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Erratum.—On p. 110 of this volume, instead of *Tinnunculus alaudariu* read *Tinnunculus alaudarius.*

SPOLIA ZEYLANICA.

TOPOGRAPHICAL NOTES ON THE JAFFNA ISLANDS.

By J. P. Lewis, M.A., C.C.S.

With a Map.

Iranaitivu.

November 30, 1904.—A fine morning. Started for Irânaitivu in the "Serendib" with Messrs. Ingles and Hornell. Got off about 11 and arrived about 3 p.m. Went ashore and put up our tents. The huts erected for the accommodation of the Government Agent and other officials are roofless, the natives having helped themselves to the cadjans.

The appearance of the island is pleasing, plants of low meadow-like grass with clumps of suriya trees here and there, under which are the huts of the islanders, who are all fishers and of Pariah caste, but fine, strong-looking men. They all wear the rain cap made of palmyra ola, which is worn by the people of the neighbourhood of Chavakachcheri in the wet season, and which from its shape, not unlike the "canoe cap" of the British private, gives them a sort of smart appearance. It is decidedly effective, cheap, and useful.

December 1.—Weather still fine. Went to see the bêche-de-mer curing places on the east island. There was a Moorman trader at one and a Chinaman at the other. The latter, being an expert as regards bêche-de-mer is employed by traders at Rs. 10 a month to buy the bêche-de-mer from the fishermen and to look after the curing. This young man is the son of a Chinaman, who was well known in Jaffna, and who at one time was very rich, but afterwards managed to lose all his money through the Chetties, it is stated. His son is penniless. The Moorman had a lot of jaggery in little packets made of palmyra leaf. He told us that he gave four in exchange for one bêche-de-mer, but the fishermen did not admit this. The value of each basket is one cent. The truth seemed to be that he gave four for a very good specimen.

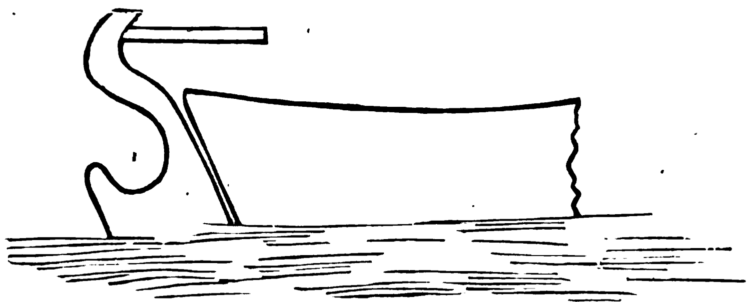
I noticed a coconut shell containing oil hanging up at the hut, and found that it was used by the fishermen for making the water clear when searching for bêche-de-mer. An experiment was tried with it, and it certainly seemed to have some effect, a semi-circle of clearer water gradually began to show itself. The oil is obtained from the liver of the shark.

Every male inhabitant of Iranaitivu, man or boy, wears the cap called "talaivaraipaddai," or "head basket," made of palmyra olas, which, as stated above, the people of Chavakachcheri and other parts of the Jaffna peninsula wear in wet weather, and he makes it also answer the purpose of a pocket. In one examined we found (1) a small looking glass 2 inches by 1, (2) betel-chewing implements, (3) an ola containing arecanuts, &c.

The people are all Pariah caste, and they only live here during the north-east monsoon. In the south-west monsoon they go to the mainland and work as reapers. The men are well made and strong-looking; most of the women I saw were miserable looking.

In the afternoon went round the village. The people live in round low huts, like the Vanni huts, which are secured when they leave the island by locks and keys made of wood.*

The following is an extract from Mr. Wright's report on the botany of Iranaitivu :—" It is interesting to note the occurrence of the lemon citronella oil grass (*Andropogon scheinanthus*), a species cultivated in India, and considered to yield an oil much more valuable than that obtained from the citronella oil grass (*Andropogon nardus*) in the low-country of Ceylon. The apparatus required is very simple and cheap, and the cultivation of this grass should be encouraged. The cultivation of this plant should be carried out in rotation with castor oil plants, fibres. and indigo."



THE RUDDER OF AN IRANAITIVU BALLAM.

The people use ballams without outriggers, which come from Cochin. They have a quaint-shaped rudder, which I have not seen on the Jaffna ballams.

There are three Roman Catholic churches, two on the east and one on the west island. They are built of coral stone, and two at least are tiled, but the masonry is of a very rough description.

There is a square trigonometrical tower so close to the chief Roman Catholic church that from the sea it looks as if it belonged to it. It is about 40 or 50 feet high, but there is no ladder or stair-

* I have sent one of these wooden locks of Iranaitivu to the Colombo Museum.

case to the top, and if it had to be used again for observations a staging would have to be erected round it. It is substantially built of cut coral stone, and as it is so well built it is a pity that it is not more picturesque. It is, I think, a pity that the Survey Department do not make their permanent towers a little less ugly. This one is exactly like a chimney, but with a little more expenditure it could have been made quite handsome. It is now a permanent feature of the Iranaitivu landscape.

The Jaffna Islands.

I omitted to mention an unfinished grotto of coral, a miniature Lourdes, just above the seashore, some 200 yards from the Roman Catholic church.

KACHCHAITIVU.

December 2.—Left for Kachchaitivu about 11 o'clock and arrived there about 2.30 P.M. This is an island between Delft and Rameswaram, about 11 miles south-west of Delft, and is uninhabited.

The wind had been rising since the morning, but we were able to find deep water close in on the south side, in which respect the chart was found to be inaccurate, making the depth much less than it was found to be.

We went ashore and had our tents put up, and Mr. Ingles immediately began the survey of the island, getting half-way round it before sunset. The island is covered with vegetation, chiefly kandal (*Rhizophora mucronata*), used for dyeing nets and sails, and stunted suriya trees, also a good many creepers and flowers, including *Gloriosa superba*, which in Jaffna is known as "November flower," as it flowers in that month. Our tent was pitched under a tree which looked like *Callotropis gigantea* grown into a tree, the leaves being very much the same. Some of the servants asserted that it was "erukkalai" (*Callotropis*), but as I had never seen a specimen of this plant larger than a bush, and the flower looked rather different, I have brought away a branch to send to the Director of the Royal Botanic Gardens for identification,* also some specimens of a plant with a flower like clover.

The "vinalai" root, the size of a tiny yam, is found abundantly in Kachchaitivu. Boiled, it is used for food, and flour is prepared from it. Twelve tons of it were imported into Delft from Kachchaitivu in March and April, 1904. It is said to be also known as "karanai."

The eastern corner of the island, opposite which we anchored, terminates in a miniature headland of coral stone, and on this Mr. Ingles found the remains of a trigonometrical station, evidently erected when the Indian Government surveyed the coast line of the Island for the Marine Survey. The island itself has never been surveyed. There is no good water on it, which accounts for the fact that it is uninhabited. Mr. Ingles found a wrecked ballam on the opposite side of the island, and we saw remains of fires indicating that it had been recently visited by fishermen. It is about a mile long by half a mile wide. There is a grass plain on the west side. We were told that there were no snakes on this island nor on Iranaitivu, but both statements were disproved by finding the skin of a snake at one of the Roman Catholic churches on Iranaitivu and here also.

December 3.—There were several squalls during the night, and the wind seemed to be gradually rising, so that it seemed expedient that we should get away as soon as possible, especially as we only had a limited supply of water (we had to wash in salt water this morning), but we had to wait till Mr. Ingles had finished his survey, which took another 3½ hours. We got away about 11.30 A.M. with a very high head wind blowing and a very heavy sea, so much so that the captain of the "Serendib" was rather anxious for the safety of the vessel, which was built for use as a harbour boat only,

* It was identified as *Tournefortia argentea* "a characteristic shore tree of the Eastern Equatorial Zone, but not hitherto recorded north of Trincomalee." The leaves certainly have a silvery shimmer, hence the name I suppose.

is long, narrow, and top heavy, and quite unsuited to the sort of sea we experienced to-day. I decided that we had better make for Delft and get under the lee of the southern coast of the island, which we accordingly did, arriving there about 2.15 P.M. If we had had a beam sea to deal with, I do not know what the consequences might not have been. Yet when we left Jaffna it was quite calm; but at this time of the year these sudden changes are to be expected.

We had our tent put up at Vellai, close to the horse enclosure, and found the cadjan shed there most useful, as for the rest of the day there were incessant squalls of heavy rain, which went on all night also. In fact it seemed to me a regular cyclone such as we had in Jaffna in 1884. We congratulated ourselves, however, that we had got away from Kachchaitivu just in time, otherwise we should have been marooned on that desert island for two or three days probably.

DELFT.

