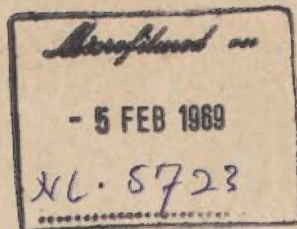


GUIDE
TO THE
ZOOLOGICAL COLLECTIONS
OF THE
RAFFLES MUSEUM,
SINGAPORE.

—+—
BY
R. HANITSCH, PH.D,
Director.

—+—
WITH 21 PLATES.

—+—
SINGAPORE:
PRINTED BY THE STRAITS TIMES PRESS, LIMITED.
1908.



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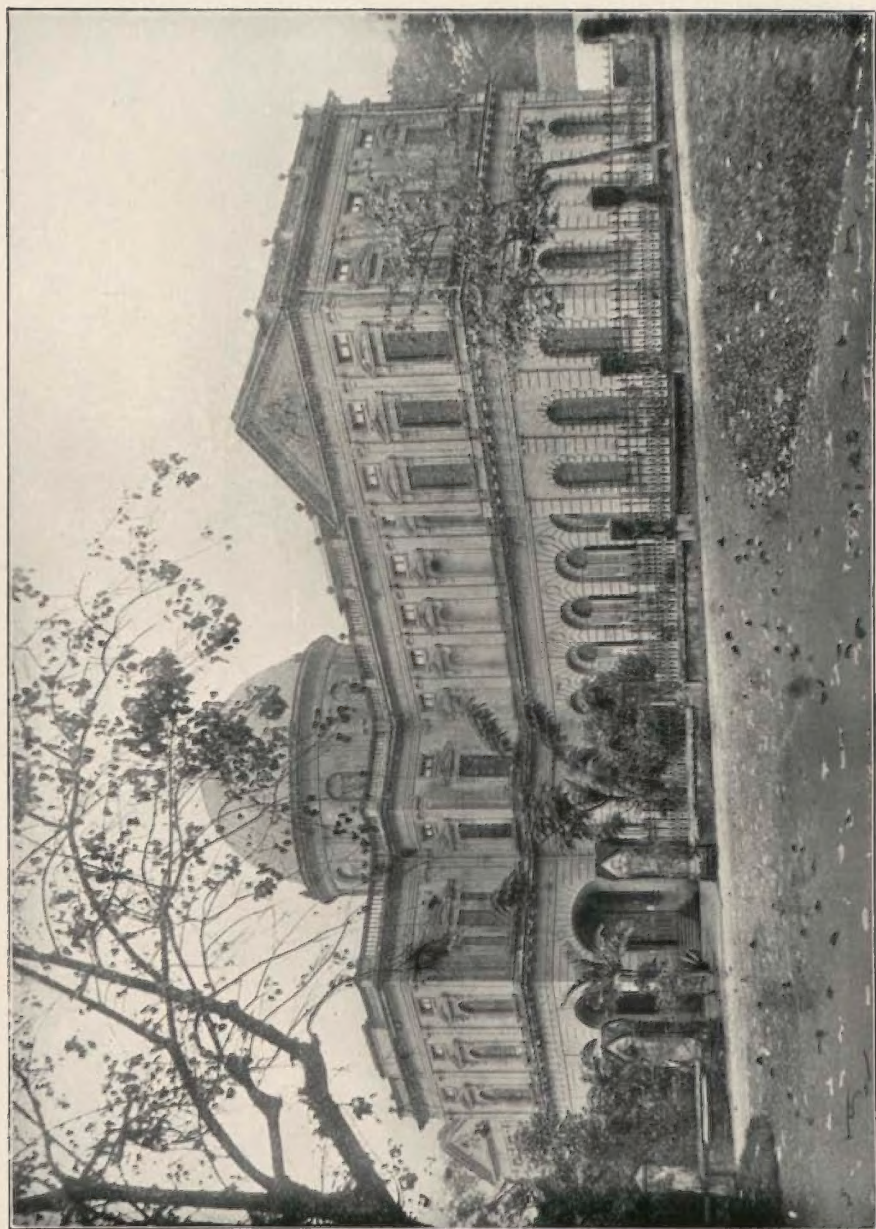
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GUIDE

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PREFACE.



THE zoological collections of the Raffles Museum are practically restricted to the Malay region so that this book, besides being a Guide to the Museum, is a popular introduction to the study of the Malay Fauna. In fact it would have been more correct to entitle the book 'An Introduction to the study of the Fauna of the Malay region, as illustrated by the specimens in the Raffles Museum,' especially as no attempt has been made in its pages actually to guide the visitor from case to case and shelf to shelf. The visitor is expected to use his eyes, and if here and there he should experience a little difficulty in finding a particular bird or insect, he will also, when successful, partake of the joy of the numerous collectors who brought the specimens together.

Of the visitors to this Museum the vast majority are unfortunately not acquainted with the English language. This 'Guide' will therefore mainly reach the Singapore European resident, the Passenger and the Singapore schoolboy. The first with his scanty leisure and the second with his short hours on shore cannot be expected to pay more than a hasty visit to the Museum. But the case is different with the Singapore schoolboy, and it is hoped that the book will be welcome to him and that he will make ample use of it. Of recent years the number of schoolboys, who have been going round the galleries note book in hand, has been steadily increasing, and this has always been a pleasing sight. The writer would be fully rewarded for the trouble of compiling the following pages, if this 'Guide' should be their constant companion on their future visits to the Museum.

The illustrations are photographs of specimens actually in the collection. For many of them I am indebted to Mr. Sim Boon Kwang and to his brother, Mr. Sim Boon Eng, who took the photographs and most generously presented them to the Museum for the purpose of this 'Guide.' A few pictures were taken by myself and the rest by local firms. The photograph of the Entrance Hall (plate II) is reproduced with the kind permission of Messrs. Lambert & Co.

Finally I wish to tender my best thanks to Mr. Makepeace for his kind help in discussing with me the scope and arrangement of this 'Guide,' in selecting the illustrations and reading the proofs.

RAFFLES MUSEUM,
SINGAPORE,
November, 1908.

R. HANITSCH,
Director.

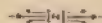
CONTENTS.



	PAGE.
MAMMALS	1
Apes, Monkeys, Lemurs	1
Shrews	3
Bats	3
Carnivora	4
Rodents	6
Elephants	7
Hoofed Animals	7
Duyongs	13
Whales, Porpoises, Dolphins	13
Edentates	14
BIRDS	15
Game Birds	16
Pigeons	17
Swimming Birds	17
Wading Birds	18
Climbing Birds	20
Perching Birds	23
Birds of Prey	32
REPTILES	36
Chelonia (<i>Turtles & Tortoises</i>)	36
Crocodiles	39
Lizards	40
Snakes	42
AMPHIBIANS	47
FISHES	50
INSECTS	53
Ants, Bees, Wasps	54
Flies & Fleas	55
Butterflies & Moths	55
Beetles.	58
Caddis Flies & Ant Lions	60
Dragonflies & Termites	60
Cockroaches, Stick & Leaf Insects, Grasshoppers	61
Bugs, Cicadas, Lanternflies	62
Springtails & Silverfishes	64

	PAGE.
MILLIPEDES & CENTIPEDES	65
SPIDERS & SCORPIONS	67
CRUSTACEA	71
Crabs & Lobsters	71
Mantis Shrimps	73
Barnacles.	73
King Crabs	74
WORMS	75
Bristle-bearing Worms	75
Leeches	76
Gephyrea	76
Flat Worms	76
Polyzoa	77
MOLLUSCA	78
Chitons	78
Snails	79
Tooth-Shells	84
Bivalves	84
Cuttle-Fishes	89
STARFISHES & SEA URCHINS	91
Starfishes	92
Brittle Stars	92
Sea Urchins	93
Sea-Cucumbers	94
Sea Lilies & Feather Stars	96
ZOOPHYTES, JELLY FISH & CORALS	98
Hydrozoa	99
Jelly-Fish	100
Corals & Sea Anemones	100
SPONGES	104

Index of Popular Names	107
Index of Scientific Names	109



ILLUSTRATIONS.

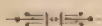


PLATE.	TO FACE PAGE.
I. Raffles Library & Museum, <i>Frontispiece</i> ...	
II. Entrance Hall.—The Tiger (<i>Felis tigris</i>) ...	4
III. fig. 1. Orang Utan (<i>Simia satyrus</i>) ...	1
2. The Proboscis Monkey (<i>Nasalis larvatus</i>)	
IV. fig. 1. The Slow Lemur (<i>Nycticebus tardigradus</i>) ...	2
2. The Tuft-eared Squirrel (<i>Reithrosciurus macrotis</i>) ...	
V. Young Leopards (<i>Felis pardus</i>) ...	5
VI. fig. 1. Skull of Orang Utan (<i>Simia satyrus</i>) ...	12
2. Skull of Babirusa (<i>Babirusa alfurus</i>)	
3. Skull of the Bearded Pig (<i>Sus barbatus</i>)	
VII. Skeleton of the Indian Whale (<i>Balaenoptera indica</i>) ...	13
VIII. fig. 1. The Scaly Ant-Eater (<i>Manis javanica</i>)	
2. The Young Malay Tapir (<i>Tapirus indicus</i>)	14
IX. fig. 1. The Booby (<i>Sula sula</i>) on Christmas Island	16
2. The Argus Pheasant (<i>Argusianus argo</i>)	
X. The Yellow Tropic Bird or Boatswain Bird (<i>Phaethon fulvus</i>) ...	18
XI. fig. 1. The Fish Owl (<i>Ketupa ketupa</i>) ...	22
2. The Rhinoceros Hornbill (<i>Buceros rhinoceros</i>) ...	
XII. fig. 1. The Green Magpie (<i>Cissa robinsoni</i>) ...	29
2. The Burmese Paradise Flycatcher (<i>Terpsiphone affinis</i>) ...	
XIII. Christmas Island Birds ...	33
XIV. fig. 1. The Gavia (<i>Tomistoma schlegeli</i>) ...	37
2. The Leathery Turtle (<i>Dermochelys coriacea</i>) ...	
XV. fig. 1. <i>Heteropteryx grayii</i> ; 2. <i>Protocerus colossus</i> ;	
3. <i>Xylorhiza venosa</i> ; 4. <i>Eutrachelus temmincki</i> ; 5. <i>Mormolyce phyllodes</i> ;	
6. <i>Galofa atlas</i> ...	59
XVI. fig. 1. <i>Phibalosoma cantori</i> ; 2. <i>Deroplatys exsiccata</i> ;	
3. <i>Phyllium scythe</i> ; 4. <i>Melastoma polyanthum</i> ;	
5. <i>Acanthoderus</i> sp.; 6. <i>Fulgora</i> sp.; 7. <i>Tacuna speciosa</i> ;	
8. <i>Belostoma indicum</i> ...	61

PLATE.	TO FACE PAGE.
XVII. fig. 1. Scorpion (<i>Palamnaeus longimanus</i>) ...	67
2. Bird-eating Spider (<i>Pocillotheria</i> sp.)	
XVIII. fig. 1. The Christmas Island Robber Crab (<i>Birgus latro</i>)	71
2. The Spiny Swimming Crab (<i>Goniosoma natator</i>)	
XIX. Shells: fig. 1. <i>Dolium maculatum</i> ; 2. <i>Trachus niloticus</i> ; 3. <i>Pteroceras scorpius</i> ; 4. <i>Harpa conoidalis</i> ; 5. <i>Murex tenuispina</i> ; 6. <i>Phorus solaris</i> ; 7. <i>Murex haustellatum</i> ; 8. <i>Conus bandanus</i> ; 9. <i>Ovulum ovum</i> ; 10. <i>Solarium trochleare</i> ; 11. <i>Voluta undulata</i>	80
XX. Corals: fig. 1. <i>Mudrepora</i> ; 2. <i>Ulophyllia</i> ; 3. <i>Stylopora</i> ; 4. Abnormal <i>Haliglossa</i> ; 5. <i>Fungia</i> ; 6. <i>Mussa</i> ; 7. <i>Podobacia</i> ; 8. <i>Haliglossa</i> ; 9. <i>Goniastraea</i> ...	102
XXI. Varieties of Neptune's Cup (<i>Poterion neptuni</i>). ...	105



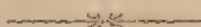


Sin Bont Kéang, Photo.
PROBOSCIS MONKEY (*Nasalis larvatus*)



ORANG UTAN (*Siamia satyrus*)

MAMMALS.



APES, MONKEYS AND LEMURS.

(*Primates and Prosimiae*).

Of the four man-like Apes two occur in the Malay region, the Orang Utan and the Gibbon. The two others, the Gorilla and the Chimpanzee, inhabit tropical Africa. They differ from the other Monkeys by being tailless and by their semi-erect attitude.

The Orang Utan or 'Mias' (*Simia satyrus*) is confined to Sumatra and Borneo. A number of them are exhibited, male, female and young ones, the males with their long and extremely powerful arms and enormous teeth, well seen in the skeletons, showing what formidable enemies they might be. (see pl. III, fig. 1, and pl. VI, fig. 1). They live in dense forests, preferably in low-lying, swampy districts, difficult of access. They travel deliberately and with great circumspection from branch to branch and tree to tree, never jumping or leaping, yet still progressing as fast as a man can do on the ground. They build their nests high up in the trees, forming them, wherever possible, of living branches, which they intertwine, filling the interstices with broken twigs and leaves.

The Gibbons are considerably smaller than the Orang Utan. They are much lighter in build and are accordingly much more agile, and have very long arms. The largest of them is the Siamang (*Hylobates syndactylus*), from the Malay Peninsula and Sumatra, with black fur. Its specific name is derived from the web joining the second and third toe. Of the smaller Gibbons, indiscriminately called 'Wah-wahs' by the Malays, the best-known are the White-handed Gibbon (*Hylobates lar*) and the Agile Gibbon (*H. agilis*), both occurring

on the Malay Peninsula. Their native name is, no doubt, derived from the strange howl with which they fill the jungle at sunrise.

The other Malayan Monkeys can be classed under four genera, viz. *Semnopithecus* (the Langurs), *Nasalis* (the Proboscis Monkey), *Macacus* (the Macaques) and *Cynopithecus* (the black Celebes Monkey). The Langurs are natives of India, China, the Malay Peninsula and Archipelago. They have long, slender bodies and long tails. The two most common species of the Malay Peninsula, called 'Lotong,' are the Dusky Leaf-Monkey (*Semnopithecus obscurus*), dark grey, with black hands, feet and face, the nose and a ring about the eyes being white; and the Banded Leaf-Monkey (*S. femoralis*), which is blackish-brown, with the exception of the abdomen and inner-side of the thighs which are white. A Bornean species (*S. rubicundus*) is chestnut red.

The most extraordinary-looking monkey in the collection is, no doubt, the Proboscis Monkey (*Nasalis larvatus*), from Dutch Borneo, which, with his enormous nose, reminds one of pictures in "Punch." A group of three of them, male, female and young male, were presented in 1905 by Dr. W. L. Abbott. The old male's nose is specially impressive. (see pl. III, fig. 2).

The Macaques are of a stouter build than the Langurs. Two species ought to be mentioned. The 'Kra' (*Macacus cynomolgus*) and the Pig-tailed Monkey or 'Berok' (*M. nemestrinus*). The 'Kra' is exceedingly common, occurring even in the Tanglin district of Singapore town. The 'Berok' is common, too, though not on Singapore island. It is larger than the 'Kra,' but has a short and thin tail. Sir Stamford Raffles described long ago how this monkey is trained in Sumatra to gather coconuts. It is put to similar use elsewhere, too.

The Black Ape of Celebes (*Cynopithecus niger*) stands between the Macaques and the African Baboons. It has large callosities on the buttocks and quite a rudimentary tail.

Lower than the Monkeys are the Lemurs, which are generally placed in a separate order, *Primates*. The Common Loris or Slow Lemur (*Nycticebus tardigradus*), called 'Kongkang' by the Malays, is a small and harmless creature, slow moving, of nocturnal habits, with large glaring eyes, short ears, thick and close fur, and no tail. It is common from N.W. India to Borneo. (see pl. IV, fig. 1.) The Tarsier (*Tarsius spectrum*) is still more extraordinary looking. It is smaller than the Slow Loris, has quite enormous eyes and a



FIG. 1.



FIG. 2.

Sim Boon Kwang Photo.

FIG. 1.—SLOW LEMUR (*Nycticebus lardigradus*).

FIG. 2.—TUFT-EARED SQUIRREL (*Reithrosciurus macrotis*).

long tail. The great size of its eyes shows that it is nocturnal too. It occurs in Sumatra, Java and Borneo.

SHREWS (*Insectivora*).

The Insectivora are few in number and small in size. As their name implies, they generally feed on insects. The Malayan Insectivora may be divided into Tree-Shrews, Gymnuras (allied to the English hedgehog) and Musk-Shrews, and it is remarkable that these three families in outer appearance strongly resemble three families of the Rodentia, to which we shall come later on, viz. the Squirrels, the Porcupines and the Rats respectively. However, the chisel-like front teeth of the Rodentia will always distinguish them from the Insectivora.

The Tree-Shrews or Tupaias, resembling squirrels in form and habit, are exceedingly common and destructive. *Tupaia ferruginea*, the 'tupai tanah' of the Malays, may serve as an example. The Gymnuras, though resembling hedgehogs, have only rough hair instead of the spines. One of them, the *Gymnura rafflesi*, possibly the 'tikus mondok' of the Malays, is white. The Musk-Shrews (*Crocidura murina* and *C. caerulea*), resembling rats, are common near human habitations and compensate for their musky smell somewhat by their usefulness in destroying insects.

Among the Insectivora is generally included the Flying Lemur (*Galeopithecus volans*) which, though distinctly a vegetable feeder, is difficult to place elsewhere. This animal, the 'Kubong' of the Malays, is about the size of a cat. It has a curious parachute formed by a membrane which arises from the angle of the jaws and encloses the entire length of the fore limbs, hind limbs and tail, leaving free only the fingers and toes. It is nocturnal, and at day time rests against the trunks of trees, the colour of which it resembles. It too has a counterpart amongst the Rodentia, viz., the Flying Squirrel.

BATS (*Chiroptera*).

The Chiroptera or Bats are the only true flying Mammals. In the Flying Lemur, just mentioned, in the Flying Squirrel and the Flying Phalanger (*Petaurus*), from Australia and New Guinea, the membrane along the body merely serves as parachute. In the Bats the fingers of the hands are enormously elongated (see skeletons) and are united by a thin

membrane which runs along the whole length of the arms and along the sides of the body to the hind-legs, connecting even the tail. The thumbs are left free so that they may be used for climbing and grasping. The toes are not elongated.

There are two kinds of Bats, fruit-eating and insectivorous Bats, the former being by far the larger. The so-called 'Flying Fox' or 'Kelawang' (*Pteropus edulis*) requires no introduction to Singapore people. In the fruiting season scores of them may be seen on a single tree, and they can do considerable damage. Quite as destructive can be another, though much smaller, member of this group, the Short-nosed Fruit Bat (*Cynopterus marginatus*).

Much more numerous are the Insect-eating Bats. However, they are considerably smaller in size, and many of them possess the most extraordinary leaf-like excrescences on nose and ears, especially the strictly nocturnal forms. These excrescences probably serve as delicate tactile organs. The Vampire Bat (*Megaderma spasma*) shows these structures well. Another species, of which a specimen from the Botanic Gardens is exhibited, is remarkable for its white wings (*Taphozous affinis*), and a third one for being almost naked (*Cheiromelis torquatus*).

CARNIVORA.

The Carnivora or Beasts of Prey fall into five groups, *Felidae* (Cats), *Canidae* (Dogs), *Viverridae* (Civets), *Mustelidae* (Martens and Otters), and *Ursidae* (Bears).

The most formidable of these are the Cats, and the centre of the Museum hall contains a magnificent specimen of the largest member of this family, the Royal Tiger or 'Harimau' (*Felis tigris*), presented alive in the year 1903 by H.H. the Sultan of Johore. (See Plate II.) Tigers are now only rarely shot on Singapore island, but they are still common enough on the neighbouring mainland. They also occur in Sumatra and Java, but curiously enough not in Borneo. The next largest Malayan Cat is the Leopard (*Felis pardus*). It has a similar distribution as the Tiger, and is absent from Borneo, too. This species occurs in two varieties, the Spotted Leopard or 'Harimau bintang,' and the Black one, generally called the Black Panther or 'Harimau kumbang,' in which, however, the star-like pattern of the spotted variety can generally be made out. The Black Panther is especially common in Southern India and the Malay Peninsula. Specimens of both varieties are exhibited: a full-grown spotted Leopard, which, however,



ENTRANCE HALL.



Sim Bona Kevoing Photo

YOUNG LEOPARDS (*Felis pardus*).

is badly in need of being replaced by a fresh specimen; two young ones, mounted in a group, the one drinking, the other munching a bone (see pl. V); and two black Panthers, one of them presented in 1903 by H.H. the Sultan of Johore.—A smaller cat, but still a fairly formidable beast, is the Clouded Leopard, 'Harimau dahan' or 'H. akar' (*Felis nebulosa*). A fine specimen of it is exhibited, said to have been obtained near Changi. This locality, however, is doubtful. Smaller again is the Marbled Cat (*Felis marmorata*). A remarkable looking animal is the Golden Cat (*F. temminckii*), with its reddish-golden fur, from Malacca. The most common cat on the Malay Peninsula is probably the Leopard Cat (*F. bengalensis*), which is only about the size of the domestic cat.

A much less interesting group are the dogs. There is a wild dog or 'Anjing utan' (*Cyon rutilans*), known from the Malay Peninsula, Sumatra, Java and Borneo. It is of reddish colour; specimens from Pahang and Mount Ophir are exhibited.

The Civets are in number of species the largest family of Malayan Carnivora. The Palm-Civet or Musang (*Paradoxurus hermaphrodita*) is the most common of them. It is plentiful in Singapore, and the group of them, male, female and two young ones, exhibited in the Museum, was caught at Cairnhill, in 1902, and presented by Mrs. Frizell. They often live in the roof of houses, and their presence is soon known by their obnoxious smell. They may be of some use in destroying rats, but do as much harm in going after pigeons, fowls and fruit. In coffee plantations they are especially unwelcome visitors.—A very pretty, but rare Civet is *Hemigalia hardwickii* of which a specimen from Pahang is shown. The body is marked by broad transverse bands of alternating yellow and black. Both this species and the Musang are easily tamed.—Considerably larger than either of these is the 'Musang jebat' (*Viverra zangalunga*) which, like the common Musang, has an unfortunate liking for coffee-berries.—Other Malayan Civets are the Otter Civet (*Cynogale bennetti*), from Malacca, and the Water-Mongoose or Musang babi (*Herpestes brachyurus*).—The Binturong (*Arctictis binturong*) would at the first glance seem to belong to the Bears rather than to the Civets, on account of its long black fur, and has therefore been called the 'Bear-Cat'. However, its long and thick and bushy tail would soon show that it cannot be a bear. This animal is widely distributed from the Himalayas to Burma, Siam, the Malay Peninsula and Malay Archipelago. It has often been tamed.

The *Mustelidae* form a small group and include Martens and Otters. Two of the former are exhibited, the Indian Marten (*Mustela flavigula*), and the Malay Weasel (*Putorius nudipes*), a pretty beast with reddish body and white head.—Of the Otter or 'Berang-berang' three species occur in this neighbourhood, *Lutra barang*, *L. sumatrana* and *L. cinerea*. The two first ones are difficult to distinguish from each other, both of them have claws and are much bigger than the third species which, on account of its having nails only instead of claws is also called *Lutra leptonyx*.

The last group of the Carnivora are the Bears, represented in this region by one species only, the Malayan Honey Bear or Bruang (*Helarctos malayanus*). It ranges from N.E. India and Indo-China down to the Malay Peninsula, Sumatra and Borneo, but is said to be absent from Java. A group of four of them, from Malacca, is exhibited. Very noticeable is its short hair, quite different from the long, shaggy coat of the Indian Bear which stands alongside. The Honey Bear is a good climber. It lives on small mammals and birds, if it is not too clumsy to catch them, but more probably on fruit, insects and grubs. Its long and narrow tongue seems specially adapted for the latter kind of food. Honey can surely form only a very occasional item of its bill of fare. Unless attacked it is a harmless beast.

RODENTS (*Rodentia*).

The Malayan Rodentia may be classified into *Hystricidae* (Porcupines), *Leporidae* (Hares), *Muridae* (Rats and Mice), *Spalacidae* (Bamboo Rats) and *Sciuridae* (Squirrels).

Two porcupines occur here, the Common Porcupine or 'Landak kawan' (*Hystrix longicauda*) and the Brush-tailed Porcupine or 'Landak batu' (*Atherura macroura*). The latter species is smaller and has a tail terminating in a tuft of bristles.

The Hares are represented by two Sumatran species (*Lepus nigricollis* and *Nesolagus netscheri*), but the Museum possesses no specimen of either.

The Rats and Mice, Malay name 'tikus,' are numerous, both in number of species and of individuals, but the average visitor will probably not be much interested in them.

The Bamboo Rat or Dekan (*Rhizomys sumatrensis*) is considerably larger than an ordinary rat. It has a yellowish fur, small eyes, small ears, short tail, strong claws and huge incisors and resembles the mole in its mode of life.

Of Squirrels, Malay name 'tupai,' there is a great variety in this region. The most common one is the 'Malayan Squirrel' (*Sciurus natatus*). It is greyish brown above, rusty red below and has white and black stripes at its sides. Abundant too is a smaller form, the Slender Squirrel (*Sciurus tenuis*) which is greyish brown above and white below. It is very destructive. A handsome species is Raffles' Squirrel (*Sciurus preostii*) which is black above, chestnut below and white at the sides. But the most beautiful species in the Museum is a large squirrel from Sarawak, *Reithrosciurus macrotis*, which is chestnut brown, with black and white stripes at its sides, long tufts on its ears and a huge bushy tail. (see pl. IV, fig 2).—Of Flying Squirrels two species are exhibited, *Pteromys nitidus*, chestnut in colour, and *Pteromys oral*. The latter species is very variable in colour. The specimen shown is nearly black.

ELEPHANTS (*Proboscidea*).

The sportsman will probably be most interested in this group and the next one, the Ungulata, which together form the large game of Malaya. Unfortunately the giant of the large game, the Indian Elephant or Gajah (*Elephas indicus*), can hardly be said to be represented in the Museum. There are only two diminutive stuffed specimens in the collection, and only the skull of a full-grown female. The Indian Elephant differs from its African brother by its flatter forehead, its considerably smaller ears, and by the plates of the molar teeth being elongated, and not lozenge-shaped as in the African. It inhabits India, Ceylon, Assam, Burma, Siam, Cochin-China, the Malay Peninsula, Sumatra and North Borneo, but is absent from Java. On the Malay Peninsula the elephant occurs in all States, but is more numerous in Johore, Pahang and Negri Sembilan, than in Perak and Selangor.

HOOFED ANIMALS (*Ungulata*).

The Malayan Ungulates or Hoofed Mammals are classified into *Rhinocerotidae*, *Tapiridae*, *Bovidae* (Oxen), *Cervidae* (Deer), *Tragulidae* (Mousedeer) and *Suidae* (Pigs).

There are two species of Rhinoceros in the Malay region. The Javan Rhinoceros or Badak gajah (*Rhinoceros sondaicus*) is the larger of the two. It possesses one horn only which in the female may even be absent altogether, and has two small incisors between the tusks of the lower jaw. It ranges from Eastern

Bengal, Burma, Tenasserim and the Malay Peninsula to Java, Sumatra and Borneo. Unfortunately the Museum does not yet possess a specimen of it.—The Hairy-eared Sumatran Rhinoceros or Badak kerbau (*Rhinoceros sumatrensis*) has two horns, but no small incisors between the lower tusks. It is smaller and more hairy than the first-named species, and the folds of its skin are less marked. It ranges from Assam, Burma, Tenasserim and the Malay Peninsula to its typical habitat in Sumatra and Borneo, but is absent from Java. The Museum possesses a stuffed specimen from Perak, a female, presented in 1901 by Mr. R. von Pustau, Acting Consul for Austria at that time; and two skeletons, one of them from N. Borneo, presented in 1901 by Mr. Rowe.

The Tapir has a remarkable distribution. Four species of it occur in Central and South America, and one in Malaya. The Malay Tapir or Tenok (*Tapirus indicus*) is the largest of them. The American species are uniformly coloured, but in the Malayan form the front part of the body is dark brown, and the hinder part, from the shoulders onwards, greyish white. Still more remarkably coloured are the newly-born specimens of which two are exhibited, one of them, from Malacca, presented by Sir Cecil Smith in 1888, and one from Palembang, Sumatra, presented by Mr. Mahomed Yahya in 1905. They are marked with broad longitudinal streaks and spots of white (see pl. VIII, fig. 2). These markings soon disappear, and a slightly older specimen, also exhibited, shows only a single faint white streak on either shoulder. The Malay Tapir is known only from Tenasserim, the Malay Peninsula and Sumatra. Europeans had long been familiar with the American Tapir, but it is strange that the Malay one became known to them only last century when Major W. Farquhar described and figured it in a letter dated Malacca, January, 29, 1816, published in the "Asiatick Researches", Vol. XIII (1820).

The Malayan Bovidae include the Seladang, the Banting, the Water-Buffalo, the Anoa and the Serow.—The Seladang or Gaur (*Bos gaurus*) has been called the "finest species of the genus *Bos* in the world." Lydekker, in his 'Great and Small Game of India, Burma and Tibet' says that it occasionally stands as much as 6 feet or even 6 feet 4 inches (= 19 hands) at the withers. "A very marked character", according to the same authority, "is the strong development of the dorsal ridge, and its very sudden termination in a step about midway between the shoulders and the root of the tail". Whilst the general colour is dark olive brown, the "forehead, from between

the eyes across the horn-crest and so on to the nape of the neck is ashy-grey;.....the lower portion of the limbs, from above the knees and hocks downwards, are pure white". The colour of the horns is between olive green and black. The largest horns on record, from a beast shot in Salwen, Burma, and now preserved in the Bombay Museum, measured $39\frac{1}{4}$ inches in length and $20\frac{1}{4}$ inches at the base.

The Museum possesses a Seladang cow from Pahang, presented in 1889 by Mr. (now Sir) J. P. Rodger, Resident of Pahang at that time, and the skeleton of a young Bull, also from Pahang, presented in the same year by Capt. H. C. Syers and Mr. W. C. Michell. In addition there is a large collection of horns from Johore and Pahang, left to the Museum in 1903 by the late Dato Hole of Johore, and a very fine pair from Blimbing, Ulu Legeh, presented in 1896 by Mr. A. D. Machado. The largest of all, however, is a pair of horns from Ulu Pahang, presented in 1898 by Mr. H. Bertrand Roberts. These horns measure, along the outside curve, $28\frac{3}{4}$ and $28\frac{1}{2}$ inches respectively, and $18\frac{1}{2}$ inches in circumference at the base.—The Seladang has a wide range, though it is confined to the mainland of S. E. Asia, from the South of India to the N. E. Himalayas, Assam, Burma and the Malay Peninsula. It does not occur on any of the islands.

The Banting or Javan Ox, in Borneo also known as the Tembadau, (*Bos sondaicus*) has a more eastern distribution than the Seladang, occurring in Burma, the Malay Peninsula, Java, Bali and Borneo. Strangely enough it has not yet been recorded from Sumatra. It is a smaller animal than the Seladang and though closely allied to it, approaches the common ox. Its dorsal ridge is much less developed, and the general colour is reddish brown to black especially in old bulls with the exception of its white 'stockings' and a white patch on the buttocks. It is a less interesting, but more useful animal than the Seladang, big herds of domesticated bantings being kept in Java and Bali and thence exported to Singapore and other places.—The Museum possesses a skull with horns from Borneo, presented in 1897 by Mr. J. E. V. Morton, R.N.

The Water-Buffalo or Kerbau (*Bos bubalus*) is really a native of India, and the wild buffaloes which occur in Burma, Siam, the Malay Peninsula, Sumatra, Java and Borneo, are probably descendants of domesticated individuals. Its horns are triangular in section and reach huge dimensions, with enormous sweeps, a pair of horns in the Raffles Museum, presumably from Siam, purchased last year (1907) measuring

56¾ and 54½ inches respectively, and from tip to tip, in a straight line, 58½ inches. However, the British Museum possesses a pair each horn of which measures above 77 inches.

The Anoa (*Bos depressicornis*) is the smallest of the oxen. A bull, a cow and a skeleton are exhibited, two of which were presented by Mr. M. Loebell. It stands only about 25 inches high at the shoulder. Its horns are short (6½ inches in length), straight, and triangular in section. The Anoa is only found in Celebes.

The Serow or Goat-Antelope (*Nemorhaedus sumatrensis*), by the Malays called 'Kambing gerun' or 'Kambing utan,' resembles the goat in its general build, but the antelope in the cylindrical shape of its horns. It was first described from Sumatra by Marsden in his 'History of Sumatra,' 1st ed., 1783, p. 93. It stands about three feet at the shoulder which means an enormous beast for a goat, and has long, coarse and shaggy hair. The horns are black and about 6 inches in length. Regarding its colour Marsden says that "over the shoulder was a large spreading tuft of greyish hair: the rest of the hair black throughout." The serow occurs on the Malay Peninsula too, especially on the difficult accessible limestone hills in Perak. A. L. Butler (P.Z.S. 1900, p. 675) describes the peninsular serow as a new species (*N. steettenhami*), as differing from the Sumatran form "in its jet-black legs, the limbs in that species being always tan to rufous." However, as Marsden distinctly states that the Sumatran form is "black throughout," there seems no need for this new specific name.—There are two pairs of horns in the Museum, one of them from Tanjong Rambutan, Perak, and the other from Chankat Mandai, Ulu Kinta, both presented by Mr. E. M. Schwabe in 1905.

The Deer tribe is on the Malay Peninsula represented by the Sambar, the 'Rusa' of the Malays. This unfortunate animal has received quite a number of specific names, *Cervus unicolor*, *C. equinus*, *C. aristotelis*, *Rusa equina*, etc. Lydekker who calls it *Cervus unicolor equinus* regards it as a local race of the typical Indian Sambar (*C. unicolor*) from which it differs by its darker colour, its more bushy tail, and shorter and thicker antlers. However, the Malay Sambar does perhaps not quite attain the size of the Indian Sambar which is the largest of Indian deer. It has simple antlers, usually with three tines only which may reach a length of 30 inches. The largest one in the Museum measures 29 inches. Besides a great number of antlers several mounted specimens from the Malay Peninsula are exhibited, also a specimen from Singapore island, shot and

presented by Mr. Ridley in 1891. The Malay Sambar ranges from Assam, Burma and the Malay Peninsula to Sumatra and Borneo. How far *C. hippelaphus*, from Java, *C. brookei*, from Borneo, and the several species which are described from the Philippines, differ from it, is a difficult question to decide.

Very much different is the Thamin (*Cervus eldi*) with its bow-shaped antlers, from Burma and Siam. Several pairs of antlers are exhibited, one of them from Lower Burma, presented by Mr. C. Landsberg in 1897, and one from Siam, presented by Mr. H. P. Kaka in 1905.

A very pretty beast is the Muntjac or Barking Deer, *Cervulus muntjac*, the Kijang of the Malays. Its English name is due to its hoarse and bark-like cry. It is a small deer, only about 20 to 22 inches in height, with a fur of a beautiful deep chestnut colour and short and two-pointed antlers which rest on long and slender bony stalks. The males have long tusks in the upper jaw. It is widely distributed from India, Burma, Indo-China and the Malay Peninsula to Sumatra, Java and Borneo. There is a stuffed doe in the Museum, and two skeletons, buck and doe.

The Mouse-deer or Chevrotains are the smallest of hoofed mammals. They differ from the true deer by having no antlers and by possessing four complete digits in each foot, of which the two middle ones, however, are much the larger ones. They resemble the Musk-deer of the Himalayas by the presence of upper tusks which especially in the male may be of considerable length.—There are two well-established species of this Mouse-deer in the Malay region, whilst a few dozen of local races have in recent years been described from the smaller islands round about here. The larger of those two is the 'Napu' of the Malays, *Tragulus napu*, of smoky-grey colour. The skeleton shows the above-mentioned tusks well, they are quite 1½ inches in length. Somewhat smaller is the 'Kanchil' or 'Petandok' of the Malays (*Tragulus javanicus*), the 'Brer Rabbit' of Malay folk-jore, of greyish rufous colour. These two species have much the same geographical distribution, Indo-China, Tenasserim, the Malay Peninsula, Sumatra, Java and Borneo.

