Persian Gulf, Malaya, Singapore, Indonesia, Siam, Philippines, China, Polynesia, Samoa.
18. <i>Sardinella sindensis</i> (Day)			
In 20°C. isotherm	25°—4°S., 62°—128°E.	Do.	Pakistan, India, Indonesia, Formosa.
19. <i>Sardinella sirm</i> (Walbaum)			
In 20°C. isotherm	22°N.—12°S., 38°E.—170°W.	Do.	Red Sea, Arabia, Zanzibar, Malaya, Indonesia, Annam coast, Hongkong, Philippines, Micronesia, Polynesia, Samoa.
20. <i>Macrura ilisha</i> (Ham.)			
In 20°C. isotherm	6°—35°N., 48°—98°E.	Littoral ; eury-haline	Iraq, Persian Gulf, Pakistan, India, Ceylon, Burma.
21. <i>Macrura kelee</i> (C.) =[<i>Hilsa kanagurta</i> (Blkr.)].			
In 20°C. isotherm	25°N.—29°S., 30°—135°E.	Do.	Aden, Zanzibar, Durban, Pakistan, India, Ceylon, Malaya, Amoy, Indonesia, Siam, Micronesia.
22. <i>Macrura sinensis</i> (L.)=[<i>Hilsa toli</i> (C.V.)]			
In 20°C. isotherm	25°N.—7°S., 62°—120°E.	Do.	Pakistan, India, Ceylon, Malaya, Indonesia, Siam, Cochin China, Cambodia, Formosa, China.
23. <i>Gudusia chapra</i> (Ham.)			
In 20°C. isotherm	5°—24°N., 67°—100°E.	Do.	Pakistan, India, Burma, Malaya.
24. <i>Gudusia variegata</i> (Day)			
In 20°C. isotherm	16°—20°N., 96°—98°E.	Do.	Burma.
25. <i>Kowala coval</i> (C.)			
In 20°C. isotherm	25°N.—18°S., 62°E.—149°W.	Do.	Pakistan, India, Ceylon, Burma, Malaya, Indonesia, Siam, Cochin China, Philippines, Melanesia, Tahiti.
26. <i>Corica soborna</i> (Ham.)			
In 20°C. isotherm	1°—26°N., 85°—111°E.	Do.	India, Pakistan, South West Borneo, Siam.
27. <i>Ilisha brachysoma</i> (Blkr.)			
In 20°C. isotherm	22°N.—7°S., 76°—114°E.	Littoral	India, Ceylon, Malaya, Indonesia, Siam, Cochin China, Hongkong.
28. <i>Ilisha elongata</i> (Benn.)			
In 20°C. isotherm	35°N.—7°S., 62°—135°E.	Do.	Pakistan, India, Ceylon, Malaya, Indonesia, Siam, Indo-China, Formosa, China, Japan, Korea.
29. <i>Ilisha filigera</i> (V.)			
In 20°C. isotherm	6°—18°N., 72°—108°E.	Do.	India, Ceylon, Indo-China.

Species	Range in latitudes and longitudes	Range of depth in metres	Distribution
30. <i>Ilisha indica</i> (Swns.)			
In 20°C. isotherm	25°N.—7°S. 38°—123°E.	Littoral	East coast of Africa, Zanzibar, Pakistan, India, Ceylon, Burma, Malaya, Indonesia, Siam, Cochin, China, Philippines, China.
31. <i>Ilisha kampeni</i> (Web. de Bfrt.)—			
In 20°C. isotherm	13°N.—7°S., 80°—118°E.	Do	India, Indonesia, Siam.
32. <i>Ilisha leschenaulti</i> (V.)			
In 20°C. isotherm	11°N., 79°E.	Do.	India.
33. <i>Ilisha melastoma</i> (C.)			
In 20°C. isotherm	25°N.—7°S., 62°—118°E.	Do.	India, Pakistan, Burma, Malaya, Indonesia, Siam, Cochin, China.
34. <i>Ilisha motius</i> (Ham.)			
In 20°C. isotherm	19°—27°N., 85°—95°E.	Do.	India, Pakistan.
35. <i>Ilisha novacula</i> (V.)			
In 20°C. isotherm	22°N.—7°S., 96°—114°E.	Do.	Burma, Indonesia, China.
36. <i>Ilisha sladeni</i> (Day)			
In 20°C. isotherm	16°—21°N., 96°—98°E.	Do.	Burma.
37. <i>Pellona ditchela</i> (V.)			
In 20°C. isotherm	17°N.—29°S., 30°—140°E.	Do.	Natal, Madagascar, India, Ceylon, Burma, Malaya, Indonesia, Pelew, Gulf of Carpentaria.
38. <i>Pellona hoevenii</i> Blkr.			
In 20°C. isotherm	17°—7°N., 83°—123°E.	Do.	India, Malaya, Indonesia, Siam, Annam coast, Philippines.
39. <i>Opisthopterus tardoore</i> (C.)			
In 20°C. isotherm	25°N.—7°S., 62°—114°E.	Littoral ; euryhaline	Pakistan, India, Ceylon, Burma, Malaya, Indonesia, Siam, Indo-China, Hongkong.
40. <i>Raonda russelliana</i> Gray			
In 20°C. isotherm	0°—25°N., 62°—105°E.	Do.	Pakistan, India, Ceylon, Burma, Malaya, Peninsula, Indonesia, Cochin, China.
Subfamily (<i>Dorosomatini</i>)			
41. <i>Clupanodon punctatus</i> (Schl.)			
In 20°C. isotherm	35°N.—18°S., 80°E.—149°W.	Do.	India, China, Japan, Korea, Tahiti.
42. <i>Clupanodon thrissa</i> (L.)			
In 20°C. isotherm	35°N.—3°S., 72°—135°N.	Do.	India, Ceylon, Philippines, Indo-China, China, Japan, New Guinea.
43. <i>Gonialosa manmina</i> (Ham.)			
In 20°C. isotherm	6°—27°N., 62°—95°E.	Do.	Pakistan, India, Ceylon.

Species	Range in latitudes and longitudes	Range of depth in metres	Distribution
44. <i>Gonialosa modestus</i> (Day)			
In 20°C. isotherm	16°—18°N., 94°—97°E.	Littoral; euryhaline.	Burma.
45. <i>Nematalosa nasus</i> (Bl.)			
In 20°C. isotherm	34°N.—29°S., 30°—123°E.	Do.	Durban, Iraq, Muscat, Pakistan, India, Ceylon, Burma, Malaya, Indonesia, Canton.
46. <i>Anodontostoma chacunda</i> (Ham.)			
In 20°C. isotherm	25°N.—7°S., 62°—142°E.	Do.	Pakistan, India, Ceylon, Burma, Malay Peninsula, Indonesia, Siam, Indo-China, Hainan, Philippines, Melanesia.
Family ENGRAULIDAE			
47. <i>Setipinna breviceps</i> (Cantor)			
In 20°C. isotherm	0°—22°N., 88°—115°E.	Do.	India, Pakistan, Burma, Malay Peninsula, Indonesia, Indo-China.
48. <i>Setipinna phasa</i> (Ham.)			
In 20°C. isotherm	16°—24°N., 85°—98°E.	Do.	India, Pakistan, Burma.
49. <i>Setipinna taty</i> (V.)			
In 20°C. isotherm	35°N.—7°S., 76°—130°E.	Do.	India, Pakistan, Ceylon, Burma, Malaya, Indonesia, Siam, Cochin China, China, Korea.
50. <i>Coilia borneensis</i> Blkr.			
In 20°C. isotherm	16°N.—2°S., 80°—115°E.	Do.	India, Burma, Malaya, Siam, Indo-China.
51. <i>Coilia cantoris</i> Blkr.			
In 20°C. isotherm	20°N., 88°E.	Do.	India.
52. <i>Coilia dussumieri</i> V.			
In 20°C. isotherm	25°N.—7°S., 62°—108°E.	Do.	Pakistan, India, Malaya, Indonesia, Siam, Indo-China.
53. <i>Coilia quadragesimalis</i> V.			
In 20°C. isotherm	6°—21°N., 79°—89°E.	Do.	India, Pakistan, Ceylon.
54. <i>Coilia ramcarati</i> (Ham.)			
In 20°C. isotherm	20°—22°N., 88°—92°E.	Do.	India, Pakistan, Burma,
55. <i>Coilia reynaldi</i> V.			
In 20°C. isotherm	1°—22°N., 88°—103°E.	Do.	India, Burma, Malaya, Singapore.
56. <i>Anchoviella commersonii</i> Lac.			
In 20°C. isotherm	24°N.—29°S., 30°—123°E.	Do.	South Africa, Muscat, India, Ceylon, Indonesia, Siam, Cochin, China, Hongkong, Amoy, Philippines.
57. <i>Anchoviella heterolobus</i> (Rupp.)			
In 20°C. isotherm	20°N.—17°S., 39°—180°E.	Do.	Red Sea, India, Burma, Indonesia, Siam, Cochin China, Philippines, Queensland, Solomon, Fiji.

Species	Range in latitudes and longitudes	Range of depth in metres	Distribution
58. <i>Anchoviella indica</i> (V. Hass.)			
In 20°C. isotherm	27°N.—29°S., 30°E.—149°W.	Littoral ; euryhaline	South Africa, Zanzibar, Pakistan, India, Ceylon, Malaya, Indonesia, Siam, Cochin, China, Annam, Hongkong, Formosa, Japan, Pelew Islands, Samoa, Tahiti.
59. <i>Anchoviella tri</i> (Blkr.)			
In 20°C. isotherm	25°N.—7°S., 62°—135°E.	Do.	Pakistan, India, Malaya, Indonesia, Cochin, China, Amoy, Philippines, Pelew Islands.
60. <i>Thrissocles annandalei</i> (Chaudhuri)—			
In 20°C. isotherm	19°N., 85°E.	Do.	India.
61. <i>Thrissocles baelama</i> (Forsk.)			
In 20°C. isotherm	25°N.—20°S., 39°E.—170°W.	Do.	Red Sea, Zanzibar, Mauritius, Seychelles, Pakistan, Ceylon, India, Malaya, Indonesia, Siam, Indo-China, Guam, Polynesia, Samoa.
62. <i>Thrissocles dussumieri</i> (V.)			
In 20°C. isotherm	25°N.—7°S., 72°—123°E.	Do.	India, Pakistan, Ceylon, Burma, Malaya, Indonesia, Siam, Indo-China, Hongkong, Philippines.
63. <i>Thrissocles hamiltoni</i> (Gray)			
In 20°C. isotherm	35°N.—18°S., 62°—140°E.	Do.	Pakistan, India, Ceylon, Burma, Malaya, Singapore, Indonesia, Siam, Cochin, China, China, Korea, Philippines, Queensland.
64. <i>Thrissocles kammalensis</i> (Blkr.)			
In 20°C. isotherm	24°N.—7°S., 85°—120°E.	Do.	India, Pakistan, Ceylon, Indonesia, China.
65. <i>Thrissocles kempfi</i> (Chaudhuri)			
In 20°C. isotherm	19°N., 85°E.	Do.	India.
66. <i>Thrissocles malabaricus</i> (Bl.)			
In 20°C. isotherm	25°N.—33°S., 27°—120°E.	Littoral	South Africa, Pakistan, India, Ceylon, North Celebes.
67. <i>Thrissocles mystax</i> (Schn.)			
In 20°C. isotherm	35°N.—18°S., 62°—140°E.	Littoral ; euryhaline.	India, Pakistan, Ceylon, Burma, Malaya, Singapore, Indonesia, Siam, Annam, China, Philippines, Queensland, Fusan.
68. <i>Thrissocles purava</i> (Ham.)			
In 20°C. isotherm	1°—25°N., 62°—142°E.	Do.	Pakistan, India, Burma, Bonin Islands, Micronesia.
69. <i>Thrissocles rambhae</i> (Chaudhuri)			
In 20°C. isotherm	19°N., 85°E.	Do.	India.

Species	Range in latitudes and longitudes	Range of depth in metres	Distribution
70. <i>Thrissocles setirostris</i> (Brouss.)			
In 20°C. isotherm	25°N.—29°S., 30°—167°E.	Littoral; euryhaline	Red Sea, South Africa, Pakistan, Malaya, Indonesia, Siam, Indo-China, China, Queensland, Melanesia.
71. <i>Thrissocles valenciennesi</i> (Blkr.)			
In 20°C. isotherm	18°N.—7°S., 72°—123°E.	Do.	India, Malaya, Singapore, Indonesia, Philippines.
72. <i>Xenengraulis spinidens</i> J. & S.			
In 20°C. isotherm	11°—22°N., 85°—101°E.	Do.	India, Burma, Siam.
Superfamily Alepocephaloidea Family ALEPOCEPHALIDAE (including Platyproctidae Roule 1919).			
73. <i>Alepocephalus bicolor</i> Alc.			
In 20°C. isotherm	13°N.—8°S., 46°—121°E.	438—1080	Gulf of Aden, 1061—1060m., 10.86°C. at 1000m., surface temperature 23.69°C.; Arabian Sea, 658m., 9.2°C., surface temperature 27.8°C.; Bay of Bengal 438—504m., 11.1°C., surface temperature 26.2°C., West coast of Sumatra, 750m.; Flores Sea, 521—538m.
74. <i>Alepocephalus blanfordi</i> —(Alc.)			
In 20°C. isotherm	6°N.—8°S., 77°—121°E.	694—1650	South of Cape Comorin, AT1650m., 5°C.; Flores Sea, 694m.
75. <i>Alepocephalus edentulus</i> Alc.			
In 20°C. isotherm	12° 50' N., 81° 36' E.	868	Off Madras coast, 868m. 7.5°C.
76. <i>Alepocephalus longiceps</i> Lloyd			
In 20°C. isotherm	12°49' 30"N., 96°24' 30"E.	1267	Andaman Sea, 1267m.
77. <i>Alepocephalus macrops</i> Lloyd			
In 20°C. isotherm	17°7'30" N., 94°5'30" E.	766	Off Arakan coast, 766m. 12.4°C.
78. <i>Alepocephalus microlepis</i> Lloyd			
In 20°C. isotherm	7°—23°N., 57°—76°E.	1102—1591	Gulf of Oman, 1260—1280m., 6.3°C.; Laccadive Sea, 1505—1591m., South of Cape Comorin, 1102m.
79. <i>Bathytroctes macrolepis</i> Gthr.			
In 20°C. isotherm	12°N.—2S., 96°—120E.	3931	Andaman Sea, North of Celebes, 3931m.
80. <i>Bathytroctes microlepis</i> Gthr.			
In 20°C. and 12°C. isotherms	12° 49' 30"N., 92° 24' 30"E. and 36°N., 7°W.	914—1993	Andaman Sea, 8 miles southeast of Cinque I., 914m.; south east of St. Vincent, Portugal, 1993m., 3.1°C.

Species	Range in latitudes and longitudes	Range of depth in metres	Distribution
81. <i>Bathytroctes rostratus</i> Gthr.			
In 20°C. and 12°C. isotherms	9°N.—6°S., 48°—85°E., and 44°N.—8°S., 2°—34°W.	1,113—2,000	Northeast coast of Africa, 1,500—2,000m., 3.5°— 5.7°C. ; between Zanzi- bar and Seychelles, 1,500 —2,000m., 3°5;—5.7°C. ; Bay of Bengal, 1,500— 2,000 m., 3.5°—5.7°C. ; Pernambuco, Brazil, Morocco coast, 1,113m., 8°C. ; 1,234m., 8°C. ; Gulf of Gascony.
82. <i>Bathytroctes squamosus</i> Alc.			
In 20°C. isotherm	15°N.—8°S., 72°—115°E.	1,018—1,353	Off the Laccadives, 1,353m., 6.7°C. ; Bali Sea, 1018m.
83. <i>Narcetes affinis</i> Lloyd			
In 20°C. isotherm	24°35'10", N., 57°46' 6"E.	1,838	Gulf of Oman, 1,838m., 4.4°C.
84. <i>Narcetes erimelas</i> Alc.			
In 20°C. isotherm	15°2'N., 72°34'E.	1,353	Northwest of Laccadives, 1,353m., 6.7°C.
85. <i>Xenodermichthys guentheri</i> (Alc.)			
In 20°C. isotherm	7°—15°N., 46°— 91°E.	786—1,240	Gulf of Aden, 1,022—1,080 m. ; Off Travencore coast, 786m., 8.3°C. ; Off Madras coast, 1,240m., 5.6°C.
86. <i>Xenodermichthys lividis</i> (Br.)			
In 20°C. isotherm	0°—31°S., 99°— 101°E.	768—903	West coast of Sumatra, 768—903m.
87. <i>Xenodermichthys nudus</i> (Br.).			
In 20°C. isotherm	0°39'2" S., 98°52' 3"E.	750	West coast of Sumatra, 750m.
88. <i>Xenodermichthys squamilaterus</i> (Alc.)			
In 20°C. isotherm	14°13'N., 93°40'E.	676—766	Off Andamans, 676—676m.— 766m., 8.3°C.
89. <i>Leptoderma affinis</i> Alc.			
In 20°C. isotherm	16°N., 82°E.	1,377	Off Kistna Delta, 1,377m. 5.1°C.
90. <i>Tauredophidium hextii</i> Alc.			
In 20°C. isotherm	18°26'N., 85° 24'E.	2,395	Off Ganjam Coast, 2,395m.; 2.3°C.
91. <i>Platytröctes apus</i> Gthr.			
In 20°C. isotherm	15°2'N., 72°34' E. ; and 1°22'N., 26°36'W.	1,353—2,743	In the neighbourhood of the Laccadive banks, 1,353 m., 3.7°C. ; Mid-Atlantic, 2,743m., 2.8°C.
92. <i>Platytröctegen mirus</i> Lloyd			
In 20°C. isotherm	12°18'46"N., 74°5'29"E.	914	Laccadive Sea, 914m., 7.6°C.

Species	Range of latitudes and longitudes	Range of depth in metres	Distribution
Family DOLICHOPTERYGIDAE			
93. <i>Aulostomatomorpha phosporops</i> Alc.			
In 20°C. isotherm	11°12'47"N., 74°25'3"E.	1,828	Laccadive Sea, 828 m. 3.7°C.
Suborder Chirocentroidei			
Family CHIROCENTRIDE			
94. <i>Chirocentrus dorsalis</i> (Forsk.)			
In 20°C. isotherm	35°N.—29°S., 30°—180°E.	Littoral	Red Sea, Natal, South Africa, Muscat, Pakistan, India, Ceylon, Burma, Malaya, Singapore, Indonesia, Siam, Annam, Hongkong, China, Formosa, Japan, Philippines, Queensland, Melanesia, Fiji.
95. <i>Chirocentrus rundus</i> Swns.	17°N.—29°S., 30°—120°E.	Do.	South Africa, India, Ceylon, Malaya, Singapore, Indonesia.
Suborder Chanoidei			
Family CHANIDAE			
96. <i>Chanos chanos</i> (Forsk.)			
In 20°C. isotherm	27°N.—29°S., 32°E.—149°W.	Littoral ; euryhaline	Red Sea, Arabia, Zanzibar, Mozambique, Mauritius, South Africa, Natal, Seychelles, Chagos Archipelago, Maldives, Laccadives, India, Ceylon, Malaya, Indonesia, Tahiti
Suborder Salmonoidei			
Family SALMONIDAE			
97. <i>Salmo gairdnerii gairdnerii</i> Richardson In 20°C., 12°C. and 6°C. isotherms	34°—36°N., 72°—76°E., 8°N., 80°E. ; 29°S., 25°E. ; 23°—55°N., 110°—130°W. ; and 0°50'W., 54°N.	Fresh water (landlocked).	Pakistan (introduced); India (introduced); Ceylon (introduced); South Africa (introduced); North America, from British Columbia to California; England (introduced).
98. <i>Salmo leuiscus</i> Walker In 20°C., 12°C. and 6°C. isotherms	11°N., 76°E. ; 29°S., 25°E. ; 35°S., 148°E., and 52°—58°N., 0°—5°W.	Do.	India (introduced); South Africa (introduced); Australia (introduced); England, Scotland.
99. <i>Salmo trutta fario</i> L. In 20°C., 12°C. and 6°C. isotherms	34°—36°N., 72°—76°E., 29°S., 25°E. ; 35°N., 148°E. ; 23°—55°N., 110°—130°W. ; and 45°—60°N., 0°—130°E.	Do.	Pakistan (introduced); South Africa (introduced); South Australia (introduced); North America (introduced); Eurasia.
Family MICROSTOMIDAE.			
100. <i>Nansenis graenlandicus</i> (Reinhardt) In 20°C. and beyond 6°C. isotherms in the arctic zone	4°N.—29°S., 30°—73°E.; and 72°N., 40°W	439—658	Off Natal and Delagoa Bay, 439—475m.; South Africa near Zanzibar, ART640—658m ; Maldivian area, 494m., 0.86°C. North Atlantic.

Species	Range of latitude and longitudes	Range of depths in metres	Distribution
Suborder Stomiatoidei			
Superfamily Gonostomoidae (HETEROPHOTODERMI)			
Family GONOSTOMISAE (GONOSTOMIDAE + MAUROLICIDAE Jordan)			
101. <i>Gonostoma elongatum</i> Gthr. in 20°C. and 12°C isotherms	7°N.—5°S., 60°— 135°E., and 1°— 41°N., 0°31'E.— 92°W.	795—4333	Laccadive Sea, 1349— 2194m., 5·6°C.; Off Mi- nikoi Id., 2194m.; Banda Sea, 658m.; South of New Guinea, 1463m.; East Coast of North America, 795—4333m.; Gulf of Guinea, 2000m.
102. <i>Cyclothone acclimdens</i> Garm. In 20°C., 12°C. and beyond 6°C. isotherm in the antarctic zone	24°N.—26°S., 41°—97°E.; 37°N.—28°S., 9°E.—21°W.; and 56°31'S., 14°29'E.	223—4411	Northeast coast of Africa, 520—4030m.; Gulf of Aden, N200, 952(—0)m.; between Chagos I. and Zanzibar, 520—2500m.; between Chages and Ceylon, 520—2500m. Arabian Sea, N200 430—984m., 12·12°C. at 400m., 10·64°C. at 600m., 9·85°C. at 800m., 8·47°C. at 1000m.; N200, 200C (O) m., 9°C. at 1000m., 5·57°C., at 1500-m., 3·18°C. at 2000m.; Bay of Bengal, 520—4000m.; between New Amster- -dam and Sumatra, 520— 4000m.; West coast of America from 0°—37°N., 223—4411m.; South Atlantic Ocean, 1500m. West Coast of Africa between Canary I. and Cape of Good Hope.
103. <i>Cyclothone microdon micro-</i> <i>don</i> Gthr. In 20°C. 12°C. and 6°C. isotherms and beyond 6°C. in the arctic and Antarctic zones	11°N.—50°S., 18°E.—90°W., 40°N.—50°S., 18°E.—88°W.; 65°—67°N.; 30°—58°W.; 53°—62°S. 95°E.—57°W.; and 40°51'N., 14°26'E.	600—5202	South coast of S. Africa, 1828—2742m.; between Maldives and Chagos Is., 600—1000m.; Bay of Ben- gal, 887m.; between New Amsterdam and Sumatra, 1000—3000m. North of New Guinea, 940—5202- m.; South of Sandwich Is. 940—5202 m.; South of Japan, 940—5202m.; North of New Zealand, 940—5202m; Galapagos; Middle and west Atlantic Ocean, 914-5202 m.; Mediterranean; East coast of south American 2500-2700 m.; West coast of Africa between Canary I. and Cape of Good Hope, 700-4000 m. Antarctic Ocean, 3292- 3611m.; Off Singny I., S. Orkneys, 2500 m., —0·68°C. at 2400m., surf. temp. —0·42°C., Daris Sirait.

Species	Range in latitudes and longitudes	Range of depth in metres	Distribution
104. <i>Cyclothone microdon pallida</i> Br. In 20°C. and 12°C. isotherms	25°N.—6°S., 43°—101°E., and 32°N.—31°S., 9°E.—64°W.	250—5071	Northeast coast of Africa, 1000—5064 m.; Gulf of Aden, N200, 900 (—0) m.; N200,—952 (—0) m.; AT 1061—1080 m.; Gulf of Oman, N100, 1500m., 5.75°C.; between Zanzibar and Seychelles, 2000—5071 m.; between Seychelles and Chagos Archipelago, 1500—4129 m.; between Chagos Archipelago and Ceylon, 2500—4133 m. Arabian Sea, N200, 430—984 m., MT 2937—3183 m., N200, 2000 (—0) m.; Bay of Bengal, 2500 m.; North of New Amsterdam, Cape Verde Is., 250—550 m.; Gulf of Guinea, South-west coast of Africa.
105. <i>Cyclothone obscura</i> Br. In 20°C. and 12°C. isotherms	9°N. 10°S., 48°—98°E., and 14°N.— 31°S., 9°E.— 21°W.	800—4900	South of Socotra, 800—4000 m.; between Seychelles and Chagos Archipelago, 800—4000 m.; Bay of Bengal, 2000—2500m.; between Cocos I. and Sumatra, 800—4000 m.; West coast of Africa between Cape Verde I. and Cape of Good Hope, 800—4000 m.; Atlantic Ocean, TYF, 2500—2700 (—0) m., 2.85°C. at 2598 m.
106. <i>Cyclothone signata signata</i> Garman, In 20°C. 12°C. and 6°C. isotherms, and beyond 6°C. in the arctic zone	13°N.—30°S., 48°E.—97°E., 31°N.—37°S., 18°E.—21°W., and 61°21'N., 80°41'W.	520—3278	Gulf of Aden, 520—2500 m.; Northeast coast of Africa, 520—2500 m.; between Zanzibar and Chagos Is., 520—2500 m.; Bay of Bengal, 800—2500 m.; between New Amsterdam and Sumatra, 520—2500 m.; Gulf of Panama, 3278m.; West Coast of Africa; between Canary Is. and Cape of Good Hope, 600—3000 m.
107. <i>Cyclothone signata alba</i> Br. In 20°C. and 12°C. isotherms	13°N.—26°S., 43°—99°E., and 24°N.— 33°S., 16°E.— 21°W.	520—4454	Gulf of Aden, 520—2500 m.; Northeast Coast of Africa, 520—2500 m.; between Chagos Archipelago and Zanzibar, 520—2500m.; between Chagos Archipelago and Ceylon, 1900—2500 m.; Bay of Bengal, 800—2500 m.; West Coast of Africa between Canary Is. and Cape of Good Hope, 520—2500 m.
108. <i>Vinciguerria lucetius</i> (Garman) In 20°C. and 12°C. isotherms	21°N.—34°S., 32°E.—79°W.; and 5°N.—3°S., 7°E.—13°W.	182—3500	Delagoa Bay; between Zanzibar and Chagos Is., 800—2500m.; between Chagos Is. and Ceylon, 800—2500m.; Bay of Bengal, 800—2500 m. between New Amsterdam and Sumatra, 800—2500m.; Molucco passage, 1500m.; Gulf of Panama 182—3339m.; West Coast of Central America, 182—3339m. Gulf of Guinea, 2000—3500m.

Species	Range in latitudes and longitudes	Range of depth in metres	Distribution
109. <i>Vinciguerria nimbarius</i> J. W. In 20°C. isotherm	9°—24°N., 54°—69°E., and 32°N., 64°W.	549—2000	Gulf of Oman, N100, 600m., 12·38°C.; Arabian Sea, 549—640m., 11·80°C. at 579m.; N100, 1500 (—0)m., 5·57°C.; N200, 2000(—0)m., 3·18°C.; N100, 1000(—0)m., 9°C.; N100, 1500(—0)m., 5·57°C., off Bermuda.
110. <i>Valencienellus stellatus</i> Garman In 20°C. isotherm	27°N.—4°S., 43°E.—111°W.; and 30°N.—3°S., 7°E.—14°W.	548—3000	Seychelles ; between Chagos Is. and Ceylon ; Bay of Bengal, 2500m. West Coast of California, 548m. ; Gulf of Guinea 3000m.
111. <i>Yarrella corythaeolum</i> (Alc) In 20°C. and 12°C. isotherms	N.—32°S., 30°—130°E.	338—740	Gulf of Aden, OT 457— 549m.; Natal Coast, 365m.; Zanzibar area, 640m., 8·8°C. at 627m.; Maldiva area, 494m., 10·86°C. at 400m.; Bay of Bengal, 338—740m., 13·3°C.—8·3°C.; Great Australian Bight.
112. <i>Triplophos hemingi</i> (Mc Ardle, -(<i>Triplophos elongatus</i> Br.) In 20°C. isotherm	4°56'N., 78°15'3"E.	2000	South of Ceylon, 2000m.
113. Family STERNOPTYCHDAE <i>Sternoptyx diaphana</i> Herm. In 20°C., 12°C. and 6°C. isotherms	5°N.—47°S., 8°E.—115°W.; and 46°N.—35°S., 16°E.—87°W.	273—4571	Off Cape Point, 1828m.; Zanzibar area, 1789m., 3·04°C. at 1780m.; 2926m., 2·17°C. at 2886m.; between Zanzi- bar and Seychelles, 1100—3000m.; Arabian Sea, 1667—1702m., 4·6° —4·2°C.; N200, 430— 984m., 8·48°C. at 1000m.; AT3676m., 1·93°C. at 3000m.; Bay of Bengal, 2500m.; between New Amsterdam and Sumatra, 1100—3000m.; Timor Sea, 828m.; about 60 miles north west of Lu- bung L., 1000m. ; Phil- ippines, 914-3930m. ; New Guinea, 914 -3930m. ; North of New Zealand, 914-3930m.; South Aus- tralia, 914—3930m.; Sand- wich Is., Japan, 914— 3930m. California ; South Atlantic, N450, 2000 m., 2·74°C.; TYF 1000(—0) m., 3·11°C.; St. Helena ; Cape Verde Is.; Antelles ; Jamaica ; Portugal, 1123 —2792m.; Morocco, 1123—2792m.; Azores Is., 1123—2792m.; between Tenerife and St. Thomas, 4571m.; Sierra Leone, 4571m.; Mid-Atlantic Ocean, 4571m.; between Canary Is. and Cape of Good Hope, 273—3082m.; New foundland, 46°N., 56°W.; East Coast of North America, 273—3072m.; West Indies, 273— 3082m. ; Off Florida.

Species	Range in latitudes and longitudes	Range of depth in metres	Distribution
114. <i>Argyropelecus aculeatus</i> V. In 20°C., 12°C. and 6°C. isotherms	20°N.—32°S. 39°—99°E.; and 32°N.—35°S., 16°E.—87°W.	250—3000	Between Chagos Archipelago and Zanzibar, 2000—2500m.; between Chagos Archipelago and Ceylon 1900m.; Red Sea; South of Madagascar; Off Ceylon, 2000—2500m.; Bay of Bengal, 2500m.; between New Amsterdam and Sumatra, 1100—2500m.; Coast of Norway; Azores; West coast of Africa 250—1000m.; Gulf of Guinea, 600—3000m.; West of Cape of Good Hope, 2000m.; Off Bermuda; Off Florida.
115. <i>Argyropelecus affinis</i> Garm. In 20°C. and 12°C. isotherms	13°N.—6°S., 43°—85°E.; and 30°N.—31°S., 8°E.—87°W.	1000—3872m.	Coast of South Africa, 1828m.; Chagos Is., 1000—2500m.; Seychelles, 1000—2500m.; Gulf of Aden, 1000—2500m.; Arabian Sea, 3840—3872m., 1.93C. at 3500m.; Maldivé area, MT2249m.; AT 1829—2051m.; Bay of Bengal, 2500m.; West Indies, 1248m.; Gulf of Guinea, 2000m.; Off Florida.
116. <i>Argyropelecus hemigymnus</i> Cocco. In 20°C., 12°C. and 6°C. isotherms	12°N.—30°S., 51°—97°E.; 39°N.—35°S., 27°E.—87°W.; and 38°N., 15°E.	1500—3297	Between Zanzibar and Chagos Is., 1500—2400m.; South of Ceylon, 2000m.; Bay of Bengal, 3297m., 1.7°C.; between New Amsterdam and Sumatra, 1500—2400m.; Azores; West coast of South Europe, North Africa; between Shetland and Faroes Is.; Coast of Norway; Off Florida; Messina; Mediterranean.
117. <i>Argyropelecus olfersti</i> (C). In 20°C., 12°C. and 6°C. isotherms and beyond 6°C. in the Arctic zone	9°N.—35°S., 18°E.—79°W.; 63°N.—3°S., 7°E.—74°W.; and 71°N., 25°E.	263—4080	West of Chagos Is., 2200—2500m.; South of Ceylon, 2000m.; between New Amsterdam and Sumatra, 2200—2500m.; Galapagos Is., 520—4080m.; Gulf of Panama, 520—4080m.; West Coast of Central America, 520—4080m.; Coast of Norway upto Cape North; Portugal, 950—1650m.; Azores; Madiera; Cape Finisterre, 2056m.; between Canary Is. and Brazil; Gulf of Guinea, 2000—4000m.; Cape of Good Hope, 914m.; East coast of North America, 263—3782.
118. <i>Argyropelecus stadeni</i> Regan. In 20°C. isotherm and beyond 6°C. in the Antarctic zone	12°N.—5°S., 41°—65°E., 12°N. 15°S., 11°E.—20°W.; and 61°25' 30"S., 53° 46' W.	430—2886	Zanzibar area, 2926m., 2.17°C. at 2886m.; Chagos Archipelago, 731—914m.; Arabian Sea, N200 430—984m., 8.48°C. at 2886m.; Off Cape Bowles, Clarence Id., 61°25' 30"S., 53° 46' W.; air temp. 1.1°C., surface temp. of sea 0.65°C., at 335m.—0.42°C.