December 4.—The captain of the "Serendib" sent a note ashore about 8 A.M. requesting us to come on board at once, leaving all our impedimenta behind, as the wind had shifted from north-east to east during the night, and he was unwilling to risk another night on the coast, as he had carried away one of his anchors (it turned out that it was only the cross-piece), and was afraid it might go round to the south and perhaps blow him ashore. We had to decide the question on the spur of the moment, and decided that it was not good enough going to Jaffna in a cyclone of wind and rain without even a change of clothes.

The "Serendib" accordingly started, and we at the same time started to cross the island to the Government bungalow (3½ miles). The last glimpse we had of the steamer she seemed to be at a stand-still and making no progress whatever in her eastward course.

I had told the captain to return for us as soon as the weather moderated, and by evening it had improved a little, though still squally. However, we had now a dry roof over our heads, and for once I felt grateful to the Mangalore tiles, which are so unpleasant in the hot weather and so effective in wet.

We were, however, pestered by sand flies called "vellundu," which abound in the bungalow, and are far worse than any mosquitoes, their bites causing more intense irritation, while at the same time they give no other indication of their presence, so that it is impossible to get at them until the mischief is done. We had very little sleep this night, and I had none the night before in the cadjan shed at Vellai from a constant apprehension that the roof would blow off and leave me entirely exposed to the rain.

December 5.—The wind had completely gone down by the evening, but there was no sign of the "Serendib" returning for us. Mr. Ingles made a survey of the Portuguese fort in the morning, and he and Mr. Hornell went to see the wells at Sarappiddi in the afternoon.

Mr. Hornell was of opinion that the wells (there are said to be 92) were neither Portuguese nor Dutch, but prehistoric.

There are no sponges to be found in Delft, but Mr. Hornell found some good specimens at Iranaitivu.

The varaku (*Pasepalum scrobiculatum*), mondi (*Andropogon sorghum*), and sami (*Panicum miliaceum*) fields are thriving.

The Maniagar of Punaryn, who returned from Iranaitivu with us, informs me that the sand flies, which are chronic here, are due to the quantity of dry cowdung lying about the seashore in the neighbourhood of the bungalow. There is an extraordinary quantity of it, and no use of it for manure is made by the Delft cultivator, though everywhere else in the Jaffna District it is carefully collected for the purpose. The Delft man has an idea that Delft cowdung is not good for manure, but this is a mere excuse for laziness. Were it not for the cost of transport it would be shipped to Jaffna, as the *kavoti* plant (*Psoralea corylifolia*, Sin. *bodi*) is now shipped to Analaitivu for the same purpose, and would be shipped to Jaffna were it not for this reason.

The Udaiyar informed me that snake bite at Kachchaitivu has no ill-results, on account of the existence of the herb called pochchintil. This is a super-excellent kind of chintil (a medicinal plant found in Delft, *Tinospora cordifolia*), but no one but a yogi can find it.

Sea snakes are common at Iranaitivu, but, as everywhere else, they are said to be so sluggish that they seldom bite any one, and "it does not matter if they do, as you have only to drink salt water three times and no harm will ensue," so an Iranaitivu fisherman told me; yet Sir Emerson Tennent says they are all deadly.

Some catamarans were out yesterday in a very rough sea, and as one started for Kayts I sent a letter by it. There are about twenty catamarans on the island.

The Delft man has a cap of his own different from those worn by the Iranaitivu men, but made, like them, of palmyra leaves. It is shaped like a mitre, and is tied down under the ears and under the chin. I procured a specimen for the St. Louis Exhibition. It is called the talaivaraipaddai, or head basket.*

Adverting to the Sarappiddi wells, the late Maniagar informs me that they are said to be 92 in number, but Casie Chitty, in his "Gazetteer," says that "the Dutch had about 400 dug through a body of solid rock." His authority apparently is the "Colombo Journal."

December 6.—The "Serendib" was sighted at 9 this morning coming from Jaffna. It took me about two hours to get on board by means of a Delft boat, owing to the strong current. The jetty at Mavilturai, the port of Delft where I embarked, has been knocked to pieces by the sea since I was here last.

It turns out that the "Serendib" did come to a standstill as we supposed, and was unable to make a foot of progress against the

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* I have sent one to the Colombo Museum.

wind and sea on Saturday, and accordingly the captain had to give up attempting to make Mandaitivu and had to go to Kayts instead.

We arrived off Mandaitivu at 3.15 P.M. Weather quite calm now.

KAYTS.

December 29.—There is a miscellaneous collection of vessels in the harbour, including half a dozen *vadas* from Masulipatam. This is a vessel of peculiar rig with very thick masts, and these boats are said to be very strong. They carry a large lug sail on the foremast, and some of them are three-masted or rather four, for they all have a small mast like a stick right on the stern, in addition to their masts proper.

There were also two *kala* dhonies from Topputturai. These have both masts close together and are rigged with square sails, very clumsy looking boats, but implicitly believed in by some native merchants. They have square sterns and immense rudders, and are always covered in with a cadjan roof.

There were besides barques, brigs, schooners, and Ceylon dhonies, which are different from the types above described, having an immense bowsprit with five foresails bent on it.

There was a small schooner without square sails, from Tondi on the south coast of India.

The kala dhonies from Topputturai bring paddy, rice, and cattle, and the vadas bring rice. The cattle from Topputturai and Ammapatam are the ordinary white "Coast bulls." Cattle, for slaughter and for up-country butchers, come from Paumben.

Pots and pans come from Pondicherry, Kudulur, and Porto Novo; also chatties, but not pots, from Ammapatam. The Pondicherry pots are much more durable than any made in Ceylon. The best Ceylon pots known in the Northern Province at any rate, are from Koddiyar in the Trincomalee District. No Jaffna-made pots are as good. Tiles and timber come from Ponani, fullers-earth from Kilakhari and Ammapatam. The timber imported is "kaltekku," which is used for boat building. Cowdung for manure is actually imported from Mannar. Paddy was imported from Paumben this year for the first time, the Sub-Collector says, from some fields in Rameswaram island; also from Kottapatam, a port on a river near Masulipatam. A considerable quantity comes also from Akyab.

Kayts is the third port in point of importance in the Island, and, unlike other ports of the Jaffna peninsula, is, owing to its sheltered position, open in both monsoons. During the south-west monsoon vessels come to it from ports on the east coast of India, south of Coconada, such as Devipatam, Tondi, Ammapatam, Kollapatanam, Adriampatam, Muttupet, Point Calimere, Topputturai, Pondicherry, Porto Novo, Masulipatam, Kottapatam, and from Coconada.

During the north-east monsoon its trade is with the South Indian ports and ports on the western coast, such as Quilon, Kolochul,* Alippay, Ponani, Cochin, Calicut, Mangalore, Kilakari.

The trade with India is almost equally divided between the two monsoons. Vessels from Paumben can come in both. Coastwise trade is more active during the south-west monsoon. Vessels come from Mannar, Point Pedro, Valavedditurai, Mullaittivu, Pesalai during the south-west, and from Galle, Beruwala, Negombo, Kalpentyn during the north-east monsoon.

The name Kayts is neither Dutch nor Tamil. The Tamil name of Kayts is Urkavatturai, "port where the village guard is kept." Baldæus corrupts this into "Ourature," and Casie Chitty takes the first part of this word as being the Sinhalese for hog, and says it is the Sinhalese for "hog ferry." So it might be were it not plainly a corruption of the Tamil name by which the place is still known.

Baldæus uses the form "Cays," as the name was originally written, which is the Portuguese for a quay.† It is to be noted that there is really no name for the whole island on which Kayts is situated, except the Dutch name Leyden, now disused. The Survey Department have called it Velanai, but this is the name of the principal village in the island only.

The Dutch called this island Leyden, and the island of Karaitivu Amsterdam. Punkudutivu was Middelburg, and the northern of the two islands of Iranaitivu Enckhuysen and the southern Hoorn.‡ The two together were called "The Two Brothers," a free translation of the Tamil name which literally means "the Double Island," like Iranaimadu, "the Double Tank" on the North road. The name, "The Two Brothers," was used even in British times. Delft is the only one of the Dutch names of these islands that is in actual use nowadays.

The headland opposite the eastern extremity of Karaitivu is known by the realistic and practical, if somewhat undistinguished, name of Vrattimunai, which means "Dry Cowdung Point."

Karaitivu is joined to the mainland now by the Punnalai causeway, which was constructed in the time of Sir William Twynam, is 2 miles long in a perfectly straight line, and has ten bridges. It has been of immense benefit to the people of Karaitivu, who are now very prosperous.

Punkudutivu.