The Malayan Pigs may be classed into three groups. The first group includes the Indian Pig and the Banded Pig. The former (*Sus cristatus*, frequently miscalled *Sus indicus*), the 'Babi utan' of the Malays, is the only wild pig of the Malay Peninsula and is still common enough on Singapore island. It also occurs all over India and Ceylon, but not in Sumatra, Java and Borneo. It is distinguished by a crest of long bristles

along the back. There is a specimen from Singapore island, shot and presented by Mr. W. T. Batten, in 1889. The young ones are marked by stripes along their sides, similarly as the young Tapir. Closely allied to it is the Banded Pig (*Sus vittatus*), with a white streak on either side of its face, occurring in Sumatra, Java, Borneo and the smaller neighbouring islands. The specimen exhibited is from Pulo Ungar, presented by Dr. Abbott in 1903. Neither of these two pigs has any warts on its face. The second group has its type in the Bearded Pig (*Sus barbatus*), from Sumatra and Borneo. It has a thick beard at the back of its chin and a substantial wart on either side of its face, the wart bearing a thick tuft of bristles. The skull is very much elongated. A stuffed specimen, a skeleton and several skulls from Baram, Borneo, all obtained through Dr. Charles Hose, are exhibited. Very similar to it is the 'Nang Oi' (*Sus oi*), of which a huge specimen is shown from Pulo Battam, an island to the South of Singapore. It was shot and presented by Mr. J. E. Romenij in 1905. The beard and the single wart on either side of its face are well marked.—The third group includes the Warted Pig (*Sus verrucosus*), from Java, of which varieties occur in Borneo, Celebes and the Philippines. It has three warts on either side of its face. Its skull is not specially elongated.

To show how the domestic Pig differs from the wild one, the skeleton of a Boar, English breed, is exhibited, which was presented in 1907 by Dr. Lim Boon Keng and Mr. Seah Eng Tiong, on behalf of the Singapore Planting Co. Its skull shows an entirely different configuration from that of the Bearded Pig which is placed alongside.

After the true Malay Pigs follows closely the Babirusa (*Babirusa alfarus*), peculiar to Celebes and Bura Island. The Malay name signifying 'Deer-Pig' is due to the upper tusks of the boar being enormously developed and being bent upwards and backwards. But a comparison of its skull with that of a typical pig (e.g. of the Bearded Pig) shows what little difference there really is between the two. Both have a bony protuberance on either side of the upper jaw from which the upper tusks spring. But whilst in the case of the pig the tusks are directed downwards and forwards (see pl. VI, fig. 3), they sweep upwards and backwards in the Babirusa. (see pl. VI, fig. 2). However, in the living Babirusa where the base of the tusk is hidden within the skin of the snout, there is the deceptive appearance of the tusks springing from the roof of the mouth.



FIG. 1.



FIG. 2.

FIG. 3.

Sim Boun Kweang Photo.

SKULLS OF (1) ORANG UTAN (*Simia satyrus*);
(2) BABIRUSA (*Babirusa affinis*);
(3) BEARDED PIG (*Sus barbatus*).



Sim Boon Keong Photo.

THE INDIAN WHALE (*Balaenoptera indica*).

DUYONGS (*Sirenia*).

There are three kinds of aquatic mammals, (1) the Seals, (2) the Sirenia, including Manatis and Duyongs, and (3) the Cetacea, including Whales, Porpoises and Dolphins.

The Seals are closely allied to the Carnivora. None of them occur in tropical waters. The Sirenia are quite different beasts. They are herbivorous and feed on seaweed, and their teeth and inner organisation show some affinity to the Pachyderms. Their front-limbs have become paddle-like, whilst the hind-limbs have disappeared altogether. They are the 'mermaids' of fairy tales. There are two kinds of these mermaids, the Manatis and the Duyongs. The Manati is restricted to the two sides of the Atlantic, *i.e.* the coast of S. America and to W. Africa. But the Duyong (less correctly called Dugong) (*Halicornes duyong*) occurs along the shores of eastern tropical seas, from the East coast of Africa to Australia. Its skin is bare, except for a few thinly scattered hairs, and it has no traces of claws or nails. It occasionally attains a length of nine feet. The Museum possesses stuffed and skeletonized specimens. The skeleton was prepared from a specimen caught in North Bornean Waters in 1895 and presented by Capt. J. Kramer. The animal was for a few weeks kept alive in a tank of seawater and exhibited in the hall of the Museum. The Northern Sea-Cow which, used to reach a length of 20 to 30 feet and became extinct about the year 1768, was a near ally of the Duyong.

WHALES, PORPOISES, DOLPHINS

(*Cetacea*).

The Cetacea comprise Whales, Porpoises and Dolphins. No Right Whales have so far been recorded from Indian seas, but two Fin-Whales occur there, two Sperm-Whales, and about fifteen species of Porpoises and Dolphins.

The Museum possesses the skeleton of the Great Indian Fin-Whale or Ikan paus (*Balaenoptera indica*) (see pl. VII). This whale was left stranded at a place called Sabatu, about 18 miles to the south of Malacca town, on June 19, 1892. A pagar was built around it to prevent its getting back at high tide, and the poor beast took a week to die, making a great noise for three days. Its voice was said to have resembled that of a bull. Nothing was done with the blubber, but the Hon'ble D. F. A. Hervey, Resident Councillor of Malacca at

that time, caused the skeleton to be prepared and to be conveyed to Singapore. Owing to lack of space it could only be mounted last year (1907), after the new building had been opened. The skeleton measures 42 feet. So it is apparently not that of a full-grown specimen, as this species is stated to attain a length of 80 to 90 feet, *i.e.* the size of the *Balaenoptera sibbaldi* of northern seas, the largest of all known animals, living or extinct.—Fin whales are not much hunted, as they yield only little blubber and their whale bone is of an inferior quality.

The Toothed Whales are represented in the collection only by a pair of lower jaw bones of the Cachalot or Sperm Whale (*Physeter macrocephalus*), measuring a little over ten feet in length. They were recently (April 1908) presented by Captain A. Fyfe, of the Sailors' Home. The Sperm Whale is met with in almost all tropical and subtropical seas, and full-grown males are said to reach sixty feet in length.

Of porpoises (Malay name 'Lomba-lomba alor') the Museum has the larger Indian Porpoise (*Orcella brevirostris*) which ranges from the Bay of Bengal to N. Bornean waters and ascends tidal rivers; and the little Indian Porpoise (*Neomeris phocaenoides*), ranging from the Cape of Good Hope through the Indian Ocean and Malay Archipelago to Japan.

Of Dolphins one species is exhibited, the Common Dolphin or Lomba-lomba sungei (*Delphinus delphis*). It seems to occur in all tropical and temperate seas.

EDENTATES (*Edentata*).

The Edentates are the lowest group of Malayan Mammals. They are represented by one species only, the Pangolin or Scaly Ant-eater, the 'Tenggiling' of the Malays (*Manis javanica*), ranging from Indo-China and the Malay Peninsula to Sumatra, Java, Borneo and Celebes. Several more species of this genus occur in other parts of Asia and in Africa, and the Armadillos, Sloths and Ant-eaters of South America belong to this order too. None of them have any front teeth, and only some of them have back teeth. The Scaly Ant-eater of Malaya is entirely toothless, but it has a long and narrow and sticky tongue with which it is able to secure the Termites or 'White Ants' out of their nests which it first has torn open with its powerful claws. The body is covered with large overlapping scales which give to the animal the appearance of a huge cone of the spruce-fir. (see pl. VIII, fig. 1.)



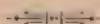
THE SCALY ANT-EATER (*Manis javanica*).



Sim Boon Kwang Photo.

YOUNG MALAY TAPIR (*Tapirus indicus*).

BIRDS.



The Raffles Museum possesses above 520 different species of Birds, which, according to the classification adopted by the British Museum, would have to be divided into 21 Orders and 67 Families. For the purposes of this popular 'Guide' such a classification would be too detailed. However, visitors who desire so, can obtain a printed check list of the Birds, classified as above indicated, at the Library Office. A simpler arrangement has here been adopted.

There is no visitor to the Museum who has not so much knowledge of the anatomy of birds, as not to know that the great majority of them possesses a 'lucky bone' and a sort of keel to their breastbone, as seen in any fowl which comes to the table. The 'lucky bone' or furcula, corresponds to the two collar bones of the human body, fused together, and both the furcula and the keel of the breastbone serve for the attachment of the muscles of flight. A few birds have lost the power of flight, and in them those two bones, together with the muscles of flight and the organs of flight, i. e. the wings, are absent or almost so. In their place the legs, and consequently the power of running, are enormously developed. These are the Ostriches (Africa), the Rheas (S. America), the Cassowaries and Emeus (Australia and neighbouring islands), and the Kiwis or Apteryx (New Zealand). None of these 'Running Birds' or 'Cursores' occur in the Malay region. However, the Cassowary (both stuffed and skeletonized) is exhibited, and the visitor is advised to compare its skeleton with that of any other bird, say, that of the Flamingo.

The remaining birds are comprised under the name Carinatae, because they have a keel (carina) to their breastbone. They may be divided into seven Orders.

Gallinaceae : Game Birds or Pheasants.

Columbinae : Pigeons.

Natatores : Swimming Birds.

Grallatores : Wading Birds.

Scansores : Scansorial (climbing) Birds.

Passeres : Perching Birds.

Raptatores : Birds of Prey.

GAME BIRDS OR PHEASANTS.

The most familiar looking of the Pheasants is no doubt the Jungle Fowl (*Gallus gallus* or *G. ferrugineus*), the species which is generally regarded as the ancestor of the domestic fowl. It occurs all over India, the Malay Peninsula and the Indo-Malayan islands. It is called Ayam beroga or A. denak or A. hutan in Malay. But the most gorgeous member of the group is the Burmese Pea Fowl or Burong merak (*Pavo muticus*), ranging from Indo-China through the Malay Peninsula to Java. Its plumage is even more brilliant than that of the common Pea Fowl of India (*Pavo cristatus*) and differs from it by the structure of its crest and by its neck being dark green, that of the Indian one being blue. The tail of these birds is, in the males, entirely hidden by the enormously developed upper tail-coverts, which form the 'train.' Wallace found the Peacock abundant at a place called Wonosalem in Java, and described its flesh as 'tender, white and delicate, and similar to that of a Turkey.'

It is curious that the Peacock is not found in Borneo and Sumatra, but at least Sumatra (together with the Malay Peninsula), may pride itself on possessing a bird which stands not far behind in grace and stateliness, viz. the Argus Pheasant or Kuwang raya (*Argusianus argus*). The chief beauty of the male lies in the wings, the secondary quills of which are enormously developed and are adorned with rows of large 'eyes.' Two beautiful specimens are exhibited, one from the Dindings, presented by Mr. R. J. Wilkinson in 1902, and one from Indragiri, Sumatra, presented by Mr. J. E. Romenij in 1905. (see pl. IX, fig. 2). In Borneo a somewhat smaller Argus Pheasant (*Argusianus grayi*) occurs.

We cannot do much more than glance at the other members of the Pheasant tribe, at the wonderful Fire-backed Pheasants or Ayam pegar of the Malay Peninsula, Sumatra and Borneo, viz. the crestless *Acomus pyronotus*, occurring in Borneo; the crested *Lophura rufa*, from the mainland and Sumatra, and Bulwer's Wattled Pheasant (*Lophophaps bulweri*) from Borneo, the head of which is almost naked and is ornamented with three pairs of blue wattles. Smaller and more soberly coloured members of the same group are the Partridges, the Red-crested one, Burong siul or chichit (*Rollulus roulroul*) and the Black



THE BOOBY (*Sula sula*) ON CHRISTMAS ISLAND.



R. Hanitsch Photo.

THE ARGUS PHEASANT (*Argusianus argo*).

Wood Partridge or Burong bertam (*Melanoperdix nigra*), and finally the Hill Partridges (*Tropicoperdix chloropus* and *T. charltoni*). Also several game birds from the Himalayas are exhibited, which may be of interest to the sportsman.

PIGEONS.

The Pigeons are abundant, too, in the Malay region, two of the prettiest species, the Malay Spotted Dove or Burong tekukur (*Turtur tigrinus*) and the smaller Barred Ground Dove or Burong merbok (*Geopelia striata*) being a common sight even in the midst of Singapore town. The Malays have an unfortunate liking for these birds, and are constantly seen to catch them with birdlime. The Green Pigeon or B.* punai (*Osmotreron vernans*) and the Bronze Ground Dove or Punai tanah (*Chalcophaps aenea*) are also common on Singapore island. Well-known too is the Nutmeg or Pied Fruit Pigeon (*Myristicivora bicolor*), the B. rawa of the Malays. It is of creamy white colour, except for the wings and the tip of the tail, which are black. Very handsome birds are the Pink-breasted Pigeon, Punai gading or Punai jambu (*Ptilopus jambu*), from the Malay Peninsula, and the 'Pigeon with the bleeding heart' (*Phlogoenas luzonica*), from the Philippines.

The larger pigeons are called 'Pergam' by the Malays. Two of them should be noticed, the Green Imperial Pigeon (*Carpophaga aenea*), which is widely distributed over India, the Malay Peninsula and Archipelago, and the Christmas Island Pigeon (*Carpophaga whartoni*). The Nicobar Pigeon (*Caloenas nicobarica*), with its metallic plumage, differing from all other pigeons by the long and narrow feathers of its neck which resemble the hackles of a game cock, forms a sub-family by itself. It is not at all restricted to the Nicobar Islands, as its name might imply, but ranges from there through the Malay Archipelago as far as the Bismarck Archipelago. Exceeding all these species greatly in size is the Crowned Pigeon from the Moluccas (*Goura coronata*).

SWIMMING BIRDS.

This order includes the Ducks and Geese; Gulls and Terns; the Cormorants, Gannets, Frigate Birds, Tropic Birds and Pelicans.

* 'B' stands here and in the following pages as abbreviation for the Malay word 'Burong' (i.e. bird.)

The little Cotton Teal or Goose-Teal or Itek ayer (*Nettopus coromandelianus*) occurs on Singapore Island and has been observed in the Botanic Gardens. Of the Whistling Teal or B. belibis (*Dendrocygna javanica*) a specimen from Pahang is exhibited. Of the Gulls and Terns the Common Noddy (*Anous stolidus*) is one of the most widely distributed tropical species. Specimens from Christmas Island are exhibited. From Christmas Island, too, are the two kinds of Gannet or Booby, which are exhibited. *Sula sula* and *S. piscatrix*. Plate IX. shows a photograph of a Booby in its natural haunt on Christmas Island. A common sight on that island is the chasing of the Boobies on their return from the fishing grounds by the Frigate Birds. They are worried by the latter until they are exhausted and disgorge the fish they have swallowed, and these unsavoury morsels are then at once caught by the Frigate Birds. The Frigate Birds are, next to the Pigeons, a much esteemed article of diet on Christmas Island. The most beautiful bird belonging to this group is the Yellow Tropic Bird or Boatswain Bird (*Phaethon fulvus*) of which several specimens from Christmas Island of different ages and different plumage are exhibited (see pl. X.) Of Pelicans, 'Burong undan,' two species occur in these parts, *Pelecanus roseus* and *P. philippensis*. Only the former is exhibited. The pouch, which hangs down from below the enormous beak, serves for storing fish from which they feed their young.

WADING BIRDS.

To this order belong the Storks, Herons and Bitterns; the Rails; the Snipes, Sandpipers and Plovers.

There are not many Storks here. Of the two species exhibited, one, the White-necked Stork (*Dissoura episcopus*), obtained in Pahang, has a wide distribution, from Tropical Africa to India, the Malay Peninsula and Archipelago as far as Celebes. The so-called Smaller Adjutant (*Leptopilus javanicus*) ranges from India to the Malay Archipelago. With its scantily feathered head and bare neck, it is certainly the ugliest bird in the collection. The Malays have given it the little flattering name 'Burong babi'. But its lack of beauty is amply made up by the Herons, Burong ruak-ruak. Many of them have an ornamental plumage during the nesting season, and the plumes called 'ospreys', so valued as ornaments, are obtained chiefly from the 'dorsal train' of the Great White Heron (*Herodias alba*), ranging from Southern Europe to Burma, from the



Sam Hoon Eng, Photo.

THE YELLOW TROPIC BIRD OR BOATSWAIN BIRD (*Phaethon fulvus*).

Australian Plumed Egret (*Mesophoyx plumifera*) and the Little Egret (*Garzetta garzetta*). Only the last of these three species is exhibited. The Cattle Egret (*Bubulcus coromandus*), so called because it is often seen on the back of Cattle, where it makes itself useful by picking up ticks, is remarkable through the change in its plumage. It is white in the winter and buff-coloured in the summer. Its Malay name is B. bangan. Other well-known species are the Purple Heron (*Phrherodius manillensis*), the Common Heron (*Ardea cinerea*), ranging over the whole of the Old World with the exception of the extreme north of Europe and Asia, and the Dusky Grey Heron (*Ardea sumatrana*).

The Bitterns (Malay name 'Puchong'), of which several species occur here, have the remarkable power of concealing themselves by assuming an upright attitude, holding the bill up vertically, and thus resembling the reeds and other water plants amongst which they live. We may mention the Little Green Bittern (*Butorides javanica*), the Chestnut Bittern (*Ardetta cinnamomea*), and the Yellow-necked Bittern (*Dupetor flavicollis*), all three from Singapore island. In December, 1907, Mr. Rowland Allen shot a very fine specimen of the Common Bittern (*Botaurus stellaris*) at the Perseverance Estate, Singapore. This beautiful bird is known from temperate Europe and Asia, visiting N. Africa, N. W. India and Burma, but had apparently previously not been taken so far south as Singapore. None of the other Bitterns are migratory.

Of Rails (Malay name 'Ayam-ayam') there are six species from Singapore in the collection. Three of them, the Blue-breasted Rail (*Hypotaenidia striata*), the White-breasted Water Hen (*Amaurornis phoenicurus*) and the Water Cock (*Gallixrex cinerea*) occur even in the Botanic Gardens.

The true Snipes and Woodcocks are cosmopolitan, with mottled plumage, to make the bird inconspicuous amidst its surroundings, and with long, flexible and sensitive bill. The Common Snipe or B. berkek (*Gallinago gallinago*) is found all over N. Europe and Asia, migrating in the winter as far as N. E. Africa, India, the Malay Peninsula and the Moluccas. A specimen from Bukit Timah is shown. The so-called Painted Snipe or B. meragi (*Rostratula capensis*), of which a specimen from Pahang is exhibited, is probably more closely allied to the Sandpipers than to the true Snipe. Of the Sandpipers the most common form in Singapore is the Wood Sandpiper (*Rhyacophilus glareola*). However, it is here only as a visitor in the winter, its home being Europe and N. Asia. Migratory, too, is the Gold-

en Plover or B. chorling (*Charadrius dominicus* = *C. fulvus*), which spends the summer in the northern portions of Europe, Asia and America, and goes far south during the winter. Here may be added the beautiful Water-Pheasant (*Hydrophasis chirurgus*), of which a group from Pahang is exhibited, and the Stone Plover (*Esacus magnirostris*), of which a specimen from the Mergui Archipelago, presented by Mr. C. B. Kloss, is shown.

SCANSORIAL OR CLIMBING BIRDS.

This order is extremely artificial, and includes widely divergent forms like the Parrots, Cuckoos, Woodpeckers, Barbets, and Hornbills, resembling each other only in the structure of their feet, which are adapted to climbing. The first four of these families agree at least in so far as their first and fourth toes are turned backwards, and their second and third toes forwards (so-called zygodactylous feet). In the Hornbills, however, only the first toe is directed backwards. The other three are turned forwards and are partially united.

The Parrots are found in the tropical parts of the whole world, extending to the south even beyond the tropics to 55° lat. There are about 500 species, America, and especially Brazil, being richest in them. They fly often only indifferently well, and are clumsy on the ground, but excel in climbing, using feet and beak. For this reason, and on account of their intelligence, they have been called the monkeys of the feathered world. And the way they perch with one foot whilst with the other foot holding up a dainty morsel when eating, certainly reminds one of the monkeys. Parrots are easily tamed and taught to imitate the human voice. They have been valued from antiquity, and the ladies of ancient Rome kept them in cages, prizing them often more than their slaves. They live on fruit and seeds, and have powerful and curved beaks, which are higher than they are long.

Only five species of Parrots (*Burong nuri*) occur in the Malay region proper (Malay Peninsula, Sumatra and Borneo), and curiously enough none have yet been recorded from Java. They are much more numerous in the Philippines, Celebes, the Moluccas and New Guinea. The purely Malayan species are:—

(1) The Blue-crowned Parroquet (*Tanygnathus salvadorii*), known only from the Mantanani Is., N. W. Borneo. Not in the collection.

(2) The long-tailed Malayan Parroquet or Bayan, (*Palaeornis longicauda*), from the Peninsula, Sumatra and

Borneo. A specimen is exhibited, with its wings spread out, to show its beautiful colours.

(3) The Malayan Parrot or Tanau (*Psittinus incertus*), from Tenasserim, the Peninsula, Sumatra and Borneo.

(4) The Indian Loriculet (*Loriculus vernalis*), from India, Burma and the Peninsula. Not in the collection.

(5) The Malayan Loriculet or Serindit (*Loriculus galgulus*), from the Malay Peninsula, Sumatra and Borneo. It has a red breast. These two last Loriculets are also called Love-birds, as the pairs are said to be specially fond of each other.

Of other Parrots exhibited the following should be noted : The Great Black Cockatoo (*Microglossus aterrimus*), from New Guinea, the biggest of all Parrots. The Rose-crested Cockatoo (*Cacatua moluccensis*), confined to Ceram and Amboyna, with a beautiful vermilion crest. This specimen had been many years in the Botanic Gardens, was acquired by Mr. Down when the living collection was broken up, and subsequently presented by him to the Museum. A striking bird is Pesquet's Parrot (*Dasyptilus pesqueti*), of which a specimen from the Astrolabe Mountains, New Guinea, was presented by Mr. A. Lousenmeyer in 1906. It is of large size, with black and red plumage.

Of the Cuckoos the best-known at least through its voice is a little grey species, the Rufous-bellied Cuckoo or Tinggal anak (*Cacomantis merulinus*), also called the Brain-fever Bird from its incessant and wearying song. The Black Fork-tailed Cuckoo (*Surniculus lugubris*), the Red-winged crested Cuckoo or B. selayur jambul (*Coccytes coromandus*), and the Caucau or B. bubut, also called Crow Pheasant (*Centropus bengalensis*), brown with numerous black cross bars, also occur on Singapore island.

After the Cuckoos with their sober plumage we come to a very gay coloured family, the Barbets. They are found within the Tropics both of the Old and the New World, are small, rather heavily built and have stout beaks, with a fringe of black bristles at the base of the beaks. Their general Malay name is B. pekaka hutan or B. pekaka rimba. The brightest of the Malay Barbets is perhaps *Chloroceryle versicolor*, B. takur, from Borneo; its body is green, but has patches of red, blue, black and yellow along head and neck. Another beautiful Barbet is *Psilopogon pyrolophus*, from the mountains in Perak; its body is grass green; behind and below the angle of the jaw it has a large grey patch; the neck is adorned with a yellow and black band, and the nasal bristles are black tipped with scarlet.

Most of the Woodpeckers, 'Belatok,' have a bright plumage too. They range over all the tropical and temperate

parts of the World, with the exception of Australia, Polynesia and Madagascar. They have strong and wedge-shaped bills the tip of which is chisel-like, and powerful muscles of the neck to enable them to cut away the bark of trees when looking for insects. Their tongue is long and worm-like, sticky at the end, supported by remarkably developed tongue-bones and muscles so that the tongue can be shot out and withdrawn at will. The brightest coloured Malay woodpecker is perhaps Hume's Yellow-naped Woodpecker (*Chrysophlegma humii*), olive green above, with red wings and a yellow crest. Some of the largest species are the Great Slaty Woodpecker, Belatok besar (*Hemilophus pulverulentus*) and the Malay Black Woodpecker or Belatok pungur (*Thripanax javensis*), black, with a red crest; one of the smallest species is the Burmese Pigmy Woodpecker (*Lyngipicus canicapillus*), olive brown, with numerous white transverse bars.

The Hornbills are without doubt the most extraordinary looking of all birds, their enormous beaks, generally surmounted by large curiously shaped casques, giving them a ludicrous top-heavy appearance. However, their clumsiness is more apparent than real, as with one exception the bill and casque consist internally merely of a cellular bony tissue. They range over Africa, India, Malaya, Celebes and New Guinea as far as the Solomon islands. One group, the Ground Hornbills, is restricted to Africa; a second group, the Solid-casqued Hornbills, is found in Malaya only, whilst a third group, the Hollow-billed Hornbills, which comprises by far the most species, ranges over all the countries mentioned above. The second and the third groups are arboreal.

To begin with the last group: the most common species is the Rhinoceros Hornbill or Enggang (*Buceros rhinoceros*) which has its popular name from its curiously shaped casque which is turned up in front (see pl. XI, fig. 2.). In the Two-horned Hornbill (*Dichoceros bicornis*) which is the largest of all Hornbills, the casque has a more or less flat and oblong platform on top, ending in front in two obtuse corners. In the Wrinkled-casqued Hornbill (*Cranorhinus corrugatus*) and the Malay Wreathed Hornbill (*Rhytidoceros undulatus*), bill and casque are corrugated at their base.

Of the Solid-billed Hornbills there is only a single species, the B. tebang mertua or B. tebang rumah mentuwa (*Rhinoptax vigil*). This bird is much sought after by the Chinese, as the substance of its solid beak and casque resembles ivory in consistency and can similarly be carved. This Hornbill is also



THE RHINOCEROS HORNBILL (*Buceros rhinoceros*).



THE FISH OWL (*Ketupa ketupu*).

remarkable for its bare neck and the great length of the two central tail feathers.

The breeding habits of the Hornbills, first described by Col. Tickell in 1855, are, if anything, still more extraordinary than their external appearance. When the female has laid her eggs in the hollow of a tree, and begins to incubate, the male closes up the hole with clay leaving only an opening sufficiently large to be able to feed his mate. This, no doubt, is done as a protection against enemies. That the nests must be inconceivably filthy by the time the young ones are ready to leave them, goes without saying.

PERCHING BIRDS.

The Perching Birds or *Passeres* (i.e. Sparrow-like Birds) are a large and extremely unwieldy order. No less than 257 out of 520 species, i.e. almost exactly one half of the birds in the Raffles Museum, belong to this order. It is almost impossible to give an exact definition of them. They are generally birds of small size, with feet adapted for perching, i.e. having three toes directed forwards and one backwards. Most of them also agree in the structure of the skull and in the arrangement of the tendons of the feet. All song birds belong to this order, though by no means all members of the order have the power of singing.

Leaving out a few small and little important groups, we divide the Perching Birds into the following 28 families :

- | | |
|---|---|
| <i>Alcedinidae</i> : Kingfishers | <i>Timeliidae</i> : Babblers. |
| <i>Meropidae</i> : Bee-Eaters. | <i>Turdidae</i> : Thrushes. |
| <i>Coraciidae</i> : Rollers. | <i>Sylviidae</i> : Warblers. |
| <i>Podargidae</i> : Frogmouths. | <i>Laniidae</i> : Shrikes. |
| <i>Caprimulgidae</i> : Nightjars or
Goatsuckers. | <i>Corvidae</i> : Crows. |
| <i>Cypselidae</i> : Swifts. | <i>Paradiseidae</i> : Birds of
Paradise. |
| <i>Trogonidae</i> : Trogons. | <i>Oriolidae</i> : Orioles. |
| <i>Eurylaemidae</i> : Broadbills. | <i>Dicruridae</i> : King Crows or
Drongos. |
| <i>Pittidae</i> : Pittas or Ant-
Thrushes. | <i>Zosteropidae</i> : White-eyes. |
| <i>Hirundinidae</i> : Swallows. | <i>Nectariniidae</i> : Sunbirds. |
| <i>Motacillidae</i> : Wagtails. | <i>Dicaeidae</i> : Flower Peckers. |
| <i>Muscicapidae</i> : Flycatchers. | <i>Fringillidae</i> : Finches. |
| <i>Campophagidae</i> : Cuckoo-
Shrikes. | <i>Ploceidae</i> : Weaver Birds |
| <i>Pycnonotidae</i> : Bulbuls. | <i>Sturnidae</i> : Starlings. |

KINGFISHERS.

The Kingfishers (Malay name 'Rajah udang') are cosmopolitan, but no part of the world contains so many species as the Malay Archipelago. There are two sub-families of them, the fish-eating species, with a long narrow bill, and the insect and reptile eating ones, with a stouter and wider bill.

There are only a few fish-eating species. The common Kingfisher or Raja udang kecil (*Alcedo ispida*) has a wide distribution, over Europe, Northern Asia, India, China and Malaya. The Malayan Blue Kingfisher or Binti binti (*Alcedo meninting*) is of a brilliant deep blue colour. Much larger is the Malay Stork-billed Kingfisher or Pekaka (*Pelargopsis malaccensis*) which has its English name from its enormous red bill.

The second group of Kingfishers contains many more species. Many of them belong to the genus *Halcyon* and are distinguished by their brilliant plumage, in which green and blue predominate, like the White-collared Kingfisher (*H. chloris*), the White-breasted Kingfisher (*H. smyrnensis*), and the Black-capped Kingfisher (*H. pileatus*). Smaller are the Banded Kingfisher or Kengkeng rimba (*Carcineudes pulchellus*), and the Three-toed Kingfisher (*Ceyx tridactyla*).

BEE-EATERS.

The Bee-Eaters, or Birik birik, are restricted to the temperate and tropical parts of the Old World. They are of a brilliant plumage, in which green predominates, and have a long and curved bill. Their food consists of Insects, which they catch on the wing. They breed usually in long tunnels, which they build in sandy banks along rivers. The most common one in Singapore is the Bay-backed Bee-Eater (*Merops sumatranus*). The largest is the Red-bearded Bee-Eater (*Nyctiornis amicta*).

ROLLERS.

The Rollers have their name from their curious flight, in which they indulge chiefly during the breeding season. The Broad-billed Roller or Tiong batu (*Eurystomus orientalis*) may serve as an example of the group. Its plumage is blackish brown on head and neck, and dull green, passing into blue, on back and wings. In the midst of the blue of the wings there is a large sea-green spot.

FROGMOUTHS.

The Frogmouths are called thus from their enormously wide and gaping mouth. They resemble the Nightjars in their mottled and vermiculated plumage. A species from the Philippines is exhibited (*Batrachostomus stellatus*).

NIGHTJARS OR GOATSUCKERS.

The Nightjars or Goatsuckers are nocturnal birds, resembling Owls in their habits and plumage. They live on insects. The Malay Nightjar or B. *tukan kayu* or Segan (*Caprimulgus macrurus*) is common in the compounds in the midst of Singapore, and its cry of Tock-tock-tock, resembling the sound produced by chipping wood, is familiar to everyone. The Eared Nightjar or Tabau tabau (*Lyncornis temmincki*) differs from it by having tufts of feathers above the eyes.

SWIFTS.

The Swifts are thus called because they are probably the swiftest of all birds. They resemble Swallows so much in their outer appearance that the Malays have only one name 'Barong layang layang' for both. They have short and wide beaks.

The Malay House Swift (*Cypselus subforcatus*) lives near and in human habitations, and the Palm Swift (*Tachyornis infumatus*) builds its nest on the underside of the leaves of the Fan palm. Larger are the Spiny-tailed Swifts. They are distinguished by the rigid shafts of the tail feathers the ends of which project beyond the web. This is well seen in the Brown-necked Spine-tail (*Chaetura indica*). Of economic importance are the various species of Swiftlets (*Collocalia*). Their nests are composed of the dried secretions of the salivary glands, these glands being in both sexes specially developed during the breeding season. These are the edible birds nests so much esteemed by the Chinese. The nests are cup-shaped and are found in caves and cliffs chiefly along the sea coast. They are of whitish colour, resembling isinglass. The best nests, i.e. those least mixed with foreign substances, are those of the Little Grey-rumped Swiftlet (*Collocalia francica*), and next in value come perhaps those of the Indian Edible-nest Swiftlet (*C. fuciphaga*), although its nests always contain some extraneous matter like grass and feathers. Unfortunately neither of these birds is in the collection. Exhibited are Hume's Swiftlet (*C. innominata*) and Horsfield's Swiftlet (*C. linchi*), from the Perak hills, and *C. natalis*, from Christmas Island.

Of what economic importance these Birds' nests are is shown by the fact that in the year 1907 nests to the total value of \$622,677 were imported to Singapore, Borneo (B. N. Borneo, Sarawak and Dutch Borneo) contributing \$238,157, Java \$235,110, Sengora \$50,900, Siam Proper \$32,750, Sumatra \$22,946, etc.; whilst the exports to Hongkong amounted to \$511,612 and to China to \$317,351.

TROGONS.

The Trogons (Malay name 'Kasumba') are found in the tropical forests both of the Old and the New World. Their plumage is peculiarly soft and of bright colouring. Their first and second toes are directed backwards. Three of the species exhibited resemble each other, viz. the Fork-tailed Trogon (*Pyrotrogon diardi* - *Harpactes diardi*), the Red-backed Trogon (*P. duvauceli*), and *P. kasumba*, which are brown above, red below, and black along neck and upper breast, whilst in two species (*P. orescius* and *P. dulitensis*) the red of the underside is replaced by orange.

BROADBILLS.

The Broadbills are restricted to the Indo-Malayan region. They are small and gaily coloured birds, with broad and flat bills. The most beautiful of them is the 'B. pachut' (*Calyptomena viridis*), from Pahang, of velvety green colour and black bars across its wings. It is stated to live on fruit, whilst the other members of the group prefer insects. Other handsome species are the Yellow-backed Broadbill or Tadah hujan rimba (*Eurylaemus javanicus*) and the Black and Red Broadbill or B. hujan (*Cymborhynchus macrorhynchus*), with a specially large bill.

PITTAS OR ANT-THRUSHES.

The Pittas or Ant-Thrushes are another family of birds which excel through their brilliant plumage. Most of them are found in the Oriental and Australian regions, and only a few in Africa. They generally live in dense jungle, hopping along the ground, and are therefore also known as Ground-Thrushes. Their food consists of insects, snails and such like. The most common Singapore species is the Blue-winged Pitta or Rimba kampong (*Pitta cyanoptera*). But the most beautiful Malay kind is Van der Bosch's Pitta (*Eucichla boschi*). It is distinguished by its brilliant orange occiput and the purple abdomen, crossed by bars of reddish brown. Its Malay name is Mertua plandok rimba, a name used for most other Pittas as well.

SWALLOWS.

The Swallows are but poorly represented in Malaya, and only one species (*Hirundo budia*) is in the collection. They are known by the same name in Malay as the Swifts, viz. Burong layang layang.

WAGTAILS.

The Wagtails are almost entirely confined to the Old World. They are graceful and active little birds, living chiefly on the ground, preferring the neighbourhood of shallow streams. The Grey Wagtail or B. kendidi (*Motacilla melanope*), visiting here during the winter months, is bluish grey above and bright yellow below. It is frequently seen in compounds even at some distance from water. The Forest Wagtail or Kendidi rimba (*Limnodromus indicus*) is dull olive green above, but its wings are black with two broad white bands.

FLY-CATCHERS.

The Flycatchers include a variety of insect-eating birds of the Old World. They have flattened beaks and a number of hairs between forehead and nostrils. Some of them are only plain and uninteresting looking, but others, like the Burmese Paradise Flycatcher (*Terpsiphone affinis*), with its metallic black and snowy white plumage and its long and graceful tail feathers, reminds one of the Birds of Paradise (see pl. XII, fig. 2.) Other handsome birds are the Large Fairy Blue-Chat (*Niltava grandis*) and the somewhat smaller Tickell's Blue Flycatcher (*Cyornis elegans*).

CUCKOO-SHRIKES.

The Cuckoo-Shrikes are confined to the Old World. They have their name from the resemblance which some of its members bear to the Cuckoos, in shape and size, in the form of the beak, and in plumage, as e.g. the Sumatran Cuckoo-Shrike (*Artamides sumatrensis*). Others, however, are brilliantly coloured, like the Indian Scarlet Minivet (*Pericructus speciosus*) with its black and scarlet plumage.

BULBULS.

The Bulbuls, ranging from Africa to India and Malaya, include some of the most common Malayan Birds, some of sober, but others of very bright plumage. The Yellow-vented Bulbul or B. merbah (*Pycnonotus analis*), is not likely to be absent from any compound in Singapore, especially when the fruits of

the Beringin on Waringin tree (*Ficus benjamina*) are in season. It is of brown colour generally, but its under tail coverts are sulphur yellow. Brighter colours we find in the Green Bulbul or B. daun (*Chloropsis zosterops*), in the Gold-fronted Green Bulbul (*Chloropsis aurifrons*), which is so frequently kept as a cage-bird, and especially in the beautiful Malayan Fairy Blue Bird or Murai gajah (*Irena cyanca*). A very pretty bird is the small Red-whiskered Bulbul (*Otocompsa emeria*=*O. jacosa*), of brownish colour with a tuft of crimson feathers just behind the eye. It has a sweet song and is a favourite cage-bird.

BABLERS.

The Babblers range from Africa through Southern Asia and China to Australia. We mention only a few birds of this large group. The Black-gorgeted Laughing Thrush (*Garrulax pectoralis*), is a big and handsome bird. It is olive brown in colour, with a white throat and a broad black band descending from the sides of the head to the breast. Much smaller is Abbott's Thrush-Babbler (*Turdinus abbotti*), of olive brown colour. The Silver-eared Mesia (*Mesia argentauris*), ranging from the Himalayas to the Perak Hills, is so called on account of its silvery-white ear-coverts. With its varied plumage and the deep orange of chin and throat it is certainly the prettiest of the Babblers.

THRUSHES.