Species	Range in latitudes and longitudes	Range of depth in metres	Distribution
119. <i>Polyipnus spinosus</i> Gthr. In 20°C. and 12°C. isotherms	35°N.—35°S.,—18°—137°E.; and 2°36'5" N., 3°27'5"E.	371—1200	Zanzibar area, OT640—658m.; Indian Ocean 457m.; Northeast Coast of Africa, 1362m.; Cape to Natal, 1188m.; between north and south Sentinel Is., 400-438m.; Off Andaman Is., 438m.; 11.1°C.; West coast of Sumatra, 371-470m.; Celebes Sea, 457m.; between Philippines; and Borneo; Sagami Bay; Australia; Gulf of Guinea, 1200m.
Superfamily Stomiatoidea (Lepidophotodermi) Family STOMIATIDAE	0°—15°N., 41°—98°E.; and 30°N.—5°S.; 71°E.—87°W.	594—2000	Gulf of Aden, 1200m. 6.1°C.; Red Sea, 700—805m.; Laccadives, 1349m., 3.1°C.; West coast of Sumatra, 594-1800m.; West Indies, 820m.; West coast of Africa, 2000m.; Gulf of Guinea, 2000m.
120. <i>Stomias affinis</i> Gthr. <i>Stomias valdiviae</i> (Br.)— In 20°C. isotherm			
121. <i>Stomias nebulosus</i> Alc. In 20°C. isotherm	6°N.—10°S., 41°—125°E.	640—1091	East coast of Africa, 639-1019m., 9°-6.4°C.; Zanzibar area, OT 640-658m.; Gulf of Manaar, 1091m., 6, 4°C.; Flores Sea; Timor Sea.
122. <i>Photostomias guernei</i> Collet [<i>Photostomias atrox</i> (Alc.)] In 20°C. and 12°C. isotherms	18°26'N., 85°24'E.; and 0°—39°N., 14°—87°W.	430—2500	Off Ganjam coast., 239m., 2.3°C.; Off the Andamans, 1108m., Azores, 1138m.; Caribbean sea; Atlantic Ocean, 15°—39°N., 20°—82° W., 0—3000 M. W.; Off Florida; Off Bermuda.
123. <i>Chauliodus pammelas</i> Alc. In 20°C. isotherm	24°N.—8°S., 46°—121°E.	400—2505	Gulf of Aden, 1022-1295m., 7.16°C. at 1280 m., 6.1°C. at 1200m. 10.2°C. at 1000m. Gulf of Oman, N200; 2500m., 2.27°C.; Arabian Sea, N200, 430—984m., 8.48°C. at 1000m.; 10.64°C. at 600m.; Maldive area, 494m., 10.86°C. at 400m.; Laccadive Sea, 2505m.; 2.2°C.; Flores Sea, 530m.
124. <i>Chauliodus sloani</i> Schn. In 20°C. isotherm	35°N.—26° S., 30°—135°E., 35°N.—34°S., 16°E.—87°W.; and 36°—38°N., 15°E.—5°W.	494—4671	Southeast coast of Africa, 548-1828m.; between Zanzibar and Seychelles, 594-2200m.; Gulf of Aden, 594-2200m.; Maldive area, 494m.; 10.86°C. at 400m.; South of Ceylon, 2000m.; Gulf of Mannar, 1091m.; Bay of Bengal, 2907m., 5°C., 1686m., 5.1°C. West coast of Sumatra, 594-2200m.; North of New Amsterdam, 594-2200m.; New Guinea, 1463-3657m.; South of Japan, 1933m.; Mediera; Mid-Atlantic, 4571m.; Bermuda Is., 4671m.; Morocco, 1123m.; East coast of north and central America, 795-3783m.; Gulf of Guinea, 600-3000m.; Southwest coast of Africa 600-3000m.; Off Florida; Mediterranean.

Species	Range in latitudes and longitudes	Range of depth in metres	Distribution
Superfamily Astronesthoidea (Gymnophotodermi)			
Family ASTRONESTHIDAE			
125. <i>Astronesthes indicus</i> Br. In 20°C. isotherm	8°N.—5°S., 46°—75°E.; and 0°56'S.—28°N., 14°—66°W.	409—3000	East of Zanzibar, 3000m.; Off the Travancore Coast, 409-529m., 12.2°C.; Atlantic Ocean; Caribbean Sea.
126. <i>Astronesthes martensii</i> Klunz In 20°C. isotherm	4°—20°N., 39°—78°E.; and 17°N., 22°W.	2000	Red Sea; South of Ceylon, 2000m.; Cape Verde I.
127. <i>Bathylchnus cyaneus</i> Br. =[<i>Astronesthes Cyaneus</i> (Br.)].— In 20°C. isotherm.	4°56'N., 78° 15'3"E., and 6°—26°N., 15° —83°W.	800-2000	South of Ceylon, 2000m. Atlantic N200, 800 (—0)m.; Caribbean Sea.
Family MELANOSTOMIATIDAE (incl. MALACOSTEIDAE)			
128. <i>Melanostomias melanops</i> Br. In 20°C. isotherm	5°23'2"N., 94°48'1"E.; and 14°38'N., 61°16'W.	1000—1024	Northwest Coast of Sumatra, 1024m.; Caribbean Sea, 1000M.W.
129. <i>Melanostomias valdiviae</i> Br. In 20°C. isotherm	0°15'2"N., 98°8'8"E.	614	West coast of Sumatra, 614m.
130. <i>Malacosteus niger</i> Ayres =(<i>Malacosteus indicus</i> Gthr.). In 20°C., 12°C. and 6°C. isotherms	13°N.—10°S., 46°—97°E., and 42°N.—38°S., 15°E.—40°W.	989—2500	Gulf of Aden, 1061-1080m.; Chagos Is., 1900-2500m. Arabian Sea, N200, 2500 (-0)m.; Bay of Bengal, 2500m.; Off Cinque I., 1188m.; North of Cocos Is., 1000-2500m.; Bar- bados, 630m.; East coast of North America, 989-1950m.; West coast of South Africa, 2000m.; Gulf Stream, 42°N., 60°W.
Family IDIACANTHIDAE			
131. <i>Idiacanthus fasciola</i> Ptrs. Br. In 20°C. and 12°C. iso- therms and beyond 6°C. in the antarctic zone	7°N.—5°S., 48°—85°E., 40°N.—36°S., 17°E.—80°W.; and 55°—56°S., 14°—16°E.	1500—4000	Between Zanzibar and Seychelles, 1500-2500m.; South of Ceylon, 2000- 2500m.; East of Bouvet Is., 56° 31' 5"S., 14°29' 2"E., 1500-4000m.; West coast of Africa, 1500- 4000m.; Off Bermuda.
Suborder Notopteroidei			
Family NOTOPTERIDAE			
132. <i>Notopterus chitala</i> (Ham.) In 20°C. isotherm	25°N.—7°S., 70°—115°E.	Fresh water	India, Pakistan, Burma, Malaya, Indonesia, Siam, Cochin China, China.
133. <i>Notopterus notopterus</i> (Pallas) = (<i>Notopterus</i> <i>osmani</i> Rahimullah & Das). In 20°C. isotherm	30°N.—7°S., 73°—115°E.	Euryhaline	Pakistan, India, Burma, Malaya, Indonesia, Siam, Cochin China, China.
Order Bathyclupeiformes			
Family BATHYCLUPEIDAE			
134. <i>Bathyclupea hoskynii</i> Alc. 20°C. isotherm	11°—14°N., 80°—93°E.	272—766	Andaman Sea, 676-766m., 348-402m., 13.3°C.; Off Madras coast, 272-457m

Species	Range in latitudes and longitudes	Range of depth in metres	Distribution
Order Galaxiiformes			
Family GALAXIIDAE			
135. <i>Galaxias indicus</i> Day In 20°C. isotherm.	13°—23°N., 80°—91°E.	Littoral	Littoral districts of Madras, West Bengal, East Pakistan.
Order Scopeliformes (INIOMI)			
Family SYNODIDAE (SAURIDAE, SYNODONTIDAE)			
136. <i>Harpodon nehereus</i> (Ham.) In 20°C. isotherm	34°N.—7°S., 38°—130°E.	Littoral	Zanzibar, Pakistan, India, Burma, Malaya, Indonesia, China, Korea.
137. <i>Harpodon squamosus</i> Alc. In 20°C. isotherm.	15°56'50"N. 81°31'30"E.	439—504	Bay of Bengal, 439—504m., 11.1°C.
138. <i>Saurida gracilis</i> (Q. & G.) In 20°C. isotherm.	25°N.—29°S., 30°E.—149°W.	Littoral	Red Sea, East and south coasts of Africa, Madagascar, Mauritius, Zanzibar, Pakistan, India, Burma, Ceylon, Indonesia, Siam, China, Philippines, Australia, Micronesia, Polynesia, Hawaii, Tahiti.
139. <i>Saurida longimanus</i> Norman In 20°C. isotherm.	25°N., 56°E.	106—201	Gulf of Oman, OT-106—201m.
140. <i>Saurida tumbil</i> (B1.) In 20°C. isotherm	34°N.—29°S., 30°—167°E.	Littoral	Red Sea, Natal, Madagascar, Zanzibar, Indonesia, Siam, China, Japan, Korea, Philippines, Australia, Sandwich Is., Vanicolo.
141. <i>Saurida undosquamis</i> (Rich.) In 20°C. isotherm	34°N.—33°S., 28°—135°E.	65—220	Red Sea, OT-65-67m., Gulf of Aden, 220m., Gulf of Oman, 73m., Zanzibar area, 183—194m., East and south coasts of Africa, Singapore, Indonesia, China, Japan, Philippines, North West Australia.
142. <i>Synodus indicus</i> (Day) In 20°C. isotherm	11°N.—34°S., 22°—80°E.	37—91	Gulf of Aden, OT-37091m.; Mossel Bay, South Africa, India.
143. <i>Synodus japonicus</i> (Hauttuyt)-[<i>Synodus variegatus</i> (Lac.)] In 20°C. isotherm	32°N.—29°S., 30°E.—155°W.	Littoral	Red Sea, Gulf of Aden, Arabia, East and South coasts of Africa, Zanzibar, Madagascar, Mauritius, New Guinea, Hawaii, Tahiti.
144. <i>Trachinocephalus myops</i> (Schn.) In 20°C. isotherm	35°N.—33°S., 28°E.—155°W., and 14°—30°N., 5°—87°W.	Littoral	Natal, Martinique, Pakistan, India, Ceylon, Malaya, Indonesia, Philippines, Formosa, Hongkong, China, Japan, Fusan, Australia, Oceania, Hawaii, St. Helena, Martinique, Off Florida.
Family SCOPELARCHIDAE			
145. <i>Scopelarchus guentheri</i> Alc. In 20°C. isotherm	22°14'25"N., 67°8'55"E.	1731	Off the Indus Delta, Pakistan, 1731m., 4.7°C.
Family EVERMANNELLIDAE (ODONTOSTOMIDAE)			
146. <i>Evermanella atratus</i> (Alc.) In 20°C. isotherm.	14°N.—4°S., 73°—93°E.	676—2,000	Chagos Archipelago, 2000 m.; Bay of Bengal, 1048, 7.4°C.; Andaman Sea, 676—766m.

Species	Range in latitudes and longitudes	Range of depth in metres	Distribution
Family SUDIDAE			
147. <i>Chlorophthalmus agassisi</i> Bonap. In 20°C. isotherm	20°N.—35°S., 18°E.—155°W., and 38°—13°N., 15° 13'E.	48-977	Zanzibar area, 288—293m.; Cape of Good Hope to Delagoa Bay, 274—548 m.; Off Colombo Lt., 48—457m.; Off Madras coast, 265—457m., 10°C.; West coast of Sumatra, 371—977m., 11°-8°C.; Madura Sea, 289m.; Fiji Is., 575m., Hawaii; East coast of North America between 28°—39°N., 70°—79°W., 291—497m; North coast of Africa, 371—977m; Mediterranean.
148. <i>Lestidium (Bathysudis) speciosus</i> Bellotti = (<i>Omosudis elongatus</i> Br.) In 20°C. and 12°C. isotherm	7°N.—29°S., 30°—97°E.; 2°N.—3°S., 3°—7°E.; and 38°N., 14°E.	1200—3000	Off Seychelles, 1200—3000m.; Off Chagos Is., 1200—3000m.; South of Ceylon, 2000m.; Bay of Bengal, 2500.; North of Cocos Is., 1200—3000m.; Gulf of Guinea, 1200—3000m.; Mediterranean.
149. <i>Bathypterois (Bathypterois) atricolor</i> Alc. In 20°C. isotherm	6°—13°N., 70°—76°E.	839—1629	Laccadive Sea, 1629m., 5°C.; Off Maldives, 839m.; Off Cape Comorin, 506m., 4.4°C.
150. <i>Bathypterois (Bathypterois) insularum</i> Alc. In 20°C. isotherm.	14°N.—29°S., 30°—70°E.	2084	Off the Laccadives, 2084m., 3.1°C.; Coast of South Africa.
151. <i>Bathypterois (Hemlpterois) guentheri</i> Alc. In 20°C. isotherm.	4°—13°N., 72°—92°E.	896-1316	Off the Laccadives, 1163m. 7°C.; Off the Maldives, 1316m., 6°C.; Bay of Bengal, 1026m., 7.2°C.; East of north Cinque I., 896m., 12.8°C.
Family SCOPELIDAE (MYCTOPHIDAE)			
152. <i>Myctophum cocoi</i> (Cocco)— In 20°C., 12°C and 6°C. isotherms.	34°N.—39°S., 18°E.—71°W.; and 46°N.—38° S., 2°E.—70°W.; and 37°35'N., 14°10'E.	520-3000	Between Zanzibar and Seychelles; South of Madagascar; Bay of Bengal, 2000m.; West of Sumatra, 520m.; East coast of Australia; Japan; New Zealand; Admiralty Is.; West coast of Chile; Gulf of Panama, 6°21' N., 80°41'W., 3279m., surf. temp. 23.9°C.; West coast of South America; between Azores Is. and New Foundland; North of Bermudas; West Indies; Off Azores; between Azores and Bermudas; Off Cape Verde Is.; Off Canary Is.; Off Brazil, Gulf of Madiera; Gulf of Guinea; Gulf of Mexico; West of South Africa, 3000m.; South, of Cape of Good Hope 2000m.
153. <i>Myctophum fibulatum</i> Gilbert & Gramer. In 20°C. and 12°C. isotherm.	23°N.—5°N., 64°E.—155°W.	1500-2000	Off the Indus Coast. N200, 2000(—0)m., 3.18°C.; N100, 1500(—0)m., 5.57°C., Hawaii.
154. <i>Myctophum indicus</i> Day In 20°C. isotherm.	17°42'N., 83°20'E		Off Vizagapatnam Coast.

Species	Range in latitudes and longitudes	Range of depth in metres	Distribution
155. <i>Myctophum laternatum</i> Garm. in 20°C. and 12°C. isotherms	34°N.—26°S., 46°E.—80°W.; and 14°N.—34°S., 16°E.—21°W.	480-3500	Between south of Socotra and Gulf of Aden, 1200-2000m. ; between Zanzibar and Seychelles, 2500m.; between Chagos Archipelago and Seychelles, 2000-2500 ; between Chagos Archipelago and Ceylon 1900-2500m.; Arabian Sea, N200, 480-980m., 12.12°-8.4°C.; Southeast of Maldives, 2500m.; Bay of Bengal, 2500m.; between New Amsterdam and Sumatra, 2200-2400m.; West coast of California between 7°N. and 27° 39'N; Gulf of Panama; Off Cape Verde Is., Sierra Leone; Gulf of Guinea 2000-3500m.
156. <i>Myctophum pterotus</i> Alc. In 20°C. isotherm	34°N.—35°S., 18°E.—135°E.	179-2000	Off Cape Point; Gulf of Oman; Arabian Sea 549-640m., 11.8°C., N200, 2000(-0)m., 3.18°; N100, 1500(-0)m.; 5.57°C.; Bay of Bengal, 179-186m.; Andaman Sea, 676-766m.; Macassar Strait; Philippines; Japan.
157. <i>Myctophum reinhardti</i> (Lutken), In 20°C. and 12°C. isotherms	34°N.—35°S., 18°E.—74°W.; and 34°N.—31°S., 10°E.—18°W.	430-4000	South of Socotra, 1500—2000m.; Gulf of Aden, 1200m.; Cape to East London; between Zanzibar and Seychelles, 2000m.; between Seychelles and Chagos Archipelago, 2000-2500 m.; between Chagos Archipelago and Ceylon, 2000m.; Arabian Sea, N200, 430-984m., 12.12°—8.48°C.; Banda Sea (surface plankton)—; Halmaheira Sea, 1000 (-0)m. (vertical net); West coast of Chile; Japan; Madeira, 1800 m.; between Africa and South America, 5°31' N. 23° 15' W., South of Canary Is., 2000 m., Coast of Sierra Leone, 1300-3000m.; Gulf of Guinea, 700-4000 m.; Southwest coast of Africa, 2000m.; Mediterranean.
153. <i>Myctophum spinosus</i> (Steind.) In 20°C. and 12°C. isotherms	34°N.—40°S., 38°—170°E., and 14°N.—7°S., 11°—29°W.		Zanzibar; Bay of Bengal, Northwest of Australia; North of Australia; Sandwich Is.; China; Japan; Mid-Atlantic Ocean.

Species	Range in latitudes and longitudes	Range of depth in metres	Distribution
159. <i>Myctophum valdiviae</i> Br. In 20° C. and 12 C. isotherms	13° N.—31° S., 46°—97° E.; and 24° N.—26° S. 7° E.—17° W.	500-4000	North east coast of Africa, 1500—2000 m.; Gulf of Aden, 1200 m.; between Zanzibar and Seychelles, 2000.; between Seychelles and Chagos Archipelago, 1500—2000 m.; between Chagos Archipelago and Ceylon, 2000 m.; Bay of Bengal, 2000—2500 m.; North-East of; New Amsterdam, 1800 m.; North of Cocos Is.; 2400 m.; between Sierra Leone and Gulf of Guinea, 600—3070 m.; South-West Africa 500—4000 m.
160. <i>Lampanyctus gemmifer</i> G. B. In 20°C. and 12°C. isotherms	22°14'25"N., 67°8'55"E.; 39°39'45"N., 71°35'15"W.	983-1731	Pakistan, off Indus Delta, 1731 m., 4.7°C.; East coast of North America, 983m.
161. <i>Lampanyctus longipes</i> Br. In 20°C. isotherm	7°N.—26°S., 53°- 97°E., and 0°- 31°N., 7°E.- 15°W.	1500-2500	Off Seychelles, 1500-2000m.; Off Chagos Archipelago, 2000m.; South of Ceylon, 2000m., Bay of Bengal, 2500m.; North of Cocos Is., 2400m.; South of Cocos Is., 2200 m.; Madeira, 1800m.; Gulf of Guinea, 2000m.
162. <i>Lampanyctus macropterus</i> Br. In 20°C. isotherm	34°N.—10°S. 46°—135°E.	430-2500	Gulf of Aden, 1200m.; Northeast coast of Africa, 1000-2000m.; between Zanzibar and Seychelles, 2000 m.; North of Chagos Archipelago, 2000 m.; Arabian Sea; N 100, 2000 (-0)m.; 430-984m., N-200, 12.12°-8.48°C., N-200, 2091 (-0); South of Ceylon, 2000 m.; Bay of Bengal, 2000-2500 m.; North of Cocos Is., 2400 m; Japan; Atlantic Ocean.
163. <i>Lampanyctus micropterus</i> (Alc.) In 20°C. isotherm	0°—6°S., 58°—99°E.; and 3°N.—1°S., 7°E.—6°W.	800-4000	East of Seychelles, 1500—2000m.; West of Chagos Archipelago; North of Chagos Archipelago, 1900-2000 m.; West coast of Sumatra, 1100 m.; Gulf of Guinea, 800-4000m.
164. <i>Lampanyctus pyrsobolus</i> (Alc.) In 20°C. isotherm	15°38'N., 82°30'E.	1261-1682	Bay of Bengal, 1261-1682 m., 4.3°C.
165. <i>Diaphus coeruleus</i> (Klunz.) In 20°C. isotherm	34°N.—32°S., 39°—135°E.	343-1500	Red Sea; Andaman Sea, 343-402m., 13.3°C.; West Coast of Sumatra, 371 m.; Molucco passage, 1500 m.; Celebes Sea, off Mindano, 457 m. Japan; Australia.
166. <i>Diaphus dumerili</i> (Blkr.) In 20°C. isotherm	13°N.—4°S., 51°—120°E.; and 39°N.—37°S., 9°E.—7°W.	214-3500	West and east coast of Seychelles, 2000 m.; North of Chagos Archipelago, 2000 m.; Off Malabar coast, 214m.; South of Ceylon, 2000m.; Bay of Bengal, 2000 m.; Celebes; Coast of Cuba; Southeast coast of South America; Gulf of Mexico; East coast of North America between 35°-39°N. and 70°-74°W. Gulf of Guinea, 600-3500.

Species	Range in latitudes and longitudes	Range of depth in metres	Distribution
167. <i>Diaphus garmani</i> Gilbert In 20°C. isotherm	9°—23°N., 54°—64° E. ; and 22°N., 80°W.	1000-2091	Pakistan, Off Indus Delta, N100, 1000 (-0) m. ; Arabian Sea, N200, 2000 (-0) m. ; N200, 2091 (-0) m. ; Cuba.
168. <i>Diaphus lutkeni</i> (Br.) In 20°C. and 12°C. isotherms	10°N.—5°S., 43°—70°E., and 9°N.—35°S., 10°E.—16°W.	125-3000	Northeast Coast of Africa, 1000-2000m. ; Zanzibar, 3000m. ; West of Chagos Is. 2000m. ; Arabian Sea, N200, 400-465m., N200, 600 (-0) m. ; Atlantic Ocean, 0°-35°S., 10°E.-14°W. ; TYF 125-1000 (-0) m., 7-57°C. at 1000m., 13-48°C. at 200m.
169. <i>Diaphus rafinesquei</i> (Cocco) In 20°C. and 12°C. isotherms	35°S.—10°N., 46° E.—140°W. ; 37°N.—40°S., 16°E.—69°W. and 38° 13'N., 15° 13'E.	400-1024	Gulf of Aden, 1061-1080m. Off Indus Delta ; N100, 1500 (-0)m. 5-57°C. ; N200 2000 (-0)m., 3-18°C. ; Arabian Sea, 759-1024 m. ; N 200, 400-645m. ; N200, 600 (-0) m. ; East coast of North America ; 37°12' 20" N., 69°39'W. ; Messina ; Japan ; Marquesas Is.
170. <i>Diaphus splendidum</i> (Br.) In 20°C. isotherm	35°N.—29°S., 32°—135°E. ; and 3°—9°S., 7°S.—9°E.	289-3872	Northeast coast of Africa, 500-2000m. ; Off Seychelles, 1500m. ; Off Mauritius, 1500 —2000m. ; Arabian Sea, 3840-3872m., 3-68°C. at 2000m ; Maldiv area, 457m. ; Bay of Bengal, 2500m. ; between Cocos Is. and West coast of Sumatra, 520-2400m. ; Madura Sea, 289m. ; Japan ; Gulf of Guinea, 700-3000m.
171. <i>Neoscopelus macrolepidotus</i> Johnson In 20°C. and 12°C. isotherm	35°N.—29°S., 30°—E.—17°W. ; and 22°—36°E., 5°—80°W.	400-1590	Alagoa Bay to Natal, 548m. ; East coast of Africa, 693m, 9°C. Arabian Sea, 658m. ; 9-2°C. ; Maldiv area, 494m., 10-86°C. at 400m. ; Andaman Sea, 343-740m., 13-3-8-3°C. ; West coast of Sumatra, 614m., 10-2°C. apan ; Northeast of New Zealand, 950-1097m., 6"-4°C.
172. <i>Scopelengys tristis</i> Alcock In 20°C. isotherm	6°—12°N., 63° —80°W.	430-3279	Laccadive Sea, 1828m. 3-7°C. ; Arabian Sea N200, 430-984m. 12-12° -8-48°C. ; Pacific coast, of Central America, 271-3279m. 3-8°-2-1°C.
Order Ateleopiformes			
Family ATELEOPIEDAE			
173. <i>Ateleopus indicus</i> (Wood Mason & Alcock). In 20°C. isotherm	14°N.—4°S., 73°—123°E.	343-529	Arabian Sea 409-529m., 12.2°—11.1°C. ; Maldiv area, 494m., 10-86°C. at 400m., Andaman Sea, 343-402m., 13-3° C. ; Philippines.

V—SUMMARY

This paper deals with the distributional pattern of 173 species of fishes of the "Indian region" belonging to the Orders Clupeiformes, Bathyclupeiformes, Galaxiiformes, Scopeliformes, and Ateleopiformes with special reference to the *mean annual* isotherms of 6°, 12° and 20°C. The regional and zonal distribution of these species is indicated according to their latitudinal and vertical ranges, and an attempt has been made to separate them out as littoral or semipelagic, bathypelagic, abyssal, endemic, Indo-Pacific, cosmopolitan and so on. These 173 species (including 4 subspecies) consist of 85 littoral or semipelagic, 3 exotic and land-locked, and 85 bathypelagic species.

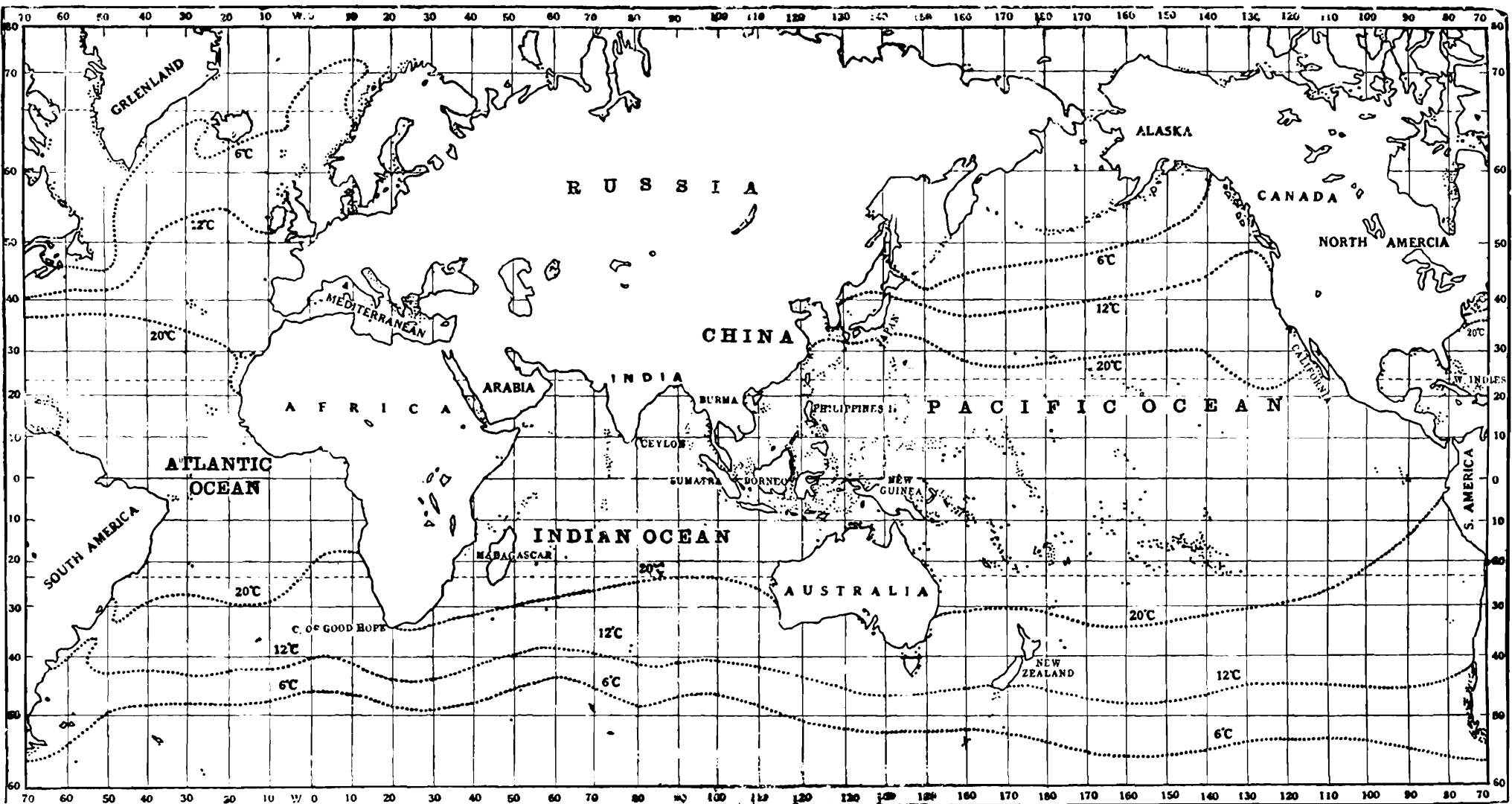
A detailed, classified list of these 173 species is given in the paper, showing their mean annual isotherms, latitudinal and longitudinal ranges, distribution, and vertical ranges, depths in metres and bottom temperatures wherever available. Out of the total 173 species, 133 belong to the Order Clupeiformes, 37 to the Order Scopeliformes and one each to the Orders Bathyclupeiformes, Galaxiiformes and Ateleopiformes. Orders Clupeiformes and Scopeliformes together constitute 170 species, out of which 83 are bathypelagic and 87 littoral or semipelagic species. Of the 83 bathypelagic species, 16 are endemic to the "Indian region", while 67 species have been recorded from the Indo-Pacific, Atlantic, Arctic and Antarctic regions, unaffected by isothermal limitations. Out of 87 littoral or semipelagic species, 3 are exotic, 16 are endemic and the remaining 68 species have a restricted range extending eastwards into the Indo-Pacific and even as far as the tropical Atlantic, but never extending westwards and penetrating the cold waters of the Atlantic west of the Cape of Good Hope. The Cape thus represents a well demarcated line of division between the Indo-Pacific and Atlantic species of littoral and semipelagic fishes.

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PLATE 34

Map, showing the mean annual surface isotherms 6°C, 12°C and 20°C in the Indian, Pacific and Atlantic Oceans.



ON A COLLECTION OF SPIDERS (ARANEAE) FROM THE DESERT AREAS OF RAJASTHAN (INDIA)

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(With 3 Text-figures)

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I—INTRODUCTION

This paper is a report on a small but extremely interesting collection of spiders made mainly by me as a member of the Rajasthan Survey Party, Zoological Survey of India, during 1956-57. The material contains about a dozen species, of which three are new to science. In addition to the notes on distribution, I have added summaries of my ecological field observations on each species. The specimens, including the types, are in the National Collections of Zoological Survey of India, Calcutta.

I take this opportunity of recording my sincere thanks to Dr. M. L. Roonwal, Director, Zoological Survey of India, for facilities and encouragement.

II—SYSTEMATIC ACCOUNT

Family 1. ERESIDAE

1. *Stegodyphus pacificus* Pocock

1900. *Stegodyphus pacificus* Pocock, *Fauna Brit. India, Arach.*, London, p. 209.

Specimens collected.—4 ♀♀, Kailana Desert Afforestation, ca. 11·2 Km. west of Jodhpur, 13-xii-1956. 1 ♀, from Bareganga, ca. 16 Km. north of Jodhpur, 17-xii-1956.

Measurements.—Total length 15·70 mm. Carapace 7·50 mm. long, 5·50 mm. wide ; abdomen 9·20 mm. long, 8·00 mm. wide.

[435]

Field notes.—This species lives on bushes of *Zizyphus* and *Acacia* sp., where they spin a large sheet-like web, with a tubular retreat. The spider lives alone, unlike *S. sarasinorum*. After cutting the tubular retreat, I found the dead mother spider partially eaten by young ones. The number of young ones in the nest was about one hundred. Another specimen was collected with a cocoon. November and December appear to be the breeding time.

Distribution.—INDIA : Western India ; Eastern Khandesh ; Poona.

Family 2. LYCOSIDAE

2. *Hippasa pisaurina* Pocock

1900. *Hippasa pisaurina* Pocock, *Fauna Brit. India, Arach.*, London, p. 250.

Specimens collected.—1 ♀ and 1 ♂, from Merta City, 13-xii-1956. 15 ♀♀ and 5 ♂♂, from Dungar College compound, Bikaner, 6-i-1957.

Measurements.—Total length 12.50 mm. Carapace 5.50 mm. long, 4.00 mm. wide ; abdomen 7.00 mm. long, 4.80 mm. wide.

Field notes.—This species lives on the ground, where it spins a sheet-like web on the surface of grass, with a tubular retreat. The spider rests on the upper surface of the sheet. When disturbed it takes shelter inside the tubular retreat.

Distribution.—INDIA : East Khandesh ; Poona ; Bangalore ; Western India.

3. *Lycosa birmanica* (Simon)

1884. *Pardosa birmanica* Simon, *Ann. Mus. Stor. Nat. Genova*, Genova, 20, p. 333. (Type-locality : Minhla, Lower Burma.)

Specimens collected.—10 ♀♀, 5 ♂♂, from Kailana tank, ca. 8 Km. west of Jodhpur, 14-xii-1956. 20 ♀♀, 5 ♂♂, from Bareganga, ca. 16 Km. north of Jodhpur, 20-xii-1956.

Measurements.—Total length 5.00 mm. Carapace 2.70 mm. long, 2.00 mm. wide ; abdomen 2.50 mm. long, 1.50 mm. wide.