December 7, 1905.—Started from Kayts about 2 P.M. by boat for Punkudutivu; arrived there about 4.30 P.M., and at the dispensary, where I am to stop, at 5. Farther down the road, just beyond the

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* A port near Quilon, noted for its nettali fish, which are largely imported into the Jaffna peninsula.

† See "Ceylon Literary Register," Vol. V., p. 204.

‡ The same names were given to two of the bastions of the Colombo Fort.

Roman Catholic church on the opposite side, is the site of the old Dutch or Portuguese church, now a heap of ruins. There is besides a small quadrangular building almost entirely surrounded by a banyan tree, which may have been the base of a tower.

There is a tank near the dispensary with a bo and a kumbuk tree (*Terminalia glabra*) of a good size, which is said to be the only kumbuk tree in the island. The shores of the island at the landing place, which is called Puliyadi ("place of the tamarind tree"), are green with ellu* and mondi-sami.

The dispensary is situated at a place called Perumkadu, "the great jungle." There is no jungle there now, but paddy fields and gardens. Next door to it is the American Mission church with masonry walls, a belfry of the American Mission pattern which consists of three spikes on top of a piece of rectangular wall, and a roof of palmyra leaves.

The population of Punkudutivu at the last three censuses was 1881, 3,499; 1891, 4,098; 1901, 5,201, so that it has increased by nearly 50 per cent. in twenty years.

ANALAITIVU.

December 8.—Embarked for Analaitivu at 9.30 A.M. We skirted Punkudutivu as far as Marutadi ("place of the kumbuk tree") point, and then sailed across to Analaitivu, which was reached at 1.30 P.M. Here I stayed in the Hindu school, about three-quarters of a mile from the landing place in this island, which is called Nadavutirutti. The distance by sea from Punkudutivu to the landing place on the south-east side must be about 4 miles.

Analaitivu is a very fertile island, where a good deal of tobacco is cultivated. The fences, as in Punkudutivu, are all of the thorny kilavai (*Balsomodendrum berryi*), and therefore have a very neat appearance, as in fact the whole place has. The village has quite the aspect of the more prosperous villages in the peninsula, *e.g.*, in Valikamam West or Vadamaradchi West, and the soil seems to be similar to the soil in the former division; a good deal of rubble stone has to be dug out of the fields.

Its length is about 2½ miles and breadth 1¼ mile. It is intersected by two roads, one running lengthwise and the other across the island. I passed a tank in the north-west corner of the island called Vadalikulam, which the people say is fed by springs; also an abandoned stone-built keni near the cross roads, which is said to contain brackish water.

Between Punkudutivu and Nayinativu there is a small island close to the former called Kurikadduvan, which means "place where the signals are shown" (the word is personified). This is because "people who wanted to go to Nayinativu used to show signals here to the people of this island that they wanted a boat."

* *Sesamum indicum*

A peculiarity of these islands is said to be that there are no squirrels and no jackals, though I believe jackals cross the shallow strait between Velanai and Punkudutivu. Analaitivu has the advantage, too, of having very few pariah dogs; it was quite quiet at night.

In Analaitivu there are only 9 licensed carts and 5 farm carts. The population returns since 1871 are 1871, 1,064; 1881, 1,296; 1891, 1,411; 1901, 1,543; an increase of 45 per cent. in thirty years. The increase in the Jaffna District during the same period is only 21·8 per cent.

I was altogether much pleased with this island, though I hear that some of these people are in debt to the Karaitivu money-lenders, the Jews of Jaffna.

It is described in the directions attached to the naval charts as "2½ miles long by 1 broad."

December 9.—Walked about three-quarters of a mile to a place called Koddaiyadi ("place of the fort"), which is the starting point for boats going to Kayts, &c., and left for the next island, Elavutivu, due north of Analaitivu. At Koddaiyadi there is a mound of earth and stones, the remains, according to the people, of a Portuguese ("Paranki") fort, which has given its name to the place.

Between the two islands there is a small one called Paruttitivu, "Cotton Island," which, owing to want of water, is uninhabited.

Elavutivu.

Landed at the extreme northern end of Elavutivu, on the side facing Kayts, where there is a good tiled bungalow for the use of the preventive officer, who is stationed here during the south-west monsoon. He is now at Mandaitivu.

This side of the island is all sand, the western side is all coral. Elavutivu is an island of palmyras, which cover it from one end to the other (consequently it is as untidy as Analaitivu is the opposite).

The people live on the palmyra; they make baskets, very strong, as they have a covering of the fibre (nar), and very cheap, the cost of one being 6 cents.

They have never been required to pay road tax as they have no road. They are not now poor, the palmyra fibre industry, now extinct, having put a good deal of money into their—I cannot say pockets—waist-cloths. A road from north to south through the island would much improve it. At present it is all higgledy-piggledy. To get from one end to the other you have to skirt compounds, first on one side and then on the other, pick your way through coral stones and prickly pear, and plough through sand and meander through the palmyras.

Elavutivu is described in the naval charts as "2 miles long, 3 cables' length broad, trees 70 feet high."

I was surprised to see some umbrella trees (*Acacia planifrons*, Tam. udai) growing here. This is the great tree of Mannar island, but there are none anywhere in the Jaffna or Mullaittivu Districts except those in this island, which is curious. They grow on the mainland opposite Mannar island, in places along the Madawachchi road as far as the 25th mile from Mannar, and then cease. What are the conditions in this island which induce the tree to select it, and nowhere else in the Jaffna District, to grow in ?

The only other trees, besides the palmyra, coconut, and the udai tree, are margosa (*Azadirachta indica*), tulip tree (*Thespesia populnea*), and tillai (*Sapium insigne*). There is a jak tree in the Police Vidane's compound, also some mangoes planted by him.

The Maniagar also tells me that male palmyra trees sometimes turn female, which seems a curious thing if true. The Kachcheri Mudaliyar confirms this statement from his own experience.

The population of the island has increased since 1881 from 227 to 324 (1901), or by nearly 43 per cent.

December 10.—Returned to Kayts in the morning. We got over quickly, the wind not being unfavourable. It must have been from the N. or N.W. and not from the N.E. The boatmen say that in the afternoon it would be from the N.E. Fort Hammenhiel, rising out of the sea on the left, is picturesque (for description of this fort see "Ceylon Literary Register," Vol. I., p. 24).

Karaitivu.

December 11.—With regard to the Karaitivu people, the money-lenders of the district, the explanation of their flourishing condition is that they are the most economical of the Jaffna people—the most Jaffnese of the Jaffnese in fact—and it is stated as an instance of the former characteristic that even women of well-to-do families work in the fields, which is not the case elsewhere in Jaffna, though the women of the poorer classes of course do. The Karaitivu people go everywhere, the Straits, &c., and save every penny. Hence it is not surprising that Karaitivu is one of the most prosperous "parishes" in Jaffna.

Nayinativu.

Nayinativu is just opposite Punkudutivu on the west. It is chiefly noted for its festival, which takes place annually in July, lasts ten days, and is attended by from 7,000 to 23,000 people ; and for its chank fisheries carried out by some of its diving population and by Moormen from the Coast. It is 2½ miles long by half a mile wide, and is intersected by a road running lengthwise through it, the temple being at the north end and the Government bungalow at the other, with three cross roads. I visited it from Delft in July, 1902.

July 14, 1902.—In the evening I went to see the procession round the temple, which started about 9 o'clock. The much-bedizened image of the snake goddess, sitting on the back of a flaming red wooden stallion, holding in her hand a whip and flanked on the right by a small Ganesa under a canopy consisting of a five-headed cobra, and on the left by Kartigesar sitting on a bull, was dragged round the temple to the accompaniment of tom-toms, flageolets or instruments like them, and a chank. Torches consisting of 3, 5, 7, or more lights headed the procession. There were not many people as it is too early yet, and the wind is too high for a large attendance to be expected. On the 19th and 20th there will be enormous crowds if the wind goes down. On the 20th (full-moon day) the images are taken round in perfect silence.

Excepting the temples dedicated to her at Kopai North and Navali, this was until lately the only temple to the goddess Naka Tambiran in the Jaffna District ; but one has recently been started at Chandilippay in the peninsula.

The goddess is known as Naka Tambiran or Nakeswara, properly Pushani (a jewel), and is a manifestation of Siva's wife. One of Siva's ornaments and of his wife's ornaments is the cobra, but the cobra is not the vehicle of either, but of Vishnu. It is not the snake, but the goddess that is worshipped.

The explanation of the origin of the cult given me was very hazy. In the time of Vedi Arasan, the fisher king, who is said to have been of Mukkuvar caste, a Brahmin found a stone in the sea off this island, with a representation on it of a serpent coiling, and he established this worship here. The Maniagar says he has seen this stone. It is on the north side of the island, and is exposed at low water.