The Thrushes are a cosmopolitan group and include some of the finest songsters. A few of them feed on fruit, but the majority on worms and insects. The Black and White Robin, also called the Magpie Robin, the 'B. murai' of the Malays, (*Copsychus saularis*), is perhaps the best known of all Singapore birds. Both his appearance, hopping about on grassy plots, and his sweet song are familiar to every one. But the best songster is the Shama or Burmese Nightingale, called B. murai batu by the Malays, (*Cittocincla macrura*). Its general colour is black, the lower back being white and the abdomen chestnut. Its tail is long and is black above and white below. A very handsome Thrush is the Chestnut-backed Forktail (*Hydrocichla ruficapilla*). Its plumage is black and white, with the exception of the crown of the head and of the upper back, which are brown.

WARBLERS.

The Warblers are generally of small size and plain plumage, but they include some excellent songsters. They are Old



THE BURMESE PARADISE FLYCATCHER (*Terpsiphona affinis*).



THE GREEN MAGPIE (*Cissa robinsoni*).

World birds. Of special interest are the Red-headed Tailor Bird (*Orthotomus ruficeps*), and the Black-necked Tailor Bird (*O. atrigularis*), both called Pantat labu in Malay, who make pocket-shaped nests of leaves sewn together along the edges and lined with cotton or other soft material. Less common in Singapore is the Indian Tailor Bird (*Sutoria sutoria*).

SHRIKES OR BUTCHERBIRDS.

The Shrikes or Butcherbirds include a curious looking bird from Borneo, the Naked-headed Shrike (*Pityriasis gymnocephala*). Its head is bare, the skin being of a yellow colour; the plumage of throat and thighs is scarlet and of the rest of the body black.

CROWS.

The Crows are an almost cosmopolitan family and include the True Crows, the Magpies, Jays, Nutcrackers, Choughs and Tits. The Jungle Crow or B. gagak (*Corvus macrorhynchus*) is a rare visitor to Singapore island, but is more common further north. The Rufous Tree Pie (*Dendrocitta rufa*), of which a specimen from Burma, presented by Mr. Wilfrid Walker, is exhibited, is of chestnut colour, varied with black and white. A pretty little bird is the Black and Yellow Tit (*Parus sultaneus*). It is only about of the size of a Bulbul, and its plumage is black, with the exception of the crown of the head and the abdomen, which are golden yellow. The Burmese Jay (*Garrulus leucotis*) is a handsome bird. Its wings are barred with light blue, like those of the European Jay. But the most beautiful members of this family are two green Magpies, the *Cissa chinensis*, with its bluish green plumage, variegated with black, white and brown, of which a specimen from Burma, also presented by Mr. Walker, is shown, and the *Cissa robinsoni*, from the Selangor—Pahang border, with its grass green general plumage and bright chestnut wings. (see pl. XII, fig. I.)

BIRDS OF PARADISE.

No Birds of Paradise occur in the Malay region: they are restricted to New Guinea and the neighbouring islands, to the Moluccas, Aru Islands, and Australia. But they are exhibited because they are without question the most wonderful of all birds, and no Museum of the 'gorgeous East' would be complete without them. Close on 80 species are known so far. Most visitors to the Museum will be surprised to hear that the

nearest relatives of these beautiful birds are the Crows, which include some of the humblest members of the feathery tribe. For a detailed account of them see Wallace's classical work, 'The Malay Archipelago.'

The Birds of Paradise became known to Europeans first during Magellan's voyage in 1521, and for the next few centuries extraordinary stories were told about them, especially as for a long time the skins which reached Europe were without legs. So the 'Greater Bird of Paradise' was called '*Paradisea apoda*', i.e. the footless one. And in Magellan's Voyage (Hakluyt Society's Publications) we read that these birds "have no wings, but instead of them long feathers of different colours, like plumes;—they never fly, except when the wind blows. They told us that these birds come from the terrestrial Paradise, and they call them 'bolon dinata', that is divine birds."—Their general Malay name is Chenderawaseh or Burong dewata.

The most gorgeous Bird of Paradise in the collection is the 'Lesser Bird of Paradise' (*Paradisea jobiensis*), with masses of snow-white plumes springing from the sides of its breast. In the Red B. of P. (*Paradisea raggiana* and *P. sanguinea*) these plumes are red. Otherwise these three species are much alike, also with regard to the wire or riband-like shafts springing from their tails. Similar tail-shafts are seen in a smaller bird, the King Paradise Bird (*Cincinnurus regius*), where they end in a spiral disk. In other species such wires spring from the wings, as in the 12-wired B. of P. (*Seleucides nigricans*), and in others again from the head, as in the Six-plumed B. of P. (*Parotia sefilata* and *P. carolae*). In the Fern-plumed B. of P. (*Pteridophora alberti*) the plumes springing from the head resemble sprigs of fern, and this species may well be regarded as the most extraordinary of all Birds of Paradise. It is not mentioned in Wallace's 'Malay Archipelago,' as it was not known yet at the time. The Gorget B. of P. (*Astrapia nigra*) and the Long-tailed B. of P. (*Epimachus speciosus*) are distinguished by their enormous tails, whilst in others the feathers of the breast assume the shape of shields, as in the Superb B. of P. (*Lophorhina superba*). In Wallace's Standard Wing (*Semioptera wallacei*) we find a pair of long and narrow feathers springing from each wing, which are erectile and can be spread out when the bird is excited. The female Birds of Paradise are all plain coloured. Exhibited are those of the Scale-breasted B. of P. (*Ptiloris magnifica*) and of the 12-wired

B. of P. (*Seleucidés nigricans*). Both are chocolate above, and white, with black bars, below.

ORIOLES.

The Orioles are Old World birds too. Their plumage is generally a golden yellow and deep black, like that of the Golden Oriole of Europe, and very similar is that of the best known local representative of the group, of the Black-naped Oriole or B. kunyit kunyit (*Oriolus indicus*). But a species from the hills of the Malay Peninsula, *Oriolus consanguineus*, is black with a small crimson patch on the edge of either wing and a large one on its breast.

KING-CROWS OR DRONGOS.

The King-Crows or Drongos are crow-like birds, ranging from Africa through Southern Asia to Australia. They usually have black plumage and a strongly forked tail. The Larger Racket-tailed Drongo, the B. chechawi or B. hamba kera of the Malays (*Dissemurus paradisicus* = *D. platurus*) is frequently seen on Singapore island. It is a splendid songster and excels in imitating other birds.

WHITE-EYES.

The White-Eyes are small birds, called thus from a narrow ring of white feathers around the eyes. They are generally seen in flocks. *Zosterops natalis*, from Christmas Island, may serve as example.

SUNBIRDS AND FLOWERPECKERS.

The Sunbirds and Flowerpeckers are two closely allied families. They are restricted to the Old World, ranging from Africa to India, Malaya, New Guinea and Australia. They are the smallest of local birds, and with their beautiful metallic plumage rival the Humming Birds of the New World. The Sunbirds are distinguished by their long and slender beaks. The two finest species exhibited are the Purple Sunbird or Kerichap hitam (*Chalcostetha insignis*), and van Hasselt's Sunbird (*Cinnyris hasselti*), both presented by Mr. Kloss. More common in Singapore is the Brown-throated Sunbird or Kerichap kelapa (*Anthothreptes malaccensis*). It is metallic lilac and violet purple above, and its chin and throat are cinnamon brown. A considerably larger, but more dully coloured bird is the Grey-breasted Spider Hunter or Kerichap (*Arachnothera modesta*).

The Flowerpeckers have much shorter bills. The Scarlet-backed Flowerpecker or Supah putri (*Dicaeum cruentatum*) is a well-known Singapore bird.

FINCHES.

Of Finches only two or three species are known from the Malay Peninsula. Of these the Tree Sparrow or B. pipit (*Passer montanus*) is as common in Singapore as the House Sparrow (*P. domesticus*) is anywhere in Europe. The crown of the head of the latter is ashy grey, whilst that of the former is chocolate brown. Both have a wide distribution, ranging over Europe and the greater part of Asia, except that in the Malay region only the Tree Sparrow is found. The so-called 'Java Sparrow' belongs to the Weaver Birds.

WEAVER BIRDS.

The Weaver Birds have their name from the large flask-shaped nests, with tubular entrance, of which numbers are occasionally seen suspended from the branches of a single tree. The nests are made of grass and are strongly woven. The Eastern Baya or Tempua (*Ploceus megarhynchus*) is the best known of these birds. The Java Sparrow, also called Rice Bird or Paddy Bird, the Gelatok of the Malays (*Munia oryziwora*), belongs to a sub-family of the Weaver Birds. Its nest is not suspended, but built between the branches of bushes; it is of globular shape and has a small opening at the side. It is a well-known cage bird in Europe.

STARLINGS.

The Starlings include several familiar birds. The Common Glossy Starling or B. perling (*Calornis chalybeius*), with shining black plumage, may at times be seen in hundreds on a single tree. Much larger are the Burmese Grackle or Talking Myna (*Eulabes* or *Mainatus intermedia*), and the Javanese Grackle (*Eulabes javanensis*), both with black plumage and yellow wattles along the head. They are favourite cage birds and easily learn to talk. Their Malay name is 'Tiong,' from their usual call. A curious looking bird is the Bald Grackle (*Sarcops calvus*), from the Philippines, with its bare, pink head.

BIRDS OF PREY.

The Birds of Prey consists of two groups, the Owls (*Strigiformes*), and the 'Hawk-like Birds' (*Accipitriformes*), the latter comprising (a) Vultures, (b) Hawks and Eagles, and (c) Ospreys. We begin with the Hawk-like Birds of Prey.



Sam Hoan Eng. Photo.

CHRISTMAS ISLAND BIRDS.

The Vultures inhabit the tropical and subtropical parts of the Eastern Hemisphere, and though they abound throughout India and Northern Burma, they are of rare occurrence in the northern parts of the Malay Peninsula, and none have so far been recorded from the South. There are none in the collection.

The Hawks and Eagles are a large and cosmopolitan family. Their general Malay name is 'Burong lang.' The most common of the local forms is the Besra Sparrow Hawk (*Accipiter virgatus*), called 'Burong sewah belalang' or 'Burong lang rajawali' by the Malays. Boys here greet it with the rhyme

"Lang lang rajawali
Malam malam churi kuali."

In India this bird is trained for hawking, much as the somewhat larger Common Sparrow Hawk (*Accipiter nisus*) was formerly in England.—The Christmas Island Hawk (*Astur natalis*) is common on that island. It exceeds, if anything, the other birds of that place in its stupid curiosity, allowing itself to be knocked down with sticks. A group of four of them is exhibited.—The Serpent Eagle or Lang borek (*Spilornis baha*), feeds upon snakes and lizards. It is easily distinguished by its long crest and the large white spots on its shoulders and lower parts.—The White-bellied Sea Eagle, Burong lang siput or B. lang laut (*Haliaetus leucogaster*) is the largest of local Eagles. It feeds on fish and water birds. It is frequently seen at the Impounding Reservoir, Thomson Road, from which locality two not quite mature specimens are exhibited, their under parts being mottled white and brown. The old ones are pure white below, like the two magnificent specimens from the Dindings, presented by Mr. R. J. Wilkinson.—Another common, but handsome bird is the Brahminy Kite or B. lang merah (*Haliaetus indus*), often seen in the harbour and elsewhere, so conspicuous with its chestnut-red wings and white head, neck and breast. It too lives chiefly on fish. It is consecrated to the Hindu God Vishnu.—The Pariah Kite (*Milvus govinda*) is exceedingly common in India, nearly as much as the crow, and acts there as scavenger in towns and villages. But it is rare on the Malay Peninsula.—The Slender-billed Pern or Asiatic Bat Hawk (*Machaerampus alcinus*), the B. lang malam of the Malays, is a handsome bird, with a long crest and black plumage. Only its throat and the middle of its breast are white. It shows itself mostly at dusk.—The Honey Buzzards live on the larvae of bees and wasps which they tear out of the combs, and as protection against the stings of the adult insects they have

scale-like feathers at the sides of the head. The Crested Honey Buzzard (*Pernis ptilorhynchus*) may serve as an example.—The Black Crested Baza or Cuckoo Falcon (*Baza lophotes*) is a small and handsome bird, black above, with the exception of a white bar across the wings, and white, barred with brown, below. Its long erectile crest adds much to its beauty.—The dwarfs amongst the Falcons are the Falconets. They are hardly bigger than a lark. The Black-legged Falconet or B. lang belalang (*Microhierax fringillarius*) is a pretty bird with black plumage above, and with white spots on the inner webs of the feathers of wings and tail.—The Peregrine Falcon (*Falco peregrinus*), ranging all over Europe and Northern Asia, is occasionally seen here in the winter.—The Kestrel or Windhover (*Cerchneis tinnunculus* = *Tinnunculus alaudarius*), has a similar distribution and visits here during the cold season too.

The third group of the 'Hawk-like Birds' are the Ospreys and Fishing Eagles. They are a small family, comprising only about half a dozen species which, with one exception, occur all in the Eastern Hemisphere and occupy an intermediate position between the Hawks and Owls. They resemble the former in their general appearance and especially in the position of their eyes, but the latter in their outer toes being reversible, i.e. they can be turned forwards or backwards at will. The structure of their leg bones and the absence of an aftershaft to their feathers also point to a close relationship with the owls. They feed almost exclusively upon fish, and to enable them to get a firm hold of their slippery prey, the scales of the soles of their feet are hard and almost spike-like. The Osprey or Fish-Hawk (*Pandion haliaetus*) is found almost over the whole of the Old World and occurs in the Malay Peninsula too, but is not yet represented in the collection. Exhibited is Hodgson's Fishing Eagle (*Polioaetus humilis*), a species which ranges from Burma and the Malay Peninsula through the Archipelago as far as Celebes.

The Owls differ from the other Birds of Prey (1) by their large and forward directed eyes; (2) by their soft and fluffy plumage, generally of mottled colouring; (3) by the outer or fourth toe being reversible, i.e. being able to be placed forwards or backwards at will, the usual position being that the 2nd and 3rd toes are placed in front, and the 1st and 4th toes behind the perch; (4) by being mostly nocturnal, the other Birds of Prey being chiefly diurnal. To these characters may be added that most owls have 'ear-tufts,' a bunch of feathers which projects horn-like above the eyes, and that most of them have a 'facial

disk,' i.e. a circular arrangement of feathers, radiating from the eyes, to which much of their comical appearance is due. The advantage of the soft and fluffy plumage mentioned above is obviously to make a noiseless and stealthy flight possible. Their general Malay name is Burong hantu.

The Fish Owl or Kudong ketampi (*Ketupa ketupa*), is a large and handsome bird, feeding upon fresh-water fish. The soles of its feet are provided with spicules, as in the case of the Ospreys. The specimen exhibited was presented by Mr. G. Fripp in 1906. (see pl. XI, fig. 1.) This owl is restricted to Malaya, whilst allied species occur in other parts of Asia and Africa.—The Malay Eagle Owl (*Huhuia orientalis*) is another large bird, with prominent ear-tufts. The Eagle Owls are the largest and most powerful of all owls, attacking fair-sized mammals and birds. They occur both in the Old and in the New World.—The smallest of local owls are the Scops Owls, of which the Collared Scops Owl (*Scops bakkamoena*), is the most common one.—An interesting group are the Hawk Owls. Their plumage is not nearly so soft and fluffy as that of other owls, but resembles in its firmness that of the Hawks. Their colouring too is not mottled, but uniform, and their face has a hawk-like look. Exhibited is the Brown Hawk Owl or B. punggok (*Ninox scutulata*).—The Wood-Owls, belonging to the genus *Syrnium*, are a large group, ranging over nearly the whole world, including Malaya, but are not yet represented in the Museum.—The Bay Owl (*Photodilus badius*) is found in the Himalayas, Burma, the Malay Peninsula and Archipelago. It looks somewhat like a small Barn Owl, and in fact its skeleton shows that it forms a connecting link between the species considered so far and the Barn Owl. The true Barn Owl (*Strix flammea*), does not occur here, but another species which is exceedingly like it, the Javanese Barn Owl (*Strix javanica*). It has, like its European relative, a well developed 'facial disk.'

REPTILES.

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The Reptiles form the third class of the back-boned animals or Vertebrates. The Mammals and Birds which we have just passed, have a covering of fur or feathers respectively, necessary to keep their warm blood at a constant temperature. In the cold-blooded Vertebrates, the Reptiles, Amphibians and Fishes, no such covering is required, and they have scales or shields instead, horny ones in the case of Reptiles, bony ones in Fishes, or even a bare skin, as in Amphibians.

The Reptiles readily group themselves into four orders :

(1) Chelonia : Turtles and Tortoises ; (2) Crocodiles ; (3) Lizards ; (4) Snakes. All these four orders are well represented in Malaya, in fact in superabundance.

CHELONIA.

The most characteristic feature of the Turtles and Tortoises is their bony shell consisting of an upper half (carapace) and a lower half (plastron) which encases the body. This bony shell is made up of a number of separate plates which are immovably united with the thoracic vertebrae and the ribs in all Chelonians, except in the Leathery Turtle. There the vertebrae and ribs are free, and this turtle forms therefore a section by itself. The bony shell is in the great majority of cases covered by horny scales or shields. The exception form the Leathery Turtle and the Soft Turtles. In the marine Chelonians, generally called Turtles, the limbs are paddle-shaped and either clawless (Leathery Turtle) or provided with one or two claws only. The Fresh-water Turtles (or 'Soft Turtles') have only the three inner toes clawed, whilst the terrestrial Chelonians, generally called Tortoises, have properly developed toes and four or five claws. None of the Chelonians have any teeth, differing thus from all other Reptiles. Instead they have their jaws covered with horny sheaths. The general Malay name for the marine Turtles is 'Penyu' ; for the Tortoises 'Kura-Kura' ; and for the fresh-water Soft Turtles 'Labi-Labi'.

The Leathery Turtle (*Dermochelys coriacea*) is the largest of living Chelonians. It may reach a length of 8 feet. Its shell is marked with seven longitudinal keels and has no



FIG. 1.



FIG. 2.

FIG. 1. — THE GAVIAL (*Toxistoma schlegelii*).
FIG. 2. — THE LEATHERY TURTLE (*Dermochelys coriacea*).

horny scales, but is covered by a hard leathery skin. This turtle is very fertile, and is said to lay as many as 350 eggs at a time. It is therefore rather surprising that it is nowhere abundant, although it occurs in all tropical seas and occasionally finds its way as far north as England. It is carnivorous, and its flesh is like that of the other turtles which indulge in such diet, not edible. Tickell describes in the Journal, Asiatic Society of Bengal, Vol. XXXI (1862), p. 367, the capture of such a Turtle near the Ye river, Tenasserim. She had laid about a hundred eggs in the sandy beach when she was surprised by a number of Burmese fishermen. Her entire length was 6 feet 2½ inches, and her strength was so great that she dragged six men endeavouring to stop her, down the slope of the beach, until she was overpowered by increased numbers. Tickell describes the eggs as spherical, 1½ inches in diameter, and as palatable, whilst only a few of the natives would eat the flesh.—The specimen in the Museum measures 5 feet 9 inches in its entire length. It was caught at Siglap, Singapore, in 1883 and presented by the Hon'ble A. M. Skinner. (see pl. XIV, fig. 2).

Much more common are the other turtles which, as indicated, differ from the Leathery Turtle, by having their bony shell fused with the thoracic vertebrae and the ribs, and having it covered by horny scales. Specially conspicuous are those scales in the Hawksbill-Turtle (*Chelone imbricata*), the 'sisek lilin' of the Malays, a form which occurs in all tropical and subtropical seas. It is the chief source of the 'tortoise-shell' of commerce. In young specimens the shields overlap like the slates on a roof and only fuse in old age. It grows to 3 feet in length. Besides half-grown and nearly full-grown specimens also some quite young ones are exhibited, their shell being only about 2 inches in length. It is carnivorous too and not edible. Tortoise shell has been known from antiquity, and the Romans greatly prized it as veneer for their more costly furniture. Small pieces of it may by heat and pressure be welded into larger pieces and moulded into almost any shape.

The Green or Edible Turtle (*Chelone mydas*), Malay name 'Penyu,' the turtle of civic banquets, occurs also in all tropical and subtropical seas, but the most famous place for it is Ascension Island. It has a shorter and a weaker beak than the other turtles, as it feeds on seaweed only. It may reach a length of 4 feet. Besides being edible it is also useful through its shell. However, according to Saville Kent ('Great Barrier Reef of Australia') its shell is worth only about 4s. to 5s. per lb., against 20s. to 25s. per lb. of that of the Hawksbill-Turtle.

Of about the same size is the Loggerhead Turtle (*Thalassochelys caretta*). The Malays call it 'penyu tembaga' from its coppery colour. It has a powerful head and a strongly hooked beak and feeds on cuttle-fish and shellfish, its strong jaws finding no difficulty in crushing the shells. It is not edible. It is also found in all tropical and subtropical seas.

Very different are the 'Soft Turtles' (Malay name 'labi-labi') living in fresh water, chiefly in rivers. They have no horny scales, and their bony shell is covered merely by a soft skin. Their jaws are concealed under fleshy lips, and their snout ends in a proboscis. The name of the family 'Trionychidae' is due to their having three claws only. They have a long and flexible neck which, together with the head, can completely be withdrawn below the shell. Almost more than in structure they differ from the marine Turtles by their habit. They are exceedingly ferocious, their head and neck can dart out from below the shell with incredible rapidity and inflict serious bites. Of course they are carnivorous. Not unfrequently specimens are caught which on their back bear inscriptions in Chinese characters. The Chinese have the custom of catching these and indeed any turtles, to inscribe some pious sayings upon their skin and to let them go again, as insurance for the next world. The two best known 'Soft Turtles' of the Malayan region are *Trionyx cartilagineus* and *Pelochelys cantoris*. Their shell reaches a length of 24 inches, but the largest specimen in the Museum measures only 19 inches.

The Tortoises can at once be distinguished from the Turtles by their well-formed feet with four or five claws. Their head, neck and limbs can be withdrawn within the shell, and in order to make this protection still more perfect, we find that in some instances the lower shell is furnished with a transverse hinge so that its two halves may close tightly against the carapace. They are terrestrial or semi-aquatic. Their general Malay name is 'Kura-Kura.' The largest of the Malay Tortoises exhibited is a species called *Batagur baska*, from the little Siak River, Sumatra, presented by Dr. Abbott in 1906. Its shell, that of a male, is just over two feet in length. Not quite so large is the *Testudo emys* which is fairly common on the hills of the Malay Peninsula. One of the specimens in the Museum was caught only in August last (1907) just below the "Gap" Resthouse, Selangor. It laid five eggs a few days after it had been captured, and when two months later it was killed, previous to being stuffed, it was found to contain

twenty-six fully formed eggs, each about two inches in diameter. Its shell measures 17 inches in length.—On Singapore island four species of Tortoises occur: The largest, but rarest of them, is the *Callagur picta* which is easily distinguished by its red nose. The shell of the largest specimen in the Museum measures 18½ inches.—Next in size comes the Flat-backed Tortoise (*Cyclemys platynota*) which is found in a little stream near Selitar, also in the brooks leading to the Impounding Reservoir and elsewhere. A very pretty species which is fairly common on Bukit Timah, is the Spiny Tortoise (*Geocemyda spinosa*). The spines along the margin of the shell are most marked in young specimens. Lastly there is the Box Tortoise (*Cyclemys amboinensis*). It has a smooth black upper shell and two yellow stripes along the neck. The lower shell has a transverse hinge so that it can be closed tightly against the upper one. It is common in swamps and paddy fields. The Malay name is 'tongtong' or 'tuntong.'

CROCODILES.

The Crocodiles of the world consist of three families, the true Crocodiles, the Gavials and the Alligators. Of these only the first two families are found in the Malay region, whilst the Alligators, with one exception, are restricted to the New World. However, Singapore people very frequently speak of 'Alligators' as occurring here, the same way as they say with preference 'Boa constrictor' instead of Python, 'Iguana' instead of Monitor, and 'Chamaeleon' when they mean the green lizard *Calotes*.

The external differences between Crocodiles and Alligators may be briefly stated as follows: In Crocodiles the fourth tooth of the lower jaw is very large and fits into a distinct notch or indentation at the margin of the upper jaw; they have fourteen to fifteen teeth in each half of the lower jaw; they have horny shields on the upper surface only, and their hind feet are completely webbed.

In Alligators the margin of the upper jaw is not indented, and the fourth lower tooth merely fits into a pit; they have seventeen to twenty-two teeth in the lower jaw; they have horny shields on the lower surface as well as on the upper one, and their hind feet are incompletely webbed.

Crocodiles and Gavials, however, can be distinguished at the first glance. It is impossible to confuse the long narrow snout of the latter with the broad triangular head of the former.

The Crocodile or 'Buaya' (*Crocodylus porosus*) is still common in the estuaries of Singapore island. The largest stuffed specimen in the Museum, from Serangoon, shot and presented by Mr. G. P. Owen in September 1887, measures 15½ feet. Still larger specimens are very rare, but there is also exhibited a skull, measuring 27½ inches from the snout to the supraoccipital crest, presented in the same year by Mr. G. Edgar, which must have belonged to a monster quite 22 feet in length. It probably came from Java.—There is also a large skull measuring 24½ inches, with very perfect teeth, from the Dindings, presented by Mr. R. J. Wilkinson in 1903. Being unknown on the West Coast of India, this Crocodile ranges from the East Coast of India and Ceylon to Burma, the Malay Archipelago, Southern China and Northern Australia.

Crocodiles lay from twenty to sixty eggs at a time. The eggs are oval and have a hard white shell and measure about 3 inches in length. It is astounding how vicious the young ones are if one opens an almost mature egg. They wriggle and snap and do all credit to the old ones. Some eggs, half opened, with the young ones nearly fully developed, are exhibited.

The more common Crocodile of India is *Crocodylus palustris*, but it is doubtful whether it occurs on the Malay Peninsula.

The Gavial, or more correctly 'Gharial' (*Tomistoma schlegeli*), the 'buaya julong-julong' of the Malays, is characterized by a long and narrow muzzle, with about twenty teeth in the upper jaw and nineteen in the lower. It lives in rivers and feeds chiefly on fish, but occasionally also attacks man. It is much scarcer than the Crocodile. The Museum possesses specimens from Sumatra and Borneo, but the Gavial also occurs on the Malay Peninsula. The largest specimen exhibited measures only 8 feet 4 inches, though monsters of fourteen to fifteen feet have been recorded. (see pl. XIV, fig. 1).

LIZARDS.

The lizards exceed by far the Chelonians and Crocodiles together in number of species and individuals, and more than sixty different kinds are exhibited. There are five families of Malayan lizards four of which contain well-known forms.

- (1.) *Geckonidae*, including the House Geckos.
- (2.) *Agamidae*, including the Flying Lizard and the Green Tree Lizard.
- (3.) *Varanidae*, the Monitors, wrongly called Iguanas, the largest members of the group.

- (4.) *Lacertidae*, forms with a very long and fragile tail, closely allied to the English Lizard.
- (5.) *Scincidae*, the Skinks.

Some species of the small Gecko abounds in every house in Singapore, the most common being *Hemidactylus frenatus*, the tail of which is rounded and covered with a few rows of minute spines, and *Gehyra mutilata*, with a broad flat tail. They hardly need a description, as every one will have watched them at night time when they hunt the insects attracted by the light, and will have admired the ease with which they run up walls and along the ceiling. They are enabled to do so by means of the adhesive disks into which their feet are expanded. Their Malay name is 'Chechak' or 'Chichak'. Larger forms of Gecko are called "to'kek" by the Malays, from their voice, though that of the smaller ones is very similar. These larger species are especially *Gecko monarchus*, about 7 inches in length, brownish or grey, with a double row of black spots along its back, and the huge *Gecko verticillatus*, 10 or more inches in length, grey with bright red spots. But the most beautiful one of Malay Geckos is *Gymnodactylus pulchellus*, which occurs on the hills of the Malay Peninsula. It is about 8 inches in length, and its body and tail are set off with a large number of broad brown bands and rings upon a light ground.

Familiar to every one must be the Flying Lizards, 'Chechak terbang,' of which *Draco volans* is the most common species. Their 'wings' are built on quite a different principle from those which we know in birds and bats and flying squirrels. They are membranes at the sides of the body, supported by the ribs which are much elongated. However, they serve merely as parachutes.

To the same family belongs the green Tree Lizard (*Calotes cristatellus*), wrongly called 'Chamaeleon,' the 'sumpah-sumpah' of the Malays, so common in Singapore. It is of a beautiful grass-green colour which it can change into a grey-brown when alarmed. The largest specimen exhibited measures 21 inches of which, however, the greater part (not less than 16 inches) is taken up by the tail. Closely allied are the various species of *Gonyocephalus* from the hills of the Malay Peninsula. If not longer, they are at least much stouter in the body than the *Calotes* and have a much larger dorsal crest.

The Monitors are by far the largest of Malayan Lizards. The best known form is the Water Monitor (*Varanus salvator*) called 'Biawak' in Malay. It is misnamed 'Iguana' in the Straits. A specimen in the Museum measures 5 feet 3 inches from snout

to tip of tail. They are found in marshy localities and mangrove swamps, also on trees overhanging the water. They live on crabs, small mammals and birds, frogs and reptiles, and on the eggs of birds and reptiles.—The true Iguanas are almost entirely restricted to the western hemisphere. Most of them have a large dorsal crest which is absent in the Monitors.

The closest ally of the English Lizard is in Malaya rather a rare form with a very long and fragile tail, *Tachydromus sexlineatus*. The tail is four times as long as the body.

Exceedingly common again are the numerous species of Skinks, Malay name 'bengkarong' or 'mengkarong.' They frequent dry and sunny places where with their bronzy colour they form very conspicuous objects. The largest and most common of them is *Mabuia multifasciata*, easily recognized by the red stripe at its side. A specimen from the Botanic Garden is shown measuring not less than 13½ inches in length. It was presented by Mr. Ridley in 1898.

An extraordinary looking skink is *Lygosoma larutense*, from Perak. It is of a much elongated and cylindrical shape and has extremely short legs so that at the first glance it could be taken for a snake. The English blindworm, which, of course, is a lizard too, has further developed in the same direction and has lost its legs altogether.

SNAKES.

Still more numerous than the Lizards, if not in individuals, certainly so in species, are the Snakes, and the Museum collection contains more than one hundred different species. Unfortunately they cannot be classified by external characters only, the structure of the skull being a much more important character than the colour of the beast or the shape and the arrangement of the scales. Nor can Snakes scientifically be classed into venomous and non-venomous forms.

In all Snakes there is an elastic ligament between the two halves of the lower jaw, and in most cases the bones of the upper jaw and of the palate are movable too, so as to allow the mouth greatly to be dilated.—Only the Python and the Boa constrictor (the latter form American!) have traces of hind limbs which externally are visible in the shape of claw-like spurs on each side of the vent. Many snakes have poison fangs. These are enlarged teeth of the upper jaw with a groove into which the duct of the poison gland leads. Or the edges of the groove may have become fused, so as to form a proper

tube. The poison glands are modified salivary glands. They are situated below and behind the eye and may extend a considerable way along the neck. They are covered by muscles so that the poison may be forced into the tooth. Notwithstanding the numbers of poisonous snakes in this part of the world, it is remarkable how rarely deaths through snake bite are recorded. Certainly the mischief done by these reptiles is infinitesimal as compared with that done by the Spotted-winged Mosquito (*Anopheles*), the carrier of Malaria.

We begin with the Blind Snake (*Typhlops*), a harmless little worm-like creature of burrowing habits, of a uniform yellowish or brownish colour, and rarely exceeding a foot in length. Its eyes are rudimentary and are covered by the scales of the head, nor has it any teeth in the lower jaw.

The next group are the giants amongst the snakes, the various species of *Python*, to which the American *Boa constrictor* is closely allied. They are not poisonous either. The most common of the Malayan species is the *Python reticulatus* (Ular sawah). The Museum has a stuffed and a skeletonized specimen, each 22 feet in length, both caught on Singapore island, but they are said to grow up to 30 feet. The exhibited skeleton has 320 pairs of ribs. Also a plaster of Paris cast of a young Python is exhibited, showing the beautiful carpet-like pattern of the skin.—The *Python curtus* is a short and thick species, only about 5½ feet in length.

A third group includes a snake which the Malays call 'Ular kepala dua,' i. e. snake with two heads (*Cylindrophis rufus*). It is a burrowing snake, about 2 feet long, shining black above, and below with a large number of irregular whitish or yellowish bands. The tip of the tail is bright red. The tail resembles the head not only by its shape, but also by the way it is occasionally carried, raised off the ground and curved forwards.

Omitting a little important group we come to the *Colebridae*, a family which includes by far the most snakes, non-venomous and venomous ones, land and marine. A very pretty snake is *Macropisthodon rhodomelas*, which is frequently met with in Singapore. It is of a pale brown colour and has a black line running along the middle of its back, ending on the nape in a V-shaped mark. The sides of its neck are whitish in colour, apparently due to the secretion of a gland.

Very remarkably coloured is the 'Ular selenseng' of the Malays, *Coleber oxycephalus*. It is about 5 feet in length and is of a more or less uniform bluish-green colour from snout to

vent, but there it suddenly changes into a brownish-yellow, the whole tail being of that tint. (see model).

Comparatively rare on the Peninsula is the snake called *Coluber taenihurus*, which, however, is found also in China, Siam, Borneo and Sumatra. Its usual colour is grey-brown or olive above with a black stripe along each side of the hinder part of the body. It occurs in the 'Batu Caves', Selangor, and the specimens from there are much lighter in colour, so that this serpent is locally known as the 'White Snake.' It attains a length of about 6 feet. Besides spirit specimens a water-colour sketch of such a snake is shown which Lieut. C. B. Harvey, R. E., made in the Batu Caves in 1896.

The snake *Simotes octolineatus*, 'Ular tedong usat', has its specific name from the lines (in reality only seven) which run along the whole length of its body. In the middle of the back there is a red line, followed on either side by a black one. There is an interesting model of such a snake half buried in a log of a tree and guarding a number of eggs. It had been found in that condition in the Botanic Gardens and was presented by Mr. Ridley. The eggs are leathery, of an elongated oval shape and measure about $1\frac{1}{4}$ inches in length.

A large, but harmless snake which by natives is frequently confused with the deadly Banded Adder, is the *Dipsadomorphus dendrophilus*, common in mangrove swamps, e. g. at Serangoon where they are frequently seen on branches overhanging the water. They are black with a large number of narrow yellow rings which are interrupted above and below. Size 6 feet. Its Malay name is Ular punti.

A very common snake in Singapore is the Green Tree Snake, 'Ular puchok' (*Dryophis prasinus*), also called 'Whip-Snake' from its long and thin shape. It grows to nearly 6 feet in length. A model of it is shown. The yellow variety of this snake is called 'Ular kunyet' by the Malays.

Equally common is the snake called *Chrysopelea ornata*, a snake of yellowish-green colour, the scales of the back all being black-edged. A very pretty variety of it has a line of bright red spots running along the whole length of its back, the spots being arranged in clusters of four. (See the plaster of Paris cast).

None of the above snakes is venomous, or at least the bite would affect man in no appreciable degree, though it might be sufficient to paralyse or kill small animals. But the Sea Snakes to which we come now, are all poisonous. They may easily be recognised by their strongly compressed tail, adapted

to swimming. They do not lay eggs, but produce living young. Close on twenty species have been recorded from these seas, but we can consider only two or three of them. *Distira stokesii* is one of the larger forms. Although it is only about 5 feet in length, yet its body is very stout and appears extremely powerful. It is of yellowish colour interrupted by broad black bands or rings.—*Platurus colubrinus* is about of the same length, but much more slender. It is of a yellowish colour with narrow black rings.—*Enhydria hardwickii* is about 2½ feet in length. It is of light colour with rather indistinct dark rings. The scales of the lower surface are spined.

The most dangerous of the terrestrial snakes in Malaya all belong to the subfamily '*Elapinae*' which includes the Banded Adder, the Cobra and the Hamadryad. The Banded Adder or '*Ular ketak tebu*' (*Bungarus fasciatus*) is a very handsome snake. It is of a bright yellow colour with broad black rings, and grows to about 6 feet in length. Its Malay name is, of course, from the resemblance of the alternating light and dark rings to the joints of the sugar cane. The name '*Ular katam tebu*,' given in some books, is obviously wrong. A closely allied form is called the '*Krait*' in India.

The best known Malayan snake is probably the Black Cobra (*Naja tripudians*), of evil repute. The typical Indian form is yellowish to dark brown above and has a black-and-white spectacle mark on its hood, but the variety which is most common on the Malay Peninsula and in Singapore is generally uniform black or dark brown and shows a U or O-shaped marking of the hood only in the young. The well-known power of dilating the neck into a hood is a character which distinguishes the cobras from all other snakes. There are about ten different species of cobra most of which, however, occur in Africa. A full grown Black Cobra measures about 5 feet. Its Malay name is '*Ular tedong sendok*.'