Distribution.—INDIA : Western India, Bombay ; Mysore ; Bangalore ; U. P. ; Nagpur ; Bengal. Also CEYLON and BURMA.

4. *Lycosa punctipes* Gravely

1924. *Lycosa punctipes* Gravely, *Rec. Indian Mus.*, Calcutta, 26, p. 603. (Type-locality : Bangalore.)

Specimens collected.—2 ♀♀, Merta city, 26-xii-1956.

Measurements.—Total length 5.60 mm. Carapace 3.00 mm. long, 1.60 mm. wide ; abdomen 2.60 mm. long, 1.70 mm. wide.

Field notes.—*Lycosa birmanica* and *L. punctipes* occur on damp soil mainly near the edges of tanks and lakes. They are very fast runners. *L. birmanica* also runs over the surface of water.

Distribution.—INDIA : Western India ; Bangalore ; Lucknow ; Bihar ; Bengal.

Family 3. PHOLCIDAE

5. *Artema atlenta* Walckenaer

1837. *Artema atlenta* Walckenaer, *Apteres*, 1, p. 656.

Specimens collected.—1 ♀ Merta City, 27-xii-1956. 6 ♀♀, Jorebir; ca. 16 Km. south-east of Bikaner, 11-i-1957.

Measurements.—Total length 6.10 mm. Carapace 2.60 mm. long, 2.50 mm. wide; abdomen 3.50 mm. long, 2.50 mm. wide.

Field notes.—See under *Crossopriza lyoni* below.

Distribution.—INDIA : Western India; Travancore; Meerut; Poona; Punjab. Also BURMA (Tharrawady).

6. *Crossopriza lyoni* (Blackwall)

1867. *Pholcus lyoni* Blackwall, *Ann. Mag. nat. Hist.*, London, 19(3), p. 302.

Specimens collected.—5 ♀♀, Mandore, ca. 11 Km. north of Jodhpur, 12-xii-1956. 16 ♀♀, Bhagat-ki-kuthi, ca. 7 Km. south-west of Jodhpur, 21-xii-1956.

Measurements.—Total length 4.60 mm. Carapace 1.60 mm. long, 2.00 mm. wide; abdomen 3.00 mm. long, 2.50 mm. wide.

Field notes.—*Crossopriza lyoni* is a common house spider. It spins an extremely fine but irregular cobweb from which it lies suspended upside down. It prefers dark, old and abandoned houses. No cocoon is made but eggs are glued together and carried in the chelicerae of the mother till they hatch. *Artema atlenta* often occurs in the same situations and has habits similar to *C. lyoni*, but is larger and stronger, so that it often kills the latter and occupies its web. Both the species are nocturnal.

Distribution.—INDIA : Western India; Madras; Meerut; Allahabad; Punjab. Also BURMA.

Family 4. ARGIOPIDAE

7. *Arigope arcuata* Simon

1884. *Arigope arcuata* Simon, *Ann. Mus. Stor. Nat. Genova*, Genova, 20, p. 343. (Type-locality : Burma.)

Specimens collected.—2 ♀♀, Jamsar roadside, ca. 17.5 Km. north of Bikaner, 10-i-1957.

Measurements.—Total length 11.70 mm. Carapace 3.30 mm. long, 2.90 mm. wide; abdomen 8.30 mm. long, 5.40 mm. wide.

Field notes.—*Arigope arcuata* makes its web very nicely. The web is often suspended between adjoining branches of lowgrowing plants and is large and orb-shaped, with very characteristic four white zigzag lines marking a cross "X" in the centre of the web. These white lines serve as supports for the legs. The web is spun vertically and the spider hangs vertically head downward.

Distribution.—INDIA : Western India; South India. Also BURMA and ARABIA.

8. *Cyrtophora citricola* (Forskål)

1775. *Aranea citricola* Forskål, *Descript. Animalium*, p. 86.

Specimens collected.—10 ♀ ♀, Merta City, 26-xii-1956.

Measurements.—Total length 6.80 mm. Carapace 3.00 mm. long, 2.20 mm. wide ; abdomen 4.30 mm. long, 3.10 mm. wide.

Field notes.—This species spins a very fine web which is roughly conical but may have several stages below the dome. The web commonly hangs under bushes of *Zizyphus* sp. The spider hangs downwards at the apex of the inverted bowl of the web. The webs are placed together to form a colony on a single bush.

Distribution.—INDIA : Western India ; Bangalore ; Chingleput ; Kanara ; Punjab. Also BURMA, CEYLON, AUSTRALIA, MADAGASCAR, AFRICA and SOUTH EUROPE.

9. *Araneus nauticus* Koch

1875. *Araneus nauticus* Koch, *Aegypt. Abyssin. Arach.*, p. 17.

Specimens collected.—1 ♀, Kailana tank, ca. 8 Km. west of Jodhpur, 14-xii-1956.

Measurements.—Total length 5.50 mm. Carapace 2.60 mm. long, 2.30 mm. wide ; abdomen 3.40 mm. long, 3.50 mm. wide.

Distribution.—INDIA : Western India ; Poona ; Eastern Khandesh ; Darjeeling. Also PAKISTAN and BURMA.

10. *Tetragnatha mandibulata* Walckenaer

1873. *Tetragnatha mandibulata* Walckenaer, *Hist. Nat. des. Inst.*, 2, p. 211.

Specimens collected.—8 ♀ ♀, 7 ♂ ♂, Kailana tank, ca. 8 Km. west of Jodhpur, 14-xii-1956.

Measurements.—Total length 8.40 mm. Carapace 2.00 mm. long, 1.50 mm. wide ; abdomen 6.70 mm. long, 3.20 mm. wide.

Field notes.—These spiders were collected from twigs of *Acacia arabica* overhanging a tank. The spiders rest by day with their legs stretched out before and behind and are only active at night. They spin large orb-webs at sundown among grasses and other foliage usually in the vicinity of water.

Distribution.—INDIA : Western India ; Bengal ; Nicobar Islands. Also BURMA and the AUSTRO-MALAYSIA.

Family 5. GNAPHOSIDAE

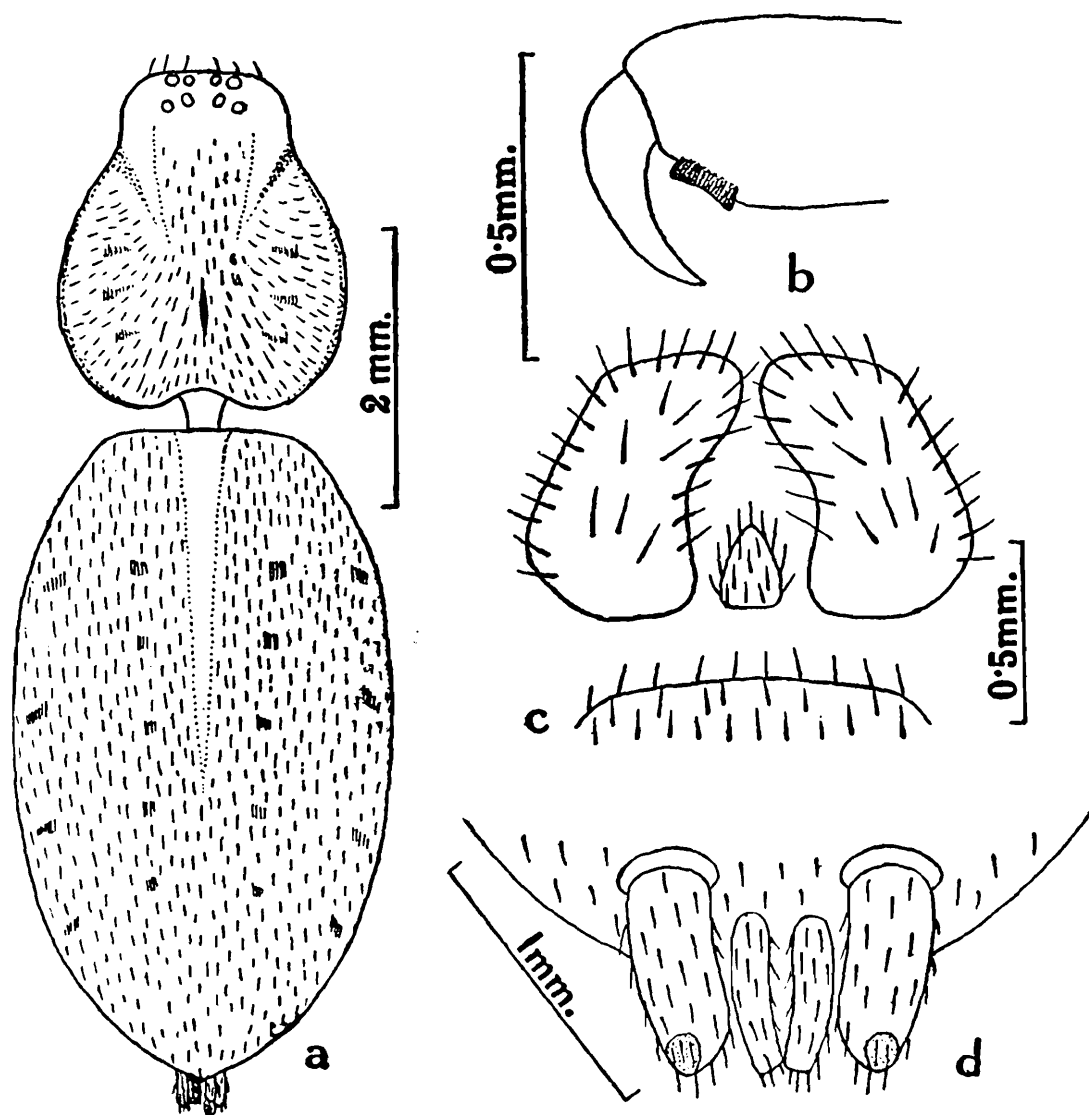
Genus *Gnaphosa* Latreille

11. *Gnaphosa kailana* sp. nov.

Material.—1 ♀, Kailana Desert Afforestation, ca. 11.2 Km. west of Jodhpur, 13-xii-1956. 1♀, Nagaur, Merta Dist, 26-xii-1956. 1♀, Lallgarh, Bikaner, 8-i-1957. All coll. B. K. Tikader.

Description.—*General* : Cephalothorax brown, legs and clypeus lighter than cephalothorax ; abdomen dirty white. Total length 8.30 mm., carapace 2.90 mm. long, 2.20 mm. wide ; abdomen 5.30 mm. long, 3.30 mm. wide.

Cephalothorax.—Heart-shaped, relatively broad in front, convex with a fovea, clothed with spine-like hairs and a brown narrow line encircling almost the entire border of cephalothorax, the tufts of dark brownish hairs, three on each side. Eyes viewed from front : anterior row of eyes slightly procurved ; anterior median eyes slightly smaller and darker than the anterior laterals ; the posterior row recurved and longer than the anterior row, posterior medians white, with irregular outline, slightly larger than the laterals and further away from each other than from laterals. Clypeus narrow, margin bearing spines, directed



TEXT-FIG. 1.—*Gnaphosa kailana* sp. nov. Female. *Holotype*. (a). Dorsal view of whole body. (b). Right chelicera. (c). Maxillae and labium. (d). Spinners.

forward. Sternum oval, pointed behind, densely clothed with spiny-hairs. Labium, maxillae and chelicerae. Text-fig. 1, b, c. Legs long, stout, with spiny-hairs and strong spines interspersed, I and IV legs longer than others, tibia I with two pairs of ventral spines and a single spine in between the former, metatarsi I and II with two pairs of ventral spines. Scopulae extend upto the base of metatarsi I and II.

Abdomen.—Elliptical, covered with hairs, a dagger-shaped line more white than the ground colour of abdomen, this line extends from the base of the anterior mid-dorsal to the middle of abdomen; several irregular tufts of dark brown hairs on the abdomen. Ventral surface uniform less white than dorsal side, clothed with hairs. Spinners Text-fig. 1d.

Type-specimens.—*Holotype*: 1 female, Z. S. I. Reg. No. 2490/18. *Paratypes*: 2 females, Z. S. I. Reg. No. 2491/18.

Type-locality.—Kailana Desert Afforestation, ca. 11.2 Km. west of Jodhpur, Rajasthan, India.

Geographical distribution.—INDIA: Western Rajasthan: Near Jodhpur; Merta city, Dist. Nagaur; Bikaner.

Comparison.—This species resembles *Gnaphosa occidentalis* Simon but is separated as follows.—(i) Cephalothorax brown and three tufts of dark brownish hairs on each side (in *G. occidentalis* cephalothorax uniform dark brown). (ii) Abdomen dirty white, several irregular tufts of dark brown hairs on the dorsum (in *G. occidentalis* abdomen uniform dark brown).

Genus *Scotophaeus* Simon

12. *Scotophaeus rajasthanus* sp. nov.

Material.—1 ♀, Merta city, Dist. Nagaur, 27-xii-1956, coll. B. K. Tikader.

Description.—*General*: Cephalothorax, legs and clypeus brown; abdomen dark brown. Total length 6.60 mm.; carapace 2.30 mm. long, 1.90 mm. wide; abdomen 3.90 mm. long, 2.20 mm. wide.

Cephalothorax.—Narrowed in front, convex, with a conspicuous fovea, clothed with fine hairs. Eyes viewed from front: anterior row slightly procurved; anterior medians considerably larger than the laterals and black. Posterior row slightly longer than the anterior row and procurved; eyes posterior row more or less equal and equidistant of each other, the posterior median white, the two laterals moderately dark. Clypeus narrow. Sternum oval, slightly pointed behind, clothed with hairs. Labium triangular and almost contiguous with the maxillae. Text-fig. 2b. Chelicerae vertical, margin without tooth. Legs long, spined, IV legs longer than others. Scopulae extend upto the base of metatarsi I and II.

Abdomen.—More or less elliptical, narrowed behind, clothed with fine pubescence, mid-anteriorly with an obscure white patch; ventral surface darker than the dorsal, with small widely placed white dots.

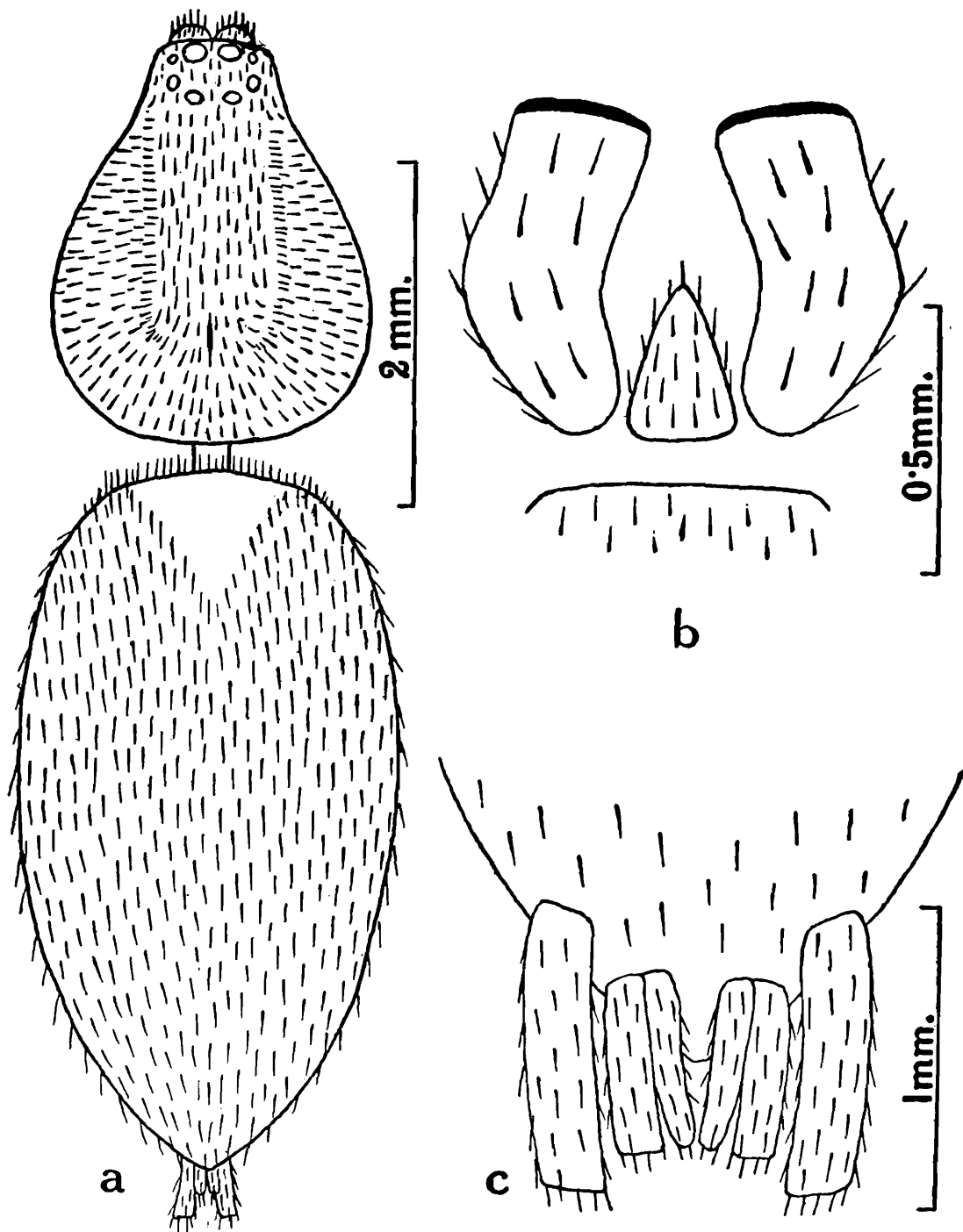
Type-specimen.—*Holotype*: 1 female, Z. S. I. Reg. No. 2492/18.

Type-locality.—Merta city, Dist. Nagaur, Rajasthan, India.

Geographical distribution.—Known only from the type-locality.

Comparisons.—This species resembles *Scotophaeus blackwalli* (Thorell) but is separated as follows.—(i) Cephalothorax brown (in *S. blackwalli* cephalothorax light to deep reddish-brown). (ii) Chelicerae vertical,

margin without tooth (in *S. blackwalli* chelicerae vertical, outer margin with three teeth and inner with one).



TEXT-FIG. 2.—*Scotophaeus rajasthanus* sp. nov. Female. Holotype (a). Dorsal view of whole body. (b). Maxillae and labium. (c). Spinners.

Family 6. THOMISIDAE

Genus *Thanatus* Koch

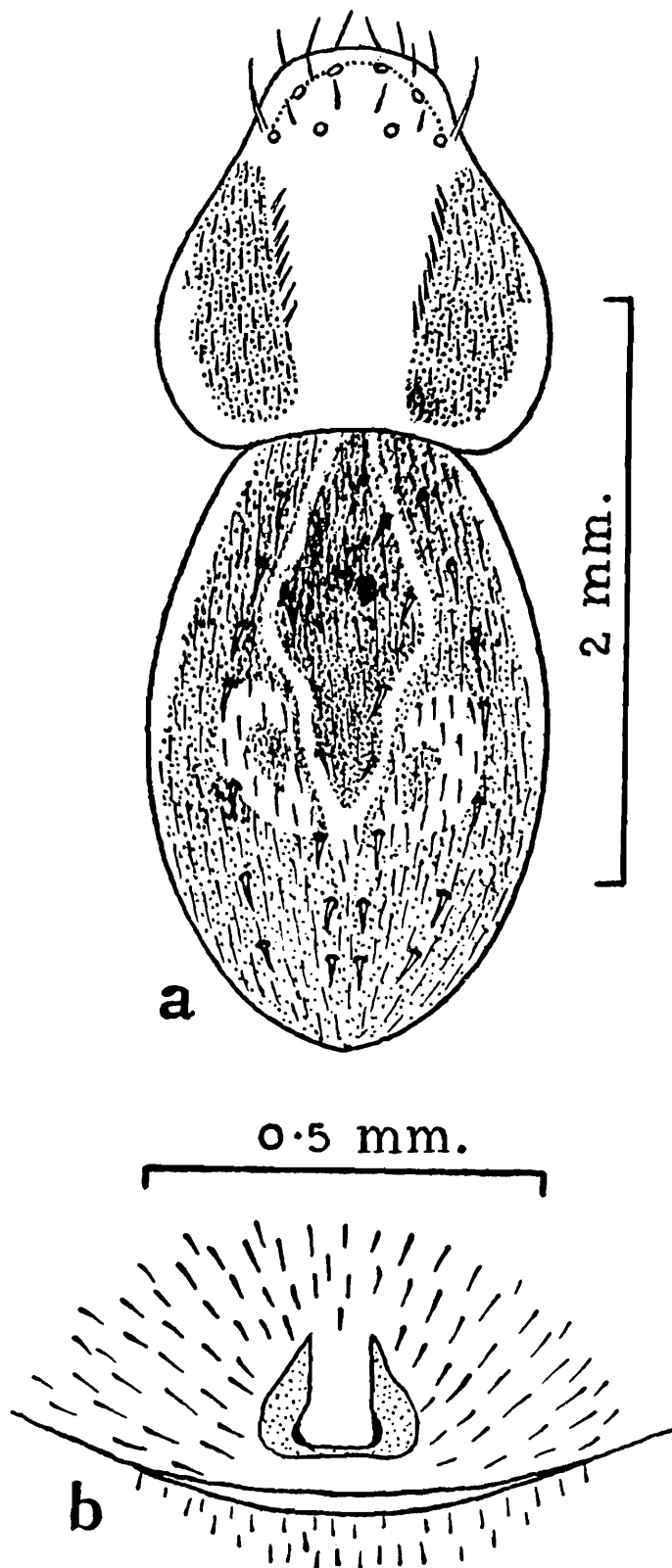
13. *Thanatus lanceoletus* sp. nov.

Material.—2 ♀♀, Bikaner town, 12-i-1957, coll. B. K. Tikader.

Description.—*General* : Cephalothorax and abdomen dirty-white ; eyes black, legs concolorous with cephalothorax ; clypeus white. Total

length 6.40 mm. ; carapace 1.60 mm. long, 1.50 mm. wide ; abdomen 3.20 mm. long, 2.20 mm. wide.

Cephalothorax.—Broader behind, narrowing in front, clothed with hairs and scanty spines ; a pale band encircles almost the entire margin



TEXT-FIG. 3.—*Thanatus lanceoletus* sp. nov. Female. Holotype. (a). Dorsal view of whole body. (b). Epigynum.

of cephalothorax and two oblong dark brown broad patches sub-laterally. Eyes black, two rows, both recurved, but the posterior row longer, both the rows form a crescent-shaped area. Clypeus long, margin with five

spines, directed forward. Sternum pale-white and hairy. Legs long, stout, spined femora, petella and tibiae with irregular longitudinal dark brown bands.

Abdomen.—Oval, clothed with fine hairs, a longitudinal dark brown lance-like spot in front on the middle, two longitudinal light bluish bands on the posterior half of the abdomen, four to six longitudinal rows of spines from the black pigmented spot on the dorsal surface of abdomen. Ventral surface pale white, with numerous irregular brown dots especially on the sides. Epigynum as seen in Text-fig. 3b.

Type-specimens.—*Holotype* : 1 female, Z. S. I. Reg. No. 2493/18, *Paratype* : 1 female, Z. S. I. Reg. No. 2494/18.

Type-locality.—Bikaner town, Rajasthan, India.

Geographical distribution.—Known only from type-locality (Bikaner, Rajasthan.)

Comparisons.—This species resembles *Thanatus striatus* Koch but is separated as follows.—(i) Cephalothorax dirty white and with two oblong dark brown broad patches sublaterally (in *T. striatus* cephalothorax yellow brown with two lateral bands of dark brown and a median brown stripe behind the posterior eyes). (ii) Sternum pale white with hairs (in *T. striatus* sternum yellow-brown, heavily spotted with dark brown).

III—SUMMARY

Three new species of spiders are described in this paper. All the species were collected from desert areas of Rajasthan. The new species belong to three genera and two families (Ganaphosidae and Thomisidae).

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A NOTE ON LADY-BIRD BEETLES (COLEOPTERA : COCCINELLIDAE)
FROM RAJASTHAN, WITH FIRST RECORD OF *BULAEA LICHATSCHOVI*
(HUMMEL) FROM INDIA

By

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(With 1 Text-figure)

During the course of a general faunistic survey of Rajasthan by the Zoological Survey of India, in 1958, the following four species of lady-bird beetles (Coleoptera : Coccinellidae) were collected by the Survey parties.

1. *Epilachna chrysomelina*, subsp. *orientalis* Zimm.
2. *Menochilus sexmaculatus* (Fabr.)
3. *Bulaea lichatschovi* (Hummel)
4. *Coccinella septempunctata* Linn.

B. lichatschovi is undoubtedly a new addition to the list of Indian Coccinellidae, as will be seen from the remarks made under this species. Except for *M. sexmaculatus*, which is an Oriental species, all the other species are of palaearctic origin. Details of the material belonging to each species together with brief notes on their geographical distribution and colour variation are given below.

Subfamily 1. *EPILACHNINAE*

1. *Epilachna chrysomelina orientalis* Zimm.

1936. *Epilachna chrysomelina* subsp. *orientalis* Zimmermann, *Z. indukt. Abstamm. u. Vererbh.*, **71**, pp. 527-537.
1950. *Epilachna chrysomelina* subsp. *orientalis* Zimm., Kapur, *Bull. ent. Res.*, **41** (1), pp. 175-179, (larva).

Material.—102 examples as follows : Rajasthan, Mohangarh, 15.I.1958 (1 example) ; Jedbaisar—Jaisalmer, 21.I.1958 (3 examples) ; Panchpodra Salt Depot, 14.II.1958 (2 examples) (all *K. K. Tiwari* Coll.) ; Gudha, Nagaur district, 10.VII.1958 (7 examples) (*A. K. Mukherjee* Coll.) ; 1.II.1958 (6 examples) ; 8.II.1958 (1 example) ; 7.IV.1958 (1 example) ; 8.V.1958 (2 examples) ; 20.V.1958 (3 examples) ; 26.V.1958 (5 examples) ; 27.V.1958 (9 examples) ; 30. V.1958 (6 examples) ; 26.VI.1958 (25 examples) ; Dudu, 11.IV.1958 (1 example) ; Sambhar Naraina road, 21.V.1958 (6 examples) ; Lihorana, 23.V.1958 (4 examples) ; Kuni, 24.VIII.1958, "on leaves of water melon" (20 examples) (all *T. G. Vazirani* Coll.).

Remarks.—Found on cucurbits, this species feeds mainly on the leaves. It occurs as a serious pest of cucurbits in the Middle East and occasionally also in northern India (note the occurrence on water melon above). We have not come across this species from eastern and southern parts of India.

Subfamily 2. COCCINELLINAE

Tribe 1. SYNONYCHINI

2. *Menochilus sexmaculatus* (Fabr.)

1781. *Coccinella 6-maculata* Fabr., *Spec. Ins.*, p. 96.
 1850. *Cheilomenes sexmaculata* (F.), Mulsant, *Ann. Soc. Agric. Lyon* (2) 2, p. 444.
 1943. *Menochilus sexmaculatus* (F.), Timberlake, *Bull. Hawaii. Sug. Ass. ent. ser.* 22, 47 (1), p. 40.
 1958. *Menochilus sexmaculata* (F.), Kapur, *Rec. Indian Mus.*, 53, p. 333.

Material.—18 examples as follows : Rajasthan, Gudha, Nagaur district, 8.II.1958 (7 examples) ; 5.III.1958 (6 examples) ; 7.IV. 1958 (1 example) ; Kuchaman road, 16.II.1958 (4 examples) (all *T. G. Vazirani* Coll.).

Remarks.—All the 18 specimens show the usual three black markings on each elytron which are light yellow to pink in ground-colour. None of the black elytral markings show any tendency towards confluence, a feature which is more evident in the populations from several other (on the whole more humid) parts of India. The size of the examples represented in the collection varies relatively considerably, the smallest specimen being 3.3 mm. long and 2.9 mm. wide, and the largest being 5.0 mm. long and 3.9 mm. wide.

This oriental species is widely distributed in South-East Asia and has been recorded from as far as Taiwan. It also occurs in the neighbouring countries of India, namely, Nepal in the north, Ceylon in the south, as well as in East and West Pakistan.

Tribe 2. COCCINELLINI

3. *Bulaea lichatschovi* (Hummel)

(Text-fig. 1)

1827. *Coccinella lichatschovi* Hummel, *Essais Entom.*, 1 (6), p. 43.
 1874. *Bulaea lichatschovi* (Hummel), Crotch, *Revis. Coccinellidae*, p. 105.
 1951. *Bulaea lichatschovi* (Hummel), Kapur, *Brit. Mus. Exped. South Arabia*, Pt. 18, p. 296.

Material.—3 examples : Rajasthan, Japog (District Jaipur), 25.IV.1958 (*T. G. Vazirani* Coll.).

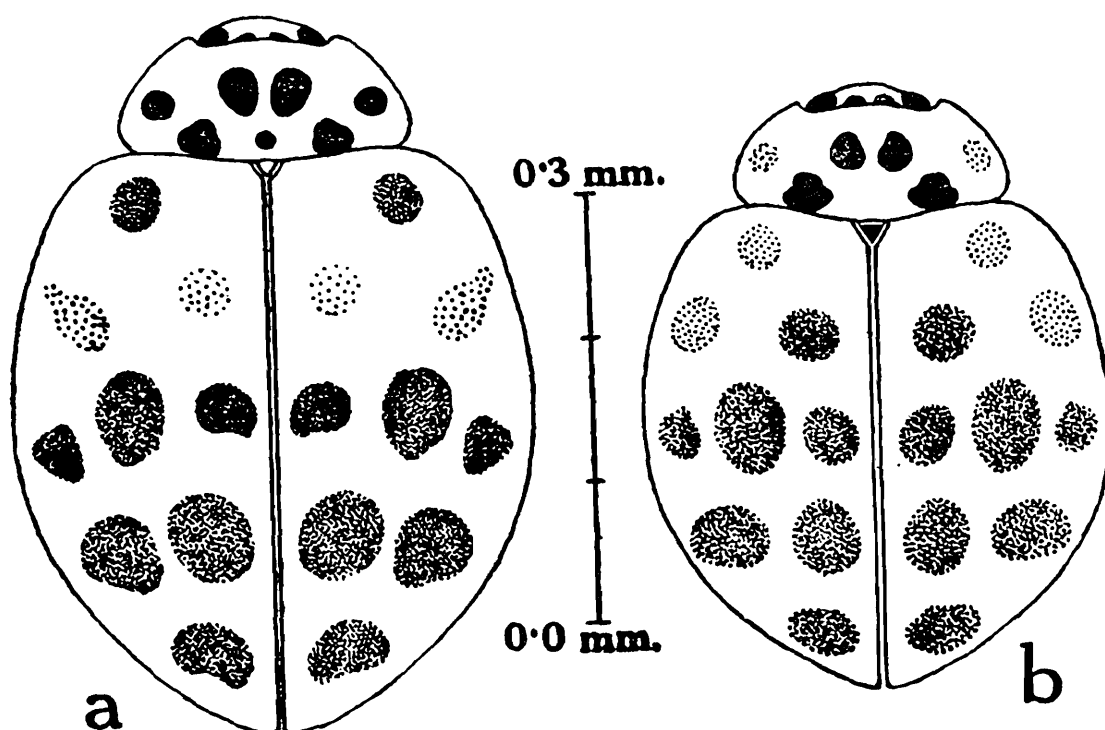
Remarks.—Crotch (*loc. cit.*) gave its distribution as “Sandy and desert places from Senegal through Egypt and Arabia to Central Asia and Persia.” Heyden (1894)¹ subsequently recorded it from Afghanistan, and Korschefsky (1932)² from Hungary, Turkey, etc. It was hitherto, not recorded from India and its occurrence in Rajasthan is, therefore, of interest.

The species shows considerable variation of spots. This has been illustrated by Kapur (*loc. cit.*) in the Arabian material studied by him. While seven examples examined by him from South Arabia had full

1. Heyden, L. von, *Dtsch. ent. Z.*, 1894, p. 83, (1894).

2. Korschefsky, R. *Coleopt. Cat. Berl.*, 16, (120), p. 377 (1932).

number of spots (large and sometime confluent), 11 examples from South-West Arabia ('Asir) were without the elytral spots; on the other hand in the six examples from Yemen and Aden the elytral spots were much reduced in size though not altogether absent. In the above-mentioned three examples from Rajasthan, the size and number of the spot is not reduced but the elytral spots are lighter in colour, being dark-brown and not quite as black as the markings and spots on the head and pronotum (Text-fig. 1 *a, b*). It is, however, difficult to state whether Rajasthan would be an area of light pigmentation for this species. Perhaps more material from Rajasthan would be required in order to determine whether or not the light pigment of the elytral spot, as noted in the examples mentioned above, would be a character of any significance at all.



TEXT-FIG. 1.—Outlines of *Bulaea lichatschovi* (Hummel) from Rajasthan, showing the relatively diffused and light elytral markings.

4. *Coccinella septempunctata* Linn.

1758. *Coccinella septempunctata* Linnaeus, *Systema Naturae* (ed. x), p. 365.

Material.—45 examples : Rajasthan, Gudha, Nagaur district, 25.IV.1958 (*T. G. Vazirani* Coll.).

Remarks.—This is a well-known species which, though of Palaearctic origin, is widely distributed in India. A detailed account of the geographical variation in the elytral markings of this species in India, by Kapur¹ has already been sent for publication. Suffice it to say here that out of 45 examples of the species, 33 examples showed reduction in the size of the spots, 10 examples had normal size spots (*i.e.*, easily comparable in size to the ones in populations from Europe, the type-locality of the species) and only two examples showed enlarged and partially confluent elytral spots.