The Nayinar, who give their name to the island, are a caste of people living at Rameswaram, who were shipwrecked on it. They are temple tenants.

The sacred cobra (nalla pambu) of the Tamils of Jaffna is light coloured, almost white, and is not more than 18 inches long. It only appears on Fridays. It is only this cobra that is sacred, the large cobras which are of pariah caste are not, and no Jaffna man has any scruple about destroying them, but he will give milk to the sacred cobra.

One of the sanitary measures gravely carried out by Government every year at the time of this festival is " not to allow the people to shave their children's heads for devotional purposes within half a mile of the temple." It is curious that this should be a necessity at this festival only, I do not recollect it among the orders issued with respect to other festivals in the Northern Province.

THE BIRDS OF DIMBULA.

By JAMES RYAN (Talawakelo).

THERE is a common delusion that birds are scarce on a tea estate, and I have heard Dimbula mentioned as exceptionally poor in bird life. A little careful work with a pair of good binoculars will very quickly show that birds of many kinds are not only common, but are there in large numbers.

As a matter of fact up-country birds are usually crepuscular to a large extent, feeding before dawn and in the gray of the evening, and they are usually silent and furtive in their habits during the daytime, and especially at midday. This may be explained by a number of reasons more or less adequate. I am inclined to think, however, that the principal one is that insect life is more abundant at morning and evening than in broad daylight.

It must bé remembered also that the primeval jungle of Dimbula was very dense, and anything like free flight must have been difficult, so birds took largely to creeping and hopping from twig to twig; whilst in tea and coffee it is obvious that the principal food supply lies in the heart, not on the upper surface of the bush. What share the necessity for avoiding snakes, lizards, vermin (rats swarm in the tea field), and hawks may have in determining the furtive habit of estate birds is difficult to appraise.

There can be no doubt, however, that the numerous hawks and eagles levy toll on bird and reptile, and that snakes, and probably some lizards, eat eggs and young birds. It may be remarked that most of the birds appear to be insectivorous, as I have found that mulberries and crumbs put out for the birds are very seldom touched. An exception of course is that "avian rat," the sparrow. Sparrows should be discouraged in every possible way; they do no good, and drive away many more useful and interesting birds. The best way to "out" them is to destroy their nests, but a handful of paddy and an ordinary sieve will soon catch a fair number.

The following list of birds was compiled with the assistance of Mr. H. F. Fernando, Taxidermist of the Colombo Museum. During his four days' visit to Talawakelo in July, 1907, in the teeth of the south-west monsoon (7·34 inches of rain were registered, and the wind was exceptionally boisterous), thirty varieties of birds were observed and thirteen shot. It may be remarked that most of the birds were observed in the immediate neighbourhood of the bungalow, where there are a few old seed-bearing tea trees and some fruit trees.

During the last few years there has been a marked increase in the number of Babblers. The Scimitar Babbler only appeared about eighteen months ago, and is becoming almost a nuisance, as he is a noisy bird with a wonderful voice for his size—little larger than the Magpie Robin. The Common Babbler ("Dung Thrush" or "Seven Sisters") has recently put in an appearance. A good deal of cattle manure has been forked out and horse litter mulched broadcast, which probably suits the habits of this family. There are two or three dams in the immediate neighbourhood, and White-breasted Kingfishers are numerous. I have seen a dozen at a time in one ravine, but this was probably a family not yet separated. I have previously never seen more than four young in a brood.

The White-eye, Munia, and Tailor birds are the principal garden birds. It is interesting to see forty or fifty Munias systematically cleaning a seed bearer of insects and then flying on to tackle the next.

Migratory birds mostly come in September and October on their way in, and in March and April on their return; but the Bee-eaters and the Painted Thrush (with the Wagtail) are always about in the north-east monsoon. The Tomtit and the Bulbul are about all the year round, but for some reason not known seem less numerous during the burst of the south-west monsoon. It is possible that they then nest up in the jungle as being more sheltered.

It may be noted that of 358 species recorded as belonging to Ceylon in the Museum Catalogue, 49 are peculiar to Ceylon, and of these 13 have been seen in Dimbula.

The mean annual rainfall at Dimbula is about 100 inches, with a minimum of 67 inches and a maximum of 183 inches.

List of Dimbula Birds (Elevation 4,000–5,000 Feet).

[S = Shot. V = Seen. * = Ceylon only. M = Migratory.]

1. Black Crow, *Corvus macrorhynchus* (seen once only).
*2. Ceylonese Magpie or Jay, *Cissa ornata*. V.
3. Indian Gray Tit or Gray-backed Titmouse, *Parus atriceps*. S.
4. Common South Indian Babbler, *Crateropus striatus*. S.
*5. Ceylonese Scimitar Babbler, *Pomatorhinus melanurus*. S.
6. White-throated Wren Babbler, *Dumetia albigularis*. V.
*7. Palliser's Ant Thrush or Ceylon Shortwing, *Elaphrornis palliseri*. V.
8. Common Indian White-eye, *Zosterops palpebrosa*. S.
*9. Ceylonese White-eye, *Zosterops ceylonensis*. S.
10. Common Iora ("Bush Bulbul"), *Ægithina tiphia*. V.
11. Black Bulbul, *Hypsipetes ganeesa*. V.
12. Madras Red-vented Bulbul, *Molpastes hæmorrhous*. S
*13. Black-capped Bulbul, *Pycnonotus melanicterus*. V.

14. Racket-tailed Drongo, *Dissemurus paradiseus* (rare; resident in the low-country).
15. Indian Tailor Bird, *Orthotomus sutorius*. V.
16. Ashy Wren Warbler, *Prinia socialis*. S.
17. Little Black-backed Pied Shrike, *Hemipus picatus*. S.
18. Common Wood Shrike, *Tephrodornis pondicerianus*. V.
19. Orange Minivet, *Pericrocotus flammeus*. S (pair).
20. Little Minivet ("Sultan Bird"), *Pericrocotus peregrinus*. V.
21. Indian Black-headed Oriole, *Oriolus melanocephalus*. V.
22. Ceylonese Dusky-blue Flycatcher, *Stoparola sordida*. S.
23. Gray-headed Flycatcher, *Culicicapa ceylonensis*. S.
24. Paradise Flycatcher, *Tersiphone paradisi* (seen every two or three years).
25. Southern Pied Bush Chat (Hill Bush Chat), *Pratincola atrata*. V.
26. Magpie Robin, *Copsychus saularis*. S.
27. Pied Ground Thrush, *Geocichla wardi* (seen once only).
28. Blue Rock Thrush [M], *Petrophila cyanus*. V.
29. White-backed Munia, *Uroloncha striata*. V.
*30. Ceylon Hill Munia, *Uroloncha kelaarti*. V.
31. Spotted Munia, *Uroloncha punctulata*. V.
32. House Sparrow, *Passer domesticus*. V.
33. Common Swallow [M], *Hirundo rustica*. V.
34. Nilgiri Bungalow Swallow, *Hirundo javanica* (seen at Watagoda).
35. Gray Wagtail [M], *Motacilla melanope*. V.
36. Purple Sun Bird, *Arachnechthra asiaticus*. V.
37. Ceylonese Sun Bird, *Arachnechthra zeylonica*. V.
38. Indian Pitta or Painted Thrush [M], *Pitta brachyura*. S.
*39. Red Woodpecker, *Brachypternus erythronotus*. V.
40. Common Indian Bee-eater [M], *Merops viridis*. V.
41. Blue-tailed Bee-eater [M], *Merops philippinus*. S. (not in July).
42. Little Indian Kingfisher, *Alcedo ispida*. V.
43. White-breasted Kingfisher, *Halcyon smyrnensis*. S.
44. Brown-necked Spine tail, *Chætura indica*. V.
45. Indian Edible-nest Swiftlet, *Collocalia fuciphaga*. V.
46. Common Couca or Crow Pheasant, *Centropus rufipennis*. V.
*47. Layard's Paroquet, *Palæornis calthrope*. V.
48. Brown Wood Owl, *Syrnium indrani*. V.
49. Forest Eagle Owl, *Huhua nepalensis*. V.
50. Scops Owl, *Scops giu*. V.
*51. Ceylon Mountain Hawk Eagle (Legge's Hawk Eagle), *Spizaetus kelaarti*. V.
52. Serpent Eagle, *Spilornis cheela*. V.
53. Marsh Harrier [M], *Circus æruginosus*. V.
54. Crested Goshawk, *Lophospizias trivirgatus*. V.
55. Besra or Jungle Sparrow Hawk, *Accipiter virgatus*. V.
56. Ceylon Crested Falcon, or Legge's Baza, *Baza ceylonensis*. V.
57. Common Kestrel [M], *Tinnunculus alaudarius*. V.
58. Bronze-winged Dove, *Chalcophaps indica*. V.
*59. Ceylon Wood Pigeon, *Alsocomus torringtoniæ*. V.
60. Spotted Dove, *Turtur suratensis*. V.