Twice as large or more is the most formidable of local Snakes, the Hamadryad (*Naja bungarus*), '*Ular tedong selar*.' It is widely distributed, being found in India, Burma, Indo-China, the Malay Peninsula and Archipelago. As Cantor says, it is very fierce and always ready not only to attack, but also to pursue, and accounts of its chasing people are frequently heard. Its bite must naturally be more dangerous than that of most other venomous snakes, as this species is so much larger and more powerful. The Museum has specimens in spirit and a plaster of Paris cast, all about 12 feet in length. But specimens as long as 14 feet have been recorded. The only redeeming

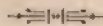
feature of this formidable reptile is that it feeds on other snakes. Therefore the scientific name '*Ophiophagus*', the 'Snake-Eater,' by which it was formerly known.

Closely allied to the Banded Adder and the Cobras is a gay coloured snake, also poisonous, the *Doliophis bivirgatus*, of which a model is exhibited too. Its head, tail and lower surface are bright red, but the back is dark with a light blue line on either side, and this line is followed again by a dark blue one. It rarely grows larger than 5 feet.

The last few snakes which we will consider are the vipers, well-known to be poisonous too and easily recognized by their triangular head. There is a black or purplish-black viper (*Lachesis purpurcomaculatus*), or 'Ular bakau,' which is frequently found near the sea, in mangrove swamps and such like places, and specimens have repeatedly been brought to the Museum from Pulo Brani. It is about 3 feet in length.

There are also several green and greenish yellow vipers, the largest of them the 'Ular kapak rimba,' *Lachesis wagleri*, often enough taken on Singapore island, as on Bukit Timah and elsewhere. The best known variety is green above; its scales are black-edged, and numerous black and yellow bands run across the body. It measures about $2\frac{1}{2}$ feet. A cast of this viper, caught in the Botanic Gardens in March of this year, is exhibited.

AMPHIBIANS.



The Amphibians, though in common parlance often classed with the Reptiles, differ from them in several characters, the two most striking ones being that their young ones, called 'tadpoles,' live in water and breathe by means of gills, and that, when adult, they have generally a smooth and clammy skin, in contrast to the scaled skin of the Reptiles. They consist of three orders :

- (1) the tailless forms : the Frogs and Toads ;
- (2) the tailed forms : the Newts and Salamanders ;
- (3) the limbless forms : the Coecilians.

Frogs and Toads are distinguished by the complete absence of the tail in the full-grown animal and by the hind limbs being more or less elongated. Their front limbs have four and their hind limbs five toes. They differ from each other chiefly in the structure of the breast bone, but, at least in the more typical cases, Frogs can be recognized by their smooth skin and long hind legs, Toads by their warty skin and less elongated hind legs.

The two most common Singapore Frogs (Malay name 'Kodok' or 'Katak') are a brown species, often having a yellow line along the middle of its back, the *Rana limnocharis*; and a bright green species, *Rana erythraea*. Both are of medium size only. A much larger creature is the *Rana macradon*, sometimes of an intense brick red colour, sometimes bronze, or even only olive brown and greenish. Specimens measuring 6 inches from snout to vent are not uncommon, but a monster measuring not less than 9¼ inches, probably one of the largest specimens ever recorded, was obtained by Mr. A. D. Machado at Selinsing, Pahang, in 1899, and presented by him to the Museum.

Almost classical has become the 'Flying Frog' from Borneo which Wallace described forty years ago in his 'Malay Archipelago.' It probably was *Rhacophorus pardalis*. The numerous species belonging to the genus *Rhacophorus* differ from the other frogs so far considered, not only by the toes, but also by the fingers being webbed, and by the tips of fingers and

toes being dilated into regular disks. These webs are especially strongly developed in Wallace's 'Flying Frog,' though it scarcely can be said that the frog has the power of flying. It has even been doubted whether the webs can serve as parachutes. But as these frogs are arboreal, it is very possible that the broadened toes with the sticky membranes between them enable their possessors to gain rapidly a foot-hold after a long leap from branch to branch. A very beautiful species of those 'Flying Frogs' is *Rhacophorus nigropalmatus*, a specimen of which was caught by Mr. Machado some years ago, January 1899, at Kuala Merbau, Ulu Pahang, and subsequently presented by him to the Museum. It had fallen into an old prospecting pit, about twelve feet deep, and could not get out, and there it was found swimming in the water. Its colour, when alive, was a bright green, with numerous white dots, and the enormous webs were black near their base, but yellowish towards the edges. It measured $3\frac{1}{4}$ inches from snout to vent. Closely allied is a Frog which is common on Singapore island and elsewhere, the *Rhacophorus leucomystax*, the 'Katak pisang' of the Malays, called thus because it is frequently found on Pisang trees. It is of a greyish-brown colour and has four darker lines along its back. Its webs are much less developed than in the 'Flying Frog.'

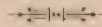
Most disappointing to newcomers is the Bull-frog, *Callula pulchra*. Though its voice must satisfy all reasonable expectations and may be heard during any rainstorm, especially in the first rainstorm after a long spell of dry weather, in size this species does not even come up to the common English Frog or Toad. It measures only about $2\frac{1}{2}$ inches from snout to vent. Its jaws are without teeth.

Coming now to the Toads (Malay name 'Kodok puru') we find *Bufo melanostictus* to be abundant on Singapore island. It is very like the English toad. It is yellowish or brownish above and has numbers of black ridges and warts. It is said to grow above 6 inches in size, but the largest specimen in the collection measures only $3\frac{1}{4}$ inches.—By far the largest toads exhibited are two specimens, male and female, of *Bufo asper*, from Bukit Kedondong, Malacca. The female which is the larger, measures 7 inches in length.

The most curious Batrachian on Singapore island is *Megalophrys nasuta* which, although it has a smooth skin, belongs to the Toads too. It is of a brownish colour, and its upper eyelids and the snout are produced into large triangular flaps of skin. It has repeatedly been caught on Bukit Timah.

The other group of Malay Amphibians are the Coecilians, a group for which there is unfortunately no popular name and apparently no special Malay name either. They are worm-shaped creatures, about 11 inches in length, of burrowing habits, without a trace of limbs and with a slimy skin thrown into ring-like folds which increase the similarity to worms. Two species occur on Singapore island: *Ichthyophis monochrous*, of a uniform purplish black colour which, according to Dr. Cantor, was first observed here by Dr. Montgomerie in 1863, "in whose garden it was turned up with the earth, from about two feet below the surface"; and *Ichthyophis glutinosus*, with a white stripe on either side of its body, the first specimen of which, recorded from this island, was obtained by Mr. L. M. Bell from excavations at the Impounding Reservoir, Thomson Road, in 1904, and presented by him to the Museum.

FISHES.



The fishes are the lowest class of the back-boned animals or Vertebrates. They are generally divided into three groups: (1) the Cartilaginous Fishes (*Chondropterygii* or *Elasmobranchii*), including the Sharks and Rays; (2) the Ganoids (*Ganoidei*), including the Sturgeons; and (3) the Bony Fishes (*Teleostei*), including the great majority of Fishes. The second of these groups is not represented in the Malay region. Of the third group, the Bony Fishes, there is a large collection of stuffed specimens in the Museum which were prepared in the years 1883 to 1887 under the direction of Dr. T. I. Rowell, Principal Civil Medical Officer at the time. They are carefully labelled with their scientific and Malay names, but are now much faded and little attractive. Pending the preparation of a fresh collection, painted in their natural colours, it is not proposed to describe them now. We only devote a few lines to the Cartilaginous Fishes, the Sharks and Rays.

Sharks, Rays and their allies differ from the Bony Fishes by having the skeleton entirely cartilaginous throughout life. The skeleton may be superficially calcified, but no true bone is formed. They have, like the Bony Fishes, two pairs of fins (pectoral and pelvic fins) which correspond to the front and hind limbs of higher back-boned animals, and, in addition to these, unpaired or median fins (dorsal, caudal and ventral ones), like the other fishes. In the Sharks and Dogfish the pectoral and pelvic fins are about equally developed, but in the Rays and Skates the pectoral fins enormously exceed the pelvic ones in size, so that the body assumes a broad and flattened shape. Both Sharks and Rays are carnivorous, but whilst the Sharks are able to swim rapidly and to pursue large prey, the Rays only progress with a kind of slow undulating motion, rarely leaving the bottom of the sea and feeding on Molluscs, Crustaceans and other small animals. Thus we find as a rule large triangular teeth in the Sharks, but small, flat and pavement-like ones in the Rays. Some members of the group lay eggs, others bring forth living young ones.

The typical Sharks, Malay name 'Ikan yu,' so dreaded by bathers, belong to the genus *Carcharias*, of which about 17 species are known from Indian seas alone. Some of these Sharks are said to attain a length of 25 feet, and to give an idea of their size Day, in his 'Fishes' (Fauna of British India), mentions that the liver of a specimen of the Black-finned Shark (*Carcharias melanopterus*) at the Government fish-oil factory at Calicut weighed 270 lbs. The largest specimen exhibited, belonging to *Carcharias dussumieri*, measures barely 8½ feet, though it appears a formidable enough monster. It was presented by Capt. C. J. Balfour, of H. M. S. 'Mercury,' in 1892. But the largest member of the group is the Basking Shark (*Rhinodon typicus*). It ranges from Ceylon to the Cape of Good Hope and is said to exceed 50 feet in length, but is fortunately harmless. It has only small teeth, and its mouth is placed near the extremity of the muzzle, not below it, as in the true Sharks. It is not yet represented in the collection.

Well-known is the liking of the Chinese for Sharks fins, and a considerable trade is carried on in Singapore in this article of food. During the year 1907 Sharks fins to the total amount of \$276,168 were imported into Singapore, Penang contributing \$90,556, Madras and the Coromandel Coast \$38,670, Ceylon \$36,545, Celebes \$27,276, Sarawak \$18,905, B. N. Borneo \$14,679, and other places smaller amounts. Exported they were chiefly to Hongkong and Chinese ports, the former taking \$120,712, the latter \$49,042.

Much dreaded is the Hammer-headed Shark (*Zygaena malleus*). It grows to 14 or 15 feet, and has its name from the curious T-shaped head, the eyes being placed at the extremity of broad lateral processes. It brings forth living young ones, and Cantor in his 'Catalogue of Malayan Fishes' relates how in Penang, in the year 1845, he opened a female containing 37 living young ones.

No animal has a more frightful weapon of offence than the Sawfish or 'Ikan gergaji.' The 'saw' is a prolongation of the snout and consists of calcified cartilage, carrying a row of formidable teeth on either side. The sawfish uses this weapon by striking sideways and swallows the pieces of flesh which he has thus torn off from his prey. The various species are classified according to the number of teeth and the structure of the fins. The Sawfish *Pristis perratteti* has a broad and comparatively short saw, with about 17 teeth on either side. The largest saw exhibited measures 5 feet 3 inches from eye to tip.

Other species, like *P. zysron* and *P. cuspidatus*, have long and narrow saws, with up to 35 pairs of teeth. The largest of those exhibited measures 5 feet 7 inches.

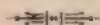
An uncanny looking monster is the Eastern Ox-Ray or Sea-Devil (*Dicerobatis eregoodoo*). It has the flattened shape of the ordinary ray or skate, but is distinguished from the latter by a curious pair of 'horns' on either side of its head. These projections are flexible in the living specimen and are said by their flapping motion to drive the smaller crustacea on which the fish feeds towards the mouth. Its teeth are only small and pavement-like. This fish inhabits the seas of India and the Malay Archipelago and reaches a width of 18 feet measured from tip to tip of the pectoral fins. The specimen exhibited was obtained near Malacca in 1889, and measures slightly over 12 feet across. The Sea-Devil is quite harmless when left alone, though with its powerful fins it can do considerable damage when being captured.

The Beaked Rays (*Rhynchobatus ancylotomus* and *R. djeddensis*) indicate in their shape an intermediate position between the Sharks on the one part, and the Rays, like the Sea-Devil, on the other.

The last members of the group we have to mention are the Torpedoes or Electric Rays. Specimens of *Astrape dipterygea* are exhibited. They give electric shocks like the Electric Eel. The rounded outline of their body distinguishes them readily from the rhomboidal shape of the ordinary Rays.

For the information of scientific visitors the *Protochordata* may be mentioned before leaving the Fishes. *Amphioxus* is represented by some young specimens from Raffles Lighthouse which in the year 1898 were collected and presented to the Museum by Mr. W. F. Lanchester and the late Mr. E. P. Bedford. They also gave a *Balanoglossus* from Pasir Panjang. Ascidians, simple and compound, are of course common on the local coral reefs. The most common Simple Ascidian found there belongs to *Polycarpa*. Mr. W. Maclear Ladds presented in 1899 a magnificent specimen of the compound Ascidian *Colella*, from a telegraph cable, lat. 11° 11' S., long. 127° 30' E., depth 30 to 40 fathoms, and in 1904 some specimens of the simple Ascidian *Culeolus*, also from a telegraph cable, 5 or 6 miles off Dana (New) Island, lat. 10° 15' S., long. 121° 17' E., depth 350 fathoms.

INSECTS.



With the Fishes we concluded the survey of the backboneed animals or Vertebrates, one of the main groups of the animal kingdom. These main groups are termed 'sub-kingdoms' or 'phyla.' The Insects which are the subject of the present chapter, constitute the highest class of another sub-kingdom or phylum, that of the Arthropoda (i.e. animals with jointed legs), this phylum including also Centipedes and Millipedes, Spiders and Scorpions, and Crustaceans. Insects invariably have six legs and have thus appropriately also been called Hexapoda. The name 'Insects' refers to the division of the body into three sections, head, thorax and abdomen. Most Insects also possess two, or more rarely one pair of wings, distinguishing them from all other Arthropods, and, in common with the Centipedes, Millipedes, Spiders and Scorpions, they possess air tubes or tracheae which permeate the body and serve as respiratory organs, whilst the Crustaceans have gills. The Arthropods breathing by means of those air-tubes have therefore been called Tracheata. The body of Insects is enclosed by a horny or chitinous covering, and the head is provided with one pair of feelers or antennae.

Everybody knows that from the eggs of Butterflies not Butterflies are hatched, but caterpillars, that these caterpillars, after having spent their whole existence in feeding and having thus greatly increased in size, change into a pupa or chrysalis, and that after a shorter or longer quiescent stage the perfect insect (or 'imago') emerges from the chrysalis. It is similar with beetles and flies, only there the larva is not called caterpillar, but grub and maggot respectively. In Cockroaches and Grasshoppers on the other hand there is no such metamorphosis. The young ones emerging from the eggs resemble more or less their parents, except that they are much smaller and have no wings. In other Insects again we find an intermediate state of affairs. The character of this metamorphosis together with the number and structure of the wings and the structure of the mouth parts, according whether they are biting

or sucking, has been used for classifying the Insects. They are generally subdivided into nine orders, viz. (1) *Hymenoptera* (Bees, Wasps and Ants); (2) *Diptera* (Flies and Fleas); (3) *Lepidoptera* (Butterflies and Moths); (4) *Coleoptera* (Beetles); (5) *Neuroptera* (Caddis Flies and Ant Lions); (6) *Pseudoneuroptera* (Dragon Flies and Termites); (7) *Orthoptera* (Earwigs, Cockroaches, Grasshoppers, Stick and Leaf-Insects); (8) *Rhynchota* (Bugs, Cicadas and Lanternflies); (9) *Thysanura* (Spring-tails and Silver Fishes.)

ANTS, BEES & WASPS (*Hymenoptera*).

The Hymenoptera which include Ants, Bees, Wasps, Sawflies and Ichneumon flies, undergo a complete metamorphosis. They have two pairs of transparent wings. Their mouthparts are adapted for biting or may, in addition, be partly modified into a proboscis for exhausting the nectar from flowers. They may be placed at the head of the Insects, both on account of their structure and of their high intelligence. Some Wasps and Bees are solitary, but others are social, and so are all Ants: they live in colonies. The elaborate structure of the nests of these social Hymenoptera, the organisation of their communities and the care for the young place them high above the other Insects.—No Ants are exhibited, and of Bees and Wasps we mention only a few of the more striking forms.

The giants amongst the Hymenoptera are the *Scoliidae*. *Scolia procera* is a large and handsome wasp-like insect, with stout and hairy body and stout legs. It is marked with three yellow spots each on thorax and abdomen.—*Salius ducalis*, belonging to the *Pompilidae*, is remarkable for its long antennae and long legs. It is dark brown in colour, with the exception of a large silver-white spot on either of its forewings.—Of the true Wasps (*Vespidae*) the most common Singapore species is the Banded Wasp (*Vespa cincta*). It is black in colour, but has a broad yellow band across the abdomen. Its huge nests are frequently seen. Two of them are exhibited. One of them was recently obtained in the Botanic Gardens and presented by Mr. Ridley. The Honey Bees and the Humming Bees constitute the family *Apidae*. The former (*Apis dorsata* and *A. indica*) are about the size of their European allies. Of Humming Bees a large black species is frequently seen in Singapore, noisily buzzing from flower to flower, the *Xylocopa latipes*. An exceedingly common, but smaller humming bee, is

Xylocopa aestuans. Its male is entirely yellow, but the female is black with exception of the thorax which is yellow. A very handsome bee is *Xylocopa caerulea*. It is of sky-blue colour, but considerably rarer than the others. As the name *Xylocopa* indicates, these Humming Bees burrow in wood, drilling long galleries, which open to the exterior by cylindrical holes. Branches of trees showing such galleries are exhibited.

FLIES & FLEAS (*Diptera*).

The Diptera include Flies, Gnats (or Mosquitoes) and Fleas. Their metamorphosis is complete. Their mouthparts are adapted for piercing and sucking. As the name 'Diptera' indicates, these insects have only one pair of wings, or they may be entirely wingless, like the Fleas. The wings, when present, correspond to the forewings of other Insects. The hindwings have become reduced to a pair of minute clubs, called balancers or halteres. Their function is supposed to be to balance the insect when flying. No Diptera are exhibited.

BUTTERFLIES & MOTHS (*Lepidoptera*).

Butterflies and Moths undergo a complete metamorphosis. They possess two pairs of wings which are clothed by minute scales. Their mouthparts are adapted for sucking. No definite line of demarcation can be drawn between Butterflies and Moths, but the following distinctions apply in the majority of cases :

Butterflies (or *Rhopalocera*) have clubbed antennae ; their fore and hind-wings are not interlocked at the inner margins, and the wings are placed vertically when at rest ; they are chiefly diurnal ; the chrysalis is not enclosed in a distinct cocoon.

Moths (or *Heterocera*), on the other hand, have variously shaped, but not clubbed antennae ; their wings are interlocked and placed horizontally when at rest ; they are chiefly nocturnal ; cocoons are present in many cases.

No other group of insects or animals altogether have been so much collected and studied in the Straits as the Butterflies. Distant, in his 'Rhopalocera Malayana' describes and figures above 500 species from the Peninsula alone. The Museum collection, arranged in 24 cases, contains most of them and many additional kinds from the Malay Archipelago.

The classification of the various families is based upon the structure of the feet, and, in one family, upon the shape of the antennae. The genera are classified according to the veins of the wings. We give the five families with a few representatives of each :

1. *Nymphalidae* : fore legs feebly developed in both sexes. This is the largest of the five families and contains many well-known forms. The Phantom Butterfly or Spectre, seen here and there in the depth of the jungle, is one of the most remarkable Malayan Butterflies. It is a large-winged insect, white, with black veins and blotches, and its popular name is due to its floating and uncertain mode of flight. There are two or three species of it on the Peninsula, the most common of which is *Hestia lyuceus*.—Abundant on the hills of the Peninsula are the various species of *Euploea*, large brown and blue winged butterflies. Their wings are generally spotted with white.—Almost classical has become the butterfly *Kallima paralekta* which Wallace first described from Sumatra. Its upper surface is of a rich purple, and across the fore wings runs a broad bar of deep orange. Wallace tells how this butterfly, so very conspicuous when on the wing, seemed suddenly to disappear when entering a bush, but that after several failures he managed to solve the mystery. It is not only the colour of the under surface of the wings which closely resembles that of a dead leaf, but also the tip, the midrib, the veins and the stalk of a leaf are closely imitated, so that the butterfly when reposing against a twig and with his wings closed, seems a part of the plant. This is one of the most quoted instances of 'mimicry' or protective resemblance. A similar species occurs on the Malay Peninsula, viz. *Kallima buxtoni*.—The most beautiful genus of this family is *Charaxes*. It is surpassed only by some of the *Papilionidae*. Several species of it are exhibited. Still more beautiful species of *Charaxes* occur in Western Tropical Africa.

2. *Eryciniidae* : fore legs perfect in the female only ; tarsi not spined. These butterflies are in the New World unsurpassed by their variety and brilliancy of colouring, but the Malayan species are not showy, mostly brown or rufous in colour, and there are only few of them. The genera *Abisara*, *Zemeros* and *Libythea* belong to this family.

3. *Lycanidae* : fore legs perfect in the female only ; tarsi densely spined beneath. This is a large family, containing the well-known 'Blues' and 'Coppers,' mostly small

forms, but of brilliant colouring. *Poritia*, *Nacaduba* and *Narathura* are some of the larger genera.

4. *Papilionidae*: six perfect legs in both sexes. This family is divided into two subfamilies, the Whites and Brimstones (*Pierinae*), and the Swallow Tails (*Papilioninae*). It is in the second of these subfamilies where we find the most gorgeous of Malayan Butterflies, like *Ornithoptera brookeana*. Local collectors chiefly prize the female of this rare species, of which a specimen from Tapah, Perak, was presented in 1903 by Miss Mazet (now Mrs. Chappel). From Mr. Waterstradt are some rare *Ornithopteras* from Ambon and New Guinea. Almost equally beautiful are the numerous species of *Papilio* of which Distant describes not less than thirty-seven from the Peninsula.

5. *Hesperidae*: Six perfect legs in both sexes. Antennae generally curved or hooked. These butterflies are popularly called 'Skippers' from their short and jerky flight. They have a broad and thick head and are not specially showy, brown and orange dominating in their colouring. *Tagiades* and *Telicota* are amongst the larger genera.

Although the Butterflies are a large group of Insects, the Moths are vastly more numerous and, in addition, their classification is much more complicated. Hampson in his 'Moths' (Fauna of British India) distinguishes 31 families. We can mention only a few of the more important ones.

The *Saturniidae* contain the largest and some of the finest of Malayan Moths. In beauty stands easily first a large green moth the hindwings of which are produced into long tails (*Actias selene*). Each of its wings is marked with an eye-spot. In size the Atlas Moth (*Attacus atlas*) is approached by no other Malay species. The largest specimen in the Museum measures $9\frac{1}{4}$ inches from tip to tip of the forewings. It is not at all uncommon in Singapore.

The *Sphingidae* include some well-known forms which are almost identical with European species: the Death's-head Moths (*Acherontia lachesis* and *A. styx*), the Hawk Moths (various species of *Calymnia*, *Daphnis* and *Chaerocampa*), and the Clear-wings (*Cephaonides hylas*). The wings of the last of these are transparent which together with the shape and the colouring of the body and the mode of flight produces an astonishing resemblance to hornets. They are diurnal.

The *Syntomidae* are small day-flying moths. Many of them have the body brightly coloured. In *Euchromia orientalis* it is banded black, crimson and metallic blue.

The *Zygaenidae* or Burnets resemble not only in their diurnal habits, but also in their shape and gay colouring the Butterflies. *Chalcosia coliadoides* has white wings with dark-blue spots. *Pompelan subcyanea* has black-brown wings with metallic blue margins.

The *Noctuidae* or Owl Moths are a very extensive family, mostly of large size. They are nocturnal. *Nyctipao macrops* has large 'eyes' on its forewings. A striking moth is *Phyllodes consobrina*, with its fuscous-brown forewings, resembling dead leaves, and its blue-black hindwings which at the hinder margin have a large patch of crimson and white. Another species, *Ophiusa honesta*, resembles the European 'Crimson Underwings' (*Catalpa*). In the numerous species of *Ophideres* the forewings generally resemble dead leaves in their fuscous colour, whilst the hindwings are orange with big blotches of black and brown.

The *Uraniidae* include a large moth of the shape of a Swallowtail, viz. *Nyctalemon pactroclus* which, although its colours are merely black, white and grey, is of extraordinary beauty. Smaller, but also very exquisite forms are the various species of *Urapteroides*, *Strophidia* and *Pseudomicronia*.

The *Geometridae* have their popular name of 'Loopers' from the loop-like way of progressing of the larva. The largest and brightest species of this family belong to *Euschema* in which purple, grey and golden yellow tints predominate. They are diurnal. Other species again are green, like those of *Aporandria* and *Thalassodes*.

The *Pyralidae* constitute a very extensive family of small and little attractive moths. The genera *Glyphodes* and *Pyrausta* alone contain each about fifty Indian species. Those of *Glyphodes* are generally marked by clear spaces in the wings.

BEETLES (*Coleoptera*).

Beetles have a complete metamorphosis. Their mouth-parts are biting. They possess two pairs of wings of which, however, the forewings (or 'elytra') are stiff and horny and not used as organs of flight, but serve only to cover and protect the hindwings. The hindwings are large, membranous and transparent and, when at rest, are folded up below the elytra.

The Tiger Beetles (*Cicindelidae*) of which *Cicindela octogramma* may serve as an example, are generally placed at the head of the order. They frequent dry and sandy places and in their manner of flight may easily be taken for flies. Two curious beetles belong to the same family, *Tricondyla aptera* and



FIG. 2.



FIG. 3.



FIG. 4.



FIG. 1.



FIG. 5.



FIG. 6.

Sim Boon Kwang Photo.

FIG. 1.—*Heteropteryx grayii*. FIGS. 2 TO 6.—BEETLES.

Collyris apicalis. They are ant-like in shape, their elytra are fused together and their hindwings are very small or absent altogether. Of course they are thus unable to fly.

The Ground Beetles (*Carabidae*) include, besides numerous plain looking forms, a most extraordinary insect, the Fiddler Beetle (*Mormolyce phyllodes*). This beetle is quite flat and its elytra are enormously expanded, assuming the shape of a violin (see pl. XV, fig. 5). It lives under the bark of trees.

The Malayan Staghorn Beetles (*Lucanidae*) closely resemble the European species. One of them, *Odontolabis gazella*, from Malacca and Perak, has a black body and yellow elytra.

Of the Cockchafers (*Melolonthidae*) a common Singapore form is *Lepidiota bimaculata*, which has two white spots near the hinder margin of its brown elytra.

The giants of the Malay beetles are the Goliath Beetles (*Dynastidae*), *Golofa atlas*, with its three long horns, taking the first place (see pl. XV, fig. 6). Closely allied to them are the Rose Beetles (*Cetoniidae*), many of which are of a beautiful bronze green colour.

For beauty the *Buprestidae* stand unrivalled amongst beetles. They are allied to the English Skip Jacks and Click Beetles. *Catoxanthu mouhotii*, of which a specimen from Java, presented by Mr. Alfred Lea, is exhibited, has green elytra with a pair of yellowish-white spots; *C. gigantea*, from Gunong Kledang, Perak, is entirely green. *Chrysochroa buquetti* has yellow elytra with two pairs of large blue blotches; *C. castelnaudi* is blue with a broad yellow band across its elytra.—Other Skip Jacks are the *Elateridae*. They include forms with beautifully feathered antennae, like *Oxynterus mucronatus*, presented by Master Nanson in 1899.

After these beautiful beetles we have to mention the *Anobiidae* which include some minute and most obnoxious forms, like *Anobium paniceum*, the Biscuit Weevil. This creature unfortunately does not confine itself to biscuits, but attacks books as well, especially those in more costly bindings, both in its adult state and as larva. The latter is generally called the 'bookworm.'

The Weevils (*Curculionidae*) are known by the enormous amount of damage they do. Most destructive are the Coconut Beetles, like *Rhynchophorus ferrugineus* and the still larger *Protocerus colossus* (see pl. XV, fig. 2). They are chestnut red in colour. A remarkably beautiful green and blue weevil is *Eupholus* sp.—Amongst the *Brentidae* are weevils of extra-

ordinary shape. *Eutrachelus temmincki*, from the foot of Kina Balu, B. N. Borneo, may be called the giraffe amongst the beetles, from its enormously elongated thorax (see pl. XV, fig. 4). Equally curious is *Diurus furcillatus* in which the elytra at their hinder end are drawn out into a kind of fork. It is figured in Wallace's 'Malay Archipelago.'

The Longicorns (*Cerambycidae* and *Lamiidae*) include many large and handsome species. In size stands first *Dysiatus melas*. Its elytra are of a deep chestnut colour, the rest of the body is black. It has enormous legs and antennae. The largest specimen exhibited is from Bukit Timah. One of the most common local Longicorns is *Batocera octomaculata*, grey with eight white spots. *Xylorhiza venosa* is remarkable through its curiously striated elytra which give it the appearance of a piece of rotten wood (see pl. XV, fig. 3).

Of the endless number of families of smaller beetles we mention only the Shield or Tortoise Beetles (*Cassididae*) in which the elytra are curiously expanded, as in the various species of *Aspidomorpha*; and the Lady-birds (*Coccinellidae*) of which many hundred species have been described from all parts of the world. These familiar little beetles make themselves useful by destroying plant-lice and other injurious insects.

CADDIS FLIES AND ANT LIONS

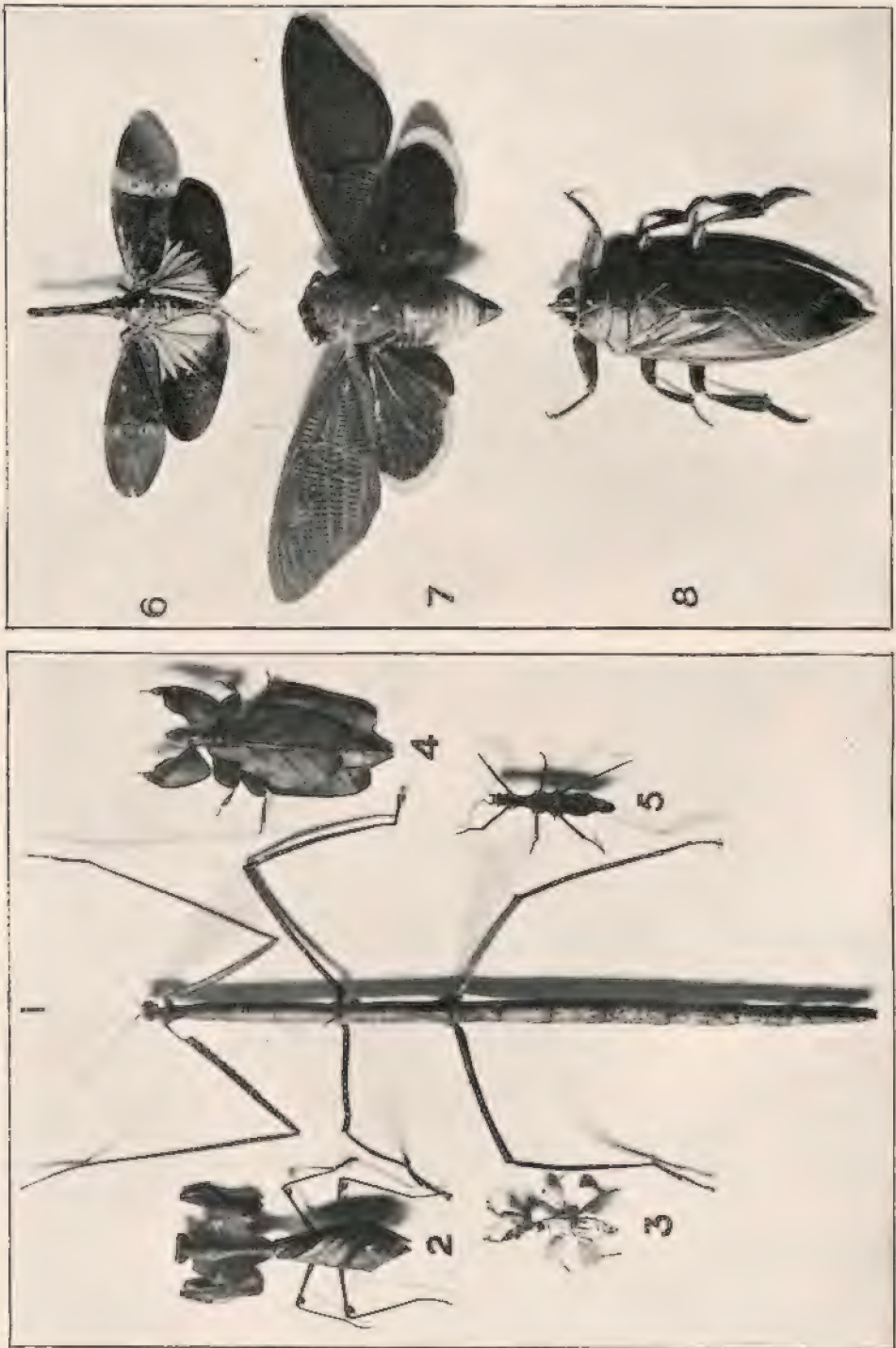
(*Neuroptera*.)

This small group, including only Caddis Flies and Ant Lions, undergoes a complete metamorphosis and differs thus from the next one, the Dragonflies and Termites, which they otherwise resemble in their general appearance and in their mouthparts which are adapted to biting and grinding. None are exhibited.

DRAGONFLIES AND TERMITES

(*Pseudoneuroptera*.)

These insects, although resembling the Neuroptera in their outer appearance, are really more closely allied to the Grasshoppers and other insects which constitute the next order, the *Orthoptera*. The Dragonflies and Termites undergo no metamorphosis. Their mouthparts are biting, and they have two pairs of wings both of which are thin and membranous. They differ thus from the Grasshoppers and other *Orthoptera*



FIGS. 1 TO 5, STICK-AND-LEAF INSECTS; FIG. 6, LANTERN-FLY; FIG. 7, CICADA; FIG. 8, WATER-BUG.

in which, as we shall see presently, the forewings are thick and hard. None are exhibited.

COCKROACHES, STICK AND LEAF- INSECTS, GRASSHOPPERS.

(*Orthoptera.*)

The Orthoptera (literally 'straight-winged Insects') include Earwigs, Cockroaches, Praying Insects, Stick and Leaf-Insects, Grasshoppers, Locusts and Crickets. They undergo no metamorphosis, their mouthparts are biting, and they have, as a rule, two pairs of wings. The fore-wings are mostly thick and hard and serve as protection for the thin and membranous hindwings which in the resting condition are fan-like folded up below them. In a few cases, however, wings are wanting. Some of the members of the group are uninteresting, others again are amongst the most curious forms of the animal kingdom, adopting the strangest forms of protective disguises, like the Stick and Leaf-Insects.

The Earwigs (*Forficulidae*) and Cockroaches (*Blattidae*) will probably receive only scant attention from the visitor. Cockroaches especially make themselves sufficiently familiar in all sorts of places where they are not wanted.

The Praying Insects or Soothsayers (*Mantidae*) have their popular name from the attitude which they often assume with their thorax and fore-legs. The name has nothing to do with any mild mental disposition, on the contrary, they are blood-thirsty creatures, living on other insects, the females at times devouring even their own mates. Their fore-legs are veritable death traps. Two of the joints, the femur and the tibia, are provided with sharp spines and teeth which fit into each other when the joints close after the manner of a pocket-knife. A common Singapore species is *Rhombodera basalis*. It is of green colour, whilst another species, *Deroplatys exsiccata*, resembles a dead leaf (see pl. XVI, fig. 2). Yet more remarkable is a small pink Mantis, *Hymenopus bicornis*, which mimicks the flowers of the Sendudock or Straits Rhododendron (*Melastoma polyanthum*). A specimen from Johore, presented by Mr. W. Fox, is exhibited (see pl. XVI, fig. 4).

Stick and Leaf-Insects (*Phasmidae*) show the most curious resemblance to dry sticks and living leaves. At the first glance there would seem to be a great difference between the two. However, there is a special show-case displaying the

development of one of the largest insects known, of *Eurycnema herculanea*. Beginning with the egg a series of young ones, of increasing sizes, is exhibited, and all of them are distinctly stick-like. They are grey in colour, have no wings and look like dried-up twigs. But suddenly when the insect has attained its full size and has cast its last skin, we see a totally different creature, of bright green colour and large wings. A similar insect is *Heteropteryx grayii*, $6\frac{1}{8}$ inches in length, of which a specimen from the hills between Selangor and Pahang, from an elevation of 3500 ft., is exhibited. The adult insect has quite a bulky body (see pl. XV, fig. 1.) However, some Stick-Insects remain stick-like throughout life, like *Phibalosoma cantori*. It measures $9\frac{1}{2}$ inches (see pl. XVI, fig. 1.) Some Stick-Insects are covered with spines, like *Acanthoderus* sp. (see pl. XVI, fig. 5).

Of true Leaf-Insects two beautiful species are exhibited, *Phyllium scythe*, from Bukit Timah, presented by Mr. Chye Tian Fook (see pl. XVI, fig. 3), and *Phyllium siccifolium*, from the same locality, presented by Mr. T. C. Loveridge. In these insects the body is broad and flat, the wings are green in colour and veined like a leaf, whilst the legs bear leaf-like expansions.