1. Kapur, A. P. *Proc. 1st All-India Congr. Zool.*, (1959) Pt. 2, pp. 479-492 (1962).

SUMMARY

During a general faunistic survey of Rajasthan carried out during 1958 by the Zoological Survey of India, the following four species of lady-bird beetles were collected : (1) *Epilachna chrysomelina*, subsp. *orientalis* Zimm., (2) *Menochilus sexmaculatus* (Fabr.), (3) *Bulaea lichatschovi* (Hummel) and (4) *Coccinella septempunctata* Linn. Of these only *M. sexmaculata* is oriental, while the rest are of palaearctic origin. *B. lichatschovi* is recorded for the first time from India. *E. chrysomelina orientalis* is a phytophagous species which occurs generally as a pest of Cucurbits in several parts of northern India and of the Middle East while the other three are well known carnivorous species.

FULER DESCRIPTION OF A RECENTLY DESCRIBED SPECIES OF THE MARINE BORER *BANKIA* (*NEOBANKIA*) *ROONWALI* RAJAGOPALAIENGAR FROM WEST BENGAL, INDIA

By

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(With 2 Plates and 1 Table)

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I—INTRODUCTION

During the years 1958 and 1961 a detailed survey of the marine molluscan borers in the Port Canning and the adjacent areas of the Sundarbans (West Bengal) was carried out. Ten species of the family Teredinidae were thus collected. A preliminary description of a new species found, namely, *Bankia* (*Neobankia*) *roonwali*, has been published recently (Rajagopalaiengar, 1961), and a fuller description, with illustrations and ecological notes, is given here. About 40 entire specimens and several shells were collected around Sajnakhali, Sundarbans, West Bengal. The specimens were extracted from the following kinds of mangrove trees, of which all but the last mentioned were living :—

Bengali name	Botanical name	Family
1. “ Baen ”	<i>Avicennia officinalis</i> Linnaeus <i>Avicennia alba</i> Blume <i>Avicennia marina</i> Vierhapper }	Verbenaceae
2. “ Gengwa ”	<i>Excoecaria agallocha</i> Linnaeus	Euphorbiaceae
3. “ Goran ”	<i>Ceriops decandra</i> Ding Hau } (= <i>C. roxburghiana</i> Arn.) }	Rhizophoraceae
	<i>Ceriops tagal</i> (Perry) Robinson } (= <i>C. candolleana</i> Arn.) }	Rhizophoraceae

- | | | |
|---------------|---|-------------|
| 4. “ Khalsi ” | <i>Aegiceras corniculatus</i> (Linnaeus) | Myrsinaceae |
| 5. “ Pussur ” | <i>Xylocarpus molluccensis</i> Roemer
(= <i>Carapa molluccensis</i> Lamarck) | Meliaceae |

I am indebted to Dr. M. L. Roonwal, Director, Zoological Survey of India, for placing at my disposal the valuable material to work out and for many useful suggestions. I am thankful to Dr. H. C. Ray, Zoologist, Zoological Survey of India, for kindly going through the paper, to Dr. A. Daniel, Zoologist, for his valuable co-operation in the preparation of this paper and to Shri K. Thothathri of the Central National Herbarium, Howrah, for kindly supplying the correct botanical names of the plants.

II—SYSTEMATIC ACCOUNT

Genus *Bankia* Gray

1840. *Bankia* Gray, *Gen. Synops. Brit. Mus.*, London, 42nd ed., p. 154 (*nomen nudum*).
 1842. *Bankia* Gray, *Gen. Synops. Brit. Mus.*, London, 44th ed., p. 76 (diagnosed, but no species named).
 1847. *Bankia* Gray, *Proc. zool. Soc. Lond.*, London, 15, p. 188 (type-species designated).

Type-species :—*Teredo bipalmulata* Lamarck.

Subgenus *Neobankia* Bartsch

- 1921 *Neobankia* Bartsch, *Proc. biol. Soc. Wash.*, Washington, 34, p. 25.

Type-species :—*Bankia* (*Neobankia*) *zeteki* Bartsch.

Bankia (*Neobankia*) *roonwali* Rajagopalaiengar, 1961

(Pls. 35 and 36 ; Table 1)

(a) *Material*

Lot A.—Coll. H. C. Ray, Sajnakhali, Lat. 28° 7' N., Long. 88° 50' E., 24-Parganas, West Bengal, 21—28 March, 1958, as follows :—(i) 1 example, Sajnakhali Forest Office jetty, 21.iii.1958, ex. a log of wood. (ii) 6 examples, south bank of Sajnakhali Khal, east of the Forest Office 23 and 28.iii.1958, ex. pieces of living mangrove trees. (iii) 12 examples, Tetulbaria camp about 17 Km. south west of the Forest Office, 25—26. iii. 1958, ex. pieces of living mangrove trees.

Lot B.—Coll. A. S. Rajagopalaiengar, Sajnakhali, Lat. 28° 7' N., Long. 88° 50' E., 24-Parganas, West Bengal, 26th April—3rd May, 1961 as follows :—(iv) 1 example, south bank of Sajnakhali Khal about 200 metres west of the Forest Office, 26.iv.1961, ex. a piece of living “Gengwa” tree. (v) 2 examples, Baentolla-Bharani, a creek about a Km. west of the Forest Office, 26—27.iv.1961, ex. a piece of living “Gengva” tree. (vi) 3 examples, south bank of Sajnakhali Khal

about 3 Km. east of the Forest Office, 29.iv.1961, ex. trunk of a living "Goran" tree. (vii) 4 examples, bank of Gomdi river about 5 Km. west of the Forest Office, 30.iv.1961, ex. pieces of living "Goran" tree. (viii) 3 examples, bank of Gomdi river about 5 Km. west of the Forest Office, 30th April—1st May, 1961, ex. pieces of living "Khalsi" tree. (ix) 3 examples, Sajnakhali Forest Office jetty, 2.v.1961, ex. a piece of "Pussur" wood. (x) 2 examples, Sudhanyakhali about 13 Km. south of the Forest Office, 3.v.1961, ex. pieces of living "Goran" tree. (xi) 3 examples, Sudhanyakhali about 13 Km. south of the Forest Office, 3.v.1961, ex. a piece of "Baen" tree.

Lot C.—1 example, Sewri timber pond, Bombay, January, 1957. Coll. V C. Palekar, ex. wood.

(b) *Description*

1 *Shell* (Pl.36, Figs. 1, 2 ; and Table 1).—Globular, thin, white to deep pink depending upon nature of wood infested. Extreme anterior area marked by usual sinus, without much callus. From this region radiate dental ridges curving downwards over anterior lobe. Anterior lobe with 38—56 equidistant ridges having finely denticulated free margin. Space between ridges twice as wide as ridges but slightly narrow towards umbo ; ridges closer in younger shells. Length of anterior lobe almost equal to its height. Line marking junction of anterior and anterior median portion wavy. Anterior part of median lobe about half as wide as anterior lobe and separated from it by an impressed wavy line, with more closely set ridges than in anterior lobe, bearing 28—32 denticulated ridges. Dental ridges meeting those on anterior lobe at slightly greater than a right angle but not continuous with them. Middle portion of median lobe narrow, extending from umbonal region to ventral knob ; its surface crossed by wavy lines of growth irregularly. Posterior part of median lobe as wide as anterior part of median lobe, with feeble lines of growth. Posterior-median portion bending slightly inwards at its junction with posterior lobe but without clear demarcation. Posterior lobe forming the auricle, quite conspicuous and bearing translucent lines of growth.

Interior of shell smooth, middle part of median lobe appearing as a depressed groove. Umbone projecting as a knob. Apophysis (hypophysis or blade of some authors) springing from the umbone curves and passing downwards almost to ventral knob ; lying oblique to inner surface of shell. Auricle extending over median lobe as a shelf.

TABLE 1.—*Measurements (in mm.) of Bankia (Neobankia) roonwali*
Rajagopalaiengar

Body-part	Range (15 exs.)	Holotype
1. Total length	56.0—180.0 (in spirit) 378.0 (living)	112.5
2. Length of shell	6.0—12.0	12.0
3. Height of shell	6.0—12.0	12.0
4. Length of pallet	13.0—36.0	36.0
5. Length of stalk	5.0—20.5	15.0
6. Length of blade	7.0—21.0	21.0
7. Diameter of blade	2.0—4.0	4.0

2. *Pallets* (Pl. 35, Fig. 3 ; Pl. 36, Figs. 3-6, and Table 1).—Long, fragile, well-formed cone-in-cone type, with a cylindrical stalk white or pink depending upon the wood it is infested. Blade yellowish brown to chocolate consisting of a series of cones, somewhat semicircular in cross-section, *i.e.*, slightly bulged along outer surface and flat along inner surface. Individual cone-elements of blade arranged very compactly, leaving no space for the narrow tapering part of cones to be visible. Cones asymmetrical, *i.e.*, more developed on one side of the axis, the condition being reversed on the other blade. Number of cones 6-13 (13 in holotype). Membrane (periostracum of some authors) covering the cones thrown into pectinate processes (denticulation of some authors) at the free margins of cones on both sides. Lateral borders of cups (cones) not drawn out and with or without pectination—in the latter case pectination being eroded or lost. Number of pectinate processes variable, 23-46 along outer margin with average 36, and 19-35 (average 25) along inner margin. Range for holotype : 30-43 (average 37) along outer margin, 19-30 (average 26) along inner margin. Pectination appearing bifid in some cases. Outer and inner margins concave. Concavity either nearly equal in depth on both sides, or outer margin slightly deeper than inner. Outer margin circularly concave, inner margin with a distinct angulation in the mid-region resulting in almost a V-shaped condition.

A cylindrical rod (similar to the stalk), projecting axially from the distal extremity of blade (*i.e.*, from the centre of concavity of last cone indicating the continuation of the stalk through the whole length of pallet as its core), present in some but not clear in others, is present in the holotype.

3. *Siphons* (Pl. 35, Fig. 3).—Fairly long, conjointed, almost equal in length and mottled with reddish brown spots irregularly. Inhalent and exhalent siphons separate just subterminally. Tip of inhalent siphon wider than that of the exhalent and bearing a few tiny papillae-like structures along the rim.

4. *Collar*.—A well developed collar present at base of siphons and slightly rolled out on itself.

5. *Burrow*.—It is lined by a calcareous tube non-adherent to the animal except at the collar region. Calcareous tube fairly thick, particularly at posterior end.

(c) *Type-specimens*

All type-specimens deposited in the National Zoological Collections, Zoological Survey of India, Calcutta.

Holotype.—One example from Material Lot B (viii), above, Z.S.I. Reg. No. M16751/2, Sajnakhali, coll. A. S. Rajagopalaiengar, 30.iv.1961, ex. a piece of living "Khalsi" tree. *Paratypes*. : Four, as follows :—Two from Material Lot B (vii), one from (ix) and one from (xi), above, Z.S.I. Reg. Nos. M 16752/2 to 16754/2.

(d) *Type-locality*

INDIA : West Bengal ; Sajnakhali (24-Parganas District), about 5 Km. west of the Sajnakhali Forest Office, Lat. 22° 7' N., Long. 88° 50' E.

(e) *Geographical Distribution*

INDIA : Bombay : Sewri timber pond, West Bengal : (24-Parganas District), Sajnakhali and its vicinity

(f) *Comparisons*

Bankia (*Neobankia*) *roonwali* has certain unique characters not met with in any of the species so far known of the subgenus *Neobankia*. In respect of compactness of cones on the blade, it resembles *B. (N.) tenuis* Sivickis, whereas in the pectination of the free margin of cones it approximates *B. (N.) lineata* Nair. In general shell characters it bears some resemblance to *B. (N.) zeteki* Bartsch, *johnsoni* Bartsch, *lineata* Nair and *denticuloserrata* Daniel.

Another peculiarity which distinguishes this species from all others is in the arrangement of denticulated ridges on the anterior lobe of the shell. According to Bartsch (1927) and Nair (1955) these ridges, which are apart in the early stage of the shell, become closer-spaced as the shell increases in age, whereas in the case of *B. (N.) roonwali* the reverse obtains.

Roonwal (1954) recorded *Bactronophorus thoracites* (Gould) for the first time in India from living mangrove trees of Sundarbans. Ganapati & Rao (1959) also reported the incidence of four species of Teredinid marine borers from mangroves of the Godavari estuary. My specimens of *Bankia* (*Neobankia*) *roonwali* also are collected from stems of different kinds of living mangrove trees of Sundarbans.

III—KEY TO KNOWN SPECIES OF SUBGENUS *Neobankia* (GENUS *Bankia*)

(A). Cone elements distantly placed—

- | | |
|--|---|
| 1. One of the margins denticulated | 2 |
| Both margins denticulated | 5 |
| 2. Outer free margin of segments (cones) denticulated, while the inner free margin smooth | <i>barthelowi</i> Bartsch |
| Inner free margin denticulated, outer free margin smooth | 3 |
| 3. Cones of the blade somewhat angularly cupped | <i>occasiuncula</i> Iredale
<i>et. al.</i> |
| Cones not angularly cupped but the outer margin more deeply concave than the inner | 4 |
| 4. New cups of pallet formed at the distal extremity of blade (lateral borders drawn out into slender processes, longer on one side than on the other), inner margin of cup straight, outer deeply concave | <i>rubra</i> Sivickis* |
| New cups of pallet formed at the proximal extremity of blade (inner margin of cup with eight prominent teeth, lateral borders of cups drawn out into slender processes longer on one side than on the other) | <i>konaensis</i> Edmondson |
| 5. Inner free border being straight, while the outer is curved | <i>Zeteki</i> Bartsch |
| Both margins curved (concave) | <i>Johnsoni</i> Bartsch |

**hawaiiensis* Edmondson is possibly a synonym of *rubra* Sivickis.

- (B). Cone elements large in number, lateral borders drawn out into slender processes—
- 6. The joints (cones) tulip-shaped and covered with a radiant white membrane 7
 The joints not tulip-shaped . 8
 - 7. Margin of outer surface has regular teeth *rochi* Moll
 - 8. Denticles in the intermediate space of rim (margins) simple and non-serrated (denticles stronger and stouter along margin) *lineata* Nair
 Each denticle in the intermediate space of rim (margins) bears on either side 5 to 8 serrated structures *denticuloserrata* Daniel
- (C). Cone elements compact, lateral borders not drawn out 9
- 9. Stalk continuing through the whole length of pallet as its core (lateral borders not drawn out, inner margin of cones with a distinct angulation in the middle, both margins pectinate) *roonwali* Rajagopalaiengar
 - Stalk not continued through the whole pallet (free margins pectinate or comb-like) *tenuis* Sivickis

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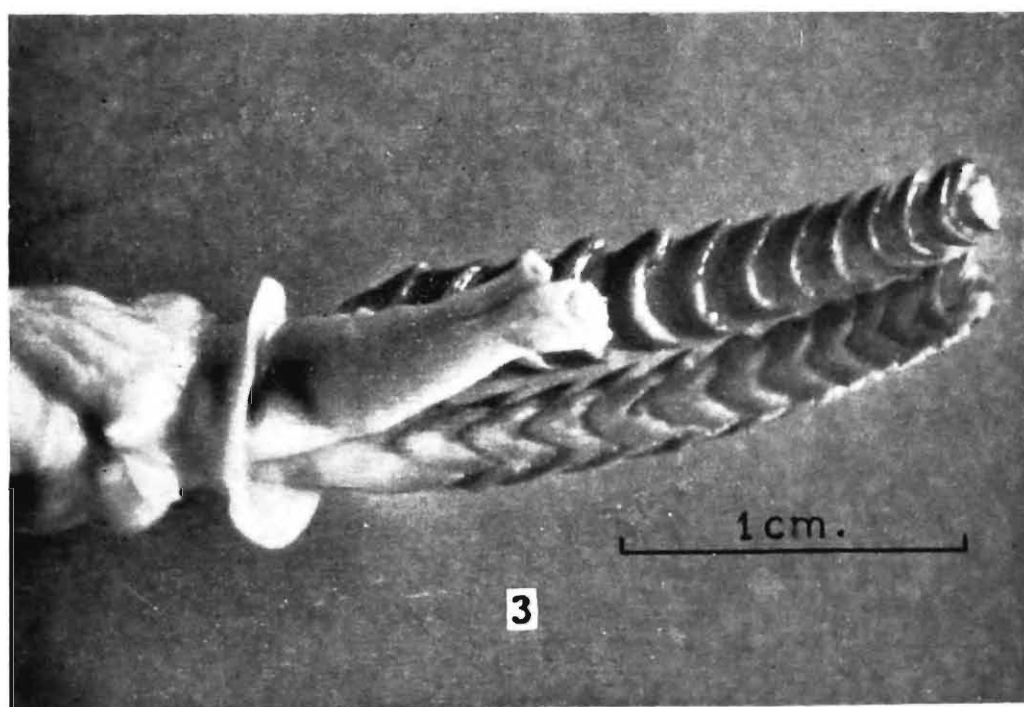
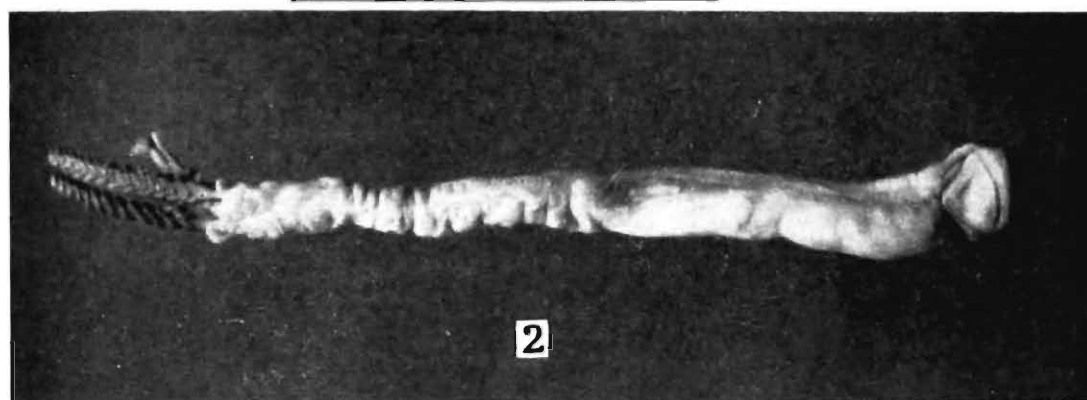
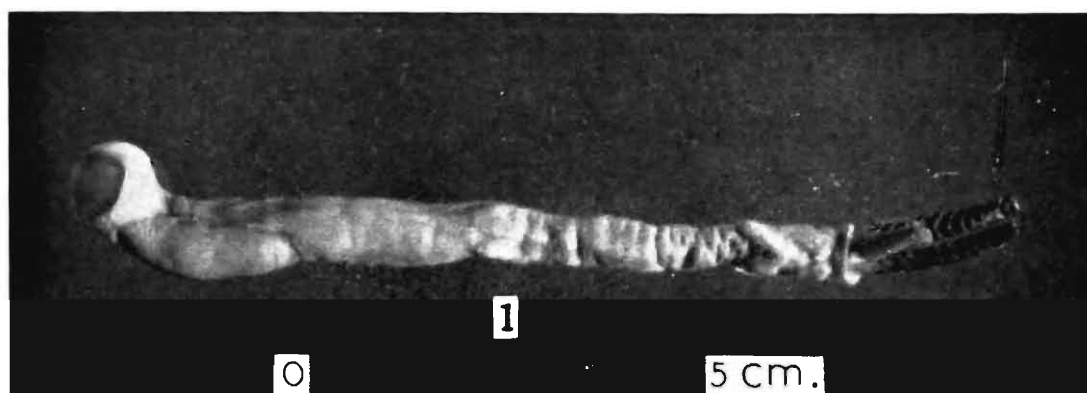
PLATE 35

Bankia (Neobankia) roonwali Rajagopalaiengar, 1961.

FIG. 1.—Left lateral view of the entire animal (Holotype).

FIG. 2.—Right lateral view of the entire animal (Holotype).

FIG. 3.—Enlarged left lateral view of posterior region of the Holotype, showing siphons and pallets.



Bankia (Neobankia) roonwali Rajagopalaienger.

PLATE 36

Bankia (Neobankia) roonwali Rajagopalaiengar, 1961.

FIG. 1.—Shell, outer view.

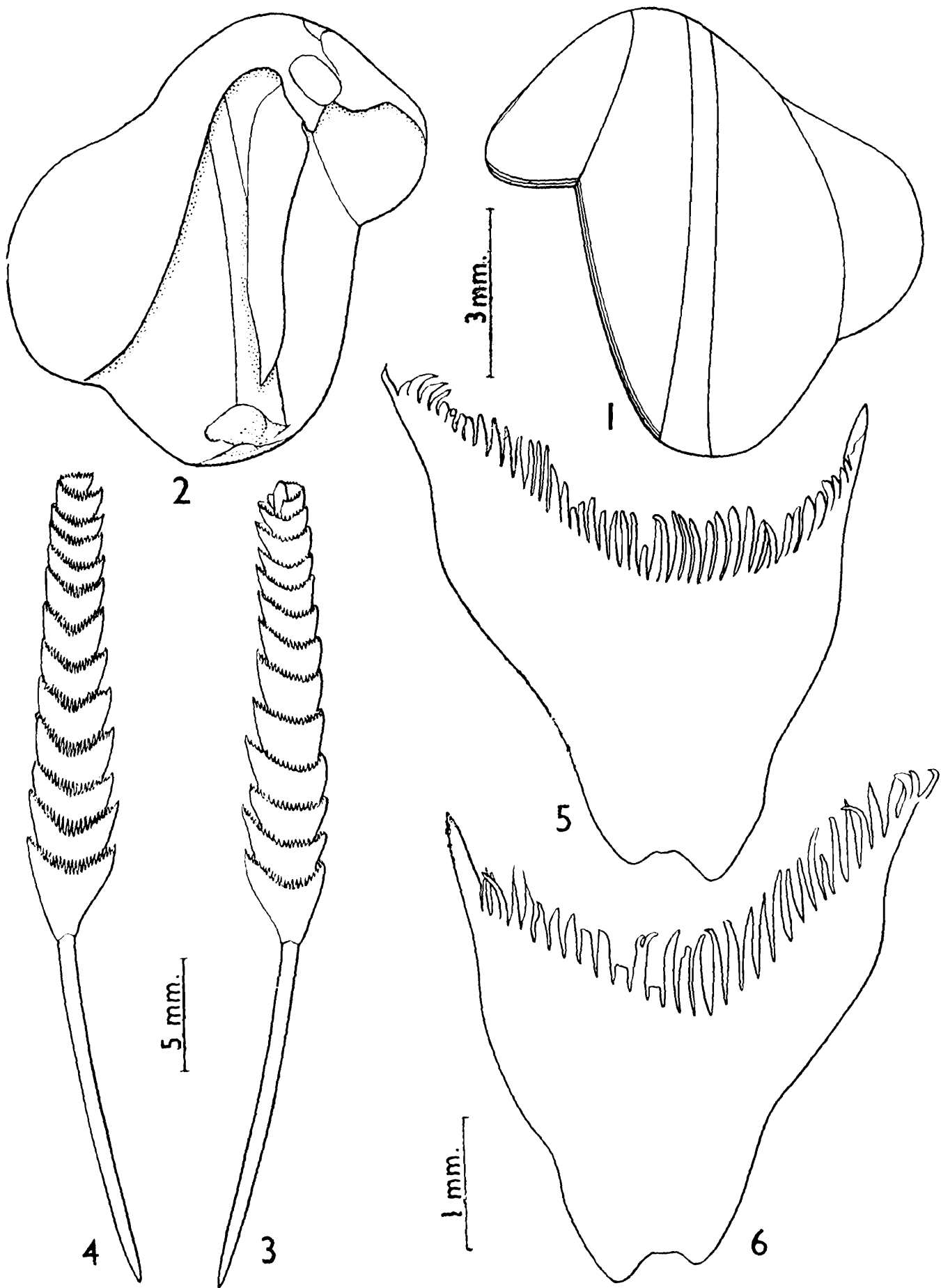
FIG. 2.—Shell, inner view, drawn to same scale as Fig. 1.

FIG. 3.—Pallet of Holotype, outer view.

FIG. 4.—Pallet of Holotype, inner view, drawn to same scale as Fig. 3.

FIG. 5.—A cone element of pallet enlarged, outer view.

FIG. 6.—A cone element of pallet enlarged, inner view. (Drawn to same scale as Fig. 5.)



Bankia (Neobankia) roonwali Rajagopalaienger.

OBSERVATIONS ON THE FEEDING HABITS OF SOME SARDINES TOGETHER WITH THE KEY TO THE IDENTIFICATION OF THE YOUNG ONES OF THE GENUS *SARDINELLA*.

By

M. D. K. KUTHALINGAM*

(With 3 Tables and 3 Text-figures)

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I—INTRODUCTION

The nutrition of fishes provide valuable data not only for determining the food charts, but also the seasonal scarcity, shoaling and migration of fishes, and such information will be useful to commercial fisheries in forecasting the movements of the fish into or out of their feeding grounds. It is hoped that the present account on the food of larvae, juveniles and adults of *Sardinella sirm*, *S. gibbosa*, *S. melanura*, *S. clupeoides*, *S. albella* *S. fimbriata*, *S. sindensis* and *S. longiceps*, together with a key to the identification of some young stages of sardines, will add to our knowledge of Indian Sardines. In preparing the key, Misra (1953) was of considerable help. Other references such as Day (1889), Weber and Beaufort (1913), Fowler (1931), and Nair (1953) were also consulted.

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I am thankful to Dr. C. P. Gnamuthu, Director, Madras University Zoology Research Laboratory for his constant help. My thanks are also due to Dr. (Miss) M. V. Lebour and the late Dr. G. A. Steven, Laboratory Citadel Hill, Plymouth for some helpful criticisms. I am also thankful to Dr. Krishnaswamy, Reader, Zoology Research Laboratory, Madras for having helped me in identifying the copepods.

II—MATERIAL AND METHODS

The material for the study consisted of 621 young fishes and 881 adults collected from Madras, Nagapatam, Mandapam and Ernakulam areas at a depth ranging from 4-20 fathoms. Shore-seines, boat-seines, hand nets and gill nets are the main types of gear employed in the fishery.

The fishes were examined, fixed and preserved in 5 per cent formalin and brought to the laboratory where detailed examination was made. A detailed description of the method of analysis and the method of determining the volume of stomach contents of young fishes has been already dealt with by the author (Kuthalingam 1955). As the diet of the fishes varies even in the same species during different stages of growth and maturity, four broad divisions were made regarding the sexual maturity, *i.e.*, immature, mature, ripe and spent.

The vague and indefinite terms used by many authors were avoided in describing the larval stages and the recommendation by Hubbs (1943) was followed. For the purpose of convenience three terms are recounted below.

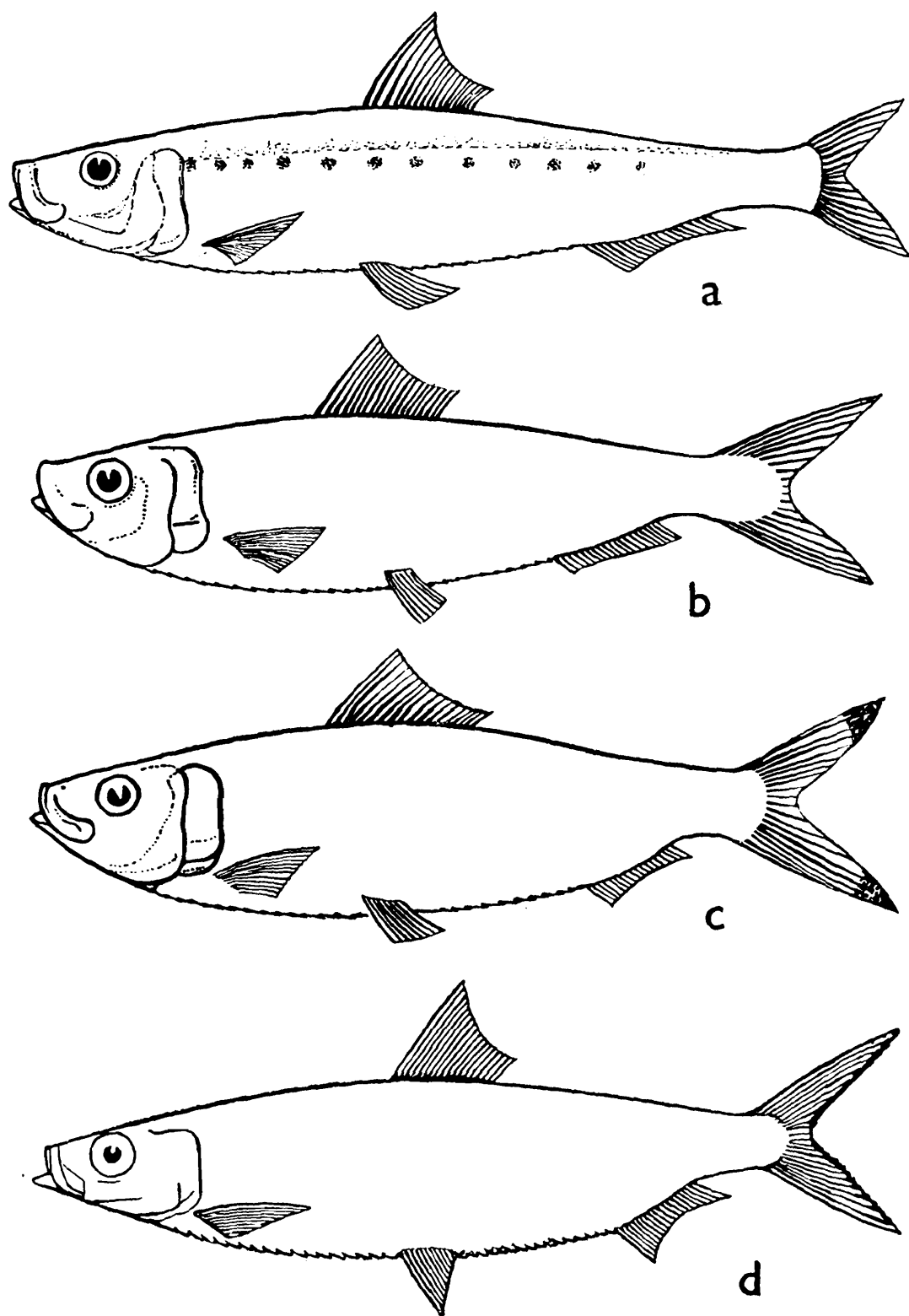
Post larvae.—The structure and form continue to be strikingly unlike that of the juveniles and the digestive system is differentiated enough to take in food.

Juvenile.—Young essentially similar to adults with all the taxonomic characters.

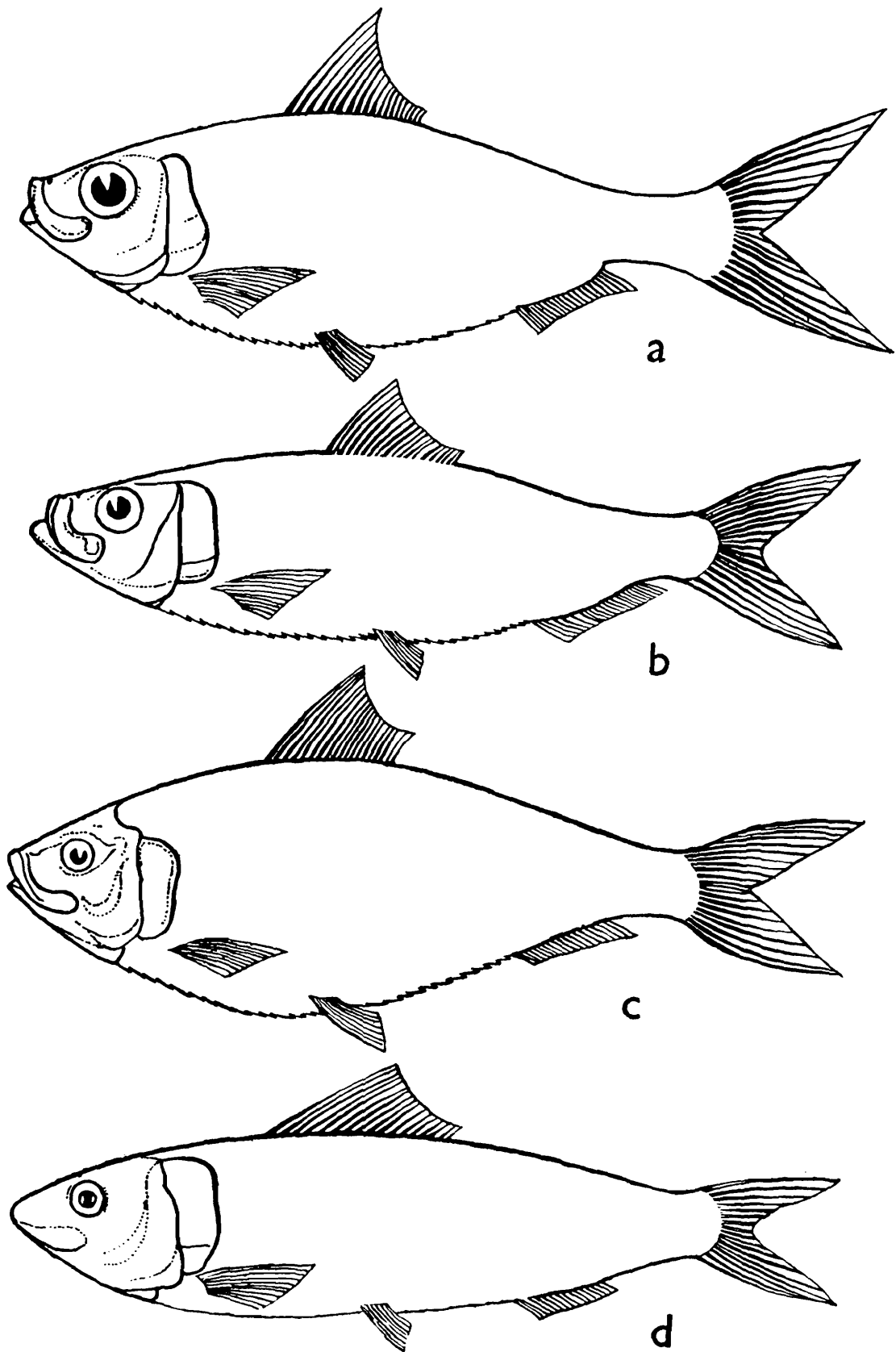
Adults.—Full grown with all mature features.