*61. Ceylon Jungle Fowl, *Gallus lafayettii*. V.
*62. Ceylon Spur Fowl, *Galloperdix bicalcarata*. V.
63. Blue-breasted Quail, *Excalfactoria chinensis*. V.
64. The Bustard Quail, *Turnix pugnax*. S.
65. Common Sandpiper [M], *Totanus hypoleucus*. V.
66. The Woodcock [M], *Scolopax rusticula*. A very rare migrant.
67. Solitary Snipe, (?) Wood Snipe [M], *Gallinago nemoricola*, (seen only once). V.
68. Pintail Snipe [M], *Gallinago stenura*. S.
69. Jack Snipe [M], *Gallinago gallinula*. S.
70. Cattle Egret, *Bubulcus coromandus*. V.
71. Pond Heron, *Ardeola grayi*. V.
72. White-breasted Water-hen (rarely flushed but very common). *Amaurornis phœnicurus*.

It will be noted that waterfowl are rare in Dimbula, because water is rarely stagnant, but I suspect the existence of many rails and waterhens seldom flushed.

I suggest that for educational purposes a case in the Colombo Museum containing Dimbula birds would be of great value. I would also suggest that photographs be made of the rarer birds for general guidance from shot specimens. A careful search in the Medakumbura Valley should show many unrecorded species, and some Patena dwelling birds, Pipits, &c., still require identification.

DESCRIPTION OF A NEW SPECIES OF APANTELES FROM CEYLON.

By P. Cameron.

Apanteles acherontiæ, sp. nov.

BLACK, the coxæ, apex of hind tibiæ somewhat broadly, the apex of the basal joint of the first antennal joint narrowly, of the others more broadly, black, the rest of the legs reddish yellow, except that the trochanters are infuscated. Wings clear hyaline, the costa, radius, and stigma black, the other nervures white. Female and male. Length 2·5 mm. Peradeniya, Ceylon. Bred by Mr. E. Ernest Green from larva of *Acherontia lachesis.*

Smooth, shining, the mesonotum finely, minutely punctured. Basal segment of abdomen as long as it is wide, slightly gradually widened, its sides furrowed, the furrows oblique; it is separated from the second segment by a distinct transverse furrow.

In the centre of the second segment is a raised pyriform area (the narrowed end at the base); from the base of this a curved, distinct furrow runs to the outer edge of the apex. Ovipositor short, very slightly projecting.

The fourth abdominal segment is longer than the second or third, the latter being of equal length. Metanotum not keeled. Scutellum raised, separated from the mesonotum by a shallow smooth furrow; on either side of the latter is a wider, more distinct, weakly crenulated furrow.

The larvæ of this species, like many others of the genus, spin in common a large egg-shaped cocoon of white cotton-like substance of the length of 47 mm. and a breadth of 27 mm., having a peduncle by means of which it is attached to a twig of about the same length but very much thinner, the peduncle being about 2 mm. broad at the top and about 10 at its junction with the common cocoon. The larval cocoons are about 2 mm. in length and, like the outer covering, are white. They are enveloped in the cottony mass, which is much thicker and denser on the outer side than in the inner where the cocoons are. It is not uncommon for the larvæ of *Apanteles* to spin their cocoons in company around the caterpillar upon which they have preyed, but I have never seen a pedunculated common cocoon before. Being conspicuous objects, it is not surprising to find that the larvæ of *Apanteles* are preyed upon by other Ichneumons, particularly *Hemiteles* and *Mesochorus*, as well as by small *Chalcididæ*. As *Apanteles* and its ally *Microgaster* are among the commonest enemies of Lepidopterous larvæ, and are consequently beneficial to the farmer and gardener, *Hemiteles*, &c., must be looked upon as injurious insects, unlike the majority of Ichneumons.

Apanteles taprobanæ, Cam. (Manchester Mem., 1897, p. 38), was reared by Col. Yerbury from an unknown Lepidopterous larva; *A. pratapæ*, Ashm., by Mr. E. E. Green from the larva of *Pratapa deva*, as well as *A. tivacholæ*,* Ashm., from the larva of *Tiracola plagiata*, Walk. (*cf.* Ashmead, Proc. U. S. Nat. Mus., XVIII., p. 647).

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* I have not seen the original description of this species, but if this name is correctly transcribed, it must have been based upon a misreading of the name of the host.—E. E. G.

Cocoons of *Apanteles acherontiæ*.

NOTE ON THE PARASITE APANTELES ACHERONTIÆ OF THE CATERPILLAR OF THE "DEATH'S HEAD" MOTH.

By E. Ernest Green.

With a figure.

THE huge caterpillars of the "Death's Head" moth occur commonly upon the "dadap" tree (*Erythrina lithosperma*), and might become a serious pest if they were not kept in check by the parasite described above by Mr. Cameron. This parasite is of almost miscroscopic dimensions, being only one-tenth of an inch long; but makes up for its minute size by the enormous number of individuals that infest a single caterpillar. It is probable that fully seventy-five per cent. of the caterpillars are infested and ultimately killed by the parasites. They feed inside the body of the unfortunate victim until it is fully grown. The caterpillar then suddenly becomes flaccid, and hundreds of tiny grubs make their way through its skin and spin the remarkable compound cocoon—resembling a mass of white cotton wool—that may frequently be observed attached to the leaves of the dadap tree. The empty carcase of the caterpillar usually falls off, and leaves no clue to the origin of the cocoon. Though externally appearing homogeneous, this mass is composed of separate cocoons surrounded and bound together by loose woolly matter. The resulting insects are minute black wasps.

From the smaller cocoon shown in the figure, 1,226 of these tiny insects emerged, and others (probably several hundred more) failed to extricate themselves from their woolly covering. It can scarcely be supposed that this number represents the progeny of a single parent. It seems probable that the insects attack the caterpillar *en masse*.

Mr. Cameron describes the compound cocoon as being attached to a twig by a peduncle, but this is not usually the case. The larger cocoon represented in the figure is closely attached to the leaf for its whole length, and this is the more common formation. The mode of attachment naturally depends upon the position occupied by the caterpillar at the time of its death.

DESCRIPTION OF A NEW PLUME-MOTH FROM CEYLON, WITH SOME REMARKS UPON ITS LIFE-HISTORY.

By T. Bainbrigge Fletcher, R.N., F.E.S.

With Figures in the text.

Trichoptilus paludicola, n.s.

Male 12—13 mm. Head and thorax brownish-ochreous with a few white scales intermixed. Palpi grayish; terminal joint white, fuscous at base; second joint reaching middle of face, about two-thirds of third. Antennæ ciliated (1), whitish, narrowly annulated with dark fuscous, with a black line above. Abdomen ochreous-brown, longitudinally striated with numerous black and white scales, the latter more developed towards base of abdomen and tending to form obscure transverse bands at distal extremities of segments; apex of abdomen with two obliquely ascending divergent hair-pencils and with long hairs concealing genitalia. Tibiæ white, longitudinally streaked with black; posterior tibiæ dilated with dark fuscous scales and slightly tufted at points of emission of spurs; spurs long (proximal about 1·4 mm., distal about ·8 mm.); tarsi banded with black.

Forewings cleft from before middle, segments linear; brownish-ochreous with scattered dark fuscous scales; usually a few white scales mixed with black along basal half of costa; a black spot followed by a white one on inner margin near base; sometimes a suffused white central streak reaching from base nearly to cleft; a patch of dark fuscous scales on lower inner edge of cleft: first segment slightly suffused with darker fuscous, with a white bar before its middle and another midway between the first bar and apex, extreme apex usually with some white scales; second segment with corresponding but less distinct white markings: cilia dark gray on costa barred with white opposite white fasciæ and usually white at apex, on lower margin of first segment mixed with white below fasciæ and with some black scales in middle, on upper margin of second segment with a row of black scales between two patches of white scales opposite fasciæ and a few black scales nearer apex, on lower margin of second segment with a white patch of scales before cleft, another (obsolescent) below proximal fascia, and a third before apex, with four tufts of black scales, first at one-third of segment, last apical.

Hindwings cleft firstly from before one-third, secondly from base; segments linear; dark fuscous; cilia gray; third segment without any scale-tooth on inner margin.