Of Grasshoppers there is an abundance in the Malay region. They are divided into two groups. The Short-horned Grasshoppers (*Acridiidae*) are distinguished by their short antennae and small and inconspicuous ovipositor. The Coffee-Locust (*Cyrtacanthacris nigrovaria*) is one of them. It is common everywhere. Curious grasshoppers are the various species of *Tryxalis* in which the head is cone-like prolonged.—The Long-horned Grasshoppers (*Locustidae*) have long antennae and a long and sword-like ovipositor. *Phyllophora citrifolia*, with its beautiful semi-transparent green wings, may serve as example. Well-known is the chirping sound produced by grasshoppers. In the *Acriidae* it is caused by their minutely spined hind-legs rubbing against the upper wings; in the *Locustidae* by the rubbing of the upper wings against each other.

The Crickets (*Gryllidae*) are distinguished by their rounded head, the long whip-like antennae and the thick and massive body. Their chirping is produced in the same way as in the *Locustidae*.

BUGS, CICADAS and LANTERNFLIES. (*Rhynchota*).

The Rhynchota include insects which differ enormously in appearance, habits and attractiveness. Some of them, like

the Lantern-Flies, rival the Butterflies and Moths in their delicate beauty. Others are repulsive, like the bed-bugs and lice. Most of them live on land, others are found in the water or on the surface of it. Many, like the plant-bugs, are feared and detested by farmers and horticulturists on account of the damage they do; others, like the Cochineal Insect (of Mexico) and the Lac Insect are highly useful and are cultivated. Most of them are mute, whilst others, like the Cicadas, are extremely noisy and by their shrill note may drown every other animal sound in the jungle.

The metamorphosis of the Rhynchota is not complete. Their mouth parts are in the form of a beak and are adapted to piercing and sucking. Most of them have two pairs of wings. However, wings may be absent altogether, as in bed-bugs and lice, or be present in the males only, as in Scale Insects. When present, front wings and hind wings may be similar in structure (suborder *Homoptera*), or the front wings may be partly stiff and horny (suborder *Heteroptera*).

In the 'Fauna of British India' the order is divided into 28 families. We can consider only a few of the principal ones.

The Shield Bugs (*Pentatomidae*) are called thus from their shape which is that of a scutcheon. Many of them have a pungent odour, and practically all are destructive to plants. Best known is perhaps the small green bug *Nezara viridula* which is almost cosmopolitan. A common Singapore species is *Erthesina fullo*, grey with whitish spots. A very showy form is *Cantao ocellatus*. It is of reddish-ochraceous colour, with 8 black spots.

The next family, the *Coreidae*, are dull grey coloured insects. Their antennae are long and four-jointed, and their legs are, as a rule, curiously dilated and provided with spines. *Prionolomia malaya* may serve as example.

The Pond-Skaters (*Hydrometridae*) live on the surface of pools and slow-moving streams. Most of them have enormous legs, like *Ptilomera laticaudata*. The species of the genus *Halobates* are found on the surface of the sea, sometimes at great distances from land. They are the only marine insects known.

The Malayan Water-Scorpions (*Nepidae*) resemble those of Europe. They received their popular name from their shape and especially from their front-legs, but are quite harmless. *Laccotrephes robustus* is exhibited.

The Water Bugs (*Belostomatidae*) include some gigantic forms, like *Belostomatia indicum* (see pl. XVI, fig. 8). A specimen from the New Filter Beds, Bukit Timah Road, measuring $3\frac{3}{4}$

inches in length, was recently (April 1908) presented by Mr. J. R. Broadley. It is peculiar that these insects carry their eggs, in a cemented mass, on their back and that this is done by the male, the female having deposited them upon her spouse.

The musicians amongst the insects, and, with the exception of the Grasshoppers and Crickets, the only ones, are the Cicadas (*Cicadidae*). The sound, resembling that of a specially powerful tin whistle, is produced by the males only. This was known already to the Ancients, for a Greek poet, Xenarchus, who appreciated domestic peace as well as modern man, said "Happy are the Cicadas, for they have voiceless wives." The sound-producing apparatus consists of two drums, one on either side, situated near the upper surface of the base of the abdomen. The drums contain membranes which are put in vibration by certain sets of muscles. Most Cicadas have transparent wings, like the huge *Pomponia imperatoria*, measuring $8\frac{1}{4}$ inches from tip to tip of the wings, or the more common and smaller species of *Dundubia*. Velvety black wings, with reddish-brown veins, are met with in *Tacuna speciosa* (see pl. XVI, fig. 7).

The Froghoppers (*Cercopidae*) are mostly small insects. They have powerful hindlegs with which they can give long leaps. Their larvae produce the so-called 'Cuckoo-spit.' One of the largest of them is *Cosmoseurta tricolor*. It is dark brown with orange spots.

The Lanternflies are the best-known members of the family *Fulgoridae*. Their head is prolonged into a huge rostrum which may be as long as the rest of the body (see pl. XVI, fig. 6). The function of this rostrum is unknown. It is not luminous, as was formerly supposed. The Lantern-flies are amongst the brightest coloured Insects, rivalling Butterflies and Moths. *Fulgora oculata* has white wings with eye-like spots. *Pyrops nobilis* has a spined rostrum.

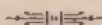
SPRINGTAILS and SILVER FISHES.

(*Thysanura*).

The Thysanura are small and wingless insects. They undergo no metamorphosis and are usually covered with hairs or scales. The Springtails (*Collembola*) have a forked tail which serves as leaping apparatus. They live under flower pots and such like places. The Silver-fishes (*Lepisma* sp.) have soft bodies covered with shiny scales and ending in three bristle-like tails. Old books and old clothes are their favourite places of abode. None are exhibited.

MILLIPEDES AND CENTIPEDES

(*Myriapoda.*)



Millipedes and Centipedes breathe by means of air tubes (tracheae) like the Insects. They resemble each other by the elongated shape of the body which is divided into a large number of ring-like pieces or segments. The head is distinct from the body and is regarded as formed by the fusion of four segments. Most of the segments bear legs. The differences between the two groups are as follows :

Millipedes (*Diplopoda* or *Chilognatha*) are cylindrical in shape ; the first four or five segments of the body have only one pair of legs each or are legless altogether, and the last segment is legless too, but all other segments have two pairs of legs each ; antennae and legs are short ; the jaws are small and without poison glands. They live on vegetable matter and are harmless. Omitting a great number of small species we mention only three well-known forms. The large black or red-brown Millipedes which reach a length of 9 inches and above, belong to the genera *Spirostreptus* and *Thyropygus*. Their body has more than thirty segments. The Pill-Millipedes which, when rolled up, resemble a ball, belong to the genus *Zephronia*. Their body has only thirteen segments. The largest, when rolled up, measure about $1\frac{1}{4}$ inches in diameter. Easily distinguished are also the various species of *Acanthodesmus* in which each segment bears at its sides a lobe-like process. They have twenty segments.

Centipedes (*Chilopoda*) have a flattened body ; each segment has one pair of legs only ; the antennae are long ; so are the legs which enable these animals to move rapidly ; they have powerful jaws with poison glands and live on animal food. Of larger species the most common one here is *Scolopendra subspinipes*. A full-grown specimen in the collection measures $6\frac{1}{4}$ inches. An exceedingly slender species, measuring a little

over 2 inches in length and barely $\frac{1}{8}$ inch in thickness, is *Orphnaeus brevilabiatus*. It is phosphorescent and is frequently seen in houses, on mosquito curtains and such like places. On account of its small size it is probably quite harmless to man. Uncanny creatures are the species of *Scutigera*. They have exceedingly long spider-like legs with which they are able to move about with incredible speed. A specimen caught in the Lunatic Asylum, in 1897, presented by Dr. H. J. Gibbs, is exhibited.

We add here a rare and curious creature, the *Peripatus*, which is generally placed into a class by itself, the *Protracheata*. It shows in its structure an interesting mixture of features, its tracheae indicating a relationship to the *Tracheata*, and its excretory organs, the so-called 'nephridia', to the worms (or more correctly speaking, to the Annelids). There are several species of it. They all have a soft and worm-like body. The head which, however, is not sharply marked off from the rest of the body, carries a pair each of ring-like antennae, of jaws and oral papillae, simple eyes and a mouth. They have short and stumpy legs which in the different species vary from 17 to 43 pairs, each of them bearing two claws. They are therefore also called *Onychophora*. The skin is velvety and is thrown into numerous folds covered by minute papillae. They live in damp places, beneath the bark of trees, under stones and rotten logs of wood. Their food consists of insects which they capture with the sticky slime squirted out from their oral papillae.

The first species of *Peripatus* was described from the Antilles, but others were afterwards discovered in South America, South Africa, Australia, Sumatra and finally also in the Malay Peninsula. The members of the Skeat Expedition found it in 1899 on Bukit Besar near Patani and at Kuala Aring Kelantan, and Butler discovered soon after a specimen on the Larut Hills, Perak. The specimen in the Museum was presented by Mr. Kloss who had found it on the Sekudai Road, Johore, about 16 miles north of Johore Bahru, in May 1905. It is apparently identical with, or closely allied to *Eoperipatus butleri*. It has twenty-three pairs of feet, and its length is 63 mm (= 2½ inches).



FIG. 1.

R. Hanitsch Photo.



FIG. 2.

FIG. 1.—SCORPION (*Palamnus longimanus*).
FIG. 2.—BIRD-EATING SPIDER (*Pacillotheria* sp.).

SPIDERS AND SCORPIONS.

(*Arachnida.*)



Spiders and Scorpions have no antennae and no distinct head and differ thus from Insects, Centipedes and Millipedes. Their body consists of only two sections, cephalothorax and abdomen, of which the former is to be regarded as formed by the fusion of head and thorax. They have six pairs of appendages, and the cephalothorax which bears them, is therefore considered as consisting of six segments. The twelve segments of the abdomen have no appendages. The first pair of appendages are the jaws or mandibles. The second pair are called 'palpi' when they are leg-like and used as tactile organs, as in Spiders; or 'chelae' when they are pincer-like, as in Scorpions. The third, fourth, fifth and sixth pairs are the legs. In a few cases the first pair of legs may be long and slender. They are then used not as locomotory, but as tactile organs, as in the Whip-Scorpions. The respiratory organs are in some cases tubular tracheae, as amongst Insects, Millipedes and Centipedes, but in other cases they have become modified into 'book-leaf tracheae' or 'lungs', sac-like structures containing numerous lamellae arranged like the leaves of a book.

We follow Pocock's classification of the group into nine orders :

1. *Scorpiones.* Of the eighteen segments of the body of Scorpions the last five are long and narrow and form the tail. At the extremity of the tail is a hard and pear-shaped organ containing two poison glands and ending in a curved sting. The second pair of appendages are developed into powerful pincers with which the Scorpion grasps and holds its prey, whilst the flexible tail is rapidly thrown forwards and the poison sting inserted. On the under side of the body, just behind the last pair of legs, there is a pair of curious comb-like organs, the 'pecten', which is supposed to be sensory in func-

tion. Scorpions have four pairs of book-leaf tracheae (lungs).—The largest of local species is *Palumnacus longimanus* of which a couple, obtained at Changi in 1896, is exhibited (see pl. XVII, fig. 1). They were found under a log of wood, their usual habitat. Much smaller is *Hormurus australasiae* which has a short tail and short and stout pincers. Very slender forms, with long tail and long and thin pincers, are *Archisometrus* (= *Lychas*) *mucronatus* and *Isometrus maculatus*.

2. The *Uropygi* or Tailed Whip-Scorpions differ from the true Scorpions by a marked constriction between cephalothorax and abdomen, by the absence of pectines and poison glands, by their long and thread-like tail, and by the second pair of appendages not ending in pincers, but in claws. The first pair of legs is long and slender and not used for locomotion, but as a tactile organ. The local species belong to *Thelyphonus*. Specimens of it have repeatedly been found in the Botanical Gardens under old logs of wood.

3. The *Amblypygi* or Tailless Whip-Scorpions are closely allied to the *Uropygi* and are often united with them into one order called 'Pedipalpi'. They are still more uncanny looking creatures than the former two orders. Their limbs are very long and beset with spines, and especially the first pair of legs is exceedingly slender and whip-like. Two species are exhibited, *Phrynichus reniformis*, from Chantaboon, Siam, presented in 1898 by Captain S. S. Flower, and *Phrynichus charon*, from Singapore, presented in 1900 by Master Willie Hocquard. Both *Uropygi* and *Amblypygi* have two pairs of book-leaf tracheae.

4. The *Solifugae* or False Spiders are distributed over Southern Europe, Africa, the greater part of Southern Asia and America, but have apparently not yet been recorded from the Malay region. *Galeodes* is the typical genus of the order.

5. No *Palpigradi* occur in this part of the world. They include only a single species from Southern Europe.

6. The *Araneae* or True Spiders are by far the largest order of the class. Their first pair of appendages, or mandibles, is provided with poison glands; the second pair is never pincer-like, but are in the form of tactile palpi, resembling the legs, though much shorter as a rule. The third, fourth, fifth and sixth pairs of appendages are the legs. The abdomen is connected with the cephalothorax by a narrow stalk ('pedicel') and bears a number of spinning mamillae. The body is usually covered with hairs and bristles.—Spiders exclusively live

on other animals, chiefly insects, the blood of which they suck, but the way they obtain their prey differs greatly. Some spiders make no snares, but get their prey by their own agility, by running or leaping; others construct the most diversified webs in which their prey gets entangled, others again build ingenious traps, like the Trap-door Spiders. Those spiders which spin no webs, use the secretion of their spinning glands merely to line the tubes in which they live, or to make cocoons for the protection of their eggs.—In the first chief group, the *Mesothelae*, the abdomen is segmented and bears eight spinning mamillae. There is only a single genus the type of which, *Liphistius desultor*, came from Penang. But it is not yet represented in the Museum.—In the second group, the *Opisthothelae*, the abdomen is unsegmented. This group is again subdivided into two sections, the *Mygalomorphae* (or *Tetrapneumones*), with vertically working mandibles, with four spinning mamillae and two pairs of book-leaf tracheae (or lungs), but without tubular tracheae; and the *Arachnomorphae* (or *Dipneumones*), with horizontally working mandibles, with six spinning mamillae and one pair of book-leaf tracheae and tubular tracheae in addition.—The *Mygalomorphae* contain the largest spiders. A huge specimen of a Bird-eating Spider (*Poecilotheria* sp.), from Bukit Timah, is exhibited (see pl. XVII, fig. 2). Flower records large dark brown and very hairy spiders from Penang Hill, which make burrows, sometimes a couple of feet deep, in the steep banks at the side of the hill paths, and refers them to the species *Coremiocnemis cunicularius*. The specimen from Penang Hill which is exhibited, probably belongs to this species. It was presented by Dr. G. D. Freer in 1899 who had caught it at the Belle Vue Bungalow. Still larger Bird-eating Spiders are to be found in tropical America where they are said to reach almost a rat in size. These spiders do not spin webs, but pursue their prey. They use their spinning glands merely to line the holes and tubes in which they live, with silky films. The Trap-door Spiders belong to the same group.

The *Arachnomorphae* contain many more species than the former group and embrace most of the better-known spiders. A familiar species is *Nephila maculata*, a large spider, with long, cylindrical body and very long and slender legs. Its cephalothorax is black in colour, and the abdomen olive brown, marked with yellow lines and spots. Resting in the midst of its web, made of yellow silk, it is a conspicuous object and is frequently seen on trees in gardens and in the jungle, also on

telephone wires, e.g. on the way to Tanjong Katong. The most common spider in houses and stables is *Epeira insulana*. It is mottled grey above and is marked below with bright red and yellow spots. Its legs are alternately banded black and white. It constructs large and elaborate webs, and is widely distributed from S. Europe and N. Africa through S. Asia to Australia.—The most extraordinarily shaped Malayan Spiders are the various species of *Gasteracantha*. *G. diadestia* has a body broader than long, somewhat after the shape of a crab, drawn out into two spines at either side. It is yellow above, with two brown bands. Yet more curious is *G. arcuata* in which the body at either side is prolonged into a very long and slender horn. It is yellow above, with numerous brown tubercles. Both species spin webs.—The Hunting Spider (*Heteropoda venatoria*) does not construct snares, but hunts its prey. It is a large and long-legged, hairy species, running side-ways, in a crab-like fashion, but with great speed, and is often seen in houses after dark. The female carries her eggs in a flat cocoon below her body.—Common in houses and gardens are the *Attidae* or Jumping Spiders. They are of small size, have short legs and construct no snares either. They are frequently seen on mosquito curtains going after moths.

7. The *Opiliones* or Harvest Spiders resemble the true Spiders in outer appearance, but differ from them by having tubular tracheae instead of 'lungs,' and by the absence of spinning mamillae. Their body is small, but the legs are exceedingly long and slender.

8. The *Pseudoscorpiones* or False Scorpions are all small, even the largest species barely reaching $\frac{1}{4}$ inch in length. They resemble the true Scorpions in their general shape, especially through their comparatively large pincers, but differ from them by having no tail and no poison sting and by breathing through tracheae instead of through lungs. They are found under the bark of trees, under moss and stones, also in books, in insect cabinets and such like places. From their habitat they have also been called 'Book-Scorpions.' They do no damage, but on the contrary they are useful by destroying mites. The best known genus is *Chelifer*.

9. The *Acari* or Mites and Ticks are of minute size. They show a great diversity in structure, many of them having become degenerated through their parasitic mode of life. Their respiratory organs, when present, are tracheae: however, they may be absent altogether. None are exhibited.





FIG. 1.

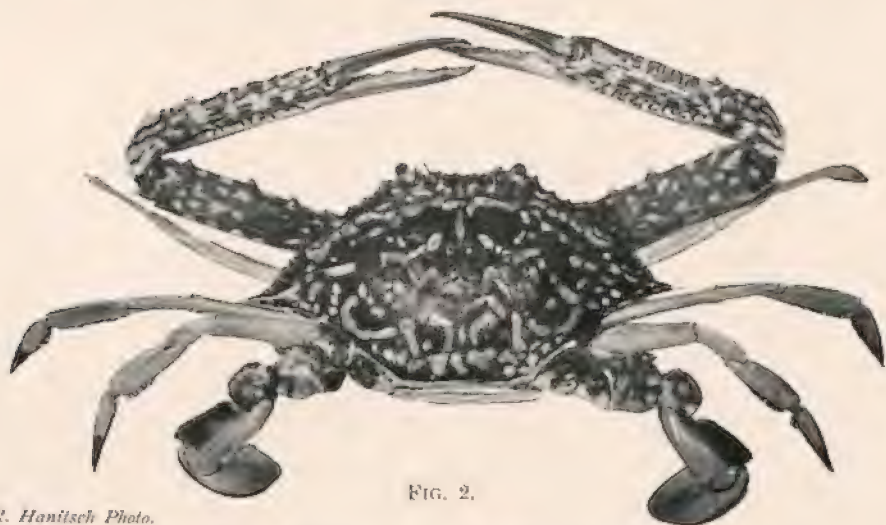
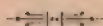


FIG. 2.

R. Hanitsch Photo.

FIG. 1.—THE CHRISTMAS ISLAND ROBBER CRAB (*Birgus latro*),
FIG. 2.—SPINY SWIMMING CRAB (*Goniosoma natutor*).

CRUSTACEA.



The Crustacea include Crabs, Lobsters, Crayfish, Barnacles and many more allied forms. They differ from the other Arthropoda (Insects, Millipedes and Centipedes, Spiders and Scorpions) chiefly by breathing by means of gills instead of tracheae. The vast majority of them live in water; exceptions are only the Land Crabs and Wood-lice. In typical cases they have two pairs of antennae. The name 'Crustacea' is due to their chitinous integument having become hard through the deposition of carbonate of lime.

The classification of the Crustacea is in the first instance based upon the characters of the larval stages. To discuss these in a popular 'Guide,' would be too technical, nor can we attempt to examine the various orders which contain only species of minute size. We restrict ourselves to those groups the leading features of which are large enough to be studied with the naked eye.

CRABS AND LOBSTERS (*Decapoda*).

Crabs and Lobsters together form the order 'Decapoda,' so called because they have five pairs of strongly developed limbs. However, their total number of appendages is much greater, most of the segments of the body (generally nineteen) bearing appendages, like antennae, jaws and swimmerets. The Crabs are called 'Brachyura' from their short tails, and the Lobsters 'Macrura' from their long tails.

One of the most common local crabs is *Goniosoma natator* (see pl. XVIII, fig. 2). It can at any time be seen in the Fish Market. The generic name is due to the body being drawn out into a sharp angle at either side. Closely allied is the much rarer *Goniosoma cruciferum* which on its back shows a large and distinct cross, yellow upon olive-brown ground. A specimen of it was presented by Mr. C. H. Clarke in June last.—Most curious is *Podophthalmus vigil* which name may be translated as the 'Stalk-eyed Watchman.' Its eyes are placed on long movable stalks which are quite two inches in length. Specimens of it

were also presented by Mr. Clarke.—A familiar sight on the shore at low tide, on sandy beaches and in mangrove swamps, are *Ocypoda ceratophthalma* ('The Horn-eyed Runner') and *Gelasimus vocans* ('The Laughable Calling Crab'). The former is the larger of the two. It has a square body, and its eyes are placed on stalks. On account of their remarkable speed it is difficult to catch these crabs when running, but they are easily dug out of the sand when they have taken refuge in their holes. The other species, *Gelasimus vocans*, is smaller, gaily coloured blue and red, and the males have one of their claws enormously enlarged which they brandish about in a ludicrous fashion as if beckoning.—There are quite a number of crabs belonging to the genus *Potamon* which live in fresh water and in damp places in the jungle, even at high elevations.—A common sight on Christmas Island is the little red land-crab (*Gecarcinus lagostomus*). It is met with anywhere in the jungle where it honeycombs the ground with its burrows. Once a year it goes to the sea to spawn, and during these migrations incredible numbers of them are seen, which are exceeded only when the young ones have been hatched and return to the land.

The *Macrura* include Lobsters, Crayfishes, Prawns, Shrimps and Hermit Crabs. There is no local species which closely resembles the English Lobster and Crayfish. Nearest perhaps comes *Thalassina anomala*. This species is only rarely seen, though its high and conical mounds, so common in mangrove swamps and on newly reclaimed land, are familiar sights in Singapore. It has a pair of pincers, like the English Lobster, but differs from it by its long and narrow abdomen. By far the largest of local lobsters is *Panulirus fasciatus*. It has no pincers, and its first pair of legs is not larger than the other four pairs. A full-grown specimen measures close on two feet, and its antennae two or three feet in addition. A near ally, though smaller and much different in external appearance, is *Themus orientalis*. It has a curiously flattened body and has no pincers either, and its outer antennae have been transformed into broad plates.—Of Prawns and Shrimps there is a great variety in these waters. A huge fresh-water species is *Palaemon carcinus* the body of which measures 8 inches and the pincers not less than 10 inches. A curious little Shrimp (*Alpheus* sp.) lives on the Coral reefs, e.g. at Blakang Mati, where it is generally found adhering to Feather Star Fishes, or hidden in the crevices of corals and sponges. It is only about 1½ inches in length. It has two pairs of pincers. The second pair is very

small, but one of the pincers of the first pair is enormously developed. When alarmed it makes a sharp clicking noise with these pincers, so loud that when the little creature has been placed into a glass jar of sea water, it gives the impression as if the vessel had become cracked.—Conspicuous everywhere at low tide are the Hermit Crabs (*Pagurus* and other genera), dragging behind them the shells which they inhabit. That they are not crabs, but really belong to the Lobster tribe, is shown by their long, though soft-skinned and twisted abdomen, a condition which has come about through their curious habit. No Hermit Crab inhabits the same shell throughout life, but changes as its growth in size necessitates a larger house.—Closely allied to the Hermit Crabs is the Robber Crab (*Birgus latro*), found on the islands of the Indo-Pacific seas. Several specimens from Christmas Island are exhibited (see pl. XVIII, fig. 1). These huge beasts are abundant on the island, they live and breed on dry land and have never been known to enter the sea. They are most inquisitive, obtruding their company where they are not wanted, entering even camp and tents at night time.

MANTIS-SHRIMPS (*Stomatopoda*).

The Stomatopoda comprise a single family, the *Squillidae* or Mantis-Shrimps, so-called because their chief pair of limbs resembles the front legs of the Praying Mantis (see p. 61). These limbs fold up like a pocket knife and can inflict serious wounds. The body of these animals is much elongated, the abdomen is broad and strong and ends in a powerful tail fin. An unusually large specimen of a *Squilla*, measuring 12½ inches in length, obtained at the Fish Market in 1899, is exhibited. There is also a beautifully black and white banded species, from Cocos Keeling Island, presented by Mr. K. Maclean in 1904.

BARNACLES (*Cirripedia*).

The Barnacles would at the first glance seem to have little in common with the Crustacea, their shells reminding of the Molluscs. However, their larval stages and their internal structure show that they are true Crustaceans. The young ones, when first hatched, have three pairs of appendages and are free swimming, but after several moults and other changes the larvae settle down and develop a shell consisting of several pieces. The full-grown barnacles have generally six pairs of

long tendril-like feet which do not serve for locomotion, but keep up a constant sweeping motion by which they bring food particles into the mouth. Leaving out certain parasitic forms there are two families of them, the Stalked Barnacles (*Lepadidae*) and the Stalk-less ones (*Balanidae*). The Stalked Barnacles include forms like *Lepas* which are often found on the bottom of ships and on floating timber. The Acorn Barnacles (*Balanus* and other genera) which are so common on rocks between tidal marks, belong to the second group.

KING CRABS (*Gigantostraca*).

The Gigantostraca or King Crabs include a single genus, *Limulus*. It is usual to place them after the Crustacea, although their relationship with the latter is only a slight one. Notwithstanding the fact that they are aquatic and breathe by means of gills, they seem to stand nearer to the Spiders and Scorpions. Their nearest allies were the Trilobites which flourished during the Palaeozoic epoch and are amongst the earliest known fossils. There is a striking resemblance between the larva of the King Crab and the Trilobite, so that that particular stage has been called the Trilobite stage.

Seen from above the King Crab shows three sections: a huge round shield covering the cephalothorax; a smaller hexagonal shield covering the abdomen, carrying six movable spines at either side; and the long spike-like tail. The tail serves only the function of lever when the animal wishes to turn over. Seen from below the animal shows in the region of the cephalothorax a pair of nippers in front of the mouth, five pairs of walking legs, and a plate-like pair of limbs, the operculum, which covers the five leaf-like pairs of abdominal appendages. These leaf-like feet serve the double purpose of swimming and breathing.

The species which occurs in these seas is the Moluccan King-Crab (*Limulus moluccanus*). Other species are found in Chinese and Japanese waters and off the East Coast of the United States.

WORMS.



The animals which we have considered so far, represent only two sub-kingdoms or phyla, viz. the phylum of the Vertebrates (Mammals, Birds, Reptiles, Amphibians and Fishes) and that of the Arthropoda (Insects, Centipedes and Millipedes, Spiders and Scorpions, and Crustaceans). The worms or *Vermes* constitute the next phylum, and at the first glance they would appear to form a well-circumscribed group. But whatever little difficulty there may be in characterizing creatures like the Common Earthworm, the task is almost an impossible one when attempting to give a comprehensive definition of all the animals which for the sake of convenience have been placed amongst the *Vermes*. We shortly pass in review only four classes of them.

BRISTLE-BEARING WORMS

(*Annelida*.)

The Annelids comprise those kinds which are best known as 'worms' in common parlance. They have a more or less elongated cylindrical body which is distinctly segmented and bears bristles. In the order *Oligochaetae* the bristles may be few and microscopic, as in the Common Earthworm (*Lumbricus*), or they may be greatly developed, as in the order *Polychaetae*. They are then borne on stump-like processes of the body which on account of their resemblance to feet are called 'parapodia' and are occasionally developed to such a degree that they form a thick hairy covering of the sides of the body, as in the Sea-mouse.

The largest of local polychaete worms, which are all marine, is *Eunice gigantea*. The two specimens exhibited were caught on the coral reef at Blakang Mati, in 1896. They were found coiled up in the crevices of blocks of coral, and it required much patience to haul them out in perfect condition. For all these worms are exceedingly fragile, and these particular specimens kept on contracting and expanding like pieces of india rubber. The larger of the two measured close on 4 feet when alive. A short and broad species, with dense masses of yellow

bristles, is *Chloëia flava*, which resembles the Sea-mouse of English seas. It is frequently found at low tide at Tanjong Rhoo and on sandy beaches generally. These two species are free swimming and prey on other animals. But some polychaete worms live in tubes and their food consists of vegetable matter. These tubes may be leathery and flexible, or they may be built of sand and fragments of shells, or they may be calcareous. Attached to the head of these worms are the gills which have the shape of delicate branching trees. When the animals are undisturbed, the gills are fully expanded, offering a beautiful sight, but when disturbed in the slightest degree they are instantaneously retracted. Exhibited is *Sabella* sp. which has a leathery tube.

LEECHES (*Hirudinea*.)

The Leeches differ from the Polychaetes by the complete absence of bristles. They have a more or less flattened and highly contractile body, with two suckers. The sucker at the posterior end of the body merely serves for attachment. The anterior sucker leads into the mouth. Most leeches are aquatic, but there are certain tropical forms (*Haemodipsa* sp.) living on land which infest swampy jungle and are much dreaded by travellers.

CEPHYREA.

The Gephyreans are marine worms of cylindrical shape, showing no segmentation. Two large species from Gaya, B. N. Borneo, are exhibited, *Sipunculus robustus* and *S. nudus*. They live in the sand and are used as bait. The specimens were presented by the late Mr. H. S. Haynes, in 1900. They measure 18 and 12 inches in length respectively.

FLAT WORMS (*Plathelminthes*.)

The best-known Flat Worms are the parasitic species like the Tapeworm (*Taenia solium*) and the Liver Fluke (*Distomum hepaticum*). But there are many more free living species. They are all exceedingly flat, but may be long and tape-like, or broad and leaf-like. *Cerebratulus* is a long and narrow form. The specimen shown, measuring fully 24 inches in length, was collected on the coral reefs of Blakang Mati in 1898. *Thysanosoön* is leaf-like. The exhibited specimen, also from local reefs, was presented by the late Mr. F. P. Bedford in 1899. An interesting group are the Planarians, of which there are fresh-

water, marine and terrestrial species. The terrestrial forms live in damp places, as under dead leaves and under flower pots. Many of them are striped or banded with brilliant colours. Thirteen species are known to occur in Singapore and on the Malay Peninsula, about one half of which belong to the genus *Bipalium*.

POLYZOA.

The *Polyzoa*, also called *Bryozoa* or Moss Animals, are all aquatic, occurring both in the sea and in freshwater, and nearly always live in colonies. The individuals which are always small, are held together by some substance which may be either soft and gelatinous, or parchment and horn-like, or calcareous. The calcareous *Polyzoa* include forms of great beauty, like the Lace-Coral (*Retepora*). The popular name 'Lace Coral' is due merely to a superficial resemblance of these animals to the true Corals. There is no real relationship between the two. Exhibited is a collection of *Polyzoa* picked up from telegraph cables, depth 45 fathoms, lat. 10° 47' S., long. 127° 15' E., presented by Mr. W. Ladds in 1902. But similar species can be dredged in Keppel Harbour, whilst practically no stone can be picked up from the Coral reefs which does not show some sort of encrusting Polyzoan.

MOLLUSCS.



As the name 'Molluscs' signifies, the animals comprised under this sub-kingdom or phylum have soft bodies which, however, in the majority of cases are protected by a calcareous shell. The shell may consist of a single piece, as in snails; or of two pieces, as in bivalves; or of eight pieces, as in chitons. It is secreted by the mantle, a fold of skin which envelopes from above the greater part of the body. Below we find the foot, a thick muscular mass, which is highly characteristic of the Molluscs. It is used for locomotion and burrowing. A distinct head is present in all classes, except the bivalves. Besides the mantle (with its product, the shell), the foot and the head, a fourth organ is to be mentioned which is present in practically all Molluscs with the exception of the bivalves and which is of great systematic importance. This is the radula, a thin ribbon-like chitinous membrane, beset with transverse and longitudinal rows of minute teeth. It rests upon the tongue, a kind of cushion on the floor of the mouth. Special muscles are attached to this tongue so that it can perform a licking movement and make its way through substances of great hardness, the teeth being siliceous. Seen under the microscope the radulae are beautiful objects, the teeth varying in size and shape, arrangement and numbers in the different species.

The Molluscs may be divided into five classes, (1) Chitons or *Amphineura*, (2) Snails or *Gastropoda*, (3) Tooth-shells or *Scaphopoda*, (4) Bivalves or *Lamellibranchiata* and (5) Cuttlefish or *Cephalopoda*.

CHITONS (*Amphineura*).

The Chitons are bilaterally symmetrical Molluscs, of an elliptical outline, somewhat of the shape of an egg cut lengthways into two halves. They are exclusively marine, and though found chiefly between tidal marks, sticking to rocks, a few have been obtained from great depths. They are readily distinguished by the eight separate pieces of their shell which cover the curved back, lying behind and overlapping each other like the tiles of a roof. This arrangement allows the animal to roll

itself up like a wood-louse. The margin between the shell and the edge of the foot is studded with close-set spines. The name 'Amphineura' refers to the two pairs of nerve trunks which run along the length of the body of these animals. The Museum possesses specimens of *Chiton spiniger* from Sumatra and the Lankawi Islands, presented by Mr. E. Rostados in 1897, and from South Pagi, presented by Mr. Kloss in 1902. They are about 3 inches in length.

SNAILS (*Gastropoda*.)

The snails are by far the largest class of the Molluscs. Their body is asymmetrical and is covered by a shell which consists of a single piece and is usually spirally coiled. In some cases the shell may be very small or may have disappeared altogether, as in the Slugs. The name 'Gastropoda' refers to the well-developed muscular foot upon which the animal rests and by the continual contraction and expansion of which it moves along. Thousands of species live on land and in fresh-water, but the great majority (about 75%) are marine.

The marine forms breathe by means of gills, the terrestrial ones have lungs, whilst some freshwater species (*Paludina*) have gills and others lungs (*Limnæa*, *Planorbis*), showing thus a derivation from marine and terrestrial ancestors respectively. One freshwater species even possesses both gills and lungs; this is the large and almost spherical snail which is so common here in rivers and swampy places (*Ampullaria*). The so-called 'lungs' of the Gastropods are, however, quite different from those found in Vertebrates, and are not spongy organs. They consist of a sack the roof of which is formed by the mantle and is overspread by a network of blood vessels. The cavity of the sack is called the 'pulmonary cavity'. It opens to the outside by the 'respiratory aperture.'

Many snails possess an 'operculum,' i.e. a horny or calcareous disk attached to the foot by means of which the opening of the shell can be closed when the animal has withdrawn itself. Some opercula are of considerable thickness and are manufactured into buttons and simple ornaments.

According to their respiratory organs the Gastropods are subdivided into four orders :

(1) The *Scutibranchiata* are thus named from the gills being arranged in a circle between mantle and foot, this being the case at least in the most typical member of the order, the Limpet (*Patella*). The Limpets are some of the most charac-

teristic members of the litoral fauna, found almost everywhere attached to rocks between tidal marks. Their shell has the shape of an oval saucer. Closely allied are the Key-hole Limpets (*Fissurella*) which have a slit at the top of the shell. The Ormers or Sea-ears (*Haliotis*) have beautiful pearly shells, up to 6 inches in length. The shells are perforated with a series of holes to admit the water to the gills. They also live in shallow water, attached to rocks like the limpets. Other well-known forms belonging to this order are *Trachus* (see pl. XIX, fig. 2), and *Turbo*. The latter has a thick and globular shell, with some resemblance to a spinning top, as the name indicates, and takes a brilliant polish. Its opercula are much used for ornaments, like rings and brooches.

(2) The *Prosobranchiata* are thus called because the branchial cavity and the auricle of the heart lie in front of the ventricle. An operculum is nearly always present. Most marine Gastropods belong to this order, and also some land and freshwater forms. The freshwater species include *Paludina*, *Ampullaria* and *Melania*. *Paludina* (also called *Vivipara*) lives in swamps or in the mud of rivers. It has a greenish globular shell and is viviparous. *Ampullaria* is similar, but larger and is restricted to the warmer parts of the world. *Melania* has a turriculated (i.e. spire-like) shell, the top of which is almost invariably eaten away. It is dark brown in colour. All these three species have an operculum. Of terrestrial species *Cyclophorus malayanus* is common on the hills of the Malay Peninsula. Its name is due to the disk-shaped operculum with which it is provided. No such opercula exist in the vast majority of the land snails which constitute the next order, the *Pulmonata*. Closely allied to *Cyclophorus* is a curious looking shell, *Hybocystis elephas*, which is also found on the Malay Peninsula. This shell is, probably both on account of its strange shape and of its scarcity, used by Sakeis as ornament, chiefly on necklaces. The last but one of its whorls is curiously inflated. Its generic name is therefore quite appropriate, as the first part of it signifies 'hunchback.' The marine species include many well-known forms, such as may be seen at any time in the streets of Singapore, especially on mail days when they are being carried about by innocent-eyed Malays for the benefit of perspiring passengers. There is the Spider-shell (*Pteroceras*), with its claw-like projections (see pl. XIX, fig. 3); *Phorus solaris*, a flat shell, with ray-like spines (see pl. XIX, fig. 6); there are the numerous species of Cowrie-shells (*Cypraea*) of which a small yellow kind (*C. moneta*) is used as coin by some



SHELLS.