III—KEY TO THE IDENTIFICATION OF SOME YOUNG SARDINES

The young sardines were collected from the plankton as well as from the fishermen's nets. They measured from 25 mm. up to 60 mm. Since these sardines are alike in general shape, structure and appearance, the need for identifying these commercially important groups of fishes was felt, in order to identify them without much difficulty. The easily recognisable characters, such as, fin formula, number of scutes, colour and other important taxonomic features are given in Table I against the names of the respective species. Text-figures 1 & 2 were drawn directly from the specimens.



EXT-FIG. 1.—Young sardines. (a). *Sardinella sirm.* (b). *S. glbbosa*. (c). *S. melanura*. (d). *S. clupeoides*.

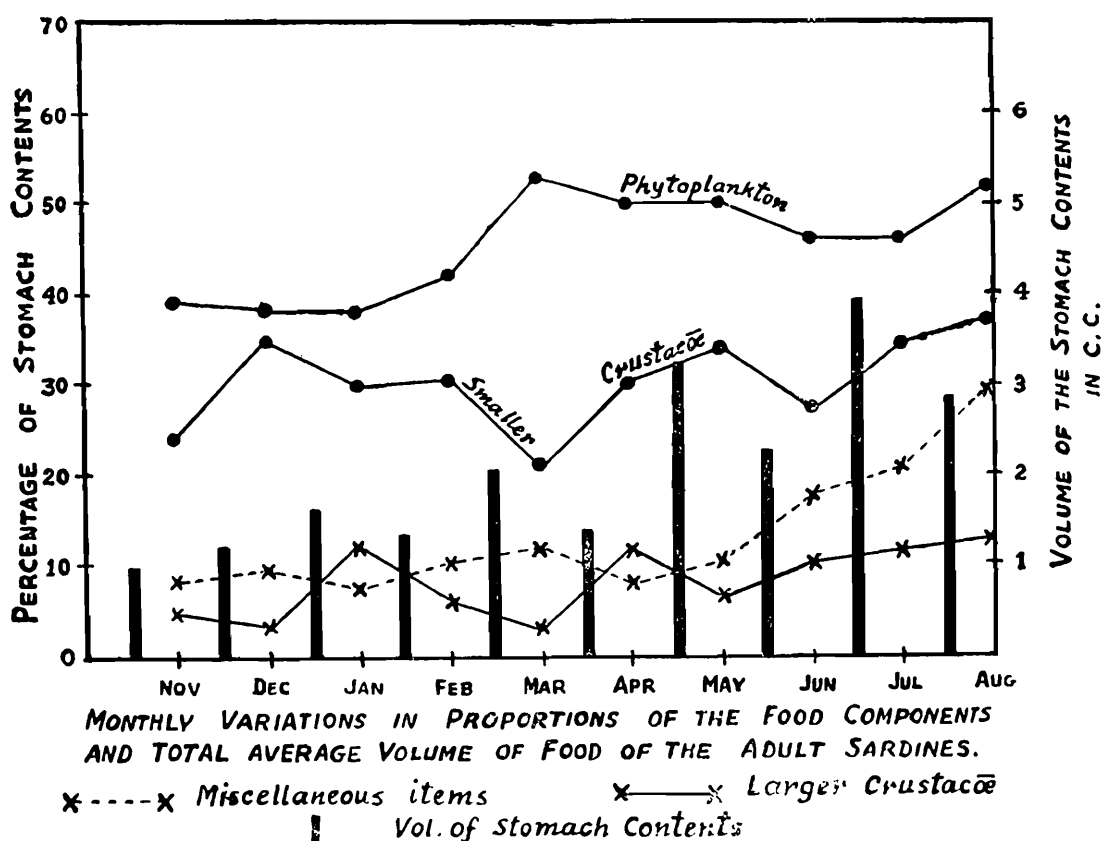


TEXT-FIG. 2.—Young sardines. (a). *Sardinella albella*. (b). *S. fimbriata*. (c). *S. sindensis*. (d). *S. longiceps*.

IV—THE FEEDING HABITS OF ADULT SARDINES

The previous work on the feeding habits of the different species of sardines of the tropical and the subtropical countries was already reviewed by the author (Kuthalingam, 1960b). In India *Sardinella longiceps* and *S. fimbriata* rank as the most valuable species along the west coast, while in south-east coast *S. gibbosa* occurs in shoals. *S. kanagurta*, *S. melanura* and *S. brachysoma*, which are commonly landed in Madras coast, are known as the Indian Sardines.

From Table No. 2 it is obvious that the males predominated the catch and the spawners were found only in the case of *S. longiceps*. It is also evident from the table that the immature fishes appear to take more food



TEXT-FIG. 3.—Graph, showing monthly variations in proportions of the food components and total average volume of food of the adult sardines.

than the mature ones and the spawners were found with empty stomachs. However, the spent fishes continued to feed once again. The present author admits that such a conclusion can only be accepted with due caution especially in view of the fact that these data were based on a study of 881 individuals belonging to eight species of sardines irrespective of the possible differences in the time of capture, ecological conditions of the catch and other bionomic factors. The total volume of food consumed by immature, mature, ripe and spent fishes was measured separately and averaged.

It is observed from the food chart as well as from the Text-fig. 3 that there was almost a similarity in feeding of these adult sardines. Phytoplankton formed the main bulk of the food. They are represented by diatoms, algae and green matter. The diatoms were identified as *Asterionella* sp., *Coscinodiscus* sp., *Thalassiothrix* sp., *Thalassionema* sp., *Rhizosolenia* sp., *Tabellaria* sp. Filamentous algae were found in the stomach mixed with copious quantities of mucus and were in a partly digested condition. *Trichodesmium* and *Oscillatoria* were the only algae that could be made out. Very frequently green matter was found. This is probably the digested algae or the sea weeds. Previous workers like Huxley (1881), and Lebour (1918) have mentioned the presence of green matter in the stomach of certain fishes and consider it as digested plant matter. Smaller crustaceae were represented by copepods (*Oithona* sp., *Temora* sp., *Acartia* sp., *Paracalanus* sp., and *Pseudodiaptomus* sp.), ostracoda, amphipoda, megalopa, zoea, cypris-larvae and crustacean remains. Larval bivalves and pteropods, polychaetes, eggs and sand particles constituted the miscellaneous item. The larger crustaceae were represented by *Acetes* sp., *Penaeus* sp., *Squilla* sp., *Lucifer*, and *Palmonidae*. However, the digested matter is not taken into consideration.

V—THE FOOD OF YOUNG SARDINES

From Table No. 3 it will be seen that smaller crustaceae formed the main bulk of the food. They were represented by copepods, copepod nauplii (*Oithona spinulosa*, *O. rigida*, *Temora* sp., *Paracalanus* sp., *Pontella* sp., *Eucalanus* sp., *Pseudodiaptomus* sp., *Labidocera* sp., and *Acartia* sp.) ostracoda, zoea, amphipoda and larval forms of *Acetes*, *Lucifer*, *Penaeus* sp., and cirripede. Larval bivalves, gastropods and broken bits of shells indicated that mollusc formed a minor item of diet; parapodia and isolated segments of polychaetes were also present in the stomach. They were found in such an advanced stage of digestion.

VI—REMARKS

From the data gathered and presented it is obvious that young as well as the adult sardines are surface feeders, feeding mainly on planktonic organisms. Though there are indications of particulate as well as filter feeding, it is observed from the data that even though they are capable of feeding on organisms of larger consistency indicating particulate feeding, the major part of its food is constituted by smaller planktonic organisms thus showing that these sardines are essentially filter-feeders. The absence of these species in certain months of the year cannot be explained unless and until we study more about their biology and the seasonal distribution of the various food organisms in the environment.

Though there has been considerable diversity of opinion as to whether the sardines are selective or non-selective in its food, the observations of many authors on the predominance of different organisms in the stomach of sardines collected at different places are worth noting. Lewis (1929) examined and found in the Californian sardine a very high percentage of diatom. Parr (1930) raised the question whether these diatoms were included in their diet in a selective manner or only accidentally along with larger copepods. Nair (1953b) reported that the food of *Sardinella longiceps*, consisted of plankton with phytoplankton predominating. Vijayarahavan (1953) showed that the three species of Sardines, *Sardinella brachysoma*, *S. kanagurta* and *S. melanura* feed mainly on zooplankton. It is Scofield (1934) who reported that the California sardine (*Sardinops caerulea*) became more efficient filter feeder capable of straining diatoms only when they grew larger and the gill rakers developed fine straining structure like those demonstrated by Kishinouye (1907) in Japanese sardine (*Sardinops melanostica*).

The foregoing analysis reveals that the adult sardines feed more on phytoplankton, whereas in the case of young ones the stomachs were filled with zooplankton. It is probable that the diversity in feeding of the young as well as the adults may be due to the development of gill rakers and filtering mechanism which are the aspects of the study which deserve further attention.

VII—SUMMARY

The analyses of the stomach contents of 1,502 specimens of sardine belonging to eight species were studied with special reference to the sex differentiation, maturity and feeding intensity. An aid to the identification of the young stages of sardines is also given. The results of the study revealed that :—

- (a) young sardines feed more on zooplankton,
- (b) phytoplankton formed the main bulk of the adult sardines,
- (c) the immature fishes appear to take more food than the mature,
- (d) the spawners were found practically starving, and
- (e) seasonal fluctuations were observed in the volume and composition of food.

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TABLE 1.—*An aid to the identification of some young fishes of the genus Sardinella.*

Serial No.	Species	Taxonomic Characters	Colouration	Fin formula
I	<i>Sardinella sirm</i> (Ruff)	Maxillary reaches almost the front margin of the eye. Scales deciduous and thin with very fine concentric stripes. Teeth were found on the Palatines, Pterygoids and tongue. Gill filaments were longer than $\frac{1}{2}$ diameter of the eye. There were sixteen pre-ventral and thirteen post-ventral scutes.	A bluish-green colour was observed on the dorsal region whereas the ventral region was silvery. The sides were also silvery. Just below the lateral line twelve dark spots were recorded, arranged in a row from the anterior region to the caudal. Both the caudal region and the pectorals were light brown. The other fins were hyaline.	B. 5 ; D. 18 ; A. 19 ; P. 17 ; V. 18 ; L. 1.40 ; L. tr. 12. (Text-fig. 1a).
II	<i>Sardinella gibbosa</i> (Cuv. Val.)	Maxillary reaches almost the pupil. Lower jaw was slightly prominent. Last two anal rays were thickened and a little prolonged. Scales with partly vertical lines and the hinder part with irregular holes were noted. Gill filaments were $1\frac{1}{2}$ times in eye diameter. Seventeen pre-ventral and twelve post-ventral scutes were found.	The upper-part of the body was dark bluish-green and the lower silvery. The base of the dorsal fin was characterised by a dark black spot. The caudal fin was light blue.	B. 6 ; D. 19 ; P. 15 ; V. 8 ; A. 20 ; C. 20 ; L. 1.45 ; L. tr. 12. (Text-fig. 1b).
III	<i>Sardinella melanura</i> (Cuv.)	Maxillary reaches under pupil as far as middle of the eye ; lower jaw was rather longer than the upper. Scales were seen in irregular longitudinal rows. 25 serrated scales were noticed along the abdominal edge. Teeth were present on the tongue. Caudal was deeply forked and the lower lobe was longer than the upper one. Fourteen pre-ventral and eleven post-ventral scutes were recorded.	The dorsal region was brownish and the sides silvery. Caudal was dipped black. The opercle had a blue spot.	B. 6 ; D. 18 ; A. 18 ; P. 14 ; V. 8 ; L. 1.44 ; L. tr. 11. (Text-fig. 1c).
IV	<i>Sardinella clupeioides</i> (Blkr.)	Maxillary reaches below the middle of the eye. Caudal fin was seen with longer inferior lobe. Abdominal profile was more convex than that of the back. Lower jaw projected beyond the upper. There were eighteen pre-ventral and sixteen post-ventral scutes.	Bluish-green above and the sides and ventral-region were purple with gold dots in it. The caudal fin was characterised with a blackish margin.	B. 6 ; D. 17 ; P. 16 ; V. 8 ; A. 20 ; C. 19 ; L. 1.47 ; L. tr. 14. (Text-fig. 1d).

- V *Sardinella albelli* (Val) Maxillary reaches middle of the eye. Lower jaw most prominent. Anal was much lower than the dorsal, its base a little shorter than that of dorsal. Scales with an irregular crenulated, incised and striated margin. Seventeen pre-ventral and twelve post-ventral scutes were recorded. The upper part was greenish and silvery below. A dark black patch was noted at the tips of the dorsal, at the base of the first three dorsal rays, at the tips of the caudal and behind the operculum. B. 6 ; D. 19 ; P. 17 ; V. 8 ; A. 22 ; C. 20 ; L. 1.45 ; L. tr. 12. (Text-fig. 2a).
- VI *Sardinella fimbriata* (Val) Maxillary extends below the front margin of the eye. Lower jaw was slightly projecting beyond the upper jaw. A band of teeth was seen along the middle of the tongue and also on the palatines. The last two anal rays were thickened and a little prolonged. The caudal is highly forked. The pre-ventral and post-ventral were sixteen and fourteen in number respectively. The dorsal region was bluish-green and the sides silvery. Numerous fine black dots were noticed on the dorsal fin. Other fins were pale yellow in colour. B. 6 ; D. 19 ; V. 8 ; A. 21 ; C. 20 ; P. 16 ; L. 1.43 ; L. tr. 12. (Text-fig. 2b).
- VII *Sardinella sindensis* (Day) Maxillary reaches to below the 1st $\frac{1}{4}$ of the eye. Lower jaw was prominent. Preorbital with a raised and branched ridge. Scales with their edges a little rough and having some vertical lines were recorded. Gill rakers were closely set, nearly as long as the eye. Only twelve post-ventral scutes were recorded. The back was deep blue and the sides golden. The end of the caudal lobes were dark. A dark small black mark was seen in the shoulder. Caudal was dipped black. B. 6 ; D. 19 ; V. 8 ; A. 19 ; C. 21 ; P. 17 ; L. 1.41 ; L. tr. 13. (Text-fig. 2c).
- VIII *Sardinella longiceps* (Cuv. & Val.) Maxillary extends below the front margin of the eye. Lower jaw slightly projected beyond the upper. Scales were indistinctly crenulated and regularly arranged. Caudal were deeply forked. Gill rakers were numerous about one half longer than the eye. Teeth on palatine pterygoids and tongue were noted. Out of thirty-one scutes noted, eighteen were pre-ventral and thirteen post-ventral. The back was blue with golden reflection and the abdomen silvery. A large greenish gold spot on the upper margin of the opercle and preopercle was noticed. Caudal and dorsal were stained green. B. 6 ; D. 17 ; P. 17 ; V. 9 ; A. 16 ; C. 17 ; L. 1.46 ; L. tr. 11. (Text-fig. 2d).

TABLE 2.—Showing the length range, sex differentiation, maturity stages, etc., of the 8 species of adult Sardines.

Serial No.	Names of Species	Tot. No. examined	Length range in m.m.	Sex		Maturity and feeding							
				No. of ♂	No. of ♀	No. of immature	Average Volume of St. cont. in c.c.	No. of mature	Average Volume of St. cont. in c.c.	No. of ripe	Average Volume of St. cont. in c.c.	No. of spent	Average Volume of St. cont. in c.c.
1.	<i>Sardinella sirm</i>	78	100—128·0	50	28	78	3·2	—	—	—	—	—	—
2.	<i>S. gibbosa</i> .	92	90—138·5	62	30	50	3·8	22	1·2	—	—	20	1·4
3.	<i>S. melanura</i> .	121	110—128·2	81	40	21	4·2	88	8·8	—	—	12	1·3
4.	<i>S. clupeoides</i>	128	119—132·0	68	60	128	5·1	—	—	—	—	—	—
5.	<i>S. albatella</i> .	132	100—128·5	90	42	—	3·9	132	0·9	—	—	—	—
6.	<i>S. fimbriata</i> .	91	95·2—110·2	68	30	98	4·1	—	—	—	—	—	—
7.	<i>S. sindensis</i> .	91	90·5—112·2	51	40	40	3·3	20	1·2	—	—	31	1·7
8.	<i>S. longiceps</i>	141	100—162·4	79	62	7	4·2	60	1·1	30	Empty	10	1·8

TABLE 2.—Showing the length range, sex differentiation, maturity stages, etc., of the 8 species of adult Sardines.—contd.

Food Chart No. 1

Food item/Months	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	August	Species
P	42·0	37·0	37·0	44·0	51·0	52·0	49·0	50·0	46·0	54·0	<i>Sardinella sirm</i>
SC	25·0	32·0	32·0	33·0	28·0	32·0	37·0	30·0	37·0	40·0	
M	10·0	14·0	6·0	12·0	12·0	10·0	8·0	18·0	28·0	29·0	
LC	4·0	2·0	8·0	6·0	2·0	12·0	10·0	12·0	4·0	20·0	
P	42·0	40·0	36·0	44·0	50·0	49·0	50·0	47·0	47·0	51·0	<i>S. gibbosa</i>
SC	30·0	38·0	30·0	32·0	20·0	31·0	38·0	29·0	38·0	37·0	
M	8·0	11·0	3·0	10·0	8·0	8·0	13·0	19·0	20·0	27·0	
LC	3·0	6·0	4·0	4·0	1·0	8·0	8·0	10·0	8·0	24·0	
P	42·0	36·0	36·0	44·0	50·0	52·0	48·0	50·0	46·0	52·0	<i>S. melanura</i>
SC	20·0	33·0	32·0	34·0	18·0	33·0	39·0	30·0	37·0	38·0	
M	9·0	10·0	12·0	11·0	20·0	9·0	5·0	18·0	18·0	30·0	
LC	6·0	5·0	8·0	10·0	3·0	20·0	9·0	11·0	12·0	8·0	
P	39·0	37·0	38·0	41·0	52·0	50·0	48·0	48·0	48·0	50·0	<i>S. clupeoids</i>
SC	20·0	34·0	26·0	33·0	16·0	32·0	37·0	24·0	30·0	40·0	
M	12·0	12·0	9·0	14·0	14·0	12·0	7·0	19·0	16·0	26·0	
LC	7·0	2·0	8·0	12·0	4·0	24·0	12·0	14·0	8·0	12·0	
P	40·0	40·0	37·0	42·0	51·0	52·0	49·0	46·0	47·0	50·0	<i>S. albella</i>
SC	22·0	39·0	31·0	27·0	21·0	26·0	30·0	27·0	34·0	36·0	
M	5·0	8·0	8·0	7·0	8·0	5·0	14·0	5·0	21·0	32·0	
LC	3·0	3·0	12·0	40·0	1·0	8·0	5·0	7·0	24·0	8·0	

TABLE 2.—Showing the length range, Sex differentiation, maturity stages, etc., of the 8 species of adult Sardines—concl'd.
Food Chart No. 1—concl'd.

Food item/Months		Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	August	Species
P	.	38·0	40·0	40·0	40·0	54·0	48·0	52·0	46·0	50·0	54·0	<i>S. fimbriata</i>
SC	.	30·0	37·0	33·0	31·0	26·0	30·0	34·0	28·0	32·0	36·0	
M		3·0	7·0	10·0	5·0	12·0	3·0	11·0	20·0	26·0	33·0	
LC		4·0	3·0	24·0	6·0	2·0	12·0	3·0	5·0	20·0	4·0	
P	.	38·0	38·0	40·0	40·0	54·0	48·0	52·0	47·0	50·0	51·0	<i>S. sindensis</i>
SC	.	26·0	37·0	27·0	28·0	27·0	27·0	32·0	25·0	33·0	37·0	
M	.	11·0	5·0	5·0	13·0	8·0	11·0	10·0	14·0	27·0	37·0	
LC		3·0	2·0	20·0	4·0	1·0	8·0	11·0	13·0	8·0	8·0	
P		39·0	36·0	40·0	41·0	54·0	49·0	52·0	50·0	50·0	54·0	<i>S. longiceps</i>
SC		27·0	30·0	29·0	30·0	20·0	29·0	30·0	31·0	39·0	40·0	
M		6·0	13·0	11·0	8·0	4·0	6·0	12·0	21·0	20·0	32·0	
LC		2·0	1·0	12·0	2·0	2·0	4·0	6·0	8·0	12·0	12·0	

Notes.—

P—Phytoplankton.
SC—Smaller crustaceae.
M—Miscellaneous.
LC—Larger crustaceae

TABLE 3.

Length of fish (mm.)	<i>Sardinella sirm</i>			<i>Sardinella gibbosa</i>				<i>Sardinella melanura</i>					
	25—30	30—35	35—40	20—25	25—30	30—35	35—40	30—35	35—40	40—45	45—50	50—55	55—60
Number of fish with food.	7	11	16	10	12	8	8	6	6	5	15	9	7
Number of fish without food.	1	—	3	2	—	—	2	1	—	4	—	—	—
Area of fishing	Madras Off-shore			Mandapam In-shore				Nagapatam Off-shore					
Time of catch	Morning			Morning				Evening					
Copepoda	23.2	18.2	20.6	12.2	18.2	30.2	10.8	20.8	15.8	28.8	12.3	10.8	8.2
Copepod nauplii	16.8	16.8	10.4	10.2	10.8	8.8	12.2	12.8	10.8	32.2	10.8	12.2	10.8
Ostracoda	13.0	10.8	8.2	8.8	16.8	—	11.2	4.3	18.2	2.2	20.2	10.2	12.2
Zoea	2.0	2.2	—	4.8	4.8	—	3.4	3.8	2.5	4.8	—	10.8	10.4
Amphipoda	—	4.3	2.2	—	4.3	—	4.4	—	5.3	6.2	—	12.2	11.2
Acetes	—	—	4.8	2.2	—	10.8	3.3	—	—	—	10.2	11.2	12.2
Squilla larva	—	—	8.8	8.2	2.2	12.2	10.8	—	—	—	8.8	3.4	4.4
Penaeus larva	—	—	12.2	2.6	—	12.8	12.2	—	2.2	—	—	4.4	3.4
Lucifer	—	—	10.2	2.2	—	4.2	10.8	2.2	8.0	—	10.2	3.4	2.2
Anomuran larva	5.8	—	—	—	6.4	11.0	2.2	10.8	8.0	—	—	2.2	3.4
Bivalve larva	4.2	4.8	2.2	—	2.5	1.1	3.4	8.2	2.0	—	2.2	—	3.0
Pteropoda	1.4	6.4	6.8	—	6.0	2.3	2.8	3.3	6.0	—	3.5	3.4	—
Algae	4.4	2.5	8.8	20.2	2.0	1.4	8.2	1.3	2.5	—	4.7	2.8	—
Diatoms	8.2	6.0	2.2	10.8	8.0	—	—	0.3	6.4	—	—	—	3.4
Polychaetes	—	2.0	—	8.8	8.0	—	—	4.2	2.2	—	6.2	—	2.8
Cirripede larvae	10.8	16.0	—	6.8	2.2	—	—	20.2	—	—	—	8.2	—
Pycnogonida	4.8	5.3	6	—	5.3	2.1	4.2	2.2	—	10.8	—	—	8.2
Eggs of crustacea	2.2	2.5	—	—	—	2.1	—	2.4	4.3	5.0	3.2	—	—
Green matter	32	3.2	—	—	2.5	—	—	2.2	5.8	3.2	2.4	4.2	—
Teleostean remains	—	—	—	2.2	—	1.0	—	1.8	—	6.8	4.4	—	4.2

KUTHALINGAM : *Feeding habits of sardines*

showing the percentage average of the various food items of the different species of young sardines

<i>Sardinella clupeoides</i>						<i>Sardinella albella</i>				<i>Sardinella fimbriata</i>			<i>Sardinella sindensis</i>		
35—40	40—45	45—50	50—55	55—60	60—65	30.5—35.5	35.5—40.5	40.5—45.5	45.5—50.5	35.5—40.5	40.5—45.5	45.5—50.5	40.5—45.5	45.5—50.5	50.5—55.5
8	14	8	8	9	7	11	15	18	2	1	18	14	26	18	22
3	—	2	—	—	1	3	2	1	—	2	1	3	1	2	—
Madras Off-shore						Ernakulam Off-shore				Madras Off-shore			Madras Off-shore		
Evening						Morning				Morning			Morning		
14.6	18.2	22.8	10.7	12.4	5.2	10.8	12.5	33.4	10.2	32.8	21.8	10.8	20.5	12.5	8.5
14.4	15.8	20.2	11.2	3.8	3.8	11.2	11.5	12.4	12.0	12.0	14.8	12.4	15.5	13.5	6.4
16.8	10.8	14.1	12.2	6.2	12.4	12.2	5.0	2.2	—	—	20.8	—	10.5	18.5	2.4
—	2.5	—	3.4	2.2	2.2	4.4	10.0	—	6.2	—	8.0	—	8.5	10.5	3.2
4.8	5.3	—	3.4	—	—	—	8.0	—	3.2	—	10.2	18.8	—	6.5	—
4.3	—	—	4.4	8.8	—	3.4	2.0	—	2.4	10.8	—	20.8	—	7.2	10.5
2.2	—	—	10.8	12.2	18.8	10.8	—	3.0	—	14.2	—	18.2	—	8.1	8.0
—	2.2	—	12.8	18.8	20.2	12.2	—	10.2	20.8	6.4	—	10.2	—	4.0	10.4
—	8.0	—	11.2	20.2	18.8	12.8	—	10.7	18.2	4.0	—	—	—	2.0	12.4
—	8.0	—	—	—	—	—	18.2	—	12.4	5.0	4.2	8.8	10.5	—	8.0
2.5	2.0	—	—	—	7.1	—	2.0	2.5	10.2	—	3.3	—	7.0	10.6	5.0
6.4	6.0	4.2	3.3	—	6.5	1.1	10.2	8.2	—	—	4.1	—	8.5	6.6	6.5
6.0	2.5	8.0	11.4	—	—	4.2	10.6	7.4	—	—	2.6	—	6.5	—	3.5
2.0	6.4	2.0	—	—	—	7.0	2.0	—	4.4	4.2	—	—	2.0	—	2.6
8.0	2.2	—	—	—	—	1.0	3.2	—	—	2.2	—	—	2.1	—	6.4
2.0	—	10.2	—	—	—	2.3	—	4.2	—	1.1	—	—	1.2	—	3.4
8.2	—	2.2	—	—	—	1.4	—	2.1	—	2.1	4.4	—	2.5	—	2.1
5.3	4.3	1.4	4.0	—	—	2.1	—	—	—	2.0	5.8	—	—	—	0.7
—	5.8	12.2	—	—	—	2.1	2.1	3.7	—	—	—	—	1.2	—	—
2.5	—	2.0	1.2	5.4	5.0	1.0	2.7	—	—	2.2	—	—	3.5	—	—

<i>Sardinella longiceps</i>						
25—30	30—35	35—40	40—45	45—50	50—55	55—60
10	20	12	18	20	10	16
—	—	—	—	2	—	—
Madras Off-shore						
Evening						
20.2	24.6	15.8	18.5	10.5	6.0	—
16.8	11.5	10.8	14.5	8.5	7.8	3.5
10.0	4.4	18.2	12.5	6.7	4.2	2.4
10.5	4.8	2.5	10.5	14.5	8.2	3.2
—	—	—	6.5	10.8	4.2	10.5
8.5	4.3	—	7.2	10.8	6.2	8.2
7.0	2.2	4.2	8.1	11.2	10.2	16.4
—	2.5	6.2	4.0	6.4	6.2	12.4
—	—	4.0	2.0	4.4	4.2	8.0
—	—	6.0	—	3.2	3.2	5.0
8.5	—	6.0	6.5	3.0	4.6	6.5
6.5	6.4	2.5	2.2	1.2	5.8	3.5
2.0	6.0	6.4	3.3	2.2	2.0	2.6
2.1	2.0	2.2	3.2	3.0	1.2	6.4
1.2	6.0	—	—	1.2	3.0	3.2
2.5	4.2	—	—	—	6.8	2.7
—	5.0	4.3	—	2.1	3.2	0.7
—	8.3	5.1	—	0.3	6.6	—
1.1	5.3	2.0	—	—	2.3	—
2.1	2.5	4.0	2.0	—	1.1	—

A REPORT ON THE INVESTIGATION OF THE STATUS OF THE
WHITE-WINGED WOOD-DUCK IN ASSAM AND RECOM-
MENDATION OF A SANCTUARY FOR ITS PROTECTION

By

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(With 3 Text figures and 1 plate)

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I—INTRODUCTION

The White-winged Wood-duck, *Cairina scutulata* (S. Müller), is reported to occur in India, Burma and Malayasian islands. Within India it ranges from the western districts of Assam (Goalpara, Kamrup, Darrang, Nowgong) to the eastern boundary of Lakhimpur District. The frequency of its occurrence increases from west to east.

In the latter part of the 19th and the beginning of the 20th centuries, this species was common in Lakhimpur and Sibsagar Districts and straggling to adjoining districts. Col. Graham (*see* Hume and Marshall, 1881) reported this bird to be quite common in Lakhimpur District. Baker (1908) stated that he collected as many as 30-40 birds during five years from Lakhimpur District. Baker (1929) further recorded a great many of these ducks from Sadiya. The population of the duck appears to have dwindled during the recent years since sportsmen and naturalists have made only stray records of a single bird or a pair. Some such records are Hutchinson (1949), of a single specimen in Manipur, Ali and Ripley (1948), a pair in Tezu and Brahamakund, and Gee (1958) from east of Phillobari, Dum Duma, 3 examples.

In view of the reported scarcity of the species during the recent years in Assam, the Indian Board for Wild Life proposed this species on the special protection list in 1952 and further in the meeting of the Bird Wing of the Board in 1956, the question of saving the species was raked up. The Indian Board for Wild Life recommended an enquiry by the Government of Assam into the present status of this species and on that basis to constitute a sanctuary for the bird. The Assam Government requested the Zoological Survey of India for assistance in this matter. A team headed by the author went for an investigation in February-March, 1961. The areas suggested by the Indian Board of Wild Life [*vide* Gee (1958)] for the possibilities of constituting a sanctuary in Lakhimpur District, and the suggestions of the Assam Forest Department, local sportsmen, tribal headmen and others were considered and a programme was chalked out accordingly concentrating the itinerary to the following forest blocks of Lakhimpur District :—

1. Upper Dihing reserve forest (West Block).
2. Upper Dihing reserve forest including Dum Duma R.F. (East Block).
3. Dibru reserve forest block.
4. Gali, Poba reserve forest blocks (North bank of Brahmaputra)

II—FINDINGS ABOUT THE WOOD-DUCK

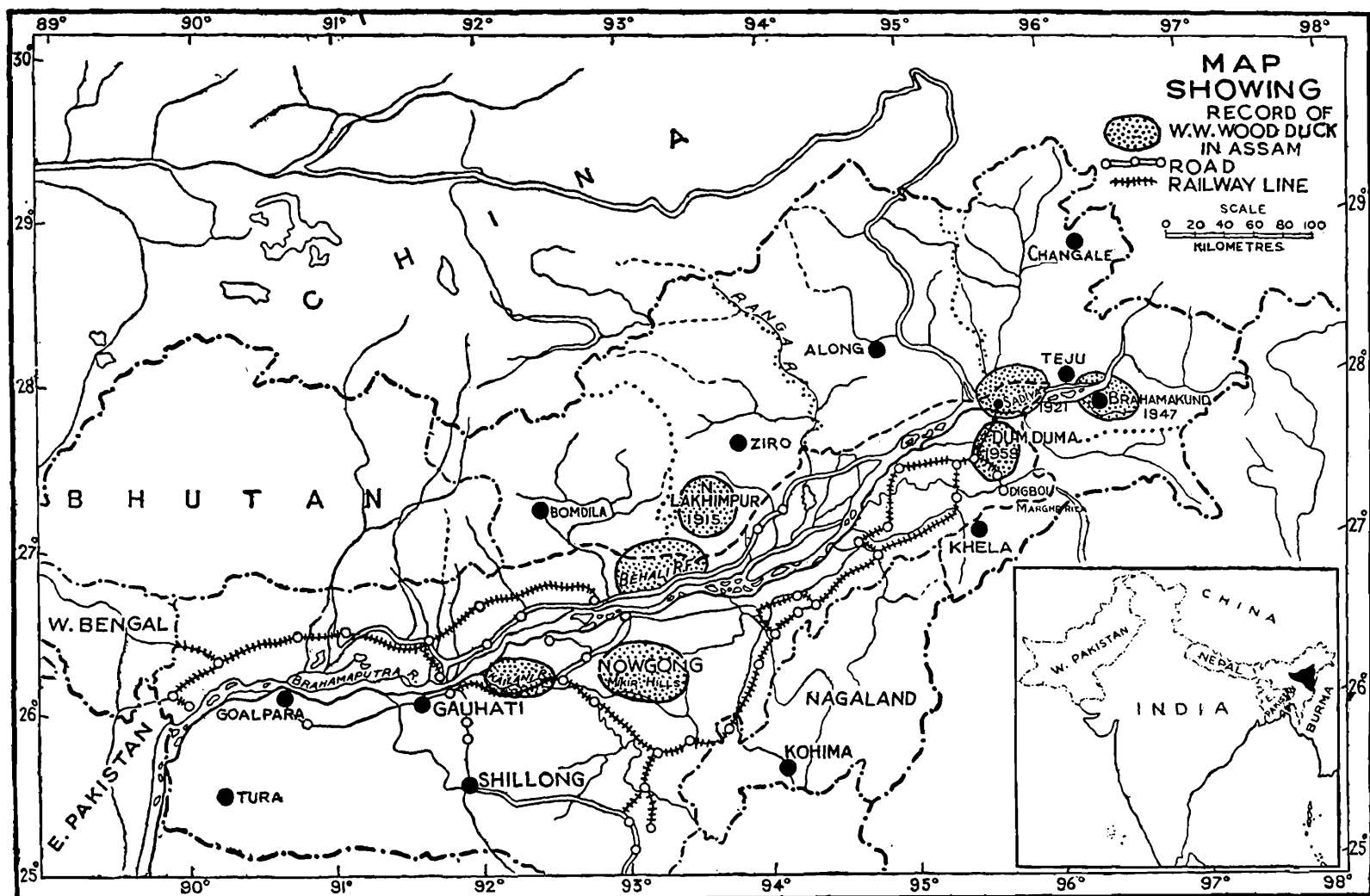
The White-winged Wood-duck was observed on two occasions after a very thorough search. A single example was seen taking to wings from the water of Namchik stream (Lat. $27^{\circ}25'$, Long. $95^{\circ}55'$), Tinkopani, Namphai reserves in the Upper Dihing reserve forest (East Block). Another pair was met with within 5 Kilometres, N.E. of Puma Pathar in Digholi beel (Lat. $27^{\circ}40'$, Long $95^{\circ}20'$) in the Dibru reserve forest block at dawn. This pair was observed perched on a dead branch of a *Hollock* tree just at the edge of Digholi beel. On the north bank of Brahmaputra river about one kilometre interior of the Poba river mouth (junction of Poba river and Brahmaputra) a long drawn honk followed by a croak was heard disclosing its presence there.