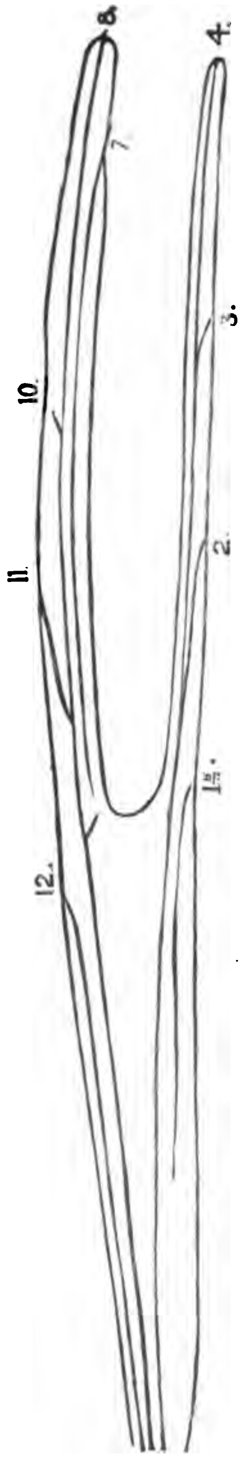


Fig. 1.—Neuration of forewing of T. paludicola. Much magnified.

♀. 11—12 mm. Without hair-pencil at apex of abdomen. Antennæ ciliated ($\frac{3}{4}$).

Otherwise as in male, but usually about 1 mm. less in expanse. Markings similar, but duller.

NEURATION.—Forewings. 2 out of 4, 3 very short, not reaching dorsal margin, 4 to apex of second segment, 5 and 6 absent, 7 parallel to 8 running into hind margin of first segment before apex, 8 to apex, 9 absent, 10 very short (sometimes rudimentary or absent), 11 out of 8, 12 reaching costa before cleft. (See Fig. 1.)

Hindwings. 2 out of 4, 3 rudimentary or absent, 4 to apex of second segment, 5 and 6 apparently absent, 7 to apex of first segment, 8 into costa at about one-third.

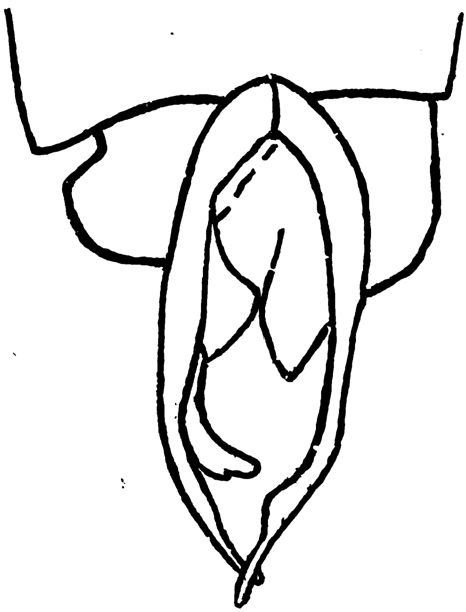


Fig. 2.—Male genitalia of T. paludicola. Magnified.

COMPARISON OF T. PALUDICOLA WITH ITS ALLIES.—This species is extremely similar superficially to *T. scythrodes*, Meyr., from Australia, but Mr. Meyrick informs me (in litt.) that "there is a good and reliable distinguishing character in the different arrangement of the dark scale-teeth in the dorsal cilia of forewings; in *scythrodes* there is a scale-tooth at each end of the dark median band of the second segment, whereas in *paludicola* there is one in the middle of the band, but not at either end."

The Life-History of Trichoptilus paludicola.

PRELIMINARY REMARKS.—In the early part of October, 1906, whilst encamped in the Royal Naval Camp at Diyatalawa, I found a species of "Plume Moth," which was quite new to me. Numerous specimens were taken at sunset on the edge of a boggy piece of swamp, and from its habitat and from the appearance of the moth I suspected at the time that it might prove to be a *Drosera* feeder, in the same way as had been recently proved to occur in the case of *Trichoptilus paludum* in Europe. (*Note.*—"Observations on the Life-History of *Trichoptilus paludum*," by Dr. T. A. Chapman; Trans. Entom. Soc. Lond., 1906, p. 133.) At that time, however, I was unable to find any *Drosera* plants in the vicinity.

In the following year on my arrival at Diyatalawa I determined to devote my first energies to a search for the larva of this species, and at last, on the 31st July, 1907, in a marshy place which had been cleared at some former time and had not been grown over to any great extent by the ordinary rank paludicolous vegetation, I came across numerous plants of *Drosera burmanni*, Vahl. *T. paludicola* was quite common here, so it seemed a likely place to look for the larva, which was soon revealed by a close search.

It is unnecessary to refer here to the great interest which was excited so recently by the original discovery that *Drosera* is the food plant of *T. paludum.* As is well known, *Drosera* is an insectivorous plant, deriving almost the whole of its nourishment from the insects which it captures and digests, and there was therefore the less reason to suspect it to be the pabulum of a caterpillar which has apparently no means to protect it from being devoured. Dr. Chapman and Mr. Bankes have, however, already shown the fallacy of this reasoning, and in the present instance I have found that *Drosera burmanni* is eaten with impunity by the larvæ of *T. paludicola* and of a Noctuid Moth, whilst the flower stems are attacked by a species of Aphid.

The *Drosera* plants themselves average about 25 mm. in expanse. In appearance the colour varies from light pink to bright red (occasionally pale green, usually in very shady places); in reality the leaves and stems themselves are a very pale green looking almost white from the minute silvery glands covering the surface; the apparent red or pink colour is given by the long red or pink glandular petioles which cover the upper surface of the leaves; those situated along the external margin of the leaves appear to be clavate at the end, but the other petioles exude a drop of clear gummy matter which forms a round drop at the tip of the petiole, and these gummy drops, as they glisten in the sun, give the plant its rather appropriate popular name of "Sundew." The flowers, which are of a pale pink colour, are borne on a long stem (not gummy), which rises from alongside the centre of the plant and attains a height of 8 or 9 inches. The roots are very small and barely serve to take a grip of the ground, but the plants seem to obtain a liberal supply of insect food, for nearly every plant examined will be found to have at least one undigested insect caught on its leaves. A small black ant seems to be the most frequent victim, but a small red ant, minute grasshoppers, small moths, &c., are also to be seen.

EGG-LAYING.—A female moth confined over plants of *Drosera burmanni* laid several ova, most of which were deposited on the seed capsules and unexpanded flower buds. One ovum was laid midway on a petiole on the edge of a young leaf.

OVUM.—When first deposited the egg is of a pale shining green colour, showing prismatic tints. There seems to be a system of rather coarse reticulation disposed regularly over the surface, but the enclosed depressions are very shallow. It is oval in longitudinal, circular in transverse, section. Its length is about ·45 mm., and its diameter about ·18 mm.

LARVA.—There are apparently four instars :—

First Instar.—The newly hatched larva is about 1 mm. long. In colour it is a pale transparent yellow which takes a reflected tint from the *Drosera* leaves, thus making the young larva very difficult to see ; the prothoracic segment is a little darker, and the head is brown and comparatively very large. Scattered over the body are short white hairs, but they are neither conspicuous nor plentiful. No warts are visible.

The larva crawls about without hesitation amongst the glandular hairs of the *Drosera* leaf, the gummy tips of the petioles standing up above it, so that it can walk about among their bases with impunity. In this stage it seems to feed entirely on the petioles and gum.

Before undergoing its first ecdysis the larva grows to about 1·5 mm. in length, and the segmental interstices are more plainly marked in a lighter yellowish colour, whereas the segments themselves have become of a darker greenish-yellow.

Second Instar.—About 2 mm. long and rather stout. Colour a greenish-yellow, paler below and on the sides on which the spiracles stand out darkly ; there are apparently small latero-dorsal tubercles which bear rather long white clubbed hairs.

It feeds on the glandular petioles, biting through the base and drawing the stalk into its mouth by a series of movements and finishing by devouring the drop of gum. It seems fairly voracious, but is evidently rather fastidious in its selection of the glandular hairs.

Third (? antepenultimate) Instar.—About 3 mm. long and fairly stout. Colour a pale green with interrupted pinkish latero-dorsal lateral, and supraspiracular stripes. Tubercles green at base, brownish at points of emission of the white hairs. The disposition of the tubercles is shown in the figure (fig 3).