(1) *Dalium maculatum*; (2) *Trachus niloticus*; (3) *Plicoverus scorpius*; (4) *Harpa penoidalis*; (5) *Murex tenuispina*; (6) *Thorus solaris*; (7) *Murex haustellatum*; (8) *Conus bandanus*; (9) *Oculium ovum*; (10) *Solarium trachilare*; (11) *Valata undulata*.

Eastern races; the Egg-shell (*Ovulum ovum*) which is pure white in colour and resembles a poached egg in appearance (see pl. XIX, fig. 9); the large Trumpet-shell (*Triton tritonis*), used as war trumpet by the natives of the Pacific islands; the Fig-shell (*Ficula reticulata*), thus called from its shape, of brownish or greyish-blue colour. Common also are the Helmet-shells which include some of the largest of univalves like *Cassis cornuta*, whilst another species, *Cassis rufa*, is frequently cut into cameos; the Tun-shells (*Dolium*) which are mostly large, globose and thin shells, with spiral ribs and grooves (see pl. XIX, fig. 1); *Solarium*, a flattened, almost disk-like shell (see pl. XIX, fig. 10); the Whelks (*Buccinum*), common here and in British seas. Closely allied to the Whelks is the genus *Fusus* of which there are several hundred species. The largest of them is *Fusus probosciferus*, of spindle-like shape, the specimen in the Museum measuring not less than 19 inches in length. Another very extensive genus is *Mitra*, characterized by a thick and fusiform shell. The best-known of them is the Bishop's Mitre (*M. episcopalis*), with its scarlet spots. The genus *Murex* includes some very remarkable and handsome species, like *M. hastellatum* (see pl. XIX, fig. 7), and *M. tenuispina* which is beset with three rows of slender spines (see pl. XIX, fig. 5). Some species of *Murex* and of the allied genus *Purpura* were in ancient times used for preparing the celebrated purple. The genera *Voluta* and *Cymbium* comprise some large and boat-shaped forms, whitish or yellowish in colour. Some of them are made into spoons. Figured is one of the smaller species, marked with undulating lines, *Voluta undulata* (see pl. XIX, fig. 11). The Harp-shell (*Harpa conoidalis*) is almost without rival in its beauty. In its general shape it is similar to the *Volutas*, but it is beset with numerous longitudinal ribs (see pl. XIX, fig. 4). The genus *Conus* includes more than 500 species from warm and especially tropical Asiatic seas. They are cone-like in shape. Figured is *C. bandanus* (see pl. XIX, fig. 8).

(3) In the *Opisthobranchiata* we find the branchial veins and the auricle of the heart placed behind the ventricle. They are nearly all marine and are divided into *Tectibranchiata* and *Nudibranchiata*, according to whether the gills are covered by the mantle or not. In some *Tectibranchiata* the shell may be well developed, in others it is much reduced or may be absent altogether. To the former belongs the Bubble-Shell (*Bulla ampulla*), a smooth, egg-shaped shell, painted with dots and blotches like a plover's egg. A collection of them, showing

much variation in their markings, from the Great Natuna I. presented by Mr. V. Knight in 1907, is exhibited. To the other *Tectibranchiata* belongs the Sea-Hare (*Aplysia*) in which the shell is represented merely by a thin plate covering the gills. The popular name is due to a fancied resemblance of the Mollusc to a crouching hare. A very large specimen, from Marudu Bay, B. N. Borneo, presented by the late Mr. R. M. Little in 1895, is exhibited. It measures now, in spirit, $5\frac{1}{2}$ inches in length, though, when alive, it was probably quite half as big again. The *Nudibranchiata* are all without shell, and both in this respect and in their external symmetry they resemble the Land Slugs to which we shall come presently. But whilst the Land Slugs are not remarkable for their attractiveness, no more beautiful objects can be imagined than a Nudibranch in its natural element. Not only is their colouring beyond description, but so is also the graceful form of their body, with the variously shaped tentacles, gills and other dorsal appendages fully expanded. Unfortunately little of the colour and shape of these animals remain when they are preserved in spirit. The species belonging to the genera *Doris*, *Kentrodorid*, *Casella*, *Plakobranchus* and *Elysia* are amongst the more common ones which may be collected at low tide in the close neighbourhood of Singapore.

(4) The *Pulmonata* breathe by means of lungs. Most of them are terrestrial, some live in freshwater and very few are marine. They never have an operculum and can thus readily be distinguished from the other *Gastropoda* which live on land, like *Cyclophorus* (see p. 80), or in freshwater, like *Paludina* (see p. 80). Many of them have a resting stage, in cold climates during the winter (hibernation), in hot climates during the summer (aestivation). The shell-bearing forms withdraw into their shell during this resting period and close the mouth of the shell with a lid, the so-called epiphragma. This lid, however, has nothing to do with the operculum. It is formed by a slimy secretion, containing lime.—The freshwater species breathe in the same way as the land *Pulmonata* and have to rise to the surface to do so. They can be drowned if prevented in this, though there are some exceptions to this rule. More than 7000 Pulmonates are known. They are found all over the globe, though they prefer localities with abundant lime and moisture. Specially rich in them are certain groups of islands, like the West Indian Islands, the Philippines and the Sandwich Islands. More than one half of them belong to the well-known genus *Helix*. 25 species of *Helix* occur in

Great Britain alone, of which the most familiar are the Garden Snail (*H. aspersa*) and the larger Edible Snail (*H. pomatia*).

The Pulmonates are divided into two sections, the *Stylommatophora* which are terrestrial, have two pairs of tentacles and have their eyes placed on the tip of the posterior pair of tentacles, and the *Basommatophora* which are generally aquatic, have one pair of tentacles only and have the eyes placed at the base of the tentacles. A further difference is that in the *Stylommatophora* the tentacles are entirely retractile within themselves, whilst in the *Basommatophora* they are only contractile.

The best-known of the local *Basommatophora* are the Earlet Shells, *Auricula judae* and the larger *A. auris midae*. They are common in mangrove swamps and have an elongated, thick, brown shell. A smaller, but also very common snail is *Pythia scarabaeus*. It has an oval, compressed shell, with a pointed spire and is one of the few members of the group which are entirely terrestrial. It is generally found in jungle close to the sea. Much more typical *Basommatophora* are *Limnaea* and *Planorbis*. They live exclusively in freshwater and have thin horny shells, of greenish colour, but whilst *Limnaea* is long and pointed, *Planorbis* is flat and disk-shaped, its convolutions lying all in one plane. Many species of either genus are known from India. In the Malay Peninsula, however, apparently only a *Planorbis* has so far been discovered, in Kinta.

The *Stylommatophora* include most Land Snails and all Slugs. Singapore island is poor in both of them, though the Peninsula, especially the limestone hills, are somewhat richer. The most common garden snail on the island is a small species, *Nanina naninoides*. It has a brown shell, about $\frac{7}{8}$ inches in diameter. Much larger is *Nanina humphreysiana* which grows up to $2\frac{1}{4}$ inches in diameter. It is not unfrequently met with on Bukit Timah, in the Botanical Gardens and elsewhere. Common under stones and flowerpots are various species of *Pupa*, a small elongated and almost cylindrical shell. A handsome bright yellow or yellowish green species is *Budimus* (= *Amphidromus*) *perversus*. Two specimens of it, from Selitar, presented by Master Karl Hanitsch in 1897, are exhibited. Very similar in shape is *B. inversus*, from the Botanic Gardens, which is light grey with slanting brown stripes. Of Slugs a flat yellowish-grey species (*Vaginula*) is common under stones on Fort Canning, whilst at Teluk Ayer the rocks at and above high water mark are sometimes found covered with a species

of *Oncidium* or *Peronia*. These slugs are dirty-brown in colour, with wart-like tubercles on their back. The leaping fish *Periophthalmus*, so well-known through its huge prominent eyes, feeds according to Semper on these slugs.

TOOTH-SHELLS (*Scaphopoda*).

The *Scaphopoda* or Tooth-Shells have curved cylindrical shells, wide at the one end, tapering towards the other, with an aperture at either end. Not only in their shape, but also in their white colour they resemble a diminutive Elephant's tusk. At the wider opening are situated a rudimentary head which is provided with numerous long feelers, and a cylindrical foot which is adapted for burrowing in the sand. The Tooth-Shells are entirely marine, they occur in all seas, also around Great Britain, in shallow water to a depth of 2500 fathoms. They live buried in the sand, allowing only the thin posterior end to project, the opening of which serves at once as inhalent and exhalent aperture. Their radula proves a relationship with the Gastropods, whilst their rudimentary head and other structures lead to the Bivalves. About 150 species of Tooth-Shells are known, most of which belong to the genus *Dentalium*. Specimens of it, dredged at Tanjong Pagar, Singapore, were presented by Mr. H. W. Ford in 1902. They are about $2\frac{3}{4}$ inches in length.

BIVALVES (*Lamellibranchiata*).

The Bivalves are symmetrical, laterally compressed Molluscs and are, without exception, covered by a shell which consists of a right and a left valve. They differ from the other Molluscs by having no head and no radula, but a mantle is always, and a foot mostly present. The mantle arises from the dorsal middle line of the body. It consists of a right and a left lobe which descend on either side, lining the valves, and may meet and fuse below to a greater or lesser degree, leaving, however, a slit for the passage of the foot. The edges of the mantle form behind two apertures, a lower inhalent and an upper exhalent one. The apertures may be simple gaps, or the margins of the mantle may be produced into long siphons. There are always sensory organs of some sort around the inhalent aperture. Bivalves live exclusively on minute organisms which enter by this latter aperture together with the water required for respiration, whilst the waste matter leaves by the

exhalent aperture. The respiratory organs are gills, of leaf-like shape. There are two on either side, hanging down between body and mantle. The foot may be cylindrical in shape, or wedge-like. In some cases it is reduced or absent, e.g. in the Oyster, when the animal has adopted a fixed mode of life and requires no locomotory organs. Frequently there is a groove near the hinder end of the foot, lined by a gland. This gland discharges a secretion which hardens on contact with the water into tough horny threads, called the 'byssus.' By means of these threads the animal anchors itself to rocks and other objects. This byssus (or 'beard') is familiar to everyone in the Common Mussel.

The two valves of the shell are usually symmetrical. In some cases they are more or less asymmetrical, especially when the animal has become sedentary, like the Oyster. Oysters lie on their left side, but other asymmetrical shells lie more usually on their right side, like *Pinna* and *Spondylus*. The shell consists of three layers, an inner or pearly, a middle or prismatic, and an outer or horny layer. The oldest part of each valve is called the umbo. It is situated close to the upper border of the shell, and forms the starting point of a series of concentric rings on the surface of the shell which are called 'lines of growth' and mark successive stages in the growth of the shell. The two valves are along their upper margins held together by an elastic and resilient ligament which causes the valves to gape if not counteracted by the so-called adductor muscles, which run across from valve to valve. Some Lamellibranchs have one, others two of these muscles, and their impressions are plainly visible on the inside of the shell. The line of attachment of the mantle which leaves an impression near the lower margin of the shell, is also easily discerned.

More than 5000 living species of Lamellibranchs are known. They are all aquatic. The majority (about 80%) are marine, the rest live in freshwater.

Various classifications have been proposed for the Bivalves. Some divide them into *Siphoniata* and *Asiphoniata*, according to whether siphons are present or not, others distinguish *Monomya*, forms with one adductor muscle only, *Isomya*, with two equally developed muscles, and *Heteromya*, with two unequally developed muscles. More modern classifications are based upon the structure of the gills, and four orders are recognized according to whether the filaments of which the gill is composed are flat and non-reflected (*Protobranchia*), or reflected (*Filibranchia*) or transversely united into a kind of meshwork

(*Eulamellibranchia*), or whether the gills have lost their function of respiratory organs (*Septibranchia*). Unfortunately it would be difficult to demonstrate these anatomical features satisfactorily even with a series of wet preparations, at least in a public Museum, and the visitor will have to accept these four orders on good faith. The collection has no specimens belonging to the first and the last of these orders, but the second and the third are well represented.

Filibranchia. We begin with a very unusual looking shell, *Placuna placenta*. It is of medium size, 4 to 5 inches in diameter, flat and almost circular, thin and so transparent that according to Tenison Woods it is used instead of glass in window frames in the Philippines, Macao etc. *Placuna sella* is much larger, about 8 inches in diameter, also nearly circular, but twisted somewhat in the shape of a saddle from which it has received its popular name of 'Saddle-Oyster.' Both of them are asymmetrical. The next sub-order includes symmetrical animals, like the Arc Shell (*Arca granosa*). A collection of them, from the Fish Market, presented by Mr. C. H. Clarke, is exhibited. The valves are boat shaped, ribbed and can always be told by their straight hinge which bears numerous teeth. It is edible.—The well-known Mussel (*Mytilus*) and its allies form a third suborder. Exhibited is *M. smaragdinus*, from Singapore, with a bright grass green shell. The most important suborder of the *Filibranchia* is that of the *Pectinacea*. It contains first of all shells with strange wing-like processes, as *Avicula macroptera*. Specimens of it, from Pulo Brani, were presented by Lieut. C. B. Harvey in 1897. Of the greatest economic importance is the Pearl Oyster (*Meleagrina margaritifera*). Some specimens of it, and apparently the first ones from this neighbourhood, were obtained two years ago close to Singapore in three fathoms of water by Mr. W. F. C. Asimont. The shells were exhibited at the Agricultural Show in August, 1906 and were subsequently presented by Mr. Asimont to the Museum. Richest in Pearl Oysters is the North Coast of Australia, and the shells of this particular species are of value not only through any pearls they may contain, but also because their mother-of-pearl may be turned into the most varied useful articles. The shells of the Ceylon Pearl-Oyster (*Meleagrina fucata*) are too small and too thin to be of much use and are of value only through their pearls. The pearls are pathological products, being a secretion of the mantle around foreign bodies. In the Pearl Oyster of Ceylon the foreign body is stated to be a small parasite, the scolex (or

'head') of a Tapeworm. Closely allied to the Pearl-Oyster is the Hammer-Oyster (*Malleus albus*), thus called from its curious T shape. The various species of the Thorny Oyster (*Spondylus*) are often brilliantly coloured. They have their name from the spine-like processes of the shell. Of Scallop Shells there is a great variety, including forms beautiful through their sculpture and colouring. They are generally marked with radiating ribs, but others are smooth. To the latter belongs *Pecten japonicus*. One of its valves is terracotta-red, marked with darker concentric lines which are as regular as if they had been painted. The other valve is white.

Eulamellibranchia. This order is larger than the preceding one and includes first of all the Edible Oyster (*Ostraea edulis*). Oysters of various species are found on rocky coasts all over the world, the Arctic regions excepted. The Singapore market receives its chief supply of them from Muar, but some also from the West Coast of Sumatra. The Muar Oysters are, from information kindly furnished by Mr. Makepeace, found in the bed of the river, some near the town of Banda Maharani, others nearer the mouth. The latter are a bigger and better quality and are reserved for the Sultan and the officials. The Oysters are found at a depth of 15 to 20 feet, on muddy bottom. They are collected at low tide by men who go over the beds in small kolehs and dive for them. Their price in Singapore is \$1 a bag, in Muar only 40 to 50 cents. Specimens from there, presented by Mr. C. H. Clarke, are exhibited. To the Oyster tribe belongs also *Pinna*, a large shell of triangular shape, common locally and usually found sticking in the mud. Its projecting razor-sharp edges inflict serious wounds to any one stepping upon them unawarily. Most freshwater bivalves belong to this order, like *Cyclas* and *Pisidium*, both of which are very small, and the much larger *Unio* and *Anodonta*. More than one thousand species belong to the Freshwater Mussel *Unio*. It differs from *Anodonta* by its thick shell and toothed hinge. Specimens of *Unio* sp., from Raub, Pahang, presented by Mr. Rostados, are exhibited. A marine shell of brilliant violet colour is *Maetra violacea*, and one showing delicate sculpture is *Venus clathrata*, from Blakang Mati. The Cockles belonging to the genus *Cardium* abound in shallow water buried in the sand. An exquisite form is the heart-shaped *Cardium cardissa*. Closely allied to the Cockle is the largest of all living Bivalves, the Giant Clam (*Tridacna gigantea*). This species abounds on the Great

Australian Barrier Reef and on many places in the Indo-Malayan region. On Cocos Keeling Island it is so common that it is used as a washing tub. The largest specimen in the Museum measures 3 feet 6 inches in length. Its right valve weighs 191 catties, its left valve 188 catties, giving a total of 505 lbs. (=229 kilos). Pelseneer makes the remarkable statement that these large Molluscs live only about eight years. If so, they would have to deposit carbonate of lime at the rate of 234 oz. per day, in order to form those huge shells, an enormous amount, considering that these creatures live on microscopic animals only. However, it is perhaps not more remarkable than that the whale, the largest of all animals, living or extinct, derives its food from Copepods, minute Crustaceans, which are not much more than microscopic. The Clams have only one adductor muscle. Its impression, placed near the centre of each valve, is plainly visible in the exhibited specimen, being about 4 inches in diameter. *Tridacna squamosa* is a smaller species, with rows of pocket like scales on its surface. Allied to the Clams is *Hippopus maculatus*. Its generic name signifying 'Horse's foot' is due to the resemblance which its two valves when placed together, have to a horse's hoof. The Razor-shell (*Solen*) has its popular name from its long straight valves, resembling the handle of a razor. It burrows in sand and can do so with great rapidity, escaping even capture. Very remarkable through their habits are the boring shells. *Pholas* bores in hard clay and chalk, or even limestone and sandstone. *Xylophaga* (literally the 'Wood-eater') and *Teredo* (i.e. the 'Borer') bore in wood. *Teredo*, the Ship-Worm, is well-known through the ravages which it does to the timber of ships and harbour works. Its shell is only small, about $\frac{3}{4}$ inch in size. Its siphons, however, are enormous, reaching two or three feet in length, and on account of its inconspicuous shell the older naturalists, including even Linnaeus, took it for a worm. It lines the tunnels which it excavates, with a calcareous tube. *Aspergillum* (= *Brechites*), the last species we have to mention, is in shape perhaps the most remarkable of all Lamellibranchs. It has a pair of normal valves only when quite young. But its long siphons soon secrete a tube which is open at the one end, and closed at the other by a sieve-like perforated disk. The original valves, only about $\frac{1}{8}$ inch in length, become soldered into this tube. This mollusc lives buried into the sand, with the sieve-like end projecting.

CUTTLE-FISHES (*Cephalopoda*).

The *Cephalopoda* include Squids, Cuttle-Fishes and Nautili, and they are all marine. They are bilaterally symmetrical and possess all the parts which above (see p. 78) were enumerated as constituting the body of a typical Mollusc. The head is large and bears two eyes which in some species are of enormous dimensions. The foot is present too, but has undergone extraordinary modifications. It has been split up into a number of tentacles or arms surrounding the mouth. Also the mantle is present and forms a spacious cavity containing the gills. The communication of this branchial cavity with the outside is established by a funnel which may consist either of one piece or of two pieces closely applied against each other. This funnel is also derived from the original foot. There is, at least in most cases, also a radula. As the arms of the Cuttle-fishes are derived from the foot, it follows that the mouth with the surrounding arms is to be regarded as situated on the ventral surface of the body. Dorsal to it is the visceral hump of the body, whilst the branchial cavity with the funnel is situated posteriorly.

A proper external shell, formed by the mantle, is found in *Nautilus* only. The shell of the Paper-Nautilus (*Argonauta argo*) is formed by the female only and is secreted not by the mantle, but by the two dorsal arms of the animal. It serves in the first instance as receptacle for the eggs, though the mother *Argonauta* can retreat in it as well.—The shell of *Spirula* is very small compared with the body of the animal, it is of the shape of a ram's horn and almost entirely internal. In the other Cephalopods the shell is much reduced or may be nearly obsolete and is covered over with the mantle. These internal shells are flat and straight and consist of calcareous or horny matter.

All Cephalopods, with the exception of the *Nautilus*, possess an ink bag. It opens into the same funnel from which the respiratory water is expelled, and the inky fluid discharged is probably a means of defence, enabling the animal to make itself invisible to pursuing enemies. Cuttle-fishes progress by walking with their arms and by swimming. The swimming is effected by the expulsion of water from the funnel. In intelligence they stand far above the other Molluscs.

The Cephalopods are divided into two principal groups according to the number of their gills, viz. into *Tetrabranchia*, with four gills, and *Dibranchia*, with two gills.

The *Tetrabranchia* have four gills, an external shell, numerous tentacles and a funnel consisting of two halves. They have no ink bag. There are only four living forms representing this group and all belong to the genus *Nautilus*, but several thousand extinct species are known. All the fossil *Ammonites* belonged to the same group. Some of them had coiled shells, like *Nautilus*, others straight ones, which have to be understood as having become unrolled. Some of those straight forms, like *Endoceras* and *Orthoceras*, used to reach a length of six feet, whilst some of the coiled *Ammonites* grew to over two feet in diameter. The shell of *Nautilus* is chambered, the animal inhabiting only the last compartment, but all the various chambers are connected with each other by holes in the septa.

The *Dibranchia* have two gills, a rudimentary internal shell, eight or ten arms, a funnel consisting of one piece only, and an ink bag. All their arms bear rows of suckers which in the largest species attain the size of a saucer. They are further divided into *Decapoda*, with ten arms, and *Octopoda*, with eight arms.

The *Decapoda* * have ten arms two of which are much longer than the eight others. Their body is generally elongated and provided with lateral fins. This section includes, besides the fossil *Belemnites*, *Spirula* (see p. 89), the true Cuttle-fish (*Sepia*), the smaller *Sepiolo*, and the Squid (*Loligo*). *Sepia* has a calcareous internal shell, but *Loligo* a horny one, in the shape of a spear head. The largest Cephalopods observed yet belong to the genus *Architeuthis* and are allied to the Squids. A monster was caught off Newfoundland, in 1874, the two long arms of which measured 24 feet each, and the eight short ones 6 feet each.

The *Octopoda* have eight uniform arms and a short rounded body. *Octopus* and the Paper-Nautilus (*Argonauta argo*) belong to this group.

Cuttle-fishes of all sorts form an important and much esteemed article of food amongst the Chinese. They are lightly salted, pressed and sun dried, and Tenison Woods says that "all kinds are eaten," but that "the best one is the little *Sepiolo* which is really a dainty morsel when properly cooked."

* It is unfortunate that the term 'Decapoda' is also used for an order of the Crustacea (see p. 71). The two groups have nothing in common.

STARFISHES AND SEA-URCHINS.



(*Echinodermata*).

The sub-kingdom of the Echinoderms includes Starfishes, Brittle Stars, Sea-Urchins, Sea-Cucumbers and Feather Stars. They are all marine and form an exceedingly well defined division of the animal kingdom.

The animals which we have considered so far, were bilaterally symmetrical, i.e. they can be cut lengthways into two equal halves, a right and a left one. But in a Starfish or other Echinoderms the chief organs of the body are arranged like the spokes of a wheel, and there are as many directions in which the animal can be bisected, as there are arms. Such an arrangement of the body is called radial symmetry, and we find such symmetry also amongst Jelly Fishes and Corals. Most Starfishes have five arms.

A further characteristic of Echinoderms (i.e. 'Spiny-skinned') are the calcareous plates which are imbedded in the skin and which are usually raised into projections or even spines. The plates may form a continuous shell, as in Sea-Urchins, or may be much reduced, being present in Sea-Cucumbers as microscopic spicules only, in the shape of anchors and wheels.

A live Starfish moves about with the mouth directed downwards, the latter lying in the exact centre of the body. The vent is on the opposite, upper side. At one side of the vent, therefore excentrically placed, is a round sieve-like perforated plate, the madreporite. Arising from the mouth are five grooves which run along the whole length of the five arms. No such grooves exist on the upper side. Each of those so-called 'ambulacral grooves' contains two rows of small transparent feet, called tube-feet which are really organs both for locomotion and sensation and end in small sucking disks. The madreporite and the tube-feet are parts of the water-vascular system

which, like the radial symmetry and the spiny condition of the skin, is a characteristic feature of the Echinoderms. From the madreporite descends a short, straight canal which joins a ring-like canal encircling the mouth. The 'ring canal' in its turn leads into five canals which run along the whole length of the arms and give off the closely-set tube-feet. Water is taken in by the madreporite and driven by cilia along the canals to the tube-feet to keep them distended.

Echinoderms are all marine. They are divided into five classes which we now proceed to consider.

STARFISHES (*Asteroidea*).

Two parts can be distinguished in the body of a Starfish, the central disk and the arms which are generally five in number. But the proportion in size between disk and arms varies greatly: the arms may be so much reduced in size that the animal assumes the shape of a five-sided cushion.—The ambulacral grooves are always present.

The most common Singapore Starfish is *Archaster typicus*. Its favourite habitat are sandy stretches where it may be picked up at low tide. Besides the normal five-rayed forms specimens with six arms are not at all uncommon, but four-rayed ones are much rarer. Specimens with 4, 5 and 6 arms respectively are exhibited side by side. A much larger Starfish is *Oreaster nodosus*. It is brick-red in colour, and its surface is raised into large black projections. *Calcita novae-guineae* has the shape of a flat pentagonal cushion. The only Singapore Starfish in the collection which normally has more than five arms is *Luidia maculata*. It is nine-rayed. One of the arms of the exhibited specimen is abnormally small, probably the result of an accident. This species is of rare occurrence.

BRITTLE STARS (*Ophiuroidea*).

The Brittle Stars have long and slender arms which are never absorbed into the body, like in some of the Starfishes, and are always distinctly marked off from the disk-like centre. The scientific name signifies 'Snake-tails,' whilst the popular name refers to the great fragility of the arms. The ambulacral groove has been transformed into a closed tube and is not visible externally. The tube-feet have no sucking disks and do not serve any more as locomotory, but only as tactile organs. The arms of some species are subdivided.

There are many more Brittle Stars on the local coral reefs than Starfishes, but unfortunately the majority are most difficult to preserve, the arms being so long and exceedingly brittle. Most fragile are the various species of *Ophiothrix*, the arms of which are beset with dense rows of spines. A spineless, smooth species is *Ophiolepis annulosa*. It is grey in colour with a black star on its disk and black bands across its arms. *Trichaster* sp. has long and stout arms the ends of which are branched. In *Astrophyton* the arms begin to divide from near their base, the branching being repeated many times, the final twigs being exceedingly slender, the whole resembling the most delicate lace-work. The specimen exhibited was dredged off St. John's Island in December 1896, in a depth of 20 fathoms.

SEA-URCHINS (*Echinoidea*).

The Sea-Urchins have lost all traces of arms. The majority are more or less spherical in shape and show a five-rayed symmetry. Others are heart-shaped or disk-shaped and are bilaterally symmetrical. Imbedded into the skin of a typical Sea Urchin we find 20 rows of plates which are arranged like the meridians of a globe and form a continuous shell. The plates are covered with spines. The tube feet are even more developed than in Starfishes. They are arranged over five double rows of those plates which are perforated for their passage and are called ambulacral plates. The other five double rows of plates which lie between the ambulacral plates and are not perforated, are called interambulacral. All those plates and pores are arranged meridionally, from the mouth on the lower surface to the vent on the upper surface of a Sea-Urchin, as can be seen on any specimen from which the spines have been removed. The mouth is surrounded by five teeth which internally are supported by a curious structure of ossicles which was first described by Aristotle and who compared it to a lantern in shape. This structure has ever since been called "Aristotle's lantern". It is seen in any ordinary Sea-Urchin which has been cut open.

Sea-Urchins are divided into three orders, the Regular Urchins (*Regularia*), the Cake Urchins (*Clypeastroidea*) and the Heart Urchins (*Spatangoidea*).

The most common of local Regular Urchins is a species of *Salmacis*. It is found on sandy places, is of greenish colour and has thin and short spines. Common also, but only on coral reefs, is *Diadema setosum*. It is of dark purple colour and

has thin spines nearly a foot in length. Very conspicuous are its five eyes of brilliant blue colour which are arranged around the vent. It is apparently very well able to see with them, as it always moves its spines in the direction from which one approaches it. Rarer locally is *Phyllacanthus annulifera*, obtainable by dredging in a few fathoms of water. Its spines are thick, about 2 inches in length and are beset with whorls of spikes. The Slate-pencil Urchin (*Heterocentrotus mammillatus*) has exceedingly thick spines. A specimen from Cocos Keeling I., presented by Mr. Ladds, is exhibited. *Asthenosoma heteractis* is locally of rare occurrence, but may be dredged in Keppel Harbour. It is of a somewhat flattened shape. Nobody who ever took it personally out of the dredge is likely to forget the occasion. It causes the most painful burning sensation on one's hands, due to poison glands at the bases of the spines. Some Sea-Urchins, like *Strongylocentrotus* and *Echinometra*, live on rocky coasts, exposed to the full force of the waves. They are found in holes from which they can be dislodged only with the greatest difficulty, their size just fitting that of the hole. It is a matter of dispute whether they make these holes, perhaps by the continuous movement of their spines, or whether they merely wander into a suitable crevice and remain there until by their increase in size they just fill up the place. Such Sea-Urchins occur on Christmas Island.

The Cake Urchins, also called Shield Urchins or Sand Dollars, are disk-shaped and quite flat, barely of the thickness of a cent piece. Various species of *Arachnoides*, *Peronella* and *Laganum* are fairly common on sandy shores, like Tanjong Katong. *Lobophora* is similar, but has two narrow slits in its shell. These Urchins are more or less bilaterally symmetrical. The ambulacral pores are arranged in leaf-like patterns, and the vent has in most cases shifted to the under surface. The spines are extremely small.

The Heart Urchins, locally represented by *Brissus carinatus*, are heart-shaped. Whilst resembling the Cake Urchins by their bilateral symmetry and the leaf-like arrangement of the ambulacral pores, they differ from them by being much thicker, by having much longer spines and by the absence of Aristotle's lantern.

SEA-CUCUMBERS (*Holothuroidea*).

We call the principal axis of the body of an Echinoderm a line running from mouth to vent. In a Starfish this axis is

very much shorter than the horizontal one from tip to tip of the arms, whilst in the regular species of Sea-Urchins it may approach the horizontal axis in length. The Holothurians are the only class of Echinoderms in which the proportions are reversed. Their body is greatly elongated in the direction of the principal axis and assumes the shape of a sausage. Their popular name of 'Sea-Cucumbers' is due to this shape. Commercially they are known as 'Trepang' or 'Bêche-de-mer.' Their skin is leathery, the calcareous plates of other Echinoderms being reduced to microscopic spicules. The tube-feet are generally present, but are not always regularly arranged. The body is in many cases somewhat bilaterally symmetrical, the animal having adopted the habit of creeping on a certain side of its body. The mouth is surrounded by a fringe of branched retractile feelers or tentacles.

The Holothurians are divided into five orders of which three are represented in the collection, viz. the *Aspidochirota*, *Dendrochirota* and *Synaptida*.

The *Aspidochirota* have shield-like feelers. It is the most important of the five orders, not only because they form nearly one third of all Holothurians, but also because apparently all edible species belong to it. Many species of this order may be collected here at low tide, and when seen lying on the sand these black sausage shaped creatures, with their slimy and sticky skin, are certainly the least attractive of marine animals especially as when handled, they shoot out the greater part of their intestine. However, when seen in clear water, with their feelers fully expanded, they offer a very much more pleasing and interesting appearance. The collection contains, besides seven species of *Holothuria*, also a specimen of the so-called 'Prickly-red' (*Stichopus variegatus*). It is yellowish-brown in colour, with red papillae. Saville Kent, in his 'Great Barrier Reef of Australia,' gives a graphic description of the Trepang fishery in Queensland. The animals when collected, are first boiled for twenty minutes in large iron caldrons, then split up, cleaned, roughly dried in the sun, then transferred to the smoke-house, placed on tiers of wire netting and smoked for twenty-four hours by a wood fire. They then look like charred sausages. It is essential that they are absolutely dry when packed for shipment, the proof of their good condition being that "they rattle like walnuts in their bags." They are practically only for the Chinese market.

The extent of the trade in this article in Singapore is seen from the following figures: during the year 1907, trepang

to the total amount of \$221,994 was imported to Singapore, viz. \$44,818 from Celebes, \$37,627 from other parts of the Netherlands Archipelago, \$31,998 from British North Borneo, \$21,975 from the Sulu Archipelago, and the balance from elsewhere. The total exports during the year amounted to \$442,102, Hongkong taking \$315, 882 and China \$124,693.

The *Dendrochirota* have feelers which are branched in a tree-like fashion. They include some attractive looking species, like *Colochirus coerules*, dredged off Tanah Merah, Singapore, which has teat-like processes, and *Haplodactyla* sp., from Pasir Panjang, which is semi-transparent and of pinkish colour.

The *Synaptida* differ from the other Holothurians by the total absence of tube-feet. Some of them are of surprising beauty when seen in their natural element, with their clear and transparent skin, and with body and tentacles fully expanded. Some are two and more feet in length and $\frac{1}{2}$ to 1 inch in thickness. Unfortunately they break up when taken out of the water and fade almost into nothing, unless special precautions are taken.

SEA LILIES AND FEATHER STARS (Crinoidea).

The Crinoids differ from the other classes of the Echinoderms by possessing a stalk, at least in their young stages, with which they are fixed to the bottom of the sea or some other object, and by their mouth being always directed upwards. The arms are well developed and are beset with a double row of short branches called 'pinnules.' The Crinoids were abundant in former periods of the earth, but only five families have survived to the present day, two of which are represented in the Museum, the *Pentacrinidae* and the *Comatulidae*.

The *Pentacrinidae* or Sea Lilies, including the two genera *Pentacrinus* and *Metacrinus*, occur only in great depths of the sea. They have long stems which are beset with whorls of branches, called 'cirri.' All the specimens in the Museum are from telegraph cables and were presented by Mr. W. Maclear Ladd. The largest of them is from the China Sea, lat. 19° 18' N., long 120° 14' E., from a depth of 114 fathoms.

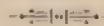
The *Comatulidae* or Feather Stars are stalked only during their early stages. They soon lose the stalk which in adult specimens is represented merely by a stump bearing a number of 'cirri' which correspond to the organs of the same name in

the Sea Lilies. The use of these cirri is to allow the animal to anchor itself to other objects. The number of the arms varies, it may be 5, 10, 20, 30, 40 or even more, and by their means the animal is able to swim about, its movements being of the most graceful character. Several hundred species of Feather Stars are known, most of them belonging to the genera *Antedon* and *Actinometra*. A few species live in European waters, but richest in them is the Malay Archipelago. They occur in great profusion on the local coral reefs, and no dredge can be raised in Keppel Harbour which does not contain numbers of them. They are of the most varied colours, yellow, orange, red, mottled brown and white, and so on. Their delicate shape, their rich tints and their graceful movement entitle them to carry the prize for beauty in the animal kingdom. *Antedon andersoni*, *A. indica*, *Actinometra nobilis* and many other species are exhibited.

Nearly all the Crinoidea, as also most of the Holothurians in the collection, were identified in the year 1899 by the late Mr. F. P. Bedford.

ZOOPHYTES, JELLY-FISH AND CORALS

(*Coelenterata*).



The sub-kingdom of the Coelenterates includes a variety of animals, the Freshwater Polyp, the Zoophytes, Jelly-Fish, Sea-Anemones, Corals, Sea-Fans and Sea Pens.

Their structure is best explained on that of the simplest member of the group, the Freshwater Polyp *Hydra*, which is so common in Europe and has been found in many other parts of the world as well, though it has not yet been recorded from Asia.

Hydra has a slender tubular body, closed at the lower end, with a mouth at the upper end and a series of tentacles, generally six to eight, arranged around the mouth. The lower end is disk-shaped and serves for the attachment of the animal to water weeds and other objects. The body-wall consists of two layers of cells, an outer one, the ectoderm, which is protective, sensory and reproductive, and an inner one, the endoderm, which is digestive. The cavity enclosed by the body-wall is called the coelenteron. Both body and tentacles are highly contractile. When fully expanded the two together may measure as much as an inch in length. When contracted they form roundish knobs barely 1/16 inch in size. *Hydra* is carnivorous and paralyzes and kills its prey by means of its tentacles. Imbedded into the ectoderm of the tentacles, and to a lesser degree into that of the body, is a curious kind of cells, called thread-cells or nematocysts. Each of these cells contains a spirally coiled up thread which is provided with barbed hooks and some poisonous substance. When the *Hydra* becomes irritated, e.g. by a passing animal, the threads become discharged and fix themselves into the body of its prey, paralyzing and killing it. All other Coelenterates possess similar thread-cells, and any one who has handled living Zoophytes and Jelly-Fish will know the stinging sensation caused by them.

Hydra shows in its tubular body and the arrangement of the tentacles around the mouth a radial symmetry of structure

which is seen more plainly in larger Coelenterates, like the Jelly-Fish and Sea Anemone. This is a point of resemblance with the Echinoderms, but otherwise they differ throughout from the Echinoderms and all other higher animals. In the latter the alimentary canal is always enclosed in a special cavity, the coelom. There is no such cavity in Coelenterates. Their body-wall forms at the same time the wall of the digestive cavity or coelenteron. The second great difference of the Coelenterates from all higher animals is the presence of the thread-cells in the former.

Coelenterates are divided into three classes, (1) the *Hydrozoa*, including chiefly *Hydra* and the Zoophytes; (2) the *Scyphozoa* or Jelly-Fish; and (3) the *Anthozoa*, including Sea Anemones, Corals, Sea-Fans, Sea Pens and their allies.