III—STATUS, HABIT, HABITAT

The bird has no doubt become rare and may accidentally be met with either singly or in a pair at dusk or dawn in the dense swampy virgin forest areas in Lakhimpur District which are still unexploited and inaccessible. Such areas should be studded with beels, pools and sluggish creeks, canopied and shaded by forest trees and creepers and with a few dead stumps here and there. The water reserves should contain fishes, planktons and other aquatic organisms.

The bird is reported to frequent also standing crop cultivated round about forest villages and its visit is during the night time perhaps for feeding.

The village headmen say that the population of the Chinaha or Raj-deohans, (White-winged Wood-duck) has deteriorated to such a great extent within the course of the last 25 to 30 years that very rarely one comes



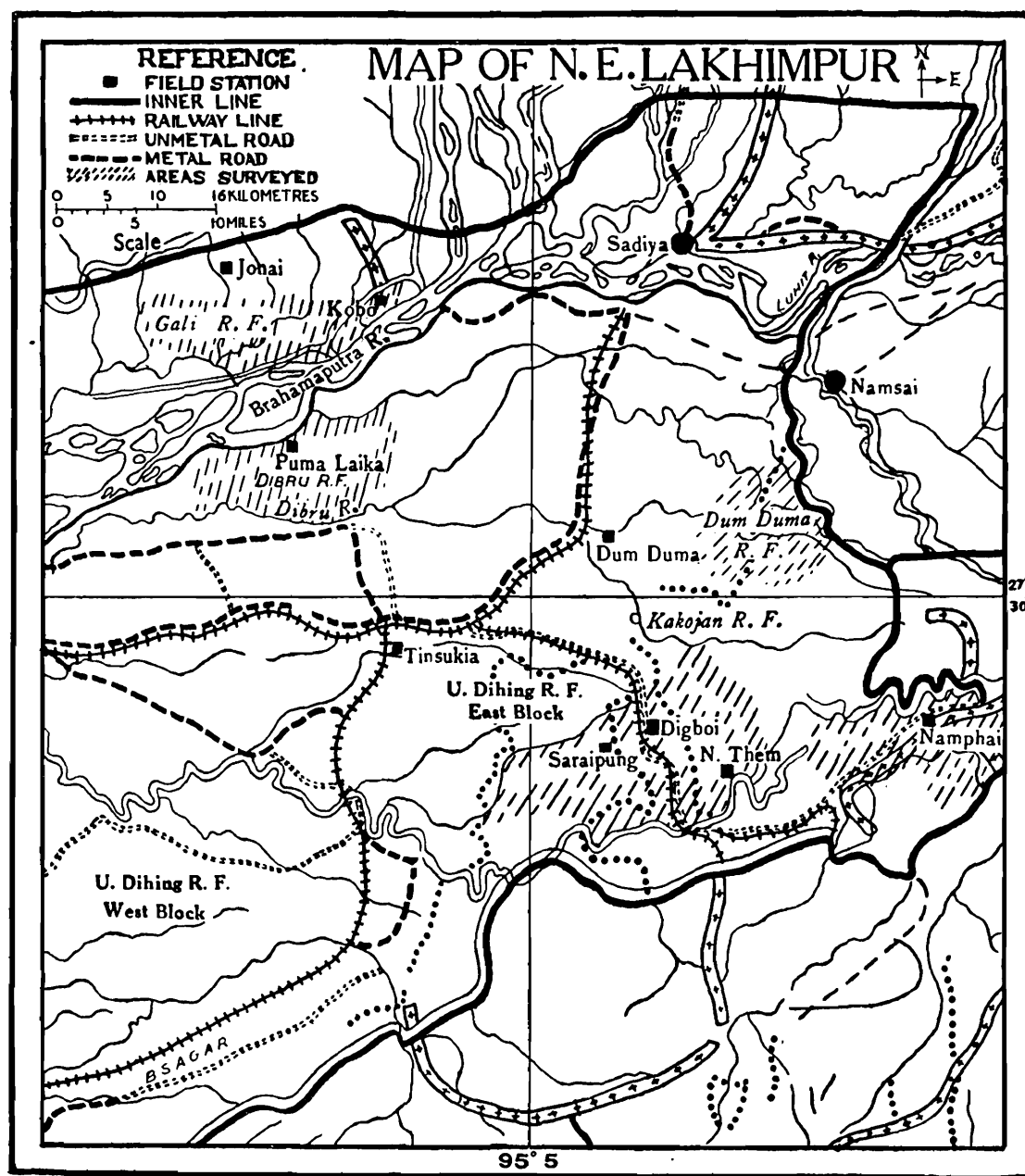
The Parliament has passed the necessary legislation for the creation of the State of Nagaland which will come into being from a date to be notified by the Government

TEXT-FIG. 1.—Record of White-winged Wood-duck in Assam.

across it. This bird was so common that in definite spots of forest one could get them without fail in waters of Buri-Dihing, Laikajan and Jonai (Murkog-Selek) rivers.

IV—PROBABLE CAUSES OF DEPLETION

There had been a lot of disturbances in the haunts of the bird during the recent past, primarily due to opening of forest areas for extension of



TEXT-FIG. 2.—*Map of N. E. Lakhimpur, showing the area surveyed to locate the Wood-duck and a possible site for a sanctuary.

agriculture, industrialisation and rehabilitation and changes in topography due to repeated earthquakes and floods since the year 1950. There also appears to be an increase in unauthorised shooting taking advantage of crop protection weapons and netting and poaching by tribal people who are quite ignorant about the rarity of the bird. It is reported by local

[*In the map for 'Metal Road' read 'Metalled Road' and for 'Unmetal Road' read 'Unmetalled Road'.]

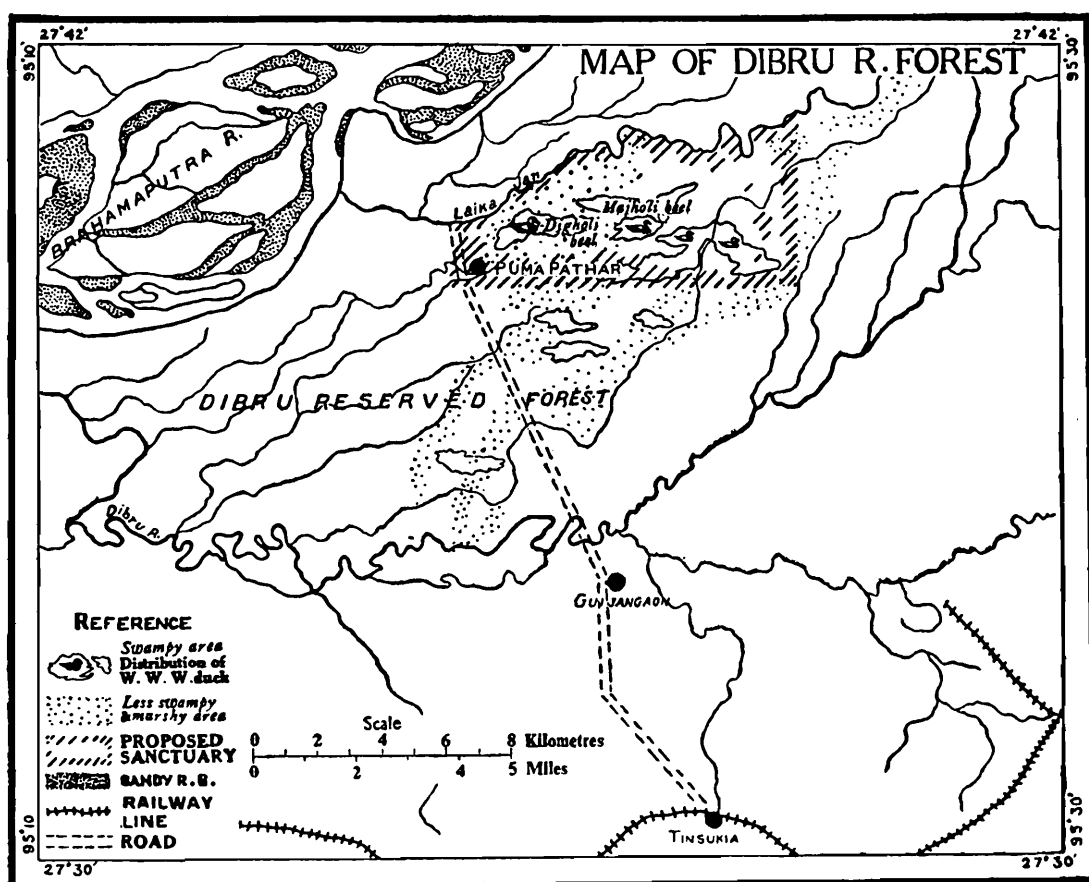
people that during the last World War, the military people stationed in Lakhimpur District took liberty to shoot without discrimination and the game suffered in their hands to a great extent and the White-winged Wood-duck could not perhaps stand the rigors and have been completely wiped out from certain areas and only in small pockets a few exist today.

V—SANCTUARY

After a careful consideration of the present status, probable reasons for depletion and ecological suitability for the bird in question, a sanctuary in the part of the Dibru reserve forest is proposed herewith.

(i) Sanctuary area

A part of the Dibru reserve forest block, approximately covering a marshy area of 30 square metres may be considered for the establishment



TEXT-FIG. 3.— Map of Dibru reserve forest, showing the site recommended for the sanctuary.

of the sanctuary. The area may roughly be demarcated in the map [based on the Survey of India map (1923-26)83 M] by Laikajan on the north and a straight line of 6 Kilometres parallel to 28°0', Latitude from Puma Pathar and then turning at right angle towards north to meet the Laikajan river. The area thus would be defined approximately between Lat. 27°38.5' and 27°41.0' and Longitude 85°18.5' and 95°22.0'

The whole area is marshy and contains several stagnant pools of which three beels, viz., Dighal, Dighali and Majholi are worth mentioning. The nullahs (jans) which interconnect, do not flow properly as there is an upset in drainage due to series of earthquake and floods since 1950. As a result the swamps are on increase and a marshy flora is prevalent.

(ii) *Flora and Fauna*

The general flora as stated is marshy composed mainly of several species of canes and palms (*viz.* *Pinanga* sp., *Calamus* sp., *Livistonia* sp.), reeds and grasses (*viz.* *Ekra* sp., *kush*, *Saccharum* sp., and *Nal*, *Phragmites* sp.), thin and thick clusters of bamboos (*viz.* *Bambusa* sp., *Dendrocalamus* sp., etc.), undershrubs (*viz.*, *Phutukula*, *Melastoma* sp., *Tora*, *Alpinia* sp.), climbers on living and dead trees (*viz.*, *Derris* sp., *Vitis* sp., *Thunbergia* sp., *Dalbergia* sp., *Tinospora* sp.). In the vast stretches of water are found various hydrophytes among which the water hyacinth (*Eichhornia crassipes*) is the most common. The timber trees are not many but Hollock (*Terminalia myriocarpa*), Gondroi (*Cinamomum* sp.), Jarul (*Lagestroemia* sp.), Nahor (*Mesua ferra*), and Hingori (*Castanopsis* sp.) may be found occasionally.

The fauna is varied and it would be unnecessary to give a list of all the animals found in that area except those which may be considered as predators or competitors of the Wood-duck. Some may devour the eggs and lift the chicks and others may attack the adult birds. Among the carnivores mention may be made of the large and small civets, *Viverra zibetha*, *Viverricula indica* respectively, the fox, *Vulpes bengalensis*, the common otter *Lutra lutra*, the jungle cat *Felis chaus*. Among the birds, the osprey, *Pandion haliaetus*; the serpent eagle, *Spilornis cheela*; and crested hawk-eagle, *Haliaetus leucoryphus* are accused for destruction of the eggs and chicks. A mention may be made of the water monitor, *Varanus salvator*, which is said to catch hold of the adults while they are busy in collection of their morsel from water.

(iii) *Approach to the proposed sanctuary*

The west part of the sanctuary is easily approachable from Tinsukia by a metalled road, with a break at Guijangaon (forest beat office) where a ferry crossing is necessary to enter the Dibru reserve forest. One has to measure 16 kilometres by jeep in dry season to Puma Laika. During the monsoon the road is lost, the available transport is a boat or an elephant.

VI—MISCELLANEOUS INFORMATION

The following information about the White-winged Wood-duck was obtained from officials, public men and tribal heads and others.

1. Shri M. L. Saikhia, D.F.O., Assam State Forest stated that he obtained a live specimen from Shri G. K. Lahon, a forest contractor, who caught the bird from a paddy field during night time in a cleared forested area of Singpho (Lakhimpur District) in January, 1961. The bird was kept with other ducks and was behaving well but after a month it unfortunately escaped from captivity.

2. Shri B. N. Das, Working Plan Officer, Assam Forest had seen a bird in the Tirap river, Namsai area some 4-5 years back.

3. Shri Mohanlal, Conservator of Forest, Assam had seen the bird in Bokajan, Manipur Road area some time in 1944-45.

4. Shri P. D. Stracey, Ex. Chief Conservator of Forests, Assam, had met the bird twice on Borjan-Digboi Road in 1943-47.

5. Shri William Needham, Ex. Manager, Murkong Selek Assam Saw Mills and Timber Company, said that the bird was not uncommon some 20 years back in the northern bank of Brahmaputra of Lakhimpur District, but he has not come across any within the last 5-10 years.

6. Shri Chiniram Regon, President and Secretary, Mishin Kebong, observed very recently a pair in kampung beel, N. Lakhimpur.

7. Shri Lathoila Duania, the village headman of N. Them, said that a pair or two were observed in Tikeri (E. Lakhimpur District) by him in 1956-57.

8. Shri Golok Chandra Bharali of Salmora village, Sibsagar, caught a pair from Majholi beel, Moriani range, Sibsagar District, in 1953.

9. Shri Durga Dhar Lagasur, Contractor, Dibru Reserve forest, had seen this bird on several occasions in Dibru reserve forest during the last 15 years.

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PLATE 37

FIG. 1.—The Namphai Forest Block where a single Wood-duck was sighted.

FIG. 2.—The thick vegetation of Poba (N. Lakhimpur District) where the call of a Wood-duck was noted.

FIG. 3.—A close up of the spot (Namchik pool) where a Wood-duck was observed swimming.

FIG. 4.—The Dighal beel (Dibru Forest) where a pair of bird was observed.

FIG. 5.—A specimen of the White-Winged Wood-duck (*Cairina scutulata*).

FIG. 6.—A veteran forestman who helped the party in trekking through the dense forest of Lakhimpur and in sighting the rare Wood-duck.



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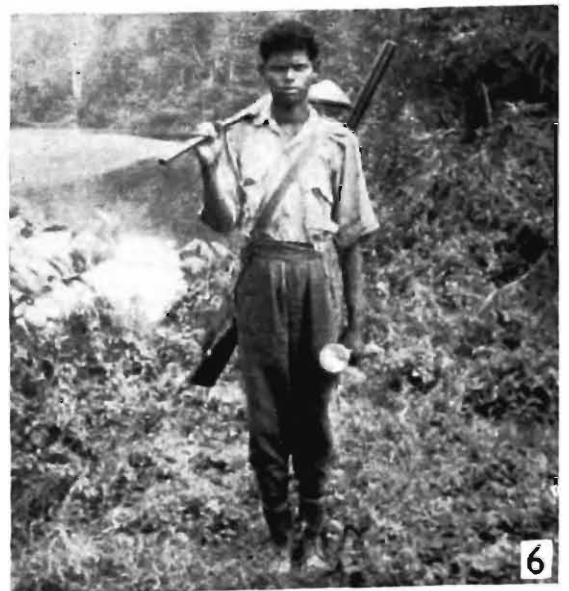
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4



5



6

Forest in N.E. Lakhimpur, Assam, frequented by the White-winged Wood-duck.

THE STRUCTURE OF THE KIDNEY OF SOME TELEOSTEAN FISHES

By

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(With 8 Plates)

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I—INTRODUCTION

Zoologists from early times have paid attention to the structure, development and nature of the kidneys of fishes. Valuable contributions were made by Müller (1884), Balfour (1882), Sedgwick (1905). Kingsley (1926), Goodrich (1930), Bridge (1932), Parker and Haswell (1940) and

others. In spite of all these, Owen (1938) remarked that, "The fish kidney has been the subject of several cytological and histological investigations, but confusion has resulted from the extreme diversity of kidney types in this group". Although several cytological and histological studies have been made by Grafflin (1929, 1933 and 1937), Smith (1929), Marshall (1930), Nash (1931), and others, the fish kidney still needs further investigation. This is not merely due to the diversified form and structure of the kidneys found in them, but also to the varying effect of the habitat upon them. It is generally admitted now that the kidneys of fishes bear the impress of the change or changes in habitat that occurred in their phylogenetic and evolutionary history. A study of the structure of the glomeruli and of the uriniferous tubules has enabled the zoologists to arrive at this conclusion. In a previous paper, the urinogenital system of sixteen species of Indian fresh-water fishes has been described by the present author, but we know little about the internal structure of the kidneys of these fishes. It was, therefore, felt that a study of the structure and condition of the glomeruli and of the uriniferous tubules present in the kidneys of these fresh-water fishes would yield useful information on a subject of which we have no knowledge at present.

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II—HISTORICAL RESUMÉ

Much work has been done in the past on the development of the kidneys in fishes. One of the earliest workers in this field was Emery (1882), who worked on the pronephros of *Feirasfer* and *Zoarces*. His studies revealed that in these fishes the pronephros is the functional kidney even in the adult. The developmental history of the pronephric tubule was given by Beard (1895) in the case of *Lepidosteus*, Dean (1897) in *Amia* and teleosts in general by Swean (1901). According to Beard, three pronephric tubules arise in *Lepidosteus*, while Dean and Swean found three to four of them in *Amia* and other teleosts, respectively. Semon and Kerr (1901) found the development of the tubules in the Dipnoi and in *Lepidosiren* to be similar, of the seven tubules in them, only two becoming functional.

Guitel (1906) points out that in *Lepidogaster* the pronephros functions as the adult kidney. Kerr (1907), while tracing the development of the pronephric tubules in *Polypterus*, found that while nine nephrocoeles became enlarged only five tubules developed. Out of these five, only two became functional.

Among those who have followed the development of the vertebrate kidney in general and of the fish kidney in particular mention may be made of Goodrich (1900), Felix (1905), Kingsley (1913) and Kerr (1926).

Renewed interest in the structure and function of the kidneys in fishes was awakened nearly a quarter of a century ago by the work of experimental physiologists. Grafflin (1929) studied in detail the structure of the

kidney in several species of teleosts and in the lung-fishes and reported the occurrence of 'Cysts' in their glomeruli. Marshall and Smith (1930) studied the condition of the glomeruli in twenty-four species of fishes belonging to twelve families, both marine and fresh-water. As a result of their observations, they arrived at the conclusion that glomeruli are best developed in fishes inhabiting the fresh-waters, whereas aglomerular condition is found in fishes leading a marine life. Grafflin (1933) observed glomerular degeneration in *Myoxocephalus scorpius*. Owen (1938) described the form and histology of the Kidney of *Cyclothone* (a deep-sea fish).

From the foregoing account, it will be seen that kidneys have acquired a new value in zoological studies, and it is necessary to examine and report upon as many fishes as possible from diverse ecological habitats so that the foundation of the new knowledge may be well laid.

III—MATERIAL AND METHODS

Very great difficulty was experienced in procuring the material required for this work. The kidneys of *Hilsa ilisha*, *Eutropiichthys vacha*, *Wallago attu* and *Mystus aor* disintegrate and alter in structure soon after removal from the water. So they had to be dissected and fixed immediately after capture on the river bank. This necessitated frequent visits to the fishing grounds by the author in the early hours of the morning.

Equal-sized pieces of the head-kidney, the anterior, middle and the posterior parts of the kidneys behind the pericardium were secured as quickly as possible and fixed in Bouin's or Allen's fluid. The duration of fixation varied in different cases. Sections were cut 5 to 7 μ in thickness and stained with Iron haematoxylin, Delafield's haematoxylin or Mayer's Haemalum and counter-stained with Eosin.

The following fishes were selected for this work, because they had already been studied by the author on an earlier occasion and a clear knowledge of the topography and disposition of the parts of the kidneys was known to the author :—

1. *Rasbora rasbora* (Hamilton).
2. *Cirrhina mrigala* (Hamilton).
3. *Labeo rohita* (Hamilton).
4. *Catla catla* (Hamilton).
5. *Notopterus chitala* (Hamilton).
6. *Notopterus notopterus* (Pallas).
7. *Mastacembelus armatus* (Lacepede).
8. *Hilsa ilisha* (Hamilton).
9. *Clarias batrachus* (Bleeker).
10. *Heteropneustes fossilis* (Bloch).
11. *Eutropiichthys vacha* (Bleeker).
12. *Wallago attu* (Bloch).
13. *Mystus aor* (Hamilton).

14. *Ophiocephalus marulius* (Hamilton).
15. *Ophiocephalus gachua* (Hamilton).
16. *Ophiocephalus punctatus* (Bloch).

IV—THE KIDNEY

A close examination of the sections of the kidneys of the above mentioned sixteen species has revealed obvious differences between its several component regions, namely, the head-kidney*, the anterior, middle and the posterior portions of the kidney behind the pericardium. The difference is not confined only to the glomeruli as mentioned by the previous investigators but also to the renal tubules and the surrounding connective tissue.

CYPRINIDAE

1. *Rasbora rasbora* (Hamilton)

(Plate 38, Figs. 1-3)

In the head-kidney there is no trace of tubules or glomeruli. It is an undifferentiated mass of lymphoidal and connective tissues. The mass is poorly vascularised.

Glomeruli are present in all the three regions—anterior, middle and posterior, that is the portion behind the pericardium, but are non-vascularised in the anterior and the posterior regions. In the middle region, where a few of them are vascularised, many of them are *small* and *ill-defined*. On the whole, there are more non-functional glomeruli than functional ones.

In all the three regions, there are a number of renal tubules which lack proper definition. *The connective tissue is thick, vascularised and lymphoidal* (Pl. 38, Figs. 1-3).

2. *Cirrhina mrigala* (Hamilton)

(Plate 38, Figs. 4-6)

The head-kidney is an undifferentiated mass of connective and lymphoidal tissues. There is no trace of uriniferous tubules or glomeruli. The connective tissue is moderately abundant.

In *Cirrhina mrigala* also, glomerular degeneration is common. Different stages of the process of disappearance of the glomeruli are seen in sections of the same fish. Many of the glomeruli although otherwise well developed are non-vascularised, some of them being represented only by means of a few tufts, while others possess only a few scattered cells. Even capsules enclosing an empty space occur (Pl. 38, Figs. 4-6). *Only the posterior part of the kidney possesses a few vascularised glomeruli.*

The renal tubules also show signs of degeneration. The tubules are comparatively fewer in number than in *R. rasbora*, the intertubular spaces being occupied by abundant connective tissue.

*Note.—The head-kidney has been studied without reference to the inter-ranal

3. *Labeo rohita* (Hamilton)

(Plate 39, Figs. 1-3)

In the head-kidney there is no trace of the tubules or the glomeruli. It is an undifferentiated mass in which the lymphoidal tissue is prominent but vascularization is poor.

Among the Cyprinidae, the kidney of *Labeo rohita* has very few glomeruli. In the anterior and the middle portions they are non-functional, whereas in the posterior portion, a few functional ones exist, but the non-functional ones predominate in number (Pl. 39, Figs. 1-3).

The anterior region of the kidney has a tendency to become lymphoidal because uriniferous tubules are few in number and an appreciable amount of lymphoidal tissue is present in this portion (Pl. 39, Fig. 1). In the middle region, *well-developed* urinary tubules are found and the lymphoidal tissue decreases in quantity. In the posterior region many of the urinary tubules are adversely affected by the presence of the lymphoidal tissue (Pl. 39, Figs. 2, 3), but a few functional ones exist.

4. *Catla catla* (Hamilton)

(Plate 39, Figs. 4-6)

The head-kidney is devoid of functional elements and consists of only an undifferentiated mass of poorly vascularised connective and lymphoidal tissues.

The glomeruli are present in the anterior and the middle portions of the kidneys lying behind the pericardium but they are wanting in the posterior section. A few functional glomeruli occur in the middle region (Pl. 39, Fig. 5), while those in the anterior portion are poorly developed and avascular (Pl. 39, Fig. 4). They are wanting in the posterior region (Pl. 39, Fig. 6).

The uriniferous tubules are fewer in number and surrounded by excess of connective and lymphoidal tissues (Pl. 39, Figs. 4-6).

The picture of the glomeruli, the urinary tubules and of the connective and the lymphoidal tissues indicates that degeneration has set in all the three portions of the kidney and the lymphoidal mass is gaining preponderance.

NOTOPTERIDAE

5. *Notopterus chitala* (Hamilton)

(Plate 40, Figs. 1-3)

The head-kidney which consists of only a dense and closely set lymphoidal tissue is devoid of all functional elements. It is very nearly avascular excepting for a few stray blood vessels.

There is no indication of the presence of glomeruli in the anterior section, but the same are present in the middle and the posterior portions. Some of the glomeruli in the middle region are vascularised, but those in the hinder portion are avascular (Pl. 40, Figs. 1-3).

Uriniferous tubules are absent in the anterior portion, while the few that occur in the middle or in the posterior portions are surrounded by lymphoidal tissue.

The structure reveals that renal function is confined only to the middle portion, while the anterior and the posterior portions are in a process of decay.

6. *Notopterus notopterus* (Pallas)

(Plate 40, Figs. 4-6)

The head-kidney consists of a lymphoidal mass and is highly vascularised, but there is no trace of the uriniferous tubules or the glomeruli.

Glomeruli are absent in the anterior portion of the kidney. A few glomeruli occur in the middle section but those in the posterior portion can be identified with difficulty and are represented only by degenerated glomerular tufts (Pl. 40, Fig. 6). As such their functional utility is doubtful.

In the head-kidney and to some extent in the anterior portion of the kidney there are strands of cells (Pl. 40, Fig. 4) which conform to the interrenals referred to by Chester Jones. In the middle and the posterior portions by far the greater part of the kidney consists of lymphoidal and connective tissues, which explains the paucity of and the damage done to the urinary tubules (Pl. 40, Figs. 4, 6).

MASTACEMBELIDAE

7. *Mastacembelus armatus* (Lacepede)

(Plate 41, Figs. 1-3)

A distinctly defined head-kidney is wanting.

Glomeruli are absent in the anterior portion of the kidney. In the middle region they occur in groups of three (Pl. 41, Fig. 2) of which only one is well developed and the rest are degenerated. Even these glomeruli are avascular. Glomeruli are hard to find in the posterior portion (Pl. 41, Fig. 3). In this species all the three portions of the kidney are therefore damaged.

The uriniferous tubules of the anterior region are indistinct and embedded in a dense lymphoidal mass. The urinary tubules of the middle and of the posterior portions are structurally degenerate and have been adversely affected by the lymphoidal tissue.

CLUPEIDAE

8. *Hilsa ilisha* (Hamilton)

(Plate 41, Figs. 4-6)

In the head-kidney the renal tubules are well defined, but no glomeruli can be identified. The tubules lie embedded in a dense mass of connective tissue, lymphoidal tissue is less prominent and the head-kidney is poorly vascularised.

Glomeruli are indistinct and degenerate in the anterior portion (Pl. 41, Fig. 4). The ones occurring in the middle and in the posterior sections of the kidney are also degenerate and avascular. Therefore, the glomeruli are either pseudo-structures or degenerate ones (Pl. 41, Figs. 5, 6).

Uriniferous tubules are discernible in all the three portions, but many of them are indistinct and hazy in outline both in the anterior and in the middle regions (Pl. 41, Figs. 4, 5). A few of them are recognisable in the posterior region but they are embedded in the connective and the lymphoidal tissues. In the anterior and the posterior portions, the lymphoidal and the connective tissues form the bulk of the kidney and the tubules constitute only an insignificant part of it (Pl. 41, Figs. 4, 6).

CLARIIDAE

9. *Clarias batrachus* (Bleeker)

(Plate 42, Figs. 1-3)

The head-kidney consists of an undifferentiated mass of lymphoidal tissue interspersed with connective tissue which is less prominent than the former and the whole mass is poorly vascularized.

Glomeruli are absent in the anterior region of the kidney of this fish and completely degenerate in the middle and posterior portions of it (Pl. 42, Figs. 2, 3).

Uriniferous tubules are present in all the three portions but their identity is ill-defined. However, their nuclei are large and prominent and acquire a deep stain. These nuclei proclaim the presence of the tubules inside the kidney (Pl. 42, Figs. 1-3).

SACCOBRANCHIDAE

10. *Heteropneustes fossilis* (Bloch)

(Plate 42, Figs. 4-6)

The head-kidney is devoid of all functional elements and the lymphoidal mass is avascular.

Glomeruli are absent from the anterior portion of the kidney of this fish but they occur in the posterior and the middle parts of it. Most of them are, however, degenerate with only a few cells in them and are avascular (Pl. 42, Figs. 5, 6).

The uriniferous tubules are better developed in the posterior portion of the kidney than in the anterior or middle sections. However, the lymphoidal tissue has adversely affected the tubules. Connective tissue occurs abundantly between the tubules (Pl. 42, Figs. 5, 6) in all the three portions of the kidney.

SCHILBEIDAE

11. *Eutropiichthys vacha* (Bloch)

(Plate 43, Figs. 1-3)

There is no well-defined head-kidney in this species.

Glomerular degeneration is evident in this fish. In the anterior portion the glomeruli are non-existent and in the posterior part they are degenerate though signs of their presence are available (Pl. 43, Figs. 1-3). They are well represented in the middle portion of the kidney but are of the avascular type.

The uriniferous tubules are present in the anterior and middle portions of the kidney but destroyed in the posterior section. The lymphoidal tissue displaces and destroys them in the posterior portion (Pl. 43, Figs. 2, 3). Although present in the anterior part of the kidney the tubules are basophilic and according to Grafflin such urinary tubules are to be looked upon as non-functional. On the whole it looks as if the kidney is losing its pristine structure and becoming transformed into a mass of lymphoidal tissue.

SILURIDAE

12. *Wallago attu* (Bloch)

(Plate 43, Figs. 4-6)

The head-kidney is an undifferentiated mass of poorly vascularised lymphoid tissue in which the connective tissue is less in evidence to view.

The glomeruli in all the three sections of the kidney behind the pericardium are pseudostructures on account of being either degenerate or non-vascular (Pl. 43, Figs. 1, 3). The degeneration of the glomeruli is evident from the fact that often empty spaces or a few avascular tufts exist in their place. Excessive development of the connective tissue has destroyed the glomeruli as well as the urinary tubules.

The surrounding connective tissue is more prominently developed than the uriniferous tubules as mentioned above. Many of the tubules are indistinct and degenerate in appearance (Pl. 43, Figs. 1-3).

BAGRIDAE

13. *Mystus aor* (Hamilton)

(Plate 44, Figs. 1-3)

The head-kidney is an undifferentiated mass in which the connective tissue is quite abundant but vascularization is poor.

A few glomeruli are present in all the three regions, but many are non-functional and degenerate. Some are degenerate because they are avascular; others because of infiltration by the lymphoidal tissue. In the middle portion a few functional glomeruli exist.

In all the three parts of the kidney functional and degenerate urinary tubules exist side by side. The basophilic ones are non-functional.