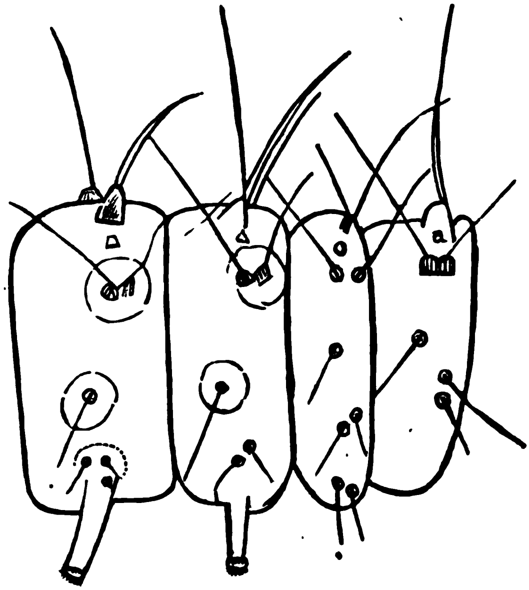


Fig. 3.—5th, 6th, 7th, and 8th Somites of larva of T. paludicola (penultimate instar.). Much magnified.

At this stage the larva feeds indifferently on the leaves and the gummy glands of the *Drosera*.

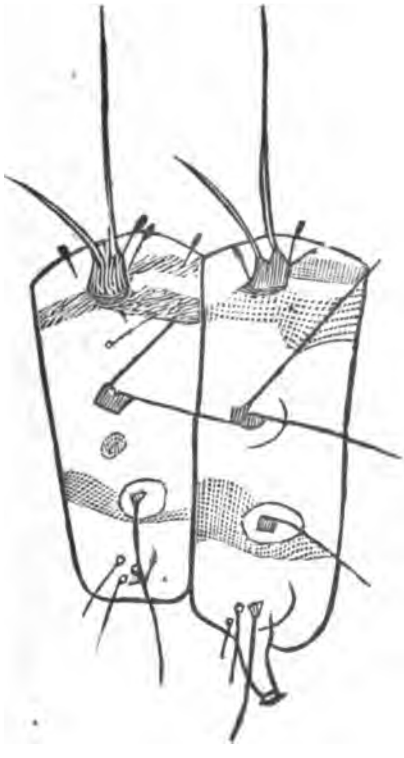


Fig. 4.—6th and 7th Somites of larva of T. paludicola (ultimate instar.).

Fourth (*ultimate*) *Instar*.—A fully fed larva on the point of pupation is just over 7 mm. long, moderately stout, stoutest about middle of body, tapering rather more rapidly towards the head. Colour pale green, a dark rather reddish narrow medio-dorsal stripe; latero-dorsal tubercles red and surrounded with dark red dashes, which assume rather a longitudinal direction, so that the larva seems to have an interrupted rather broad latero-dorsal stripe. Head pale green with dark ocellar marks on either side. Jaws and mouth parts reddish. Long palps on either side of jaws (fig. 4).

The larvæ, however, vary much, but seem divisible into three types :—

(1) Pale green with a distinctly reddish tinge; a narrow darker green dorsal stripe bordered on either side by a pale yellowish longitudinal line; head pale green with dark reddish ocellar patches; tubercles reddish-brown; hairs white, as long as diameter of segmental interstices, slightly and regularly dilated towards apex; prolegs pale green, almost transparent.

(2) Paler green, on which the tubercles show up conspicuously as a bright dark red.

(3) Very much suffused with red, so as to appear of almost as red a colour as the *Drosera* itself.

The intensity of the dorsal stripe is very variable; in some specimens it is very distinct, in others quite obsolete.

In its final instar the larva shows a decided preference for the buds and seeds of the *Drosera*, eating a hole in the side of the seed capsule and devouring the contents, but it also eats the leaves (fig. 6).

General Remarks on the Larval State.—In all its stages the larva is extremely similar to the *Drosera* and difficult to distinguish. Even a full-grown larva may easily be passed over as a glandular leaf seen edgewise, and *vice versâ*.

Ordinarily the larva seems sluggish, but can move along fairly fast when it likes. It has, indeed, little incentive to move from the food plant. When resting across the centre of the plant, with plenty of food within reach, it seems to remain there for days, until a large pile of flaccid dark-yellowish-green frass accumulates.

In some cases the frass is jerked away by a rapid movement of the anal extremity. In one instance which I noted it went about an inch up into the air and fell on to the *Drosera* plant about half an inch away from the larva; but usually, I should imagine, it falls clear of the food plant, or there would be no object in flicking it away in this manner. However, as noted above, the frass often does accumulate on the foodplant, so evidently this process of removal is not an invariable habit, but is a peculiarity confined to certain individuals.

When crawling on to a *Drosera* plant the larva seems very careful to keep clear of the gummy petioles, and is assisted to do so by its long hairs, more especially those situated upon the head, for these hairs are seen to have enlarged basal attachments, which are evidently correlated with hypertrophied tactile nerves. (See fig. 5).

When crawling over the leaves the gum is often seen to adhere to the legs of the larva, which then stops, bends down its head, and cleans them by passing the gummy legs through its mouth. The whole process rather reminds one of a cat licking itself clean.

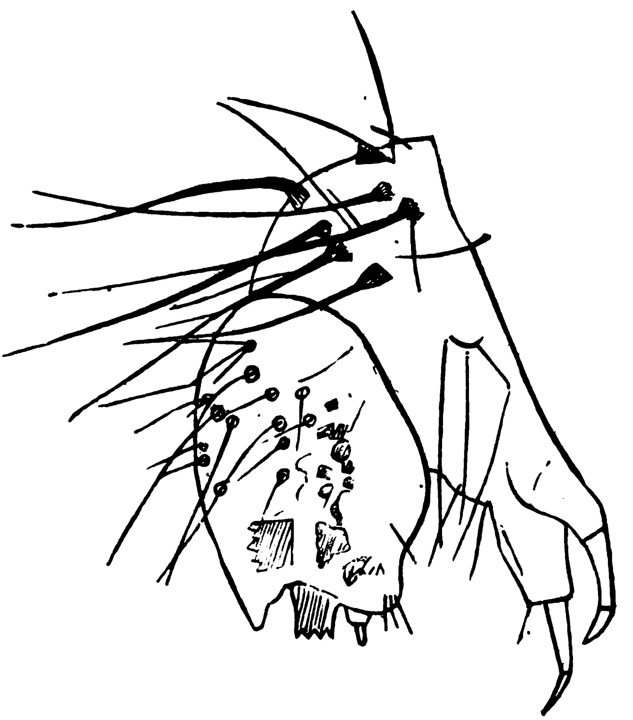


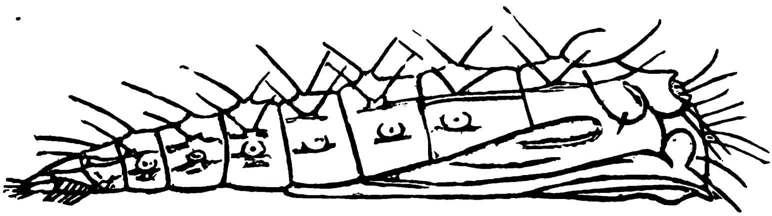
Fig. 5.—Head and Prothorax of larva of T. paludicola showing tactile hairs.

(Note the enlarged basal attachments of these hairs, evidently correlated with a hypertrophied tactile nerve.)

Pupation.—When searching for the larvæ I must have examined several scores of *Drosera* plants, which either contained full-fed larvæ or showed signs of having recently done so, but only in one case have I as yet found the pupa in a natural position, and, judging by the restless behaviour of larvæ in confinement just prior to pupation, I am constrained to believe that the larva wanders away from the plant and fixes itself up for pupation on some grass stem or other similar object, where its discovery would be rendered exceedingly difficult by its resemblance to a pendulous grass seed.

This pupa, which was found *in situ* in its natural position (on 27th August), was on a medium-sized *Drosera* plant, which was growing under the shade of a tuft of grass. The plant had evidently been badly eaten by the larva, and there was no flower stalk. The pupa was attached by its cremastral hooks to a silken pad spun on the base of a leaf just below the central bud and was lying, dorsal surface uppermost, across some leaves whose gummy petioles had been eaten away by the larva. This pupa was of a greenish-yellow-brown colour, just the tint of the faded sundew leaves, and it looked rather like a grass seed which had fallen on to the plant and stuck to the gum; it may be added that ripe grass seeds are often so found.