HYDROZOA.

The simplest member of the class is the Freshwater Polyp *Hydra*. To its description given above we only have to add that it reproduces asexually and sexually. The asexual method of reproduction or 'budding' consists in the formation of an hollow outgrowth from the sides of its body which develops tentacles and becomes in all details like the parent *Hydra*. This outgrowth or 'bud' may become detached, or may remain attached for a considerable time to form with other buds a tree-like colony. The sexual method consists in the formation of eggs in the ectoderm of the *Hydra*.

The other *Hydrozoa* are very much more complicated, both in structure and in development. They nearly always form colonies with two or more sorts of polyps. One kind of the polyps remains sterile, and devotes itself merely to feeding the colony, whilst the other kind develops into little swimming bells resembling Jelly-Fish (so-called 'Craspedote Medusae') which become detached from the parent stock, swim about freely and lay eggs from which again fixed tree-like stocks are developed. This process is repeated over and over again and is called 'alternation of generations.'

We mention only two or three of the numerous orders of this class, those which develop either a horny or a calcareous skeleton. Those with a horny skeleton are popularly called Zoophytes and are frequently mistaken for sea-weeds. They form tree-like colonies with horny stalks, and horny cups into which the little polyps can withdraw for protection. They are common in shallow water, and their dead skeletons may

often be picked up on the shore. Some of the best known genera belonging to this order are *Sertularia*, *Plumularia* and *Antennularia*. Others form a skeleton of lime, like *Millepora* and *Stylaster* and thus resemble true Corals. *Millepora* grows in solid masses, whilst the various species of *Stylaster* are delicately branched and exquisitely coloured, white, pink and salmon.

JELLY-FISHES (*Scyphozoa*).

This class includes most of the Jelly-Fishes or Medusae. Whilst *Hydra*, the type of the former class, is tubular, the Jelly-Fishes are bell or umbrella-shaped. They also have an ectoderm and an endoderm, but between the two and secreted by them is an additional layer, the mesogloea, of gelatinous consistency, which is often extremely thick and constitutes the chief mass of the body. The roof of the bell corresponds to the foot of the *Hydra*, whilst the mouth of the Medusa lies on the under side of the body, between the tentacles. Medusae occur in all seas and are generally seen near the surface, where through the pulsating movement of their wonderfully shaped and wonderfully coloured, semi-transparent bodies they offer a most interesting and beautiful spectacle. They vary greatly in size. Some are as much as three or four feet in diameter.

CORALS and SEA ANEMONES

(*Anthozoa* or *Actinozoa*).

The Anthozoa differ from the two former classes in having a special tube which leads from the mouth to the coelenteron, and in this latter cavity being divided by a number of vertical partitions, called mesenteries or septa, into as many compartments. A section across the body of a Sea Anemone or Coral would therefore appear like a wheel with its spokes. There are either 4, 6 or 8 of those mesenteries and compartments, which allows the class to be divided into *Tetracorallia*, *Hexacorallia*, and *Octocorallia*. The *Tetracorallia* are known in the fossil condition only.

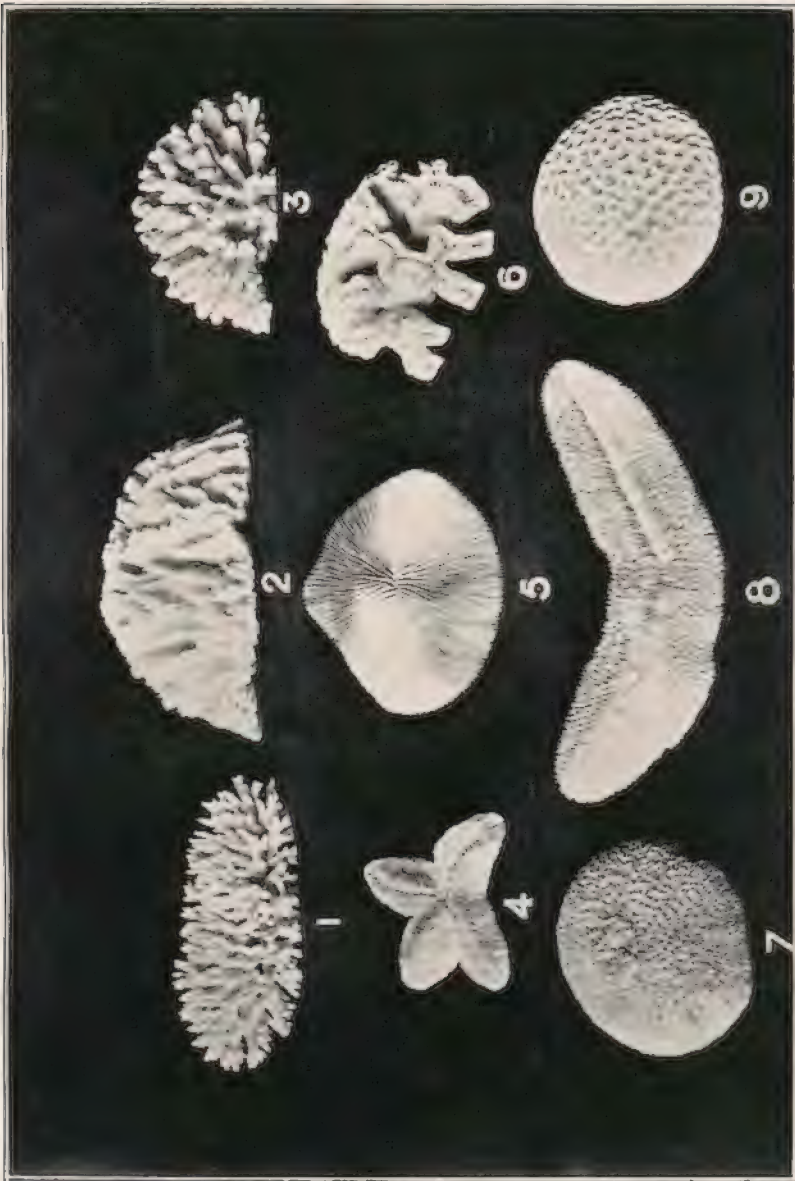
The *Octocorallia* or *Alcyonaria* have eight tentacles and eight mesenteries. *Alcyonium digitatum* or Dead Man's Finger is common on rocks of the English coast. It forms lobed or finger-like masses of white or yellowish colour, the polyps being held together by a fleshy substance (mesogloea), imbedded in which are spicules of lime. Allied species of *Alcyonium* occur

in profusion on the local coral reefs, e.g. at Blakang Mati. *A. pachyclados* has thick finger-like lobes, *A. leptoclados* thin ones, whilst *A. murale* has wall-like lobes, as the name signifies. Similar forms are *Sarcophyllum*, *Spongodes* and *Nephyta*, all of which are exhibited. A well-known form is the Organ-pipe Coral (*Tubipora musica*) with its deep red colour. Here each of the polyps is enclosed by a calcareous tube, all the polyps being arranged parallel to each other and being held together by transverse platforms. *Heliopora* forms lobed masses and can always be recognized by its blue colour. It occurs on the local reefs. The Red Coral (*Corallium nobile*), the precious coral of commerce, is found in the Mediterranean, whilst allied species are known from the coast of Timor and Japan. All these corals have a calcareous skeleton. But there are other corals with a horny one, and the genus *Isis* forms an interesting transition, as its skeleton is partly horny and partly calcareous. Those with a purely horny skeleton are the Sea-Fans (*Gorgonia* and *Rhipidigorgia*), the bush-like *Plexaura antipathes*, and the comb-like *Ctenocella*. Strange looking forms are the Sea-Pens *Pteroides* and *Pennatula* which grow in bilaterally symmetrical colonies. They consist of a stalk with leaf-like processes which carry the polyps. Imbedded in the fleshy substance of stalk and leaves are calcareous rays and spicules. Sea Pens are found in all depths, with their stalks imbedded in muddy or sandy bottom. A most remarkable organism is *Umbellula* which has so far been obtained only from the deep-sea, in 200 to 2500 fathoms. It has a long and thin stalk with a crown of long polyps on its upper end. The stalk is always swollen near its lower end. The specimen exhibited was obtained from a telegraph cable, at a depth of 350 fathoms, off Dana (New) Island, lat. 10° 51' S., long. 121° 17' E., and presented by Mr. Ladds in 1904. It is 26 inches in height.

The *Hexacorallia* or *Zoantharia* have typically six tentacles and six mesenteries, or a multiple of that number, though there are various exceptions from that rule. They include the Sea Anemones, most reef-building Corals and the Black Corals, or Fleshy, Stony and Horny Corals respectively. The Sea Anemones have no skeleton. They are generally solitary. One of the colonial forms is *Palythoa* in which the polyps are held together by a root-like crust. A specimen from Teluk Ayer is exhibited.

The vast majority of the Stony Corals form colonies or stocks. The polyps which compose these stocks are of greatly

varying dimensions. In a dead or bleached coral we see, of course, nothing of the polyps. All that remains are the calicles, the little skeletal cups which enclose and protect each polyp. Those calicles are sometimes only the size of a pin's head, as in a Staghorn Coral, or they may be $\frac{1}{2}$ inch across, as in a Star Coral. In the solitary Corals the individuals are generally much larger, reaching a foot in *Fungia*. We shall mention now seven of the more important families of the Stony Corals. The *Madreporidae* are the largest and best known family. They include the familiar Staghorn Coral (*Madrepora alvicornis*) (see pl. XX, fig. 1), which grows in abundance on the reef at Blakang Mati. However, not all species of *Madrepora* have such long and slender branches. Sometimes the branches are short and thick so that the stock resembles a cauliflower (*M. concinna*). At other times the stock forms a large flat reticulated mass. Such a coral is *M. reticulata*, of which a specimen, presented by Mr. Ladds, is exhibited. It had been picked in October 1896 by the Cable Ship 'Sherard Osborne,' in the Bali Straits, at a depth of 15 fathoms where it had grown round a cable laid in 1888. As the specimen measures 4 feet 5 inches by 2 feet 8 inches, it gives a proof of the rapid growth of Corals. To the same family belongs *Turbinaria*. One species, *T. crater*, is cup-shaped, whilst *T. peltata*, very common locally, is distinguished by its large eye-like calicles. The *Poritidae* grow in more solid masses and are generally found in the lower and outer parts of a reef, where they form a kind of base and protection for the more fragile species like the Staghorn Corals. A huge palmate mass of a *Porites* sp., from Blakang Mati, is exhibited, also a large encrusting *Porites* from Christmas I., the surface of which is raised into a number of stout cones. The *Turbinoliidae* are usually solitary. To this family belongs *Caryophyllia*, one of the few corals found in the seas around Great Britain. It never forms reefs and is cup-like. Closely allied is *Flabellum* which has the shape of a compressed cup. The *Oculinidae* grow in tree-like colonies, the calicles standing far apart from each other. Such a Coral is *Lophohelia*, found in deep water of the W. Coast of Scotland and elsewhere. Very similar is *Solenosmilia* of which there is a specimen, given by Mr. Ladds, from lat. 8° 3' S., long 115° 6' E., depth 100 fathoms. The *Astracidae* or Star Corals are thus called from the star-like shape of the calicles. They include *Galaxea* in which the calicles are slightly separated from each other; *Mussa* sp., (see pl. XX, fig. 6); the Brain Coral *Meandrina*, thus called from its brain-like convolutions;



CORALS.

(1) *Madrepora*; (2) *Ulophyllicia*; (3) *Stylopora*; (4) *Abnormal Haliglossa*; (5) *Fungia*; (6) *Massa*; (7) *Podoharctia*; (8) *Haliglossa*; (9) *Coniostrea*.



Goniastrea (see pl. XX, fig. 9), and *Ulophyllia* (see pl. XX, fig. 2) which with its frill-like shape is one of the most delicate Corals. The *Pocilloporidae* are represented by *Stylopora palmata* (see pl. XX, fig. 3), which has finger-like branches. Lastly there is the family of the *Fungidae*. Some of them are solitary, others colonial. To the former belongs *Fungia* (see pl. XX, fig. 5) which through its septa resembles a mushroom, and *Haliglossa* (literally 'Sea Tongue'), of an elongated tongue-like shape. A normal and an abnormal form of it are figured (see pl. XX, fig. 8 and fig. 4). Also three very large corals, which seem to stand between *Fungia* and *Haliglossa*, measuring about 17 by 10 inches, are exhibited. Colonial *Fungidae* are *Podobacia* (see pl. XX, fig. 7), and *Herpetolitha* (literally 'Creeping Stone'). An enormous specimen of the latter, measuring 2 feet 9 inches in length, presented by Dr. Abbott, is exhibited.

The Black Corals (*Antipatharia*) resemble the Gorgonids (see p. 101) in their bush-like growth. Their skeleton is horny and forms the axis of the branches, the latter being covered by a thin bark which contains the polyps. Some genera are greatly ramified, but the Black Coral of Commerce is not, or only slightly branched, and forms long twisted sticks, up to an inch and more in diameter. The chief supply came formerly from the Red Sea (*Antipathes arborea*), but *A. ternatensis*, from Ternate, and *A. abies*, from the Torres Straits, are now also much in demand. This coral takes a high polish and is used for bracelets, walking sticks, charms and amulets, and, of course, for medicine too. Its Malay name is 'Akar bahar,' i. e. root of the sea. The specimen in the collection was presented by Mr. P. M. de Fontaine.

The *Ctenophora* are an aberrant group of the Coelenterates. They differ from the other classes by the absence of thread-cells. There are none in the collection.

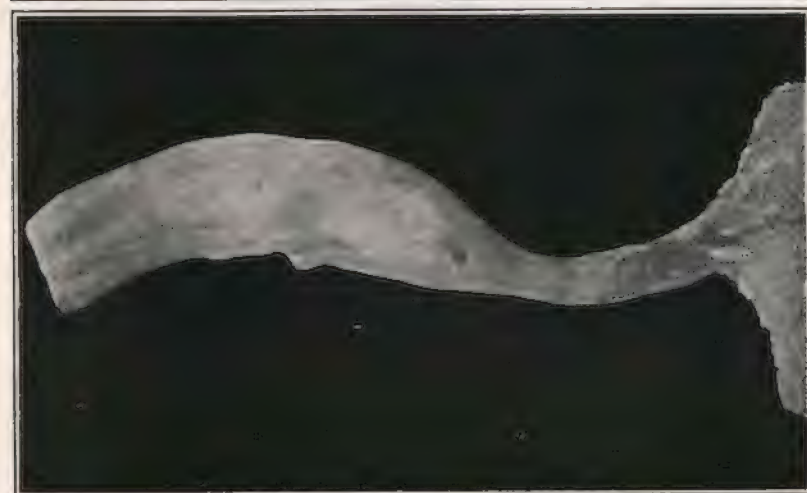
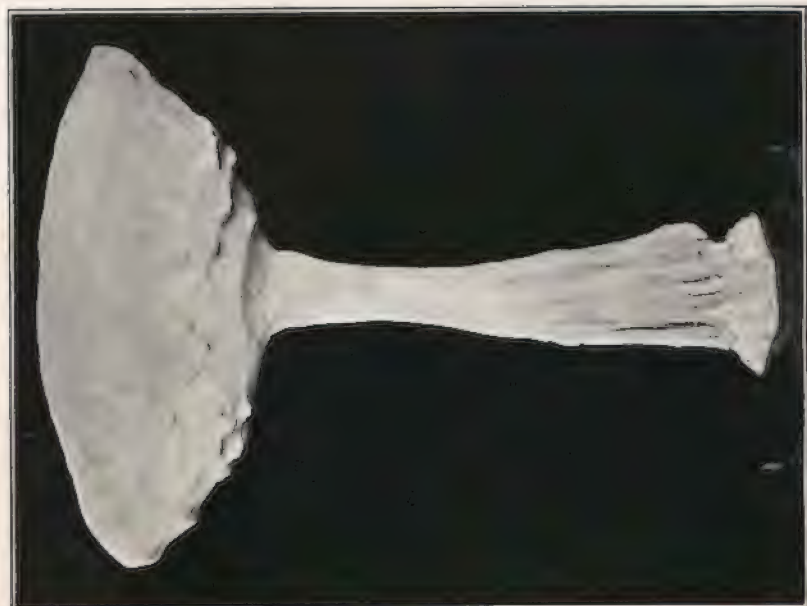
SPONGES

(*Porifera*).



The commercial Sponge, when alive, contains, besides the horny skeleton with which everyone is familiar, soft tissues of an intricate structure. Its surface is full of small pores which lead into a much-branching system of canals and chambers. Water conveying oxygen and food in the form of minute organisms is taken into these canals, is then driven along by the whip-like processes of the cells lining the chambers and finally leaves the body by large openings called 'oscula' carrying with it any waste products there may be. The name 'Porifera' by which Sponges are scientifically known, refers to the pores and oscula by which their surface is perforated.

The sponges of commerce are obtained principally in the West Indies, in the Adriatic and the eastern portion of the Mediterranean. After they have been collected their soft parts are removed by a careful process of maceration, leaving a horny and highly elastic skeleton. No Sponges of the finest qualities seem to occur in these waters, but there are many coarse kinds of Horny Sponges on the local coral reefs. They have a slimy surface and may be dark brownish green or purple or almost black in colour. In some species of Sponges the horny fibres contain sand grains and other impurities picked up from the bottom of the sea, others contain siliceous spicules which have been manufactured by the sponge itself. In other sponges again the horny fibres are absent altogether, and the skeleton consists merely of masses of siliceous spicules, arranged into regular strands or scattered loosely through the soft tissues, the spicules being of an almost endless variety in shape and size. In a few Sponges the skeleton has entirely disappeared: these are small and slimy species, generally forming a mere coating on stones and other objects. Finally some Sponges have a skeleton made of spicules of carbonate of lime. The siliceous spicules may be in the shape of rods, needles, pins, anchors, stars, crosses etc., and form beautiful microscopic objects. The calcareous spicules are simpler, one, three and four-rayed only.



VARIETIES OF THE NEPTUNE'S CUP (*Pecten neptuni*).

San Juan Kwang Photo.

According to the chemical nature of the skeleton and the shape of the spicules, if present, the sub-kingdom of the Sponges may be grouped into the following six classes which, however, are not of equal values:

1. *Myxospongiae*: Without a skeleton.
2. *Ceratosa*: Horny Sponges.
3. *Monaxonida*: Siliceous Sponges, with one-rayed spicules.
4. *Tetractinellida*: Siliceous Sponges, with four-rayed spicules.
5. *Hexactinellida*: Siliceous Sponges, with six-rayed spicules.
6. *Calcarea*: Calcareous Sponges.

The two varieties of Neptune's Cup (*Poterion neptuni*), shown on pl. XXI, belong to the *Monaxonida*. They occur in water of moderate depth and were yellowish grey in colour when alive. They are about 3 feet 6 inches in height. But on the local coral reefs *Monaxonida* of many different shapes are found, branching, fan-like, spherical, encrusting, and of all imaginable tints, yellow, grey, crimson, blue, green and black. Two specially beautiful specimens should be mentioned, both from Telegraph cables and presented by Mr. Ladds, viz. a *Chalina*, with large branching tubes, and an *Echinodictyum*, formed of a wide meshwork, fan-like spread out in one plane. The only known Freshwater Sponges (*Spongillidae*) also belong to this group. They are practically cosmopolitan and occur also in India and the northern parts of the Malay Peninsula, but have not yet been recorded from the southern parts.

The *Tetractinellida* are generally of a compact or spherical shape and of sober colouring, greyish or yellowish.

The *Hexactinellida* occur only in great depths. The best known of them is the Venus Flower Basket (*Euplectella aspergillum*). The exhibited specimens are merely the skeletons, the soft parts having been removed by maceration. Here the spicules are of great size and form thick glass-like strands or fibres. Some specimens, from the China Sea, from a depth of 115 fathoms, were given by Mr. Ladds, and others, from Cebu, said to have come from a depth of 42 feet only, by Dato Mentri Besar of Johore.

The Calcareous Sponges are white or light yellowish in colour. They attain their greatest development in the arctic seas. The local forms are few and small, mostly in the shape of little tubes, less than an inch in length.

With the Sponges we close our survey of the animal kingdom. The *Protozoa* which are the lowest animal organisms and consist of single cells only, are mostly invisible to the naked eye, and a description of them could not be attempted without microscopic preparations and elaborate models and diagrams.

INDEX

OF

Popular Names.

	<i>Page.</i>		<i>Page.</i>		<i>Page.</i>
Adjutant ..	18	Cats ..	4	Fire backed Pheasant ..	10
Alligator ..	39	Cattle Egret ..	19	Fish Hawk ..	34
Amphibians ..	47	Centipedes ..	65	Fish Owl ..	35
Anoa ..	10	Chamaeleon ..	41	Fishes ..	50
Ant-Eater ..	14	Chelonians ..	36	Fishing Eagle ..	54
Ant-Lions ..	60	Chevrotain ..	11	Flat Worms ..	76
Ant-Thrushes ..	26	Chimpanzee ..	1	Fleas ..	55
Ants ..	54	Chitons ..	78	Flies ..	55
Apes ..	1	Choughs ..	29	Flower peckers ..	31
Arc Shell ..	86	Cicadas ..	62, 64	Flycatchers ..	27
Argus Pheasant ..	16	Clear-wing ..	57	Flying Fox ..	4
Ascidians ..	52	Click Beetles ..	59	Flying Frog ..	48
Atlas Moth ..	57	Cobra ..	45	Flying Lemur ..	3
Babblers ..	28	Cockatoo ..	21	Flying Lizard ..	41
Babirusa ..	12	Cock-hafer ..	59	Flying Squirrel ..	7
Bamboo Rat ..	6	Cockle ..	87	Forktail ..	28
Banded Adder ..	45	Cockroaches ..	61	Fowl ..	16
Banting ..	9	Coconut Beetle ..	59	Freshwater Mussel ..	87
Barbets ..	21	Coelilians ..	49	Freshwater Polyp ..	98
Barking Deer ..	11	Coffee Locust ..	62	Freshwater Sponges ..	105
Barn Owl ..	35	Coppers ..	56	Frigate Bird ..	18
Barnacles ..	73	Corals ..	100	Froghoppers ..	64
Bat Hawk ..	33	Cowrie-shell ..	89	Frogmouths ..	25
Bats ..	3	Crabs ..	71	Frogs ..	47
Bay Owl ..	35	Crackle ..	32	Game Birds ..	16
Baza ..	34	Crayfish ..	72	Gannet ..	18
Beaked Rays ..	52	Crickets ..	67	Garden Snail ..	83
Bear ..	6	Crocodyles ..	33	Gavial ..	40
Bêche-de-mer ..	95	Crow Pheasant ..	21	Geckos ..	41
Bee-Eaters ..	24	Crows ..	29	Gharial ..	40
Bees ..	54	Crustacea ..	71	Giant Clam ..	87
Beetles ..	58	Cuckoo ..	21	Gibbon ..	1
Binturong ..	5	Cuckoo Falcon ..	34	Gnats ..	55
Birds of Paradise ..	29	Cuckoo-Shrikes ..	27	Goat ..	10
Birds of Prey ..	32	Cuttle-Fishes ..	89	Goatsuckers ..	25
Biscuit Weevil ..	59	Dead Man's Finger ..	100	Goliath Beetle ..	59
Bishop's Mitre ..	81	Death's-head Moth ..	57	Gorilla ..	1
Bittern ..	19	Deer ..	10	Grasshoppers ..	62
Bivalves ..	84	Dog ..	5	Green Turtle ..	37
Black Ape ..	2	Dolphin ..	14	Ground Beetles ..	50
Black Coral ..	103	Dove ..	17	Gull ..	18
Blind Snakes ..	43	Dragonflies ..	63	Gymnura ..	3
Blues ..	56	Drongo ..	31	Hamadryad ..	45
Boutswain Bird ..	18	Duyong ..	13	Hammer-headed Shark ..	51
Booby ..	18	Eagle Owl ..	35	Hammer Oyster ..	87
Brahminy Kite ..	33	Eagles ..	33	Hare ..	6
Brain Coral ..	102	Earlet Shell ..	83	Harp-shell ..	81
Brain-fever Bird ..	21	Earthworm ..	75	Harvest Spiders ..	70
Brickly-red ..	95	Earwigs ..	61	Hawk Moth ..	57
Brittle Stars ..	91, 92	Eastern Raya ..	32	Hawk Owl ..	35
Brimstones ..	57	Edentates ..	14	Hawks ..	33
Broadbills ..	26	Edible Snail ..	83	Hawks-bill Turtle ..	37
Bubble-shell ..	81	Edible Turtle ..	3	Heart Urchins ..	93, 94
Bugs ..	62	Egg-Shell ..	81	Helmet-shell ..	81
Bulbuls ..	27	Egret ..	19	Hermit Crabs ..	73
Bull Frog ..	48	Electric Ray ..	52	Heron ..	18
Burmese Nightingale ..	28	Elephant ..	7	Honey Bear ..	6
Burnets ..	58	Fairy Blue-chat ..	27	Honey Buzzard ..	33
Butcherbird ..	39	Falconet ..	34	Hornbills ..	22
Butterflies ..	55	Falcons ..	34	House Swift ..	25
Cachalot ..	14	False Scorpions ..	70	Iguana ..	41
Caddis Flies ..	69	Feather Stars ..	91, 96	Insects ..	73
Cake Urchins ..	93, 91	Fig-shell ..	81	Java Sparrow ..	32
Cassowary ..	15	Finches ..	32	Jays ..	29

	<i>Page.</i>		<i>Page.</i>		<i>Page.</i>
Jelly-Fish	98, 100	Partridge	16	Spider Hunter	31
Jungle Fowl	16	Pea Fowl	16	Spider-shell	80
Kanchil	11	Pearl Oyster	86	Spiders	67
Kerbau	9	Pelandok	11	Sponges	104
Kestrel	34	Pelican	18	Springtails	64
Kijang	11	Perching Birds	23	Squids	89, 90
King Crabs	74	Pern	33	Squirrels	7
King Crows	31	Pheasants	16	Staghorn Beetle	59
Kingfishers	24	Pig-tailed Monkey	2	Staghorn Coral	102
Kra	2	Pigeons	17	Star Corals	102
Lace Coral	77	Pigs	11	Starfishes	91, 92
Lady-Birds	60	Pill Millipedes	65	Starlings	32
Langurs	2	Pittas	26	Stick Insects	61
Lanternflies	62, 64	Plover	20	Stone Plover	20
Laughing Thrush	28	Pond Skaters	63	Stork	18
Leaf Insects	61	Porcupine	6	Sunbirds	31
Leaf-Monkey	2	Porpoise	14	Swallow Tail	57
Leathery Turtle	36	Prawns	72	Swallows	27
Leeches	76	Praying Insects	61	Swiftlet	25
Lemur	2	Proboscis Monkey	2	Swifts	25
Leopard	4	Python	43	Tailor Bird	29
Limpet	79	Rails	19	Tape Worm	76
Liver Fluke	76	Rats	6	Tapir	8
Lizards	40	Rays	50	Tarsier	2
Lobsters	71, 72	Razor-shell	88	Teal	18
Locusts	92	Red Coral	101	Tembau	9
Loggerhead Turtle	38	Reptiles	36	Termites	60
Longicorns	60	Rhinoceros	7	Tern	18
Loopers	58	Rice Bird	32	Thamin	11
Loriquet	21	Rollers	24	Thrush-Babbler	28
Loris	2	Rose Beetles	59	Thrushes	28
Lotong	3	Saddle-Oyster	86	Ticks	70
Macaque	2	Sambar	10	Tiger	4
Maggie Robin	28	Sand Dollars	94	Tiger-Beetle	58
Magpies	29	Sandpiper	19	Tits	29
Mantis	61	Sawfish	19	Toads	48
Marten	6	Scops Owl	35	Tooth-shells	84
Mias	1	Scorpions	67, 68	Torpedo	52
Mice	6	Sea-Anemones	100	Tortoise Beetles	60
Millipedes	65	Sea-Cucumbers	91, 94	Tortoises	38
Minivett	27	Sea Devil	52	Tree Snake	44
Mites	79	Sea Eagle	33	Trepang	95
Molluscs	78	Sea-Ear	80	Trogons	26
Monitor	41	Sea-Fans	101	Tropic Bird	18
Monkeys	2	Sea-Hare	82	Trumpet-shell	81
Mosquitoes	55	Sea Lilies	96	Tun-shell	81
Moss Animals	77	Sea-Mouse	76	Tupaia	3
Moths	57	Sea Pens	101	Turtles	36
Mouse Deer	11	Sea Snakes	44	Venus Flower-basket	105
Muntjac	11	Sea-Urchins	91, 93	Vipers	46
Musang	5	Seladang	8	Vultures	33
Myna	32	Serow	10	Wagtails	27
Napu	11	Serpent Eagle	33	Wah-Wah	1
Nautilus	89, 90	Shama	51	Warblers	28
Neptune's Cup	105	Sharks	50	Wasps	54
Nightjars	25	Shield Beetles	60	Water-Buffalo	9
Noddy	29	Shield Bugs	63	Water Bugs	63
Nutcrackers	18	Shield Urchins	94	Water Hen	19
Orang Utan	1	Ship-Worm	88	Water Mongoose	5
Organ-pipe Coral	101	Shrews	3	Water Pheasant	20
Oriole	31	Shrikes	29	Water-Scorpion	63
Ormer	80	Shrimps	72	Weasel	6
Ospreys	34	Siamang	1	Weaver Birds	32
Otter	6	Silver Fishes	64	Weevils	59
Owl Moths	58	Skinks	42	Whale	13
Owls	34	Skip Jacks	59	Whelk	81
Ox-Ray	52	Skippers	57	Whip-Scorpions	68
Oyster	87	Slugs	83	White Ants, see Termites	60
Paddy Bird	32	Snails	79	White-Eyes	31
Palm-Civet	5	Snakes	42	Whites	57
Palm Swift	25	Snipe	19	Windhover	34
Panther	4	Soft Turtles	38	Wood-Owl	35
Paper-Nautilus	89, 90	Soothsayers	61	Woodcock	10
Pariah Kite	33	Sparrow Hawk	33	Woodpeckers	21
Parroquet	29	Sparrows	32	Worms	75
Parrots	20	Spine-tail	25	Zoophytes	98, 99

INDEX

OF

Scientific Names.

	<i>Page.</i>		<i>Page.</i>		<i>Page.</i>
Alisara ..	56	Astrophyton ..	93	Cassis ..	81
Acanthoderus ..	62	Astur ..	33	Catocala ..	58
Acanthodesmus ..	65	Atherura ..	6	Catoxantha ..	59
Acari ..	70	Attacus ..	57	Centropus ..	21
Accipiter ..	33	Attidae ..	70	Cephalopoda ..	89
Accipitriformes ..	32	Auricula ..	83	Cephanodes ..	57
Acherontia ..	57	Avicula ..	86	Cerambycidae ..	60
Acomus ..	16	Babirusa ..	12	Geratosa ..	105
Acrididae ..	62	Balaenoptera ..	13	Gerchneis ..	34
Actias ..	57	Balanidae ..	74	Ceropidae ..	64
Actinometra ..	97	Balanoglossus ..	52	Cerebratulus ..	76
Actinozoa ..	100	Balanus ..	74	Cervidae ..	7
Agamidae ..	40	Basommatophora ..	83	Cervulus ..	11
Alcedinidae ..	23, 24	Batagur ..	38	Cervus ..	10
Alcedo ..	24	Batocera ..	60	Cetoniidae ..	59
Alcyonaria ..	100	Batrachostomus ..	25	Ceyx ..	24
Alcyonium ..	100	Baza ..	34	Chaerocampa ..	57
Alpheus ..	72	Belemnites ..	90	Chaetura ..	25
Amaurornis ..	16	Belostoma ..	63	Chalcophaps ..	17
Amblippygi ..	68	Belostomatidae ..	63	Chalcosia ..	88
Anmonites ..	90	Bipalium ..	77	Chalcostetha ..	31
Amphidromus ..	83	Biogus ..	73	Chalina ..	105
Amphineura ..	78	Blattidae ..	61	Charadrius ..	20
Amphioxus ..	52	Boa ..	43	Charaxes ..	56
Ampullaria ..	79, 80	Bos ..	8	Cheiromeles ..	4
Annelida ..	75	Botaurus ..	19	Chelifer ..	70
Anobiidae ..	59	Bovidae ..	7	Chelone ..	37
Anobium ..	59	Brachyura ..	71	Chelonia ..	36
Anodonta ..	87	Brechites ..	88	Chilogonatha ..	65
Anous ..	18	Brenthidae ..	59	Chilopoda ..	65
Antedon ..	97	Brissus ..	94	Chiroptera ..	3
Antennularia ..	100	Bryozoa ..	77	Chiton ..	79
Anthothreptes ..	31	Bubulcus ..	19	Chloecia ..	76
Anthozoa ..	99, 100	Buccinum ..	81	Chloropsis ..	28
Antipatharia ..	103	Buceros ..	22	Chondropterygii ..	50
Antipathes ..	103	Bufo ..	48	Chotorhea ..	21
Apidae ..	54	Bulimus ..	83	Chrysochroa ..	59
Apis ..	54	Bulla ..	81	Chrysopelea ..	44
Aplysia ..	32	Bungarus ..	45	Chrysophlegma ..	22
Aporandria ..	58	Buprestidae ..	59	Cicadidae ..	64
Arachnida ..	67	Butorides ..	19	Cicindela ..	58
Arachnoides ..	94	Cacatua ..	21	Cicindelidae ..	58
Arachnomorphae ..	69	Cacomantis ..	21	Cincinnatius ..	30
Arachnothera ..	37	Calcareia ..	105	Cinnyris ..	31
Araneae ..	68	Callagur ..	39	Cirripedia ..	73
Arca ..	86	Callula ..	48	Cissa ..	29
Archaster ..	92	Caloenas ..	17	Cittocinclia ..	28
Archisometrus ..	68	Calornis ..	32	Clypeastroidea ..	95
Architeuthis ..	90	Calotes ..	41	Coccinellidae ..	60
Arctictis ..	5	Calymnia ..	57	Coccytes ..	21
Ardea ..	19	Calypptomena ..	26	Coelenterata ..	98
Arletta ..	19	Campophagidae ..	23, 27	Colella ..	52
Argonauta ..	89, 90	Canidae ..	4	Coleoptera ..	58
Argusianus ..	16	Cantao ..	63	Collembola ..	64
Artamides ..	27	Caprimulgidae ..	23, 25	Collocalia ..	25
Asiphoniata ..	85	Caprimulgus ..	25	Collyris ..	59
Aspergillum ..	88	Carabidae ..	59	Colechirus ..	96
Aspidochirota ..	95	Carcharias ..	51	Coluber ..	43
Aspidomorphia ..	60	Carcineutes ..	24	Colubridae ..	43
Asteroidae ..	92	Cardium ..	87	Columbinae ..	15
Asthenosoma ..	94	Carpophaga ..	17	Comatulidae ..	96
Astraeidae ..	102	Caryophyllia ..	102	Conus ..	81
Astrape ..	52	Casella ..	82	Copsychus ..	38
Astrapia ..	30	Cassididae ..	60	Coraciidae ..	23, 24