OPHIOCEPHALIDAE

14. *Ophiocephalus marulius* (Hamilton)

(Plate 44, Figs. 4-6)

In the head-kidney and in the anterior and the posterior portions glomeruli are absent (Pl. 44, Figs. 4, 6). The few that occur in the middle portion of the kidney are also degenerate containing only a few scattered cells and being non-vascular (Pl. 44, Fig. 5).

In the anterior region functional and basophilic tubules exist ; those in the middle portion are functional. The tubules in the posterior part are destroyed by the excessive presence of connective and lymphoidal tissues (Pl. 44, Figs. 4, 6). There is a preponderance of the connective and the lymphoidal tissues in the kidney which adversely affects the uriniferous tubules and the glomeruli.

15. *Ophiocephalus gachua* (Hamilton)

(Plate 45, Figs. 1-3)

In the head-kidney the glomeruli are diffused and cannot be made out clearly. There is preponderance of connective and lymphoidal tissues.

Some of the glomeruli are well-developed and vascularised in the head-kidney as well as in all the three portions, but a few degenerate ones also occur among them (Pl. 45, Figs. 1-3).

The uriniferous tubules are better preserved in the middle portion, but many of them being basophilic are non-functional leaving a few functional ones. In the anterior and posterior regions a few of them are distinct and functional. Connective and lymphoidal tissues are present in all the three portions of the kidney.

16. *Ophiocephalus punctatus* (Bloch)

(Plate 45, Figs. 4-6)

There is a gradual increase in the number of glomeruli from the anterior to the posterior end of the kidney. Though some of them are non-vascular, others are vascularised and well-developed (Pl. 45, Figs. 4-6).

Though some of the uriniferous tubules are well-defined, most of them are adversely affected by the encroachment of the connective and the lymphoidal tissues. This is especially so in the middle and the posterior portions (Pl. 45, Figs. 4, 6).

V—FUNDAMENTAL STRUCTURE OF THE KIDNEY

The kidneys are the excretory organs of the fishes and are placed on the dorsal side of the body cavity below the vertebral column, extending from the cardiac region to the posterior end of the body cavity, and in some species extending even into the caudal region. In most cases, the kidneys

of the Teleosteans are said to be fused (Kingsley). In fact, the present author found that the two halves of the kidney are fused at one or another point on their length. Even the colour, size and shape of the kidneys vary from species to species.

The kidneys are excretory tubules having become specialised and adapted to the needs of the fish and the environment as shown by Krogh (1939). Each renal tubule begins with a cup-like Bowman's capsule lined by a layer of squamous epithelium into which enters a branch of the renal artery that forms the glomerulus. This structure, since the days of Bowman (1842), is believed to perform the function of filtering the excess of water from the blood. Another set of capillaries collect the blood, now freed of extra water, and send it back for re-circulation through the renal veins.

Behind the capsule, there is a short 'neck' which soon passes off into what is termed the 'first convoluted' portion of the 'tubule'. This, in turn, is followed by the U-shaped 'Henle's loop' having a descending and an ascending limbs. This again terminates in the second convoluted tubule' which opens into the collecting tubule emptying into the ureter. The tubules are lined by a single layer of glandular epithelial cells performing the function of abstracting excess of salts from the blood. These salts become dissolved in the water filtered by the glomerulus that passes through the tubules and thus the urine is formed which is eliminated from the body by urination. This *modus operandi* holds good in the case of freshwater fishes.

In the developmental history of the kidney of Teleostean fishes, two successive series of tubules known respectively as the Pronephros and the Mesonephros occur. Being transitory in existence, the former become changed into lymphoidal tissue in the adult and have often been referred to as the 'Head kidney' (*vide* Sedgwick (1905) and Kingsley (1926)), while the latter constitutes the functional 'Wolffian body' that persists throughout the life-time of the fish.

Several views are held in regard to the relationship obtaining between them :

- "1. That they are parts of an originally continuous excretory organ called the 'Holonephros' which became divided into separate blocks differing in respect of the time of development and functioning.
2. That they are two independent organs.
3. That they are superimposed structures which occasionally overlap, being, therefore, not homologous but homodynamous structures."

Generally the first view finds acceptance at the hands of workers like Hyrtl (1854), Balfour (1886), Kingsley (1926), Goodrich (1930) and others.

According to accepted facts, the pronephros during development in most teleosts extends from one to the sixth somites. These have a tendency to form a common chamber and a glomerulus, but it is a short-lived structure except in *Zoarcetes*, *Lepidogaster*, and *Fierasfer* where the pronephros remains the functional kidney even in the adult.

The mesonephros that develops later and behind the pronephric tubules becomes the functional kidney of the adult teleosts.

VI—HISTOLOGY AND PHYSIOLOGY OF THE KIDNEY IN FISHES

A survey of the literature bearing on this subject reveals that attention has been focussed on the piscine kidney only recently.

Grafflin (1929) and Smith (1929) were the pioneer workers in this direction. Subsequently, Marshall and Smith (1930) followed them up, and, more recently, Kempton (1943) has added to our knowledge of the structure of the Elamobranch kidney.

Grafflin (1929) working on *Lophius piscatorius* was amazed to find the limited number of glomeruli in its kidney. Further closer examination of the material revealed that the structure of the glomerulus was indistinct and unconnected with the renal tubules. This led him to doubt the functionalism of the glomeruli.

Working in collaboration with Nash and Marshall (1931-32) on the kidneys of *Myoxocephalus octodecimspinosus*, found the glomeruli well developed, but further tests proved that physiologically they were non-functional because the kidneys failed to eliminate.

“1. Glucose with a high-plasma level (even when phlorizin was administered),

2. Ferrocyanide,

and 3. Cyanol.”

Grafflin performed these tests on sixteen individuals in different stages of development and concluded that glomerular degeneration had set in these fishes at a very young stage.

In *Myoxocephalus scorpius*, according to Grafflin, there are present all gradations of glomeruli from very good to very poor ones. In some of these glomerular function seemed possible, in others doubtful and in still others inconceivable. Many of the large sized glomeruli show considerable vascularity, others varying in size or degree of degeneration, and still others show difference in size of the intracapsular space (with or without intra-capsular coagulum).

Closer examination by Grafflin revealed that even the neck region of the urinary tubules are degenerated.

These observations coupled with his tests led him to prove that the glomeruli in *Myoxocephalus scorpius* are functionless.

During the next few years between 1933-1937, Grafflin worked on two lung-fishes, four marine teleosts and a horned toad. His studies showed a certain kind of cyst formation in the glomerular tufts of these species. He was led to believe that the cyst formation is not due to a parasite but due to the degeneration of the glomerular tuft.

“The view that cysts are formed by the degeneration and liquefaction of the central portion of the avascular tufts is upheld by the presence of an amorphous mass in the centre of the cyst of the horned toad and the scattered nuclei in the cyst of *Corvina*.”

Smith (1929) suggests that the aglomerular condition is due to “the peculiar water cycle associated with a marine habitat. Fresh-water fishes take in a large quantity of water orally and this is eliminated through the kidneys, while marine fishes do not take in such a large quantity of the saline water orally and the little that is taken in is discharged extrarenally. Thus a persistent oliguria relative to fresh-water forms occurs in marine fishes and this oliguria is held to be the cause of the glomerular degeneration.”

Marshall's (1929 and 1930) studies revealed that about twenty-five species of fishes belonging to twelve marine and fresh-water families possess aglomerular kidneys. According to him, glomerular development is related to water-excretion. To prove this he advances three arguments.

- “ 1. The protovertebrate kidney was aglomerular and that the glomerulus was evolved as an adaptation to a fresh-water habitat.
2. That in the lower vertebrates, the extent of the glomerular development is related to the quantity of water normally excreted by the organism.
3. In the mammals (and possibly to some extent in lower vertebrates) the primitive water-excretory function of the glomerulus has been secondarily diverted to a filtration-reabsorption system designed to excrete waste products without the loss from the body of excessive quantities of water. ”

Marshall asserts that “there is much evidence to show that the above mentioned twenty-five species of fishes were inhabitants of fresh-water or slightly brackish water. The permanent assumption of a marine life by the teleosts appears to be from Mesozoic times ”

The tubular secretion and development depend, according to him on the extent of glomerular development.

Kempton (1943) observes that "Much emphasis has been laid by renal physiologists, including Marshall and Smith, on the presence of a "special segment" preceding the proximal convolutions in the elasmobranch kidney tubule. The existence of such a structure has been attributed to the reabsorption of urea in the Elasmobranchs by the renal tubules." But Kempton is of the opinion that, "If this were to be correct then there will be found a special cell structure associated with a specific cell function."

By various injections and other experiments Kempton came to the conclusion that there is no "special segment" in the kidney tubule of *Squalus acanthias* and asserts that such a segment should be absent from other elasmobranchs also, because the cells in the distal portion of the tubule meet with the description of the "special segment" described by other authors.

Owen (1938) described the kidney of a deep-sea fish, *Cyclothone*, as consisting of only two parallel tubules, each starting from a Bowman's capsule. He confines himself to the structural details only and information regarding the functional aspect of the glomeruli is not available from his paper. However, his description of the proximal convolute tubule as "having a droplet-like appearance as if about to be pinched off into the lumen" deserves our attention.

VII—DISCUSSION AND CONCLUSIONS

A close and careful study of the structure of the kidneys of sixteen species of common teleostean fishes found in the river Ganges or in the tanks and pools of Banaras has revealed several interesting and hitherto unsuspected features to be present in them.

Krogh (1939), Marshall (1930) and Smith (1929) assert that glomerulus is the structure or apparatus meant for filtering excess of water from the blood. Therefore, these structures ought to be fully developed in fresh-water fishes and according to Smith and Krogh they are so. An important difference between the fresh-water and the marine fishes is that the blood of the former is higher in concentration than the surrounding water whereas in the marine fishes the sea-water is higher in concentration than the blood. To make up for this loss, some marine teleosts have been reported to swallow water. Much of this swallowed water is retained in the body by excreting a very concentrated urine. To enable them to maintain this equilibrium the glomeruli have become either non-functional or degenerate.

The reverse of this is said to hold good for the fresh-water fishes. That is, water from outside tends to enter the body of the fish as the concentration of the blood of fresh-water fishes is higher than that of the water surrounding them. Thus, there is always the chance of excess of water being present in the body. To avoid this, these fishes have developed an efficient water filtering system—the glomeruli.

Out of the sixteen species of fishes studied by the present author not a single case was found where the glomeruli and the renal tubules were present in full strength or in the normal condition as will be evident from the appended Table :—

TABLE.—*Showing the presence, absence and condition of the glomeruli and of the renal tubules in the kidneys.*

I	II	III	IV	V
Name of the fish	Anterior portion	Middle portion	Posterior portion	Renal tubules
<i>Rasbora rasbora</i>	Avascular	A few of them vascularised	Degenerated	Urinary tubules lack definition.
<i>Cirrhhina mrigala</i>	Degenerated	Degenerated	A few of them vascularised	Urinary tubules show signs of degeneration.
<i>Labeo rohita</i>	Degenerated	Degenerated	A few functional ones	Lymphoidal tissue present. Urinary tubules affected by it.
<i>Catla catla</i>	Glomeruli poorly developed and avascular.	A few functional ones present	Absent.	Urinary tubules few, excessive connective and lymphoidal tissue present ; lymphoidal mass in preponderance.
<i>Notopterus chitala</i>	Absent	Present, some of them vascularised.	Present and avascular	Urinary tubules absent in the anterior portion present in the middle and the posterior portions Lymphoidal tissue present.
<i>Notopterus notopterus</i>	Absent	A few of them present	Degenerated glomerular tufts present.	Lymphoidal tissue excessively present ; urinary tubules damaged.
<i>Mastacembelus armatus</i>	Absent	Present but avascular. Several degenerated ones present.	Absent	Cell walls indistinct but nuclei are prominent. Connective tissue is in abundance.

<i>Hilsa ilisha</i>	Indistinct and degenerated	Degenerated and avascular	Degenerated and avascular	Urinary tubules indistinct in the anterior and the middle portions. A few present in the posterior portion though embedded in lymphoid tissue.
<i>Clarias batrachus</i>	Absent	Degenerated	Degenerated	Urinary tubules lack definition.
<i>Heteropneustes fossilis</i>	Absent	Present, but degenerated and avascular.	Present, but degenerated and avascular.	Connective tissue copiously present. Urinary tubules better defined in the posterior portion.
<i>Eutroplchthys vacha</i>	Absent	Well-represented but avascular	Present but degenerated	Anterior region basophilic ; middle and posterior regions destroyed by lymphoidal tissue.
<i>Wallago attu</i>	Degenerated	Degenerated	Degenerated	Tubules destroyed by excessive development of connective tissue. A few functional tubules are present in the anterior region.
<i>Myxistius aor</i>	Non-functional and degenerated present.	Non-functional and degenerated.	Non-functional and degenerated.	Functional and basophilic tubules exist side by side
<i>Ophlocephalus marulius</i>	Absent	A few present but degenerated and avascular.	Absent	Functional and basophilic tubules exist in the anterior and the middle portions, but destroyed in the posterior part.
<i>Ophlocephalus gachua</i>	Well-developed and degenerated glomeruli exist.	Well-developed and degenerated glomeruli exist.	Well-developed and degenerated glomeruli exist.	A few functional and many non-functional urinary tubules present in the middle portion, only a few functional tubules present in the anterior and the posterior portions. Connective and lymphoidal tissues present in all the three regions.
<i>Ophlocephalus punctatus</i>	Well-developed but avascular.	Well-developed and vascularised.	Well-developed and vascularised.	The middle and the posterior portions affected by the lymphoidal mass.

A close study of the sections of the various portions of the kidneys of sixteen species of fishes has shown them to be in a degenerated condition. The degree of degeneration varies with the different species. In the majority of the cases studied by the present author, the anterior portion contains avascular glomeruli and degenerate urinary tubules. The middle and the posterior portions are not free from signs of degeneration (see columns III & IV of the Table) as evinced by the condition of the glomeruli and the urinary tubules. But *Ophiocephalus gachua* and *O. punctatus* are exception to this rule. In most cases an excessive development of the connective and the lymphoidal tissues has been noticed. This shows that the kidneys of these species have to a large extent been put out of action by the inroads made by the lymphoidal and connective tissues.

It may be that these fishes originally inhabited the seas from where they migrated into the fresh-waters, where they have now come to stay. This view is in accord with the findings of Smith (1929), Grafflin (1931) and Krogh (1938).

The three species of *Ophiocephalus* differ among themselves in regard to the internal structure of the kidney. *O. gachua* and *O. punctatus* do not fall into a line with the condition found in other teleosts described here, but *O. marulius* shares their traits. It will be idle to speculate on the probable cause of this difference because our knowledge of this subject is still far from being complete in all respects.

VIII—SUMMARY

1. One important result of this study is that aglomerular or degenerate kidneys are found in these sixteen species of fresh-water fishes. This lends support to Grafflin's (1931) work.

2. The other important result is that degenerate and aglomerular kidneys of the marine fishes was due to oliguria in them as compared to fresh-water fishes. This is Smith's view. The presence of aglomerular and degenerate kidneys in these fresh-water fishes proclaims their marine ancestry. This is in consonance with Smith's view.

3. That these fishes have in all probability migrated to the fresh-water from the sea.

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PLATE 38

Photomicrographs of sections of the kidneys of : *Rasbora rasbora* (Hamilton) and *Cirrhina mrigala* (Hamilton).

Figs. 1-3.—Sections of the kidneys of *Rasbora rasbora* (Hamilton).

Fig. 1.—Section of the kidney through the anterior region. $\times 186\cdot6$

Fig. 2.—Section of the kidney through the middle region. $\times 186\cdot6$

Fig. 3.—Section of the kidney through the posterior region. $\times 186\cdot6$

Figs. 4-6.—Sections of the kidneys of *Cirrhina mrigala* (Hamilton).

Fig. 4.—Section of the kidney through the anterior region. $\times 186\cdot6$

Fig. 5.—Section of the kidney through the middle region. $\times 186\cdot6$

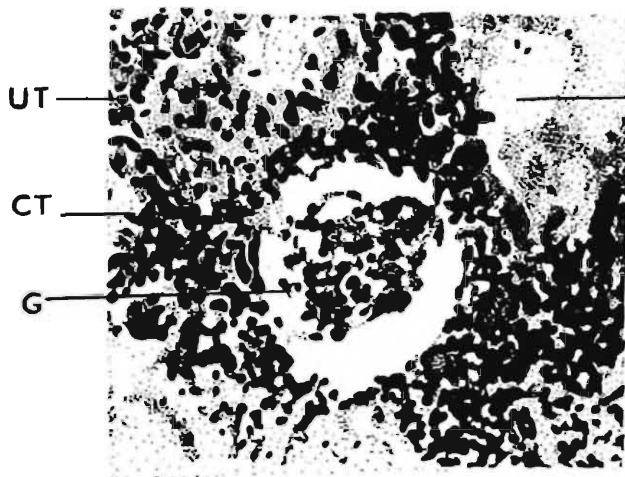
Fig. 6.—Section of the kidney through the posterior region. $\times 186\cdot6$

CT., Connective tissue.

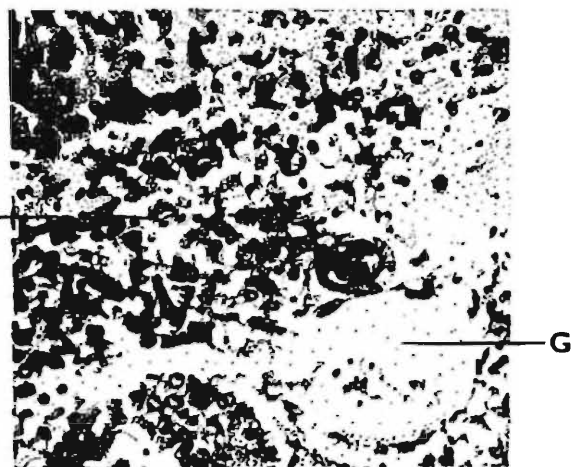
G., Glomerulus.

LT., Lymphoidal tissue.

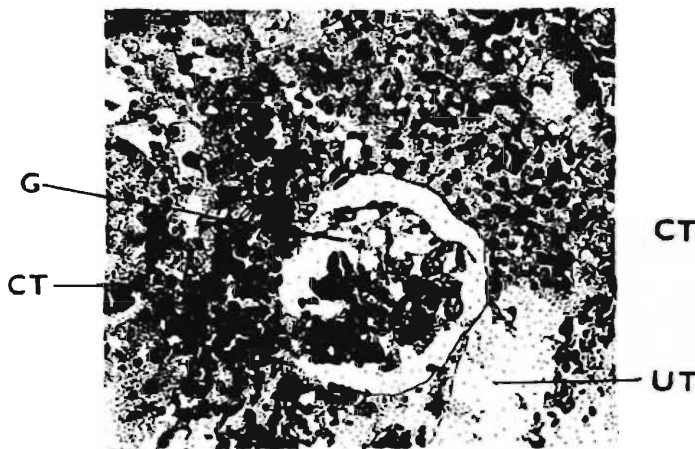
UT., Urinary tubules.



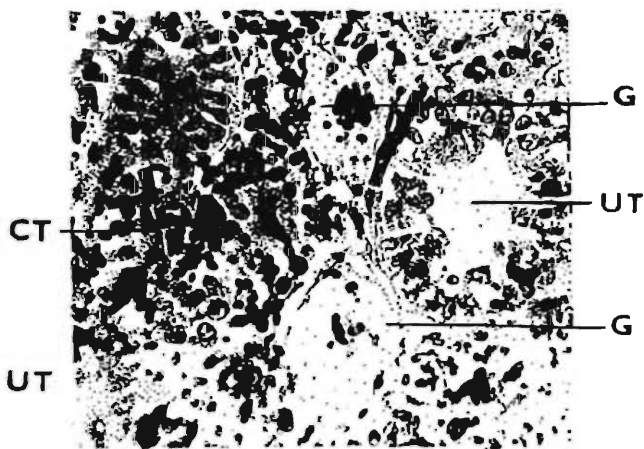
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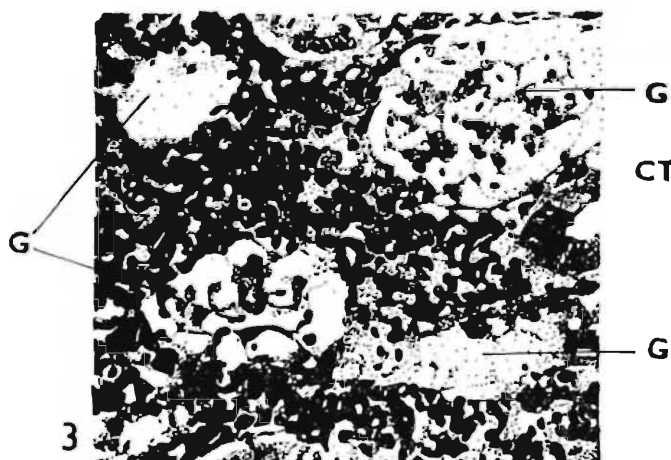
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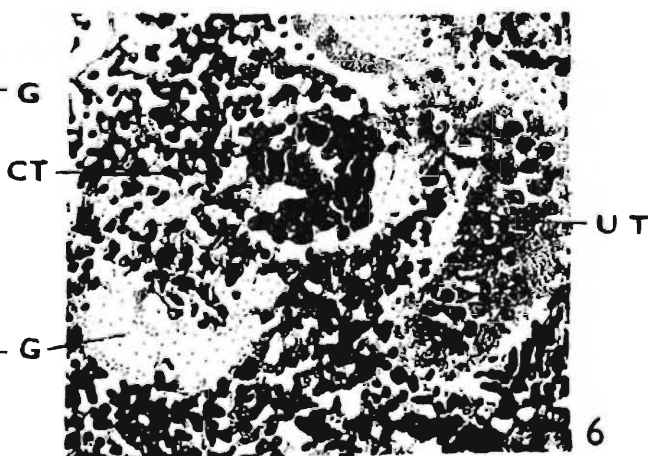
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Transverse sections of kidneys of *Rasbora rasbora* and *Cirrhina mrigala*.

PLATE 39

Photomicrographs of sections of the kidneys of : *Labeo rohita* (Hamilton) and *Catla catla* (Hamilton).

Figs. 1-3.—Sections of the kidneys of *Labeo rohita* (Hamilton).

Fig. 1.—Section of the kidney through the anterior region. $\times 186\cdot6$

Fig. 2.—Section of the kidney through the middle region. $\times 186\cdot6$

Fig. 3.—Section of the kidney through the posterior region. $\times 186\cdot6$

Figs. 4-6.—Sections of the kidneys of *Catla catla* (Hamilton).

Fig. 4.—Section of the kidney through the anterior region. $\times 186\cdot6$

Fig. 5.—Section of the kidney through the middle region. $\times 186\cdot6$

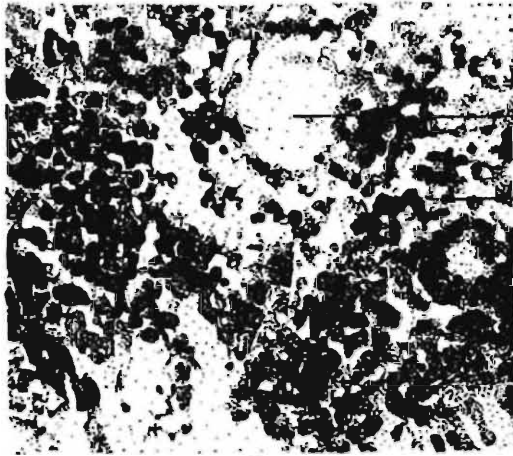
Fig. 6.—Section of the kidney through the posterior region. $\times 186\cdot6$

CT., Connective tissue.

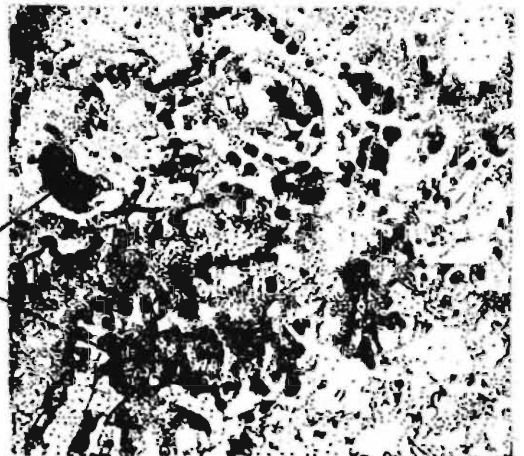
G., Glomerulus.

LT., Lymphoidal tissue.

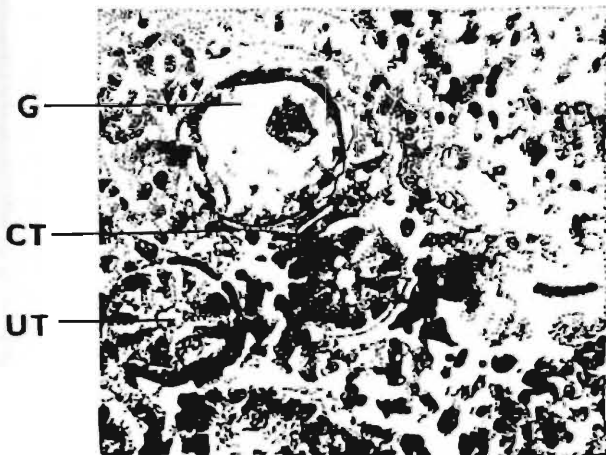
UT., Urinary tubules.



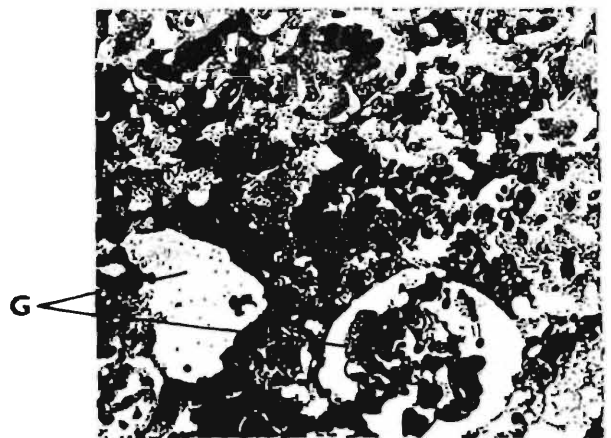
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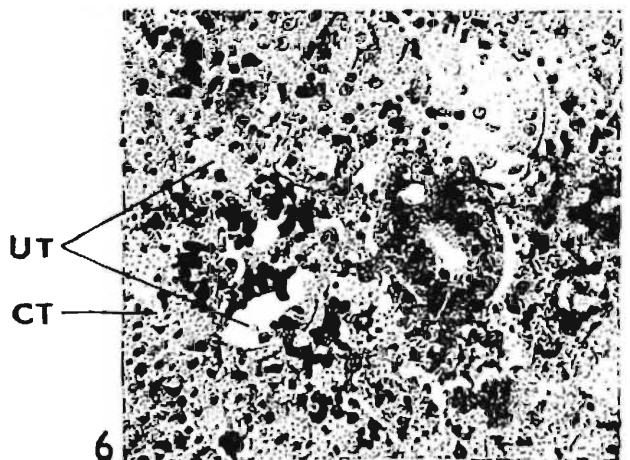
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Transverse sections of kidneys of *Labeo rohita* and *Catla catla*.

PLATE 40

Photomicrographs of sections of the kidneys of : *Notopterus chitala* (Hamilton) and *Notopterus notopterus* (Pallas).

Figs. 1-3.—Sections of the kidneys of *Notopterus chitala* (Hamilton).

Fig. 1.—Section of the kidney through the anterior region. $\times 186\cdot6$

Fig. 2.—Section of the kidney through the middle region. $\times 186\cdot6$

Fig. 3.—Section of the kidney through the posterior region. $\times 186\cdot6$

Figs. 4-6.—Sections of the kidney of *Notopterus notopterus* (Pallas).

Fig. 4. Section of the kidney through the anterior region. $\times 186\cdot6$

Fig. 5.—Section of the kidney through the middle region. $\times 186\cdot6$

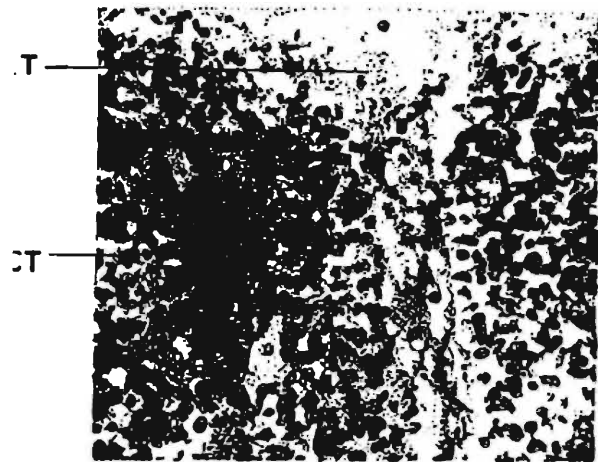
Fig. 6.—Section of the kidney through the posterior region. $\times 186\cdot6$

CT., Connective tissue.

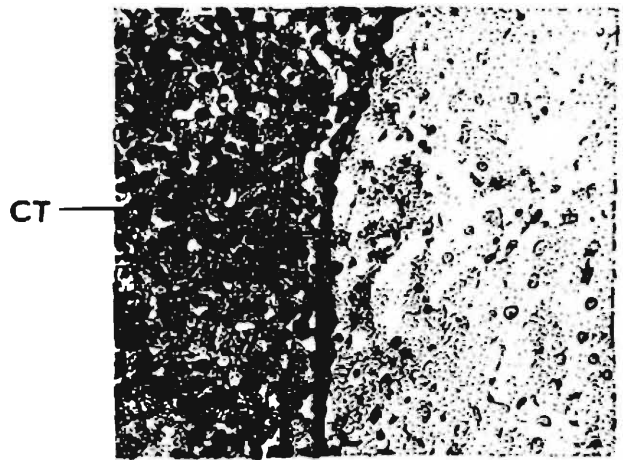
G., Glomerulus.

LT., Lymphoidal tissue.

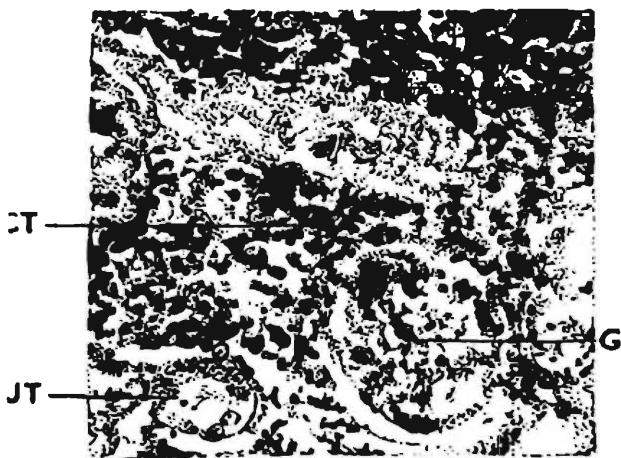
UT., Urinary tubules.



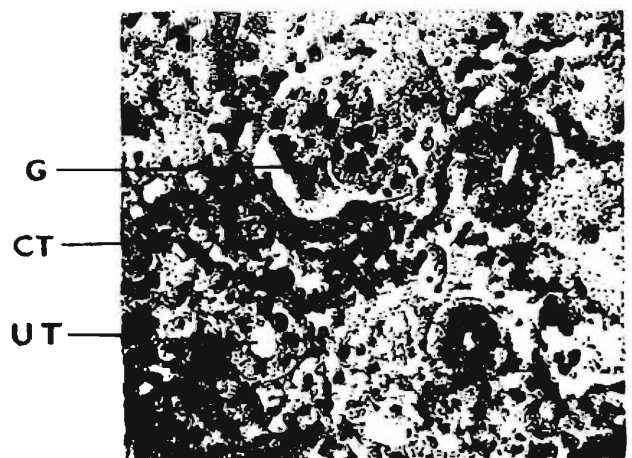
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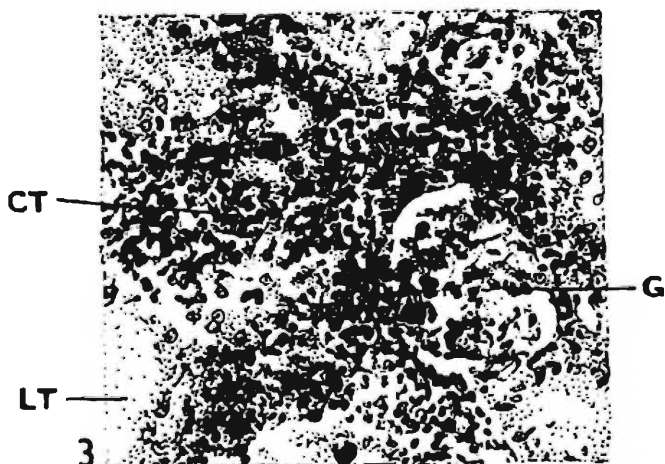
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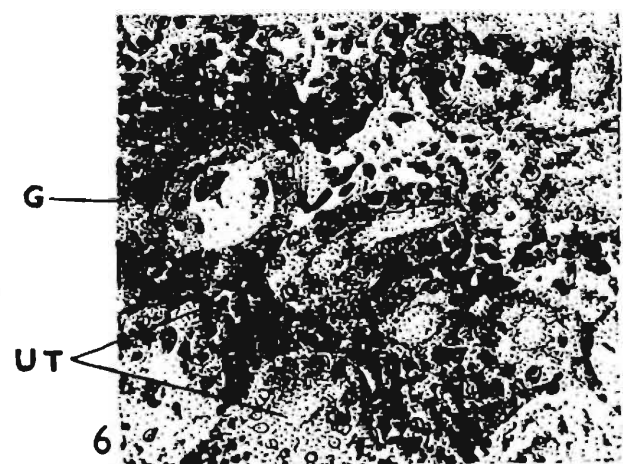
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Transverse sections of kidneys of *Notopterus chitala* and *Notopterus notopterus*.

PLATE 41

Photomicrographs of sections of the kidneys of : *Mastacembelus armatus* (Lacepede) and *Hilsa ilisha* (Hamilton).

Figs. 1-3.—Sections of the kidneys of *Mastacembelus armatus* (Lacepede).

Fig. 1.—Section of the kidney through the anterior region. $\times 186\cdot6$

Fig. 2.—Section of the kidney through the middle region. $\times 186\cdot6$

Fig. 3.—Section of the kidney through the posterior region. $\times 186\cdot6$

Figs. 4-6.—Sections of the kidneys of *Hilsa ilisha* (Hamilton).

Fig. 4.—Section of the kidney through the anterior region. $\times 186\cdot6$

Fig. 5.—Section of the kidney through the middle region. $\times 186\cdot6$

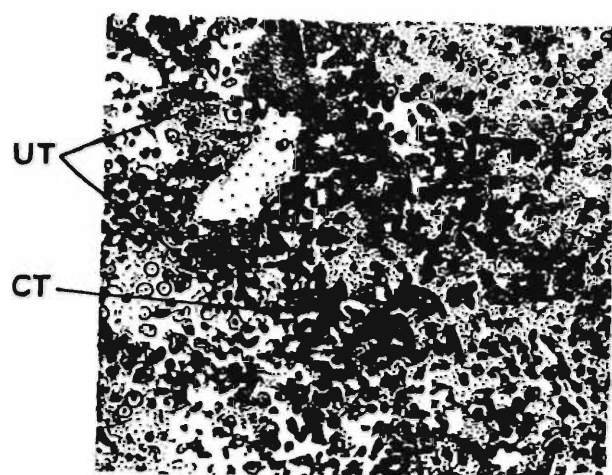
Fig. 6.—Section of the kidney through the posterior region. $\times 186\cdot6$

CT. Connective tissue.

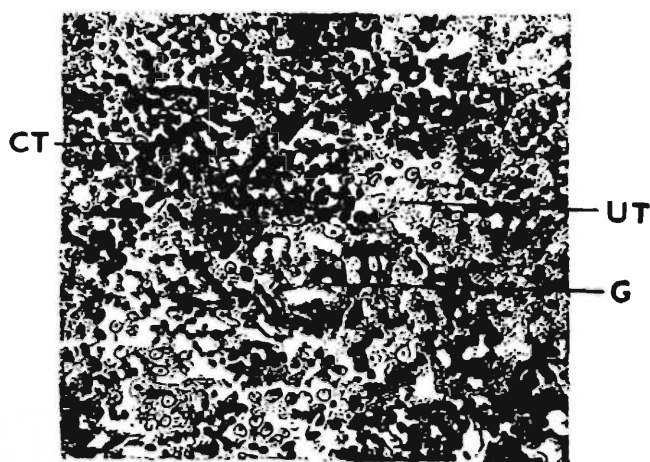
G. Glomerulus.

LT , Lymphoidal tissue.

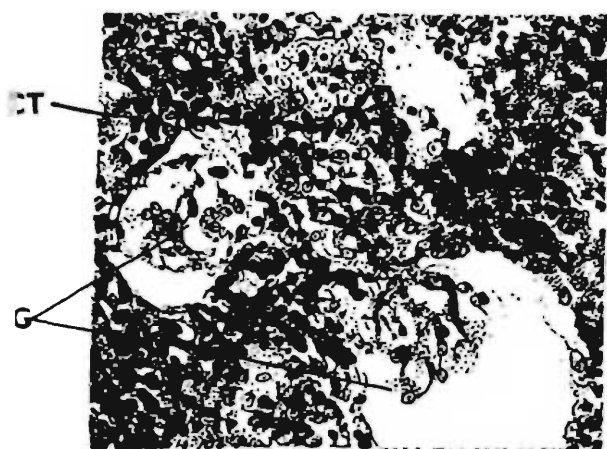
UT., Urinary tubules.



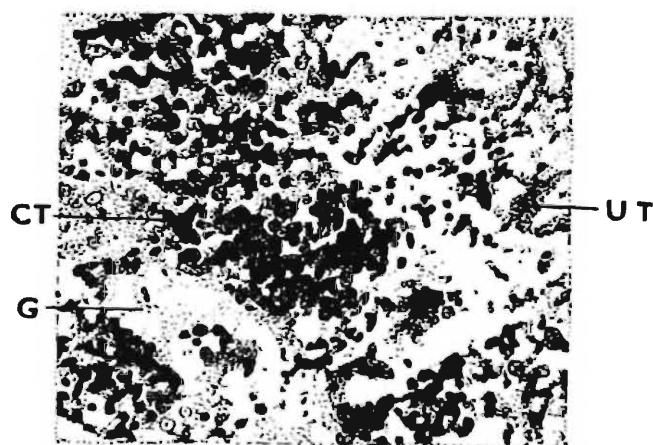
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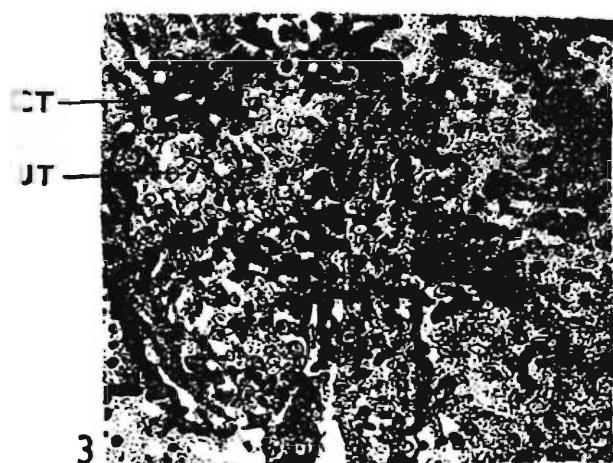


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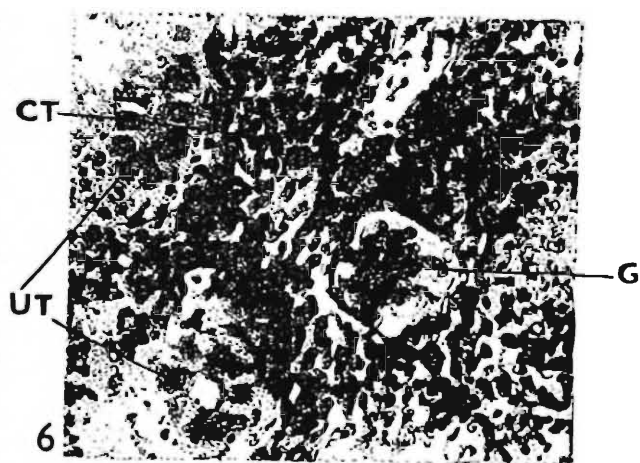


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Transverse sections of kidneys of *Mastacembelus armatus* and *Hilsa ilisha*.

PLATE 42

Photomicrographs of sections of the kidneys of *Clarias batrachus* (Bleeker) and *Heteropneustes fossilis* (Bloch).

Figs. 1-3.—Sections of the kidneys of *Clarias batrachus* (Bleeker).

Fig. 1.—Section of the kidney through the anterior region. $\times 186\cdot6$

Fig. 2.—Section of the kidney through the middle region. $\times 186\cdot6$

Fig. 3.—Section of the kidney through the posterior region. $\times 186\cdot6$

Figs. 4-6.—Sections of the kidneys of *Heteropneustes fossilis* (Bloch).

Fig. 4.—Section of the kidney through the anterior region. $\times 186\cdot6$

Fig. 5.—Section of the kidney through the middle region. $\times 186\cdot6$

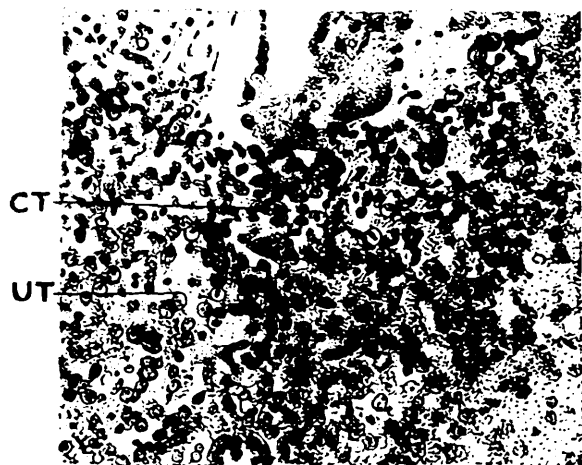
Fig. 6.—Section of the kidney through the posterior region. $\times 186\cdot6$

CT., Connective tissue.

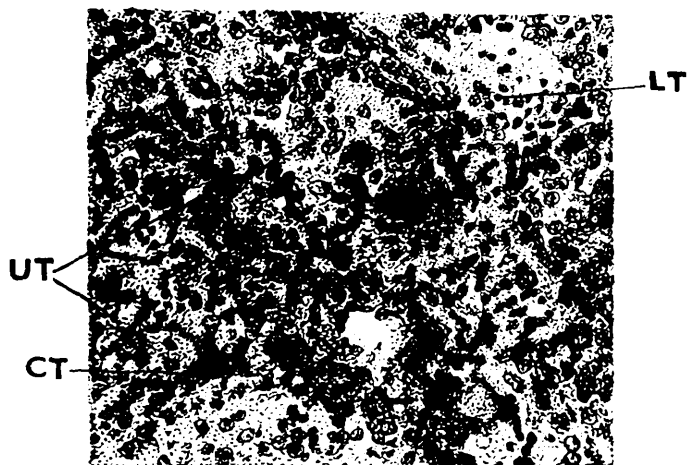
G., Glomerulus.

LT., Lymphoidal tissue.

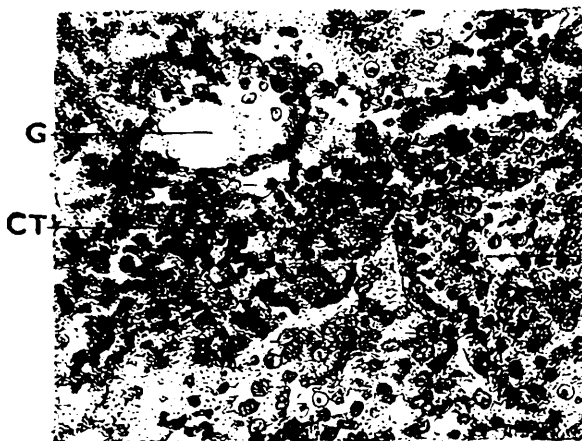
UT., Urinary tubules.



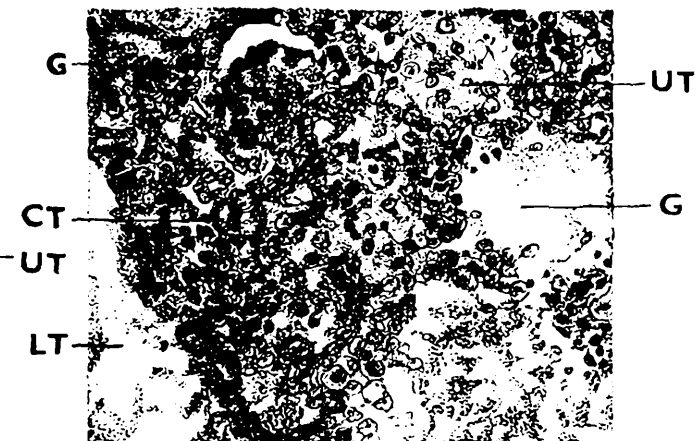
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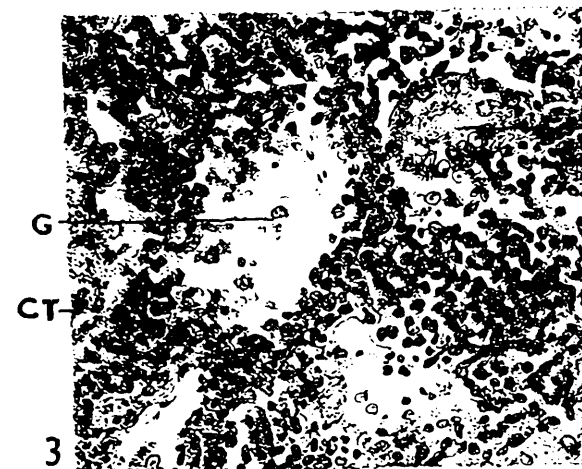
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Transverse sections of kidneys of *Clarias batrachus* and *Heteropneustes fossilis*.

PLATE 43

Photomicrographs of sections of the kidneys of : *Eutropiichthys vacha* (Bloch) and *Wallago attu* (Bloch).

Figs. 1-3.—Sections of the kidneys of *Eutropiichthys vacha* (Bloch).

Fig. 1.—Section of the kidney through the anterior region. $\times 186.6$

Fig. 2.—Section of the kidney through the middle region. $\times 186.6$

Fig. 3.—Section of the kidney through the posterior region. $\times 186.6$

Figs. 4-6.—Sections of the kidneys of *Wallago attu* (Bloch).

Fig. 4.—Section of the kidney through the anterior region. $\times 186.6$

Fig. 5.—Section of the kidney through the middle region. $\times 186.6$

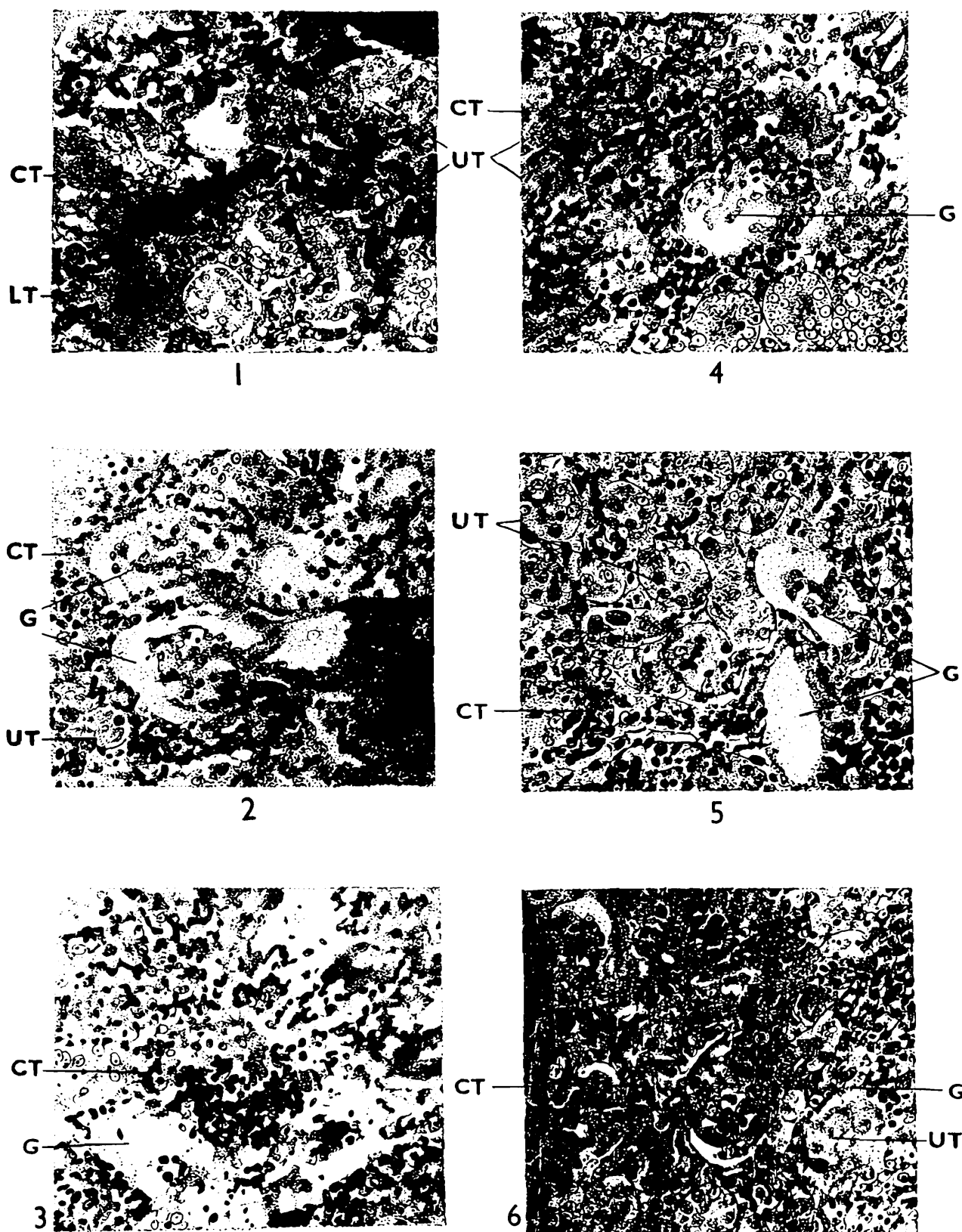
Fig. 6.—Section of the kidney through the posterior region. $\times 186.6$

CT Connective tissue.

G., Glomerulus.

LT., Lymphoidal tissue.

UT., Urinary tubules.



Transverse sections of kidneys of *Eutropiichthys vacha* and *Wallago attu*.

PLATE 44

Photomicrographs of sections of the kidneys of : *Mystus aor* (Hamilton) and *Ophiocephalus marulius* (Hamilton).

Figs. 1-3.—Sections of the kidneys of *Mystus aor* (Hamilton).

Fig. 1.—Section of the kidney through the anterior region. $\times 186\cdot6$

Fig. 2.—Section of the kidney through the middle region. $\times 186\cdot6$

Fig. 3.—Section of the kidney through the posterior region. $\times 186\cdot6$

Figs. 4-6.—Sections of the kidneys of *Ophiocephalus marulius* (Hamilton).

Fig. 4.—Section of the kidney through the anterior region. $\times 186\cdot6$

Fig. 5.—Section of the kidney through the middle region. $\times 186\cdot6$

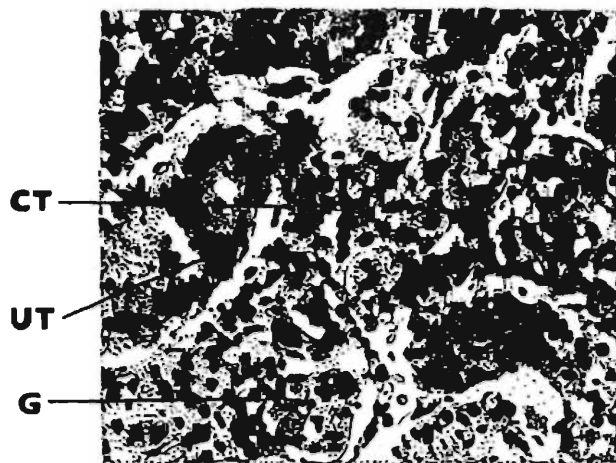
Fig. 6.—Section of the kidney through the posterior region. $\times 186\cdot6$

CT., Connective tissue.

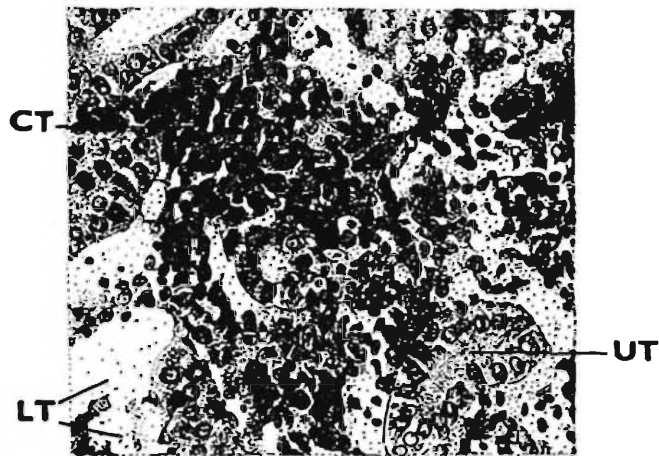
G., Glomerulus.

LT., Lymphoidal tissue.

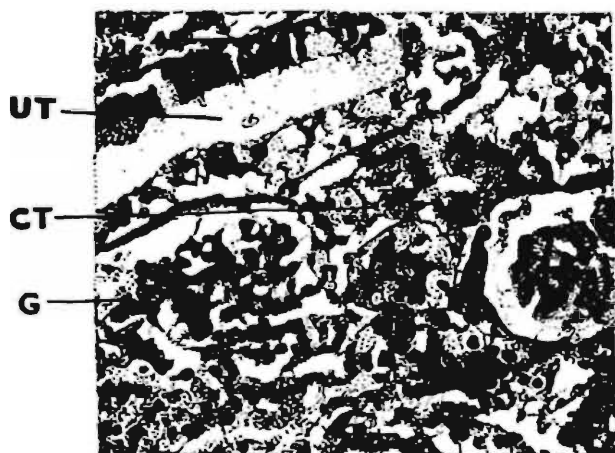
UT., Urinary tubules.



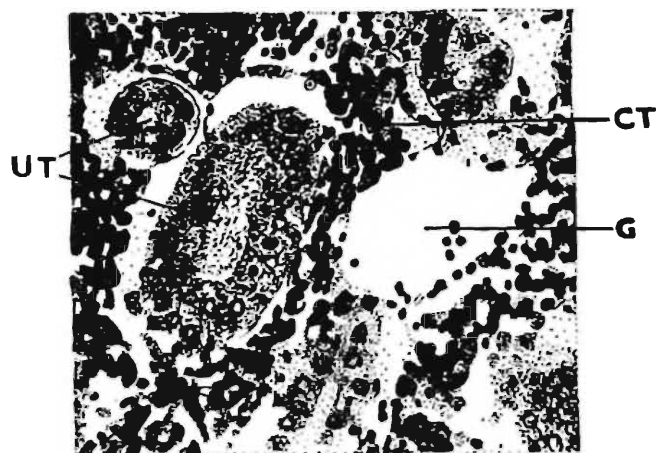
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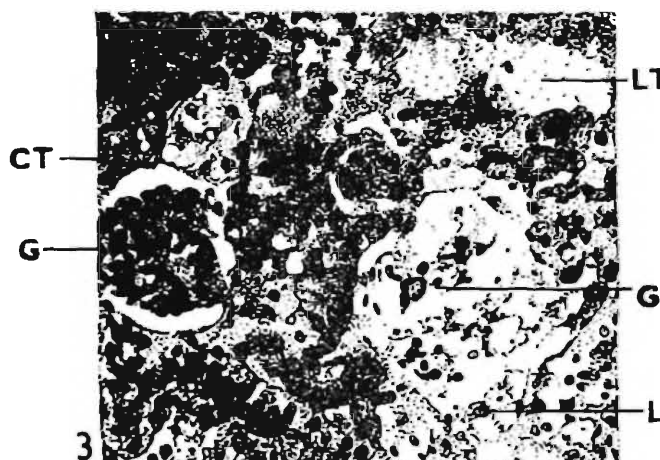
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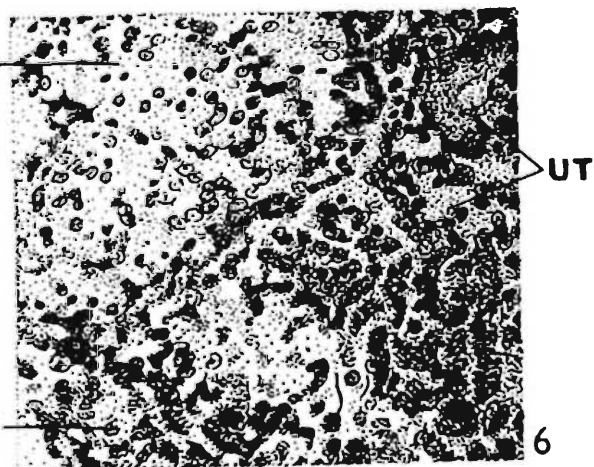
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Transverse sections of kidneys of *Mystus aor* and *Ophiocephalus marulius*.

PLATE 45

Photomicrographs of the kidneys of : *Ophiocephalus gachua* (Hamilton) and *Ophiocephalus punctatus* (Hamilton).

Figs. 1-3.—Sections of the kidneys of *Ophiocephalus gachua* (Hamilton).

Fig. 1.—Section of the kidney through the anterior region. $\times 186\cdot6$

Fig. 2.—Section of the kidney through the middle region. $\times 186\cdot6$

Fig. 3.—Section of the kidney through the posterior region. $\times 186\cdot6$

Figs. 4-6.—Sections of the kidneys of *Ophiocephalus punctatus* (Hamilton).

Fig. 4.—Section of the kidney through the anterior region. $\times 186\cdot6$

Fig. 5.—Section of the kidney through the middle region. $\times 186\cdot6$

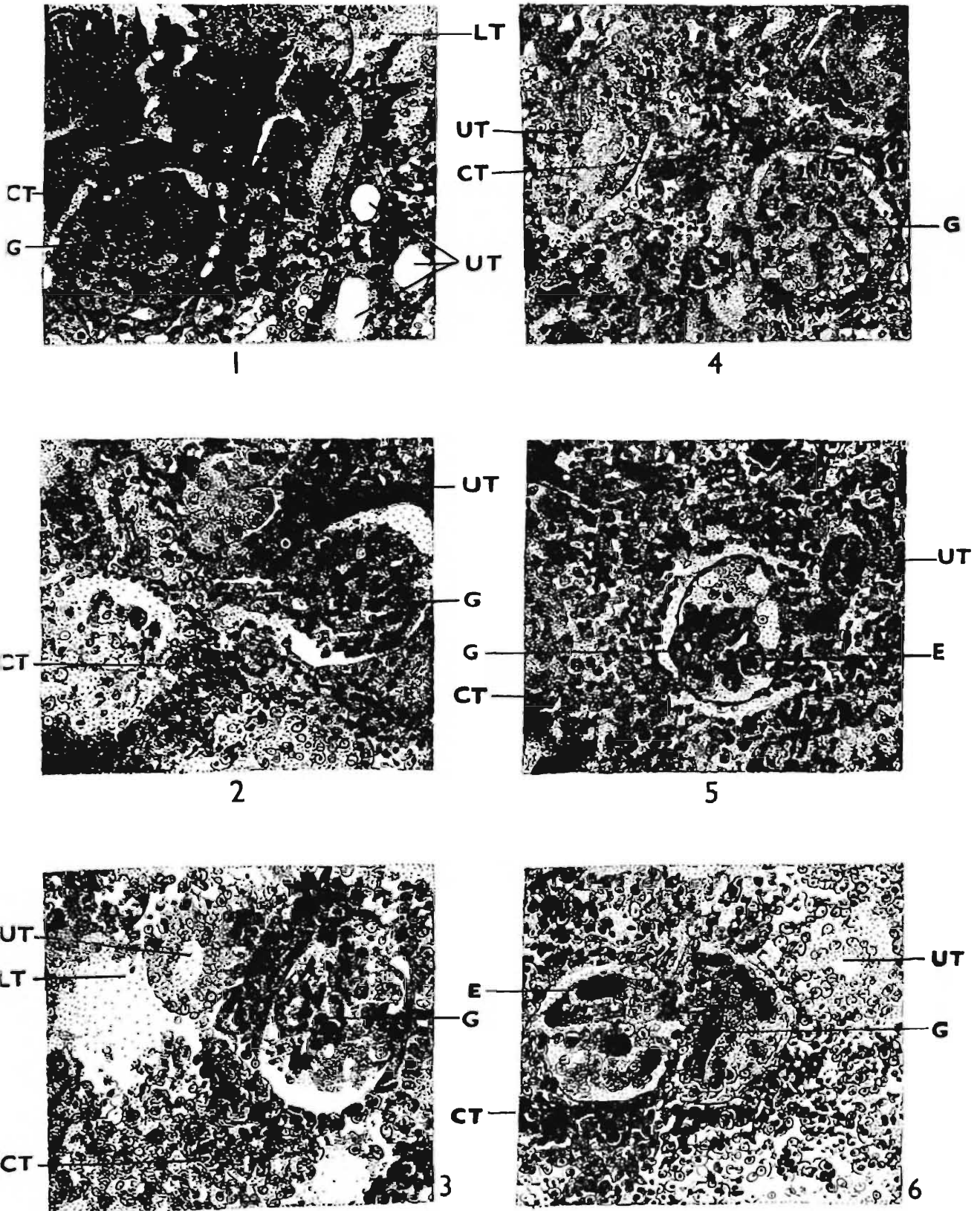
Fig. 6.—Section of the kidney through the posterior region. $\times 186\cdot6$

CT., Connective tissue.

G., Glomerulus.

LT., Lymphoidal tissue.

UT., Urinary tubules.



Transverse sections of kidneys of *Ophiocephalus gachua* and *Ophiocephalus punctatus*.

III. Lower Chordata Division

Superintending Zoologist		□ Vacant
1. Marine Fish Section	Zoologist : Dr. A. G. K. Menon	Dr. A. G. K. Menon (Officer-in-Charge)
2. Freshwater Fish Section	Zoologist : Dr. K. C. Jayarama- krishnan Asstt. Zoologist : Shri M. A. S. Menon	} Dr. K. C. Jayarama- krishnan (Officer-in-Charge)
3. Protochordata and Amphibia Section	Zoologist : Km. M. B. Kripalani	

IV. Higher Chordata Division

Superintending Zoologist		Dr. K. K. Tiwari
1. Reptilia Section	Zoologist : Shri M. N. Acharji	Shri M. N. Acharji (Officer-in-Charge)
2. Birds Section	Zoologist : Dr. B. Biswas	} Dr. B. Biswas (Officer-in-Charge)
3. Mammal and Osteology Section	Zoologist : Vacant Asstt. Zoologist : Shri G. U. Kurup	
4. Prehistoric Zoology Section	Asstt. Zoologist : Shri Bhola Nath	Shri Bhola Nath (Officer-in-Charge)

V. Other Scientific and Technical Branches

1. Taxidermy and Museum Section	Curator : Shri B. S. Lamba Asstt. Curators : Shri A. K. Mukherjee Shri Syed Mohammed Ali	} Shri B. S. Lamba (Officer-in-Charge)
2. Marine Survey Unit	Zoologist : Dr. A. Daniel	
3. Soil Zoology Unit	Zoologist : Dr. P. D. Gupta	Dr. P. D. Gupta (Officer-in-Charge)
4. Animal Population Studies Unit	Zoologist : Dr. R. S. Pillai Asstt. Zoologist : Shri R. K. Bhanotar	} Dr. R. S. Pillai (Officer-in-Charge)
5. Documentation Unit	Documentation Officer : Dr. Koshy Mathew	

IVI. Regional Stations

- | | | |
|--|--|--|
| 1. Eastern Regional Station,
Z. S. I., Shillong | Zoologist :
Dr. K. Reddiah | Dr. K. Reddiah
(Officer-in-Charge) |
| 2. Western Regional Station,
Z. S. I., Poona | Zoologist :
Shri B. K. Tikader | Shri B. K. Tikader
(Officer-in-Charge) |
| 3. Central Regional Station,
Z. S. I., Jabalpur | Zoologist :
Shri H. Khajuria | Shri H. Khajuria
(Officer-in-Charge) |
| 4. Northern Regional Sta-
tion, Z. S. I., Dehra
Dun | Zoologist :
Shri T. D. Soota | Shri T. D. Soota
(Officer-in-Charge) |
| 5. Desert and Gangetic
Plains Regional Station,
Z. S. I., Jodhpur | Zoologist :
Dr. A. K. Datta | Dr. A. K. Datta
(Officer-in-Charge) |
| 6. Southern Regional Station,
Z. S. I., Madras | Zoologist :
Shri T. G. Vazirani | Shri T. G. Vazirani
(Officer-in-Charge) |

NOTICE TO CONTRIBUTORS

SCOPE.—Articles embodying original research as well as critical reviews of modern researches by specialists in the field of zoology (including the natural history of animals) in the widest sense, but specially systematics, ecology and zoogeography of the Indian Region, will be published in the *Records of the Indian Museum*.

MANUSCRIPTS FOR PUBLICATION.—Manuscripts must be type-written, double-spaced with ample margins, on one side only of the page and should have all the pages numbered. Manuscripts should not be offered to any other journal for prior or simultaneous publication.

The manuscripts must be drastically condensed by authors. Long historical introductions and lengthy discussions will not be accepted for publication. The tables should be numbered serially in Arabic numerals. Only such tables and illustrations as are essential will be published. Papers must conform to the usage of the *Rec. Indian Mus.* in all typographical matters. They must be accompanied by a Table of Contents, and must end with a short Summary which should not be of a general character, but should resume, one by one, all the principal facts and conclusions, given in the paper. One proof is sent to authors and as few alterations as possible should be made in it. Care should be taken to replace words and/or phrases removed, by others of equal length, thus avoiding disturbance of type.

The title should include the Phylum, Order and Family of the animals dealt with. Generic and specific names of animals, which should be underlined, must be given in full at least once according to the international rule of binominal nomenclature adopted at the 10th International Congress of Zoology (1927) and include the name(s) of author(s).

The metric system should be used for measures and weights ; measures in other systems may, if desired, be given in brackets. Temperatures should be given in degrees Centigrade, with, if desired, the Fahrenheit reading in brackets.

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ANNANDALE, N. 1909. Report on a small collection of sponges from Travancore.—*Rec. Indian Mus.*, Calcutta, 3, pp. 101—104, 2 pls.

WIGGLESWORTH, V. B. 1950. *The Principles of Insect Physiology* (4th ed.), viii+544 pp.—London (Methuen & Co.).