	<i>Page.</i>		<i>Page.</i>		<i>Page.</i>
Corallium ..	101	Endoceras ..	90	Haplodaetyla ..	96
Coreidae ..	63	Enhydris ..	45	Harpa ..	81
Coremionemis ..	69	Eoperipatus ..	66	Harpactes ..	26
Corvidae ..	23, 29	Epeira ..	70	Heliopora ..	101
Corvus ..	29	Epimachus ..	30	Helarectos ..	6
Cosmosearta ..	64	Erthesina ..	63	Helix ..	82
Cranorhinus ..	22	Eryciniidae ..	56	Hemidactylus ..	41
Crinoidea ..	96	Esacus ..	20	Hemigalia ..	5
Crocidura ..	3	Euchromia ..	57	Hemilophus ..	22
Crocodylus ..	40	Eucichia ..	26	Herodias ..	18
Crustacea ..	71	Eulabes ..	32	Herpestes ..	5
Ctenocella ..	101	Eulamellibranchia ..	86, 87	Herpetolitia ..	103
Ctenophora ..	103	Eunice ..	75	Hesperidae ..	37
Culcita ..	92	Eupholus ..	50	Hestia ..	56
Culeolus ..	52	Eupictella ..	105	Heterocentrotus ..	94
Carcullionidae ..	50	Euploea ..	56	Heterocera ..	55
Cyclas ..	87	Eurycnema ..	62	Heteromya ..	85
Cyclemys ..	39	Eurylaemidae ..	23, 26	Heteropoda ..	70
Cycolophorus ..	80	Eurylaemus ..	26	Heteroptera ..	63
Cylindrophis ..	43	Eurystomus ..	24	Heteropteryx ..	62
Cymbium ..	81	Euschema ..	58	Hexacorallia ..	100, 101
Cymborhynchus ..	26	Eutrachelus ..	60	Hexactinellida ..	105
Cynogale ..	5	Falco ..	34	Hippopus ..	88
Cynopithecus ..	2	Felidae ..	4	Hirudinea ..	76
Cynopterus ..	4	Felis ..	4	Hirundinidae ..	23, 27
Cyon ..	5	Ficula ..	81	Hirundo ..	27
Cyornis ..	27	Filibranchia ..	85, 86	Holothuria ..	95
Cypraea ..	80	Fisarella ..	80	Holothuroidea ..	94
Cyprididae ..	23, 25	Flabellum ..	102	Holoptera ..	61
Cypselus ..	25	Forficulidae ..	61	Hormurus ..	68
Cyrtacanthacris ..	62	Fringillidae ..	23, 32	Huhua ..	35
Daphnis ..	57	Fulgora ..	64	Hybocystis ..	80
Dasypilus ..	21	Fungia ..	102, 103	Hydra ..	98, 99
Decapoda (Crust.) ..	71	Fungidae ..	103	Hydrocichla ..	28
do, (Ceph.) ..	90	Fusus ..	81	Hydrozoa ..	99
Delphinus ..	14	Galaxen ..	102	Hydrometridae ..	63
Dendrochirota ..	96	Galeodes ..	68	Hydrophasis ..	20
Dendrocitta ..	26	Galenpithecus ..	3	Hylobates ..	1
Dendrocoryna ..	18	Gallierex ..	19	Hymenoptera ..	54
Dentalium ..	84	Gallinaceae ..	15	Hymenopus ..	61
Dermochelys ..	36	Gallinago ..	19	Hypotaenidia ..	19
Dero-playts ..	61	Gallus ..	16	Hystricidae ..	6
Diadema ..	93	Ganoidei ..	30	Hyatrix ..	6
Dibranchia ..	80, 90	Garrulax ..	28	Ichthyophis ..	49
Dicaeidae ..	23, 31	Garrulus ..	29	Insectivora ..	3
Dicaeum ..	32	Garzetta ..	10	Irena ..	28
Dicerobatis ..	52	Gasteracantha ..	70	Isis ..	101
Dichoceros ..	22	Gastronoda ..	79	Isometrus ..	68
Dieruridae ..	23, 31	Gearcinus ..	72	Isomya ..	85
Diplopoda ..	65	Gecko ..	41	Kallima ..	56
Dipneumones ..	69	Geckonidae ..	49	Ketona ..	35
Dinsadomorphus ..	44	Gehyra ..	41	Kretrodoris ..	82
Diptera ..	55	Gelasimus ..	72	Lacertidae ..	41
Dissemurus ..	31	Geometridae ..	58	Lachesis ..	46
Dissoura ..	18	Genemvda ..	30	Laganum ..	94
Distira ..	45	Geouelia ..	17	Lamellibranchiata ..	84
Distomum ..	76	Gephyrea ..	76	Lamiidae ..	60
Durus ..	67	Gigantostroaca ..	74	Lanidae ..	23, 28
Doliophis ..	46	Glyphodes ..	58	Lepadidae ..	74
Dolium ..	81	Golofa ..	50	Lepes ..	74
Doris ..	82	Goniastroaca ..	103	Lepidota ..	50
Draco ..	41	Goniosoma ..	71	Lepidoptera ..	55
Dryonhis ..	41	Gonycephalus ..	41	Lepisma ..	61
Dandubia ..	64	Gorzonja ..	101	Leporidae ..	61
Dupetor ..	19	Grallatres ..	15	Lepropilus ..	68
Dynastidae ..	59	Groua ..	17	Lenus ..	6
Dysiatius ..	60	Gymnodaetylus ..	41	Lhythea ..	6
Echinodermata ..	91	Gymnura ..	5	Limnaea ..	79, 83
Echinodictyum ..	105	Haemodipsa ..	76	Limonkromus ..	27
Echinoidea ..	93	Haleyon ..	24	Limulus ..	74
Echinometra ..	94	Haliaetus ..	33	Linnhistius ..	69
Elapinae ..	45	Haliastur ..	33	Lobiophasis ..	91
Elasmobranchii ..	50	Halicore ..	13	Lobophora ..	16
Elaterridae ..	50	Haltiglossa ..	103	Locustidae ..	62
Elephas ..	7	Haliotis ..	86	Loligo ..	66
Elysia ..	82	Halobates ..	63	Lophohelia ..	102

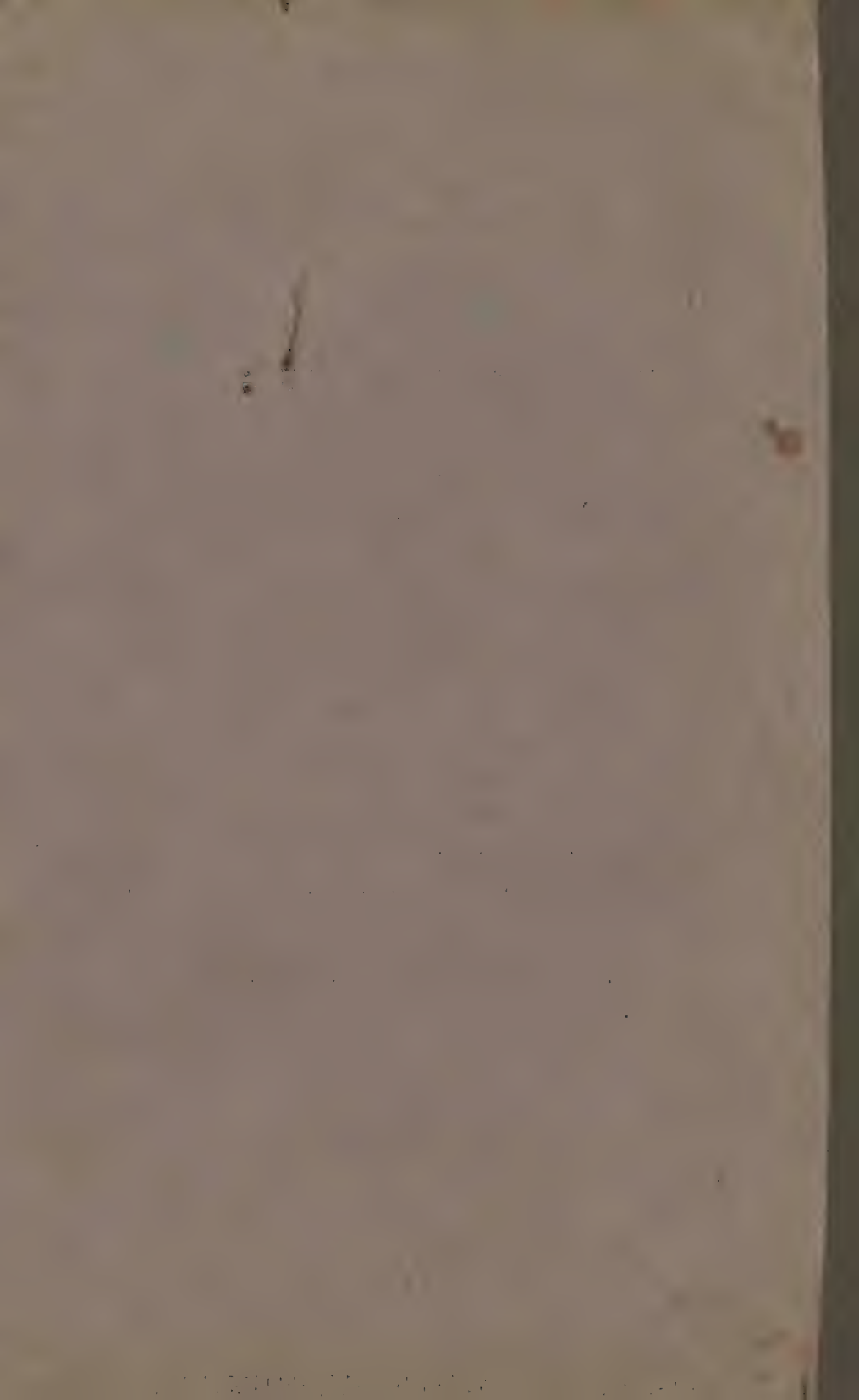
	<i>Page.</i>		<i>Page.</i>		<i>Page.</i>
Lophurina ..	30	Nezara ..	63	Perais ..	34
Lophura ..	16	Niltava ..	37	Peronella ..	94
Loriculus ..	21	Ninox ..	35	Perona ..	84
Lucanidae ..	59	Noctuidae ..	58	Phaethon ..	18
Luidia ..	92	Nudibranchiata ..	81, 82	Phasmodae ..	61
Lumbricus ..	75	Nyctalemon ..	58	Phibalosoma ..	62
Lutra ..	6	Nycticebus ..	2	Phlogoenas ..	17
Lycænidæ ..	16	Nyctornis ..	24	Pholus ..	88
Lyclas ..	68	Nyctipao ..	58	Phorus ..	80
Lygosoma ..	42	Nymphalidæ ..	16	Photodiles ..	35
Lyncornis ..	25	Oculinidæ ..	102	Phrynichus ..	68
Lynxipicus ..	22	Octocorallia ..	100	Phyllacanthus ..	94
Mabuia ..	42	Octopoda ..	90	Phyllium ..	62
Macacus ..	2	Octopus ..	90	Phylloides ..	58
Machaeramphus ..	33	Ocypoda ..	72	Phyllophora ..	62
Macropisthodon ..	43	Odontolabis ..	59	Physeter ..	14
Macrura ..	72	Oligochaetæ ..	75	Pierinæ ..	57
Macra ..	87	Oncidium ..	84	Pinna ..	85, 87
Madrepora ..	102	Onychophora ..	66	Psidium ..	87
Madreporidæ ..	102	Ophideres ..	38	Pitta ..	20
Mainatus ..	32	Ophioplepis ..	93	Pittidæ ..	23, 20
Malleus ..	87	Ophiophagus ..	46	Pityriasis ..	20
Manis ..	14	Ophiothrix ..	93	Placuna ..	80
Mantidæ ..	61	Ophiuroidea ..	92	Plakobranchnus ..	82
Meandrina ..	102	Ophiura ..	58	Planorbis ..	79, 83
Megaderma ..	4	Ophiones ..	70	Platheiminthes ..	70
Megalophrys ..	48	Opisthobranchiata ..	81	Platurus ..	45
Melania ..	89	Opisthotelæ ..	69	Plexaura ..	104
Melanoperdix ..	17	Orcella ..	14	Ploceidæ ..	23, 32
Melagrina ..	86	Oreaster ..	92	Ploceus ..	32
Melolonthidæ ..	59	Oriolidae ..	23, 31	Plumularia ..	100
Muropidæ ..	23, 24	Oriolus ..	31	Pocilloporidæ ..	105
Marops ..	24	Ornithoptera ..	57	Podargidæ ..	23, 25
Mesia ..	28	Orphnaeus ..	66	Podobacia ..	105
Mesophoyx ..	19	Orthoceras ..	90	Podophthalmus ..	71
Mesothelæ ..	69	Orthoptera ..	61	Poecilotheria ..	69
Metacrinus ..	96	Orthotomus ..	29	Polioæetus ..	34
Microglossus ..	31	Osmotreron ..	17	Polycarpa ..	52
Microhierax ..	34	Ostræa ..	87	Polychaetæ ..	75
Millepora ..	100	Otocompsa ..	28	Polyzoa ..	77
Milvus ..	33	Ovulum ..	81	Pomplon ..	58
Mitra ..	81	Oxynopterus ..	59	Pompididæ ..	54
Molluses ..	78	Pagurus ..	73	Pomponia ..	64
Monaxonida ..	105	Palæmon ..	72	Porifera ..	104
Monomya ..	85	Palæornis ..	20	Porites ..	102
Mormolyce ..	59	Palæunæus ..	68	Poritia ..	57
Motacilla ..	27	Palpigradi ..	68	Poritidæ ..	102
Motacillidæ ..	23, 27	Paludina ..	79, 80	Potamon ..	72
Munia ..	32	Palythoa ..	101	Poterion ..	105
Murex ..	81	Pandion ..	34	Primates ..	1
Muridæ ..	6	Panulirus ..	72	Prionolemia ..	63
Muscicapidæ ..	23, 27	Papilio ..	57	Pristis ..	51
Mussa ..	102	Papilionidæ ..	57	Proboscidea ..	7
Mustela ..	6	Papilioninæ ..	57	Prosimiæ ..	2
Mustelidæ ..	4	Paradisea ..	30	Prosobranchiata ..	80
Mygalomorphæ ..	69	Paradiseidæ ..	23, 29	Protobranchia ..	85
Myriapoda ..	65	Paradoxurus ..	5	Proteucus ..	59
Myristicivora ..	17	Parotia ..	30	Protochordata ..	52
Mytilus ..	86	Parus ..	29	Protozoa ..	109
Myxospongiæ ..	105	Passer ..	105	Prototracheata ..	60
Nacaduba ..	57	Passeres ..	10, 23	Pseudomicronia ..	58
Naja ..	45	Patella ..	79	Pseudoneuroptera ..	60
Nanina ..	83	Pavo ..	16	Pseudoscorpiones ..	70
Narthura ..	57	Pecten ..	87	Psilopogon ..	21
Nasalis ..	2	Pectinacea ..	86	Psittinus ..	21
Natatores ..	15	Pedipalpi ..	68	Pteridophora ..	30
Nautilus ..	89, 90	Pelargopsis ..	24	Pteroceras ..	59
Nectarinidæ ..	23, 31	Pelecanus ..	18	Pteroides ..	101
Nemorrhædus ..	10	Pelochelys ..	38	Pteronys ..	7
Neomeris ..	14	Pennatula ..	101	Pteropus ..	4
Nephila ..	69	Pentacrinidæ ..	96	Ptilomera ..	63
Nephthya ..	101	Pentacrinus ..	96	Ptilopus ..	17
Nepidae ..	63	Pentatomidæ ..	63	Ptiloris ..	26
Nesolagus ..	0	Perierocotus ..	27	Pulmonata ..	82
Nettopus ..	18	Periophthalmus ..	84	Pupa ..	83
Neuroptera ..	60	Peripatus ..	66	Putorius ..	6

	<i>Page.</i>		<i>Page.</i>		<i>Page.</i>
Pycnonotidae	23, 27	Simotes	44	Thalassodes	58
Pycnonotus	27	Siphoniata	85	Thelyphonus	68
Pyralidae	58	Sipunculus	76	Thenus	72
Pyrausta	58	Solarium	81	Thripoxax	22
Pyrops	64	Solen	88	Thyropygus	65
Pyrotrogus	26	Solenosmilia	102	Thysanozoon	76
Pyrherodias	19	Solifugae	68	Thysanura	64
Pythia	83	Spalacidae	9	Timellidae	23, 28
Python	43	Spatangoidae	93	Tianunculus	34
Rana	47	Sphingidae	57	Tomistoma	40
Raptatores	16, 32	Spilornis	35	Tragulidae	7
Regularia	93	Spirostreptus	65	Tragulus	11
Reithrosciurus	7	Spirula	89, 90	Tricondyla	58
Retepora	77	Spondylus	85, 87	Trionyx	58
Rhacophorus	48	Spongillidae	104	Triton	81
Rhinoceros	7	Spongodes	101	Tropicoperdix	17
Rhinocerotidae	7	Squilla	73	Tubipora	101
Rhinodon	51	Squillidae	73	Tupaia	5
Rhinoplax	22	Stichopus	95	Turbinulidae	102
Rhipidigorgia	101	Stomatopoda	73	Turbinaria	102
Rhizomys	6	Strigiformes	52	Turbo	86
Rhombodera	61	Strix	35	Turdidae	23, 28
Rhopalocera	55	Strongylocentrotus	94	Turdinus	28
Rhyacophilus	19	Strophidia	58	Trichaster	93
Rhynchobatus	52	Sturidae	23, 32	Tridacna	87
Rhynchophorus	59	Stylaster	100	Trochus	80
Rhynchota	62	Stylommatophora	83	Trogonidae	23, 29
Rhytidoceros	22	Stylopora	103	Tryxalis	62
Rodentia	6	Suidae	7, 11	Turtur	17
Rollulus	16	Sula	18	Typhlops	45
Rostratula	19	Surniculus	21	Ulophyllia	103
Rusa	10	Sus	11	Umbellula	101
Sabella	76	Sutoria	29	Ungulata	7
Salus	54	Sylviidae	23, 28	Unio	87
Salmacis	93	Synaptida	95, 96	Uranidae	58
Sarcophytum	101	Syntomidae	57	Uropteroides	98
Sarcops	32	Syrnum	35	Uropygi	68
Saturniidae	57	Tachydromus	42	Ursidae	4
Scansores	16, 20	Tachyornis	25	Vaginula	83
Scaphopoda	84	Tacuna	64	Varamidae	46
Scincidae	41	Taenia	76	Varanus	41
Sciuridae	6	Tagiades	57	Venus	87
Sciurus	7	Tanygnathus	20	Vermes	75
Scolia	54	Taphozous	4	Vespa	54
Scoliidae	54	Tapridae	7	Vespidae	54
Scolopendra	65	Tapirus	8	Viverra	5
Scops	35	Tarsius	2	Viverridae	4
Scorpiones	67	Tectibranchiata	81	Vivipara	80
Scutibranchiata	79	Teleostei	50	Voluta	81
Scutigera	66	Telicota	57	Xylocopa	54
Scyphozoa	99, 100	Teredo	88	Xylophaga	88
Seleucides	30, 31	Terpsiphone	27	Xylorhiza	60
Semioptera	39	Testudo	38	Zemeros	50
Semnopithecus	2	Tetrabranchia	80, 90	Zephronia	65
Sepia	90	Tetracorallia	100	Zoantharia	101
Sepioida	90	Tetractinellida	105	Zosteropidae	25, 31
Septibranchia	86	Tetrapneumones	69	Zosterops	31
Sertularia	100	Thalassina	72	Zygaena	51
Simia	1	Thalassochelys	38	Zygaenidae	52

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R. Hanitsch Photo.

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ORANG UTAN (*Simia satyrus*).



Sim Boon Kweang Photo.

PROBOSCIS MONKEY (*Nasalis larvatus*).



FIG. 1.



FIG. 2.

Sim Boon Kwang Photo.

FIG. 1.—SLOW LEMUR (*Nycticebus lardigradus*).

FIG. 2.—TUFT-EARED SQUIRREL (*Reithrosciurus macrotis*).



ENTRANCE HALL.



Sim Boon Kwang Photo

YOUNG LEOPARDS (*Felis pardus*).



FIG. 1.

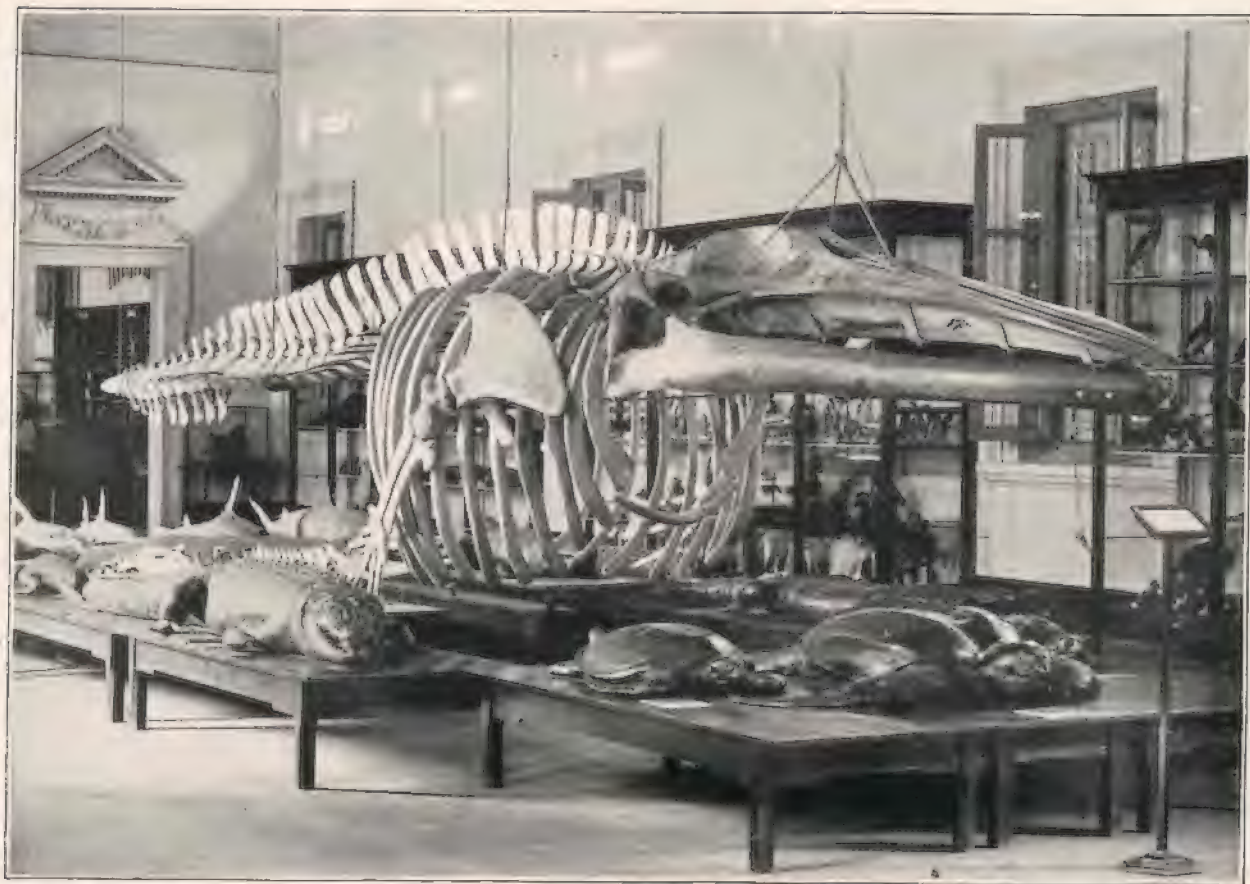


FIG. 2.

FIG. 3.

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SKULLS OF (1) ORANG UTAN (*Simia satyrus*);
(2) BABIRUSA (*Babirusa affurus*);
(3) BEARDED PIG (*Sus barbatus*).



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THE INDIAN WHALE (*Balenoptera indica*).



THE SCALY ANT-EATER (*Manis javanica*).



Sim Boon Kwang Photo.

YOUNG MALAY TAPIR (*Tapirus indicus*).



THE BOOBY (*Sula sula*) ON CHRISTMAS ISLAND.



R. Hanitsch Photo.

THE ARGUS PHEASANT (*Argusianus argo*).



Sim Boon Eng, Photo.

THE YELLOW TROPIC BIRD OR BOATSWAIN BIRD (*Phaethon fulvus*).



THE FISH OWL (*Ketupa ketupa*).



THE RHINOCEROS HORNBILL (*Buceros rhinoceros*).



THE GREEN MAGPIE (*Cissa robinsoni*).



THE BURMESE PARADISE FLYCATCHER (*Terpsiphone affinis*).



Sam Roon Eng. Photo.

CHRISTMAS ISLAND BIRDS.



FIG. 1.



FIG. 2.

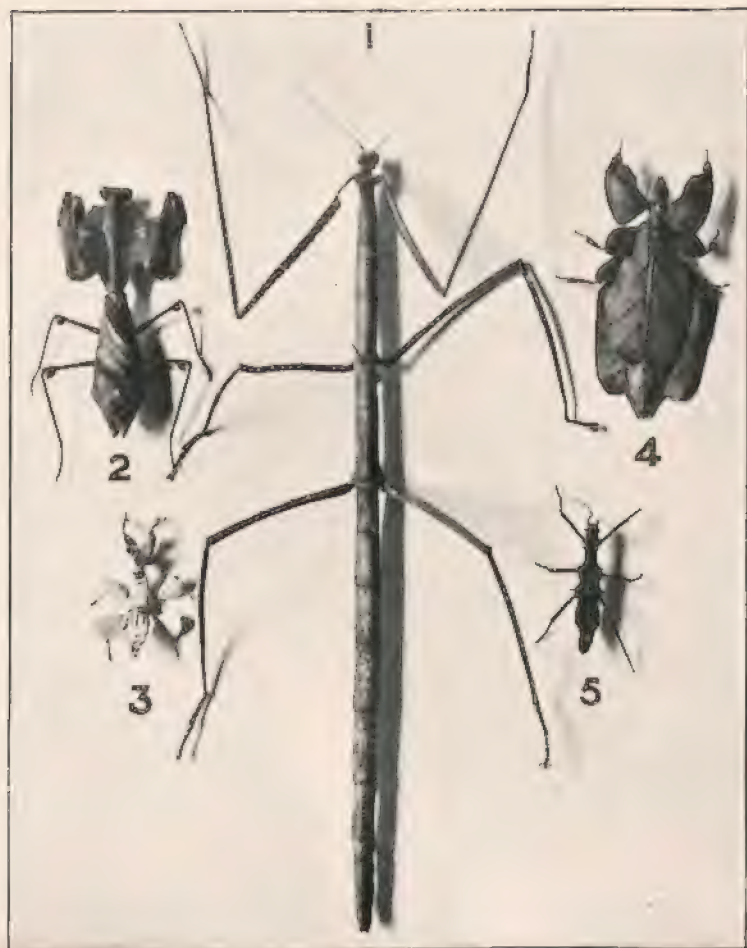
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FIG. 1.—THE GAVIAL (*Tomistoma schlegelii*).
FIG. 2.—THE LEATHERY TURTLE (*Dermochelys coriaca*).



Sim Boon Kwang Photo.

FIG. 1.—*Heteropteryx grayii*. FIGS. 2 TO 6.—BEETLES.



FIGS. 1 TO 5, STICK-AND-LEAF INSECTS ; FIG. 6, LANTERN-FLY ; FIG. 7, CICADA ; FIG. 8, WATER-BUG.



FIG. 1.

R. Hanitsch Photo.



FIG. 2.

FIG. 1.—SCORPION (*Palamnaeus longimanus*).
FIG. 2.—BIRD-EATING SPIDER (*Pacillotheria* sp.).



FIG. 1.

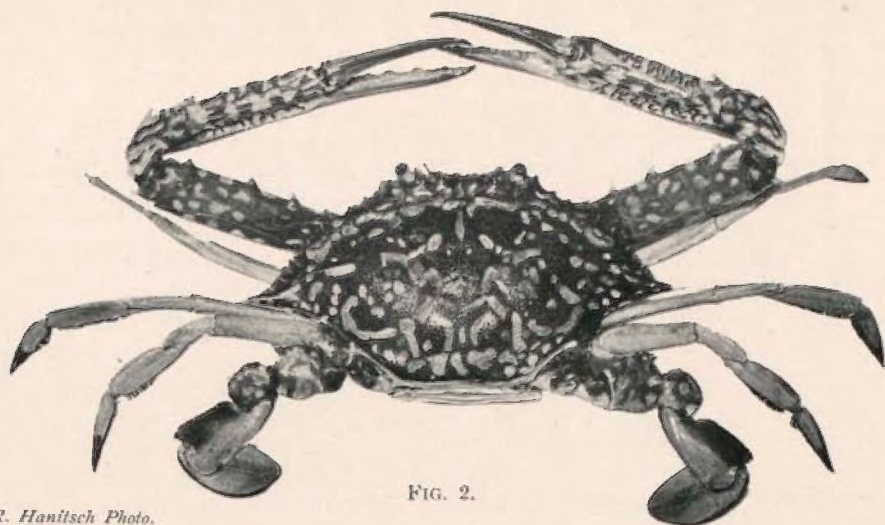
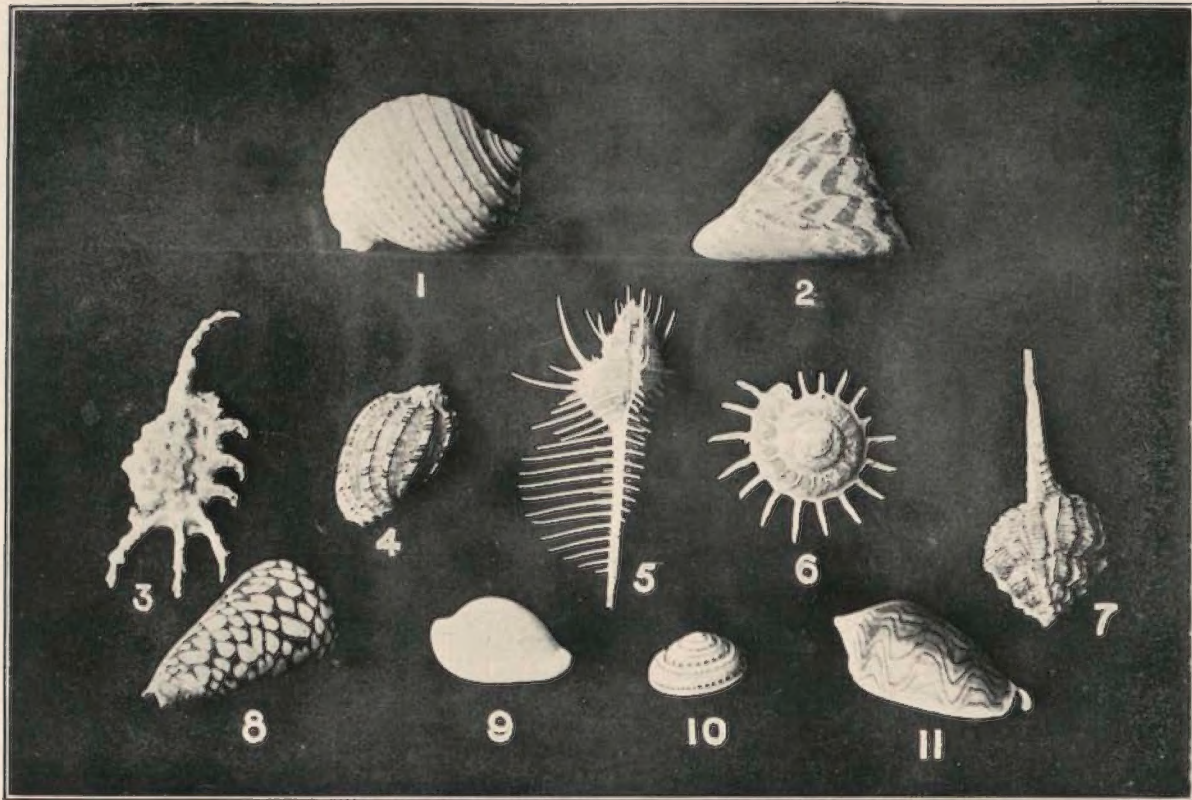


FIG. 2.

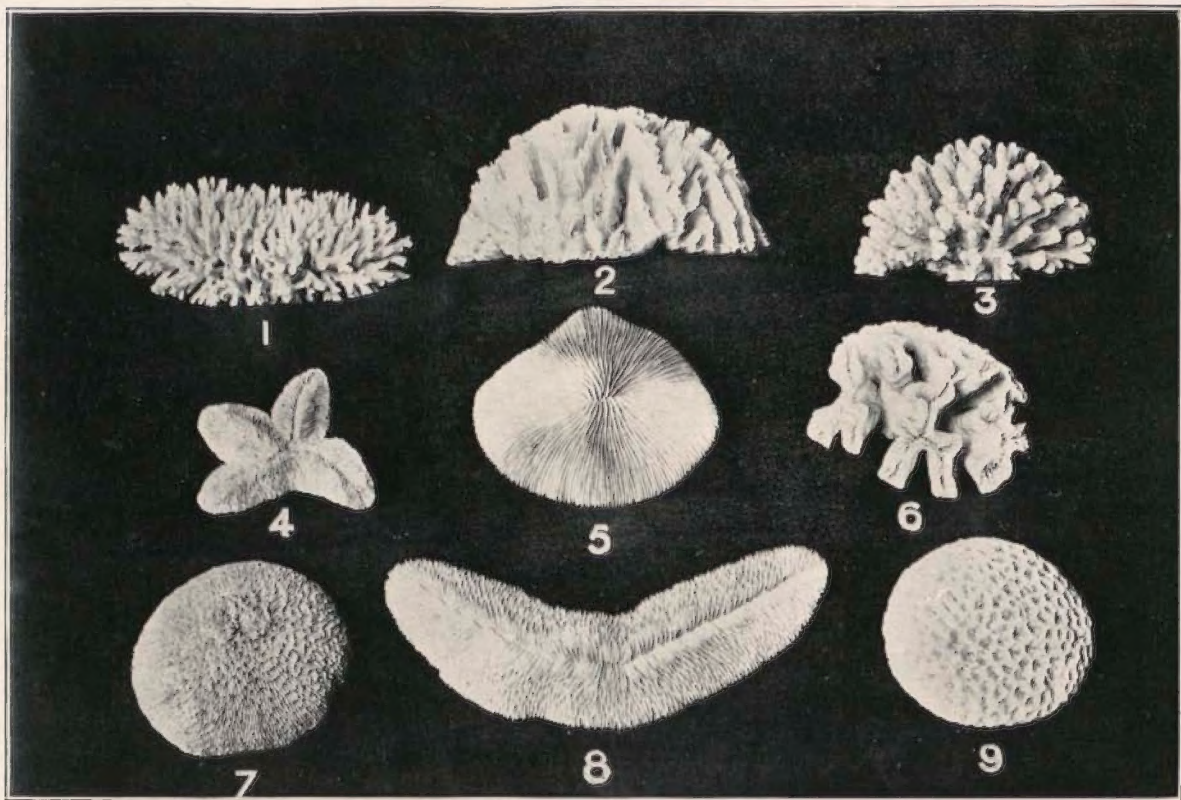
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FIG. 1.—THE CHRISTMAS ISLAND ROBBER CRAB (*Birgus latro*),
FIG. 2.—SPINY SWIMMING CRAB (*Goniosoma natator*).



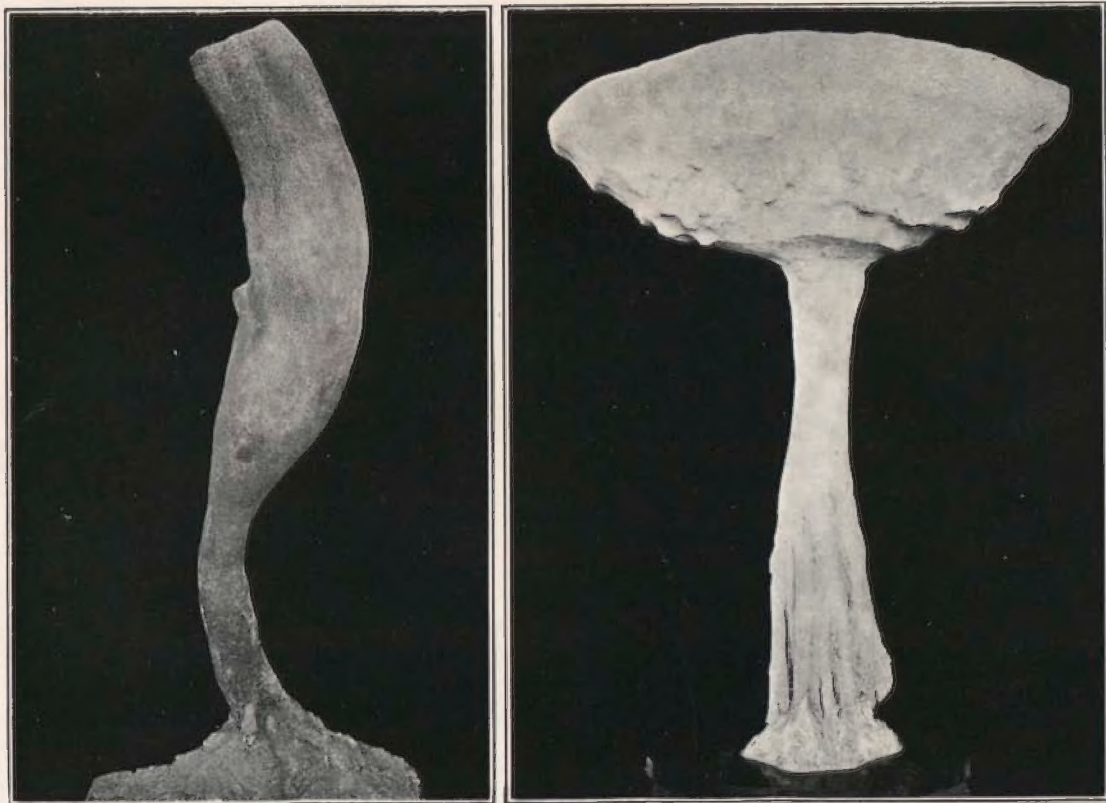
SHELLS.

- (1) *Dolium maculatum* ; (2) *Trochus niloticus* ; (3) *Pteroceras scorpius* ; (4) *Harpa conoidalis* ; (5) *Murex tennispina* ;
(6) *Thorax solaris* ; (7) *Murex haustellatum* ; (8) *Conus bandanus* ; (9) *Ovulum ovum* ; (10) *Solarium trochleare* ;
(11) *Voluta undulata*.



CORALS.

- (1) *Madrepora* ; (2) *Ulophyllia* ; (3) *Stylopora* ; (4) *Abnormal Haliglossa* ; (5) *Fungia* ; (6) *Mussa* ; (7) *Podobacia* ;
(8) *Haliglossa* ; (9) *Goniastrea*.



Sim Boon Kwang Photo.

VARIETIES OF THE NEPTUNE'S CUP (*Poterion neptuni*).