In confinement the larva exhibits a certain preference for suspension from the flower stalk of its food plant, whose colour is of a reddish green. Even when the stem is growing at an angle, its double set



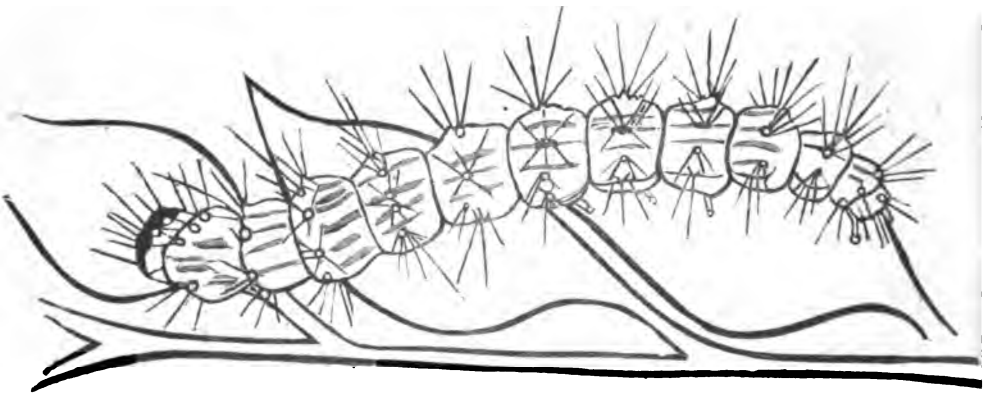


Fig. 6.—(Upper figure) Pupa from the side.
Fig. 7.—(Lower figure) Full-grown larva eating into a seed-capsule.
(From drawings by E. E. Green.)

of cremastral hooks enables the pupa to keep its ventral surface closely appressed to the lower side of the stem, so that it is not suspended freely. It seems possible that this pupa possesses a certain amount of colour adaptability, those pupæ attached to the reddish flower stems having usually an increased red suffusion in comparison with those attached to glass or white paper.

When on an approximately horizontal surface, the pupa is usually found dorsum uppermost; otherwise it invariably suspends itself head downwards and with the ventral surface appressed to its support.

In the case of a pupa in a horizontal position the cast larval skin is sometimes seen lying near it, but quite free and shrivelled up. The suspended pupa always gets rid of the larval skin entirely. This habit is the exact opposite of that found in *Trichoptilus oxydactylus*, Wlk., whose discarded larval skin is not shrivelled up, but is stretched out along the stem just above the pupa.

When first formed the pupa is of a light apple-green colour, the wing-covers and appendages of a darker green, and a narrow darker medio-dorsal stripe. On either side of this last is a series of eight red tubercles, each bearing two black spines, both pointing longitudinally in opposite directions; on about the eighth somite, however, the foremost of these two spines becomes obsolescent and quite disappears before the anal extremity is reached. (See fig. 7.) The cremaster consists of two portions approximately equal to one another, one in the centre of the ventral surface of the twelfth somite, the other at the anal extremity.

In some cases the newly formed pupa is wholly suffused with a delicate pink flush, which almost becomes a dull red in some specimens.

After a couple of days the bright green begins to fade and ultimately becomes a dull uniform pale yellowish-brown, by which time the eyes and antennæ are clearly marked in black.

The pupa is formed about thirty hours after the larva has suspended itself, and the moth emerges after about nine or ten days in the pupal state.

Emergence of Imago.—The moth always emerges in the morning, usually at about 8 a.m.

The following notes refer to one particular case of eclosion, which was watched throughout :—

"10th September, 1907, 7.30 a.m.—Pupa of *paludicola* bent away from the supporting stem. Wing covers very dark, the wings showing through; abdomen dark yellowish-brown ; capital extremity lighter.

"8 a.m.—A dark mark along base of wing covers, which seem quite separated from segments. Pupa quiescent.

"8.20 a.m.—A reddish suffusion along dorsal segments (about fifth to eighth).

"8.40 a.m.—A tremulous motion, and the pupa hangs down a little more freely.

"8.45 a.m.—Segments opposite tips of wing covers look very loosely separated, and there is a constant slight motion in the ventro-dorsal plane.

"8.48 a.m.—Antenna-case separate ; a distinct split in lower surface near eye. Head emerging. Emergence of thorax quickly follows in rapid gliding jerks.

"8.50 a.m.—Abdomen is half emerged ; tips of wings still retained ; legs and antennæ free. There is now a distinct pause.

"8.54 a.m.—A sudden jerk and the abdomen is wholly withdrawn from the pupa case, which is grasped by the first and second pairs of legs. The abdomen now hangs down, the hind legs crossed over it, whilst the wings are raised over the back. The forewings are now about as long as the abdomen; they seem comparatively very large on emergence. The anal tufts are erect and separate, but the hairs look a little matted together.

"9 A.M.—The wings are almost fully expanded, but the cilia are rather matted together.

"9.07 A.M.—The wings are separated and held in a plane parallel with the abdomen, the costal margins of the forewings being at about a right angle with one another. The third segment of the hind wing is kept separate between the other segments and the abdomen. The cilia still look matted. The antennæ are laid along the costa. The hind legs are now at an angle with the abdomen underneath the wings, which seem rather to be stretched over the spurs. Can these spurs be for the purpose of stretching and drying the wings, a thing which must be somewhat of a difficulty in the case of these long slender segments? Anyway, it certainly is the case that amongst the Plume Moths there is a correlation between long spurs and extreme fission of the wings. Normally, too, when the moth has flown, the long spurred hind legs are stuck straight out when at rest, well away from the wings.

"9.24 A.M.—The legs have now been slipped down a little, and each outer distal spur is now pressing on the costa of the second segment of the forewings, separating it out from the first segment, whilst the outer proximal spur similarly opens out the second segment of the hind wings from the first segment.

"9.29 A.M.—The legs have now been slipped down nearer the body, and are directly beneath the third segment of the hind wings. The outer distal spur is just touching the cilia of the inner margin of the second segment of the forewings, and probably acts as a sort of comb to separate the hairs.

"9.34 A.M.—The third segment of the hind wings is now resting with its apex on the outer distal spur, which spreads out the long cilia very well. The outer proximal spur combs out the inner marginal cilia of the third segment.

"9.40 A.M—The hind legs are now laid along the abdomen quite clear of the wings, which are still deflexed.

9.45–9.50 A.M.—The wings are being brought forward very slowly until the costal margins are at about right angles with the abdomen. Meanwhile the antennæ are laid beneath the wings and comb out the basal cilia as the wings are drawn forward."

I would call particular attention to the light now thrown on the *use* of the long spurs which occur on the hind legs of so many Plume Moths. The facts exhibited in the above notes, together with the constant correlation of long spurs with extreme fission of the wings, seem to point out that these spurs have been developed expressly to stretch the wings, to separate the segments, and to comb out the long cilia.

HABITS OF IMAGO.—The moth seems to fly naturally from about half an hour before to just after sunset, and again in the morning until about half an hour after sunrise; the flight is fairly swift, but gentle and floating, and not sustained. If flying naturally they rarely seem to fly more than a yard or so at a time, and not more than four or five yards if disturbed. They stop with a jerk and pitch on a grass stem, flower head, leaf, &c., with the wings rolled up and stuck out at right angles on either side, and the long spurred hind legs projecting upwards between the wings and abdomen.

I have never yet seen two *in copula*. Perhaps they pair after sunset, remain coupled all night, and separate at sunrise, the female ovipositing next evening.

Even in localities where it is abundant, *T. paludicola* is a very inconspicuous little insect, and there are so many small Rhynchota and Diptera extremely similar to it when on the wing and abundant in the same habitats that it is at first by no means easy to distinguish it even when one is on the look out for this particular "Plume." Its jerky floating flight will, however, soon become familiar to any one who is searching for it.

The moth is never to be found away from the immediate vicinity of the *Drosera*.

TIME OF APPEARANCE.—The moth was first found by me in the beginning of October, 1906. On my return to Diyatalawa at the end of July, 1907, it was quite common, and has remained on the wing quite abundantly up to the time of writing, and during the whole of this period the larva has been found in all stages, so that it appears probable that this species is continuous-brooded throughout the year.

HABITAT.—Ceylon, Province of Uva, Diyatalawa (4,000 feet). July to October, and probably throughout the year.

Mr. Meyrick informs me (in litt.) that he has also received this species from the Khasi Hills, Assam.

ENEMIES.—Amongst the agencies destructive to this species must be reckoned the human inhabitants of the districts in which it occurs; these burn off the grass, &c., of the patanas regularly, and these constant fires must destroy vast numbers of *T. paludicola* in all its stages. Luckily, however, for the moth, it is never likely to be wholly exterminated by this means, since the vegetation of the boggy valleys, which form its headquarters, is usually too lush to burn.

The adult moth is preyed on by a small crab spider (*Thomisidæ*) which lives on the seed heads of grasses, with whose colour it agrees exactly.

The larva falls a victim to a small blackish Ichneumonid, which emerges from the larva when it is full grown, and spins a small oval pale yellow silken cocoon on the *Drosera* flower stalk or on a neighbouring piece of grass or occasionally on a *Drosera* leaf. Mr. E. Ernest Green, to whom I had sent some *paludicola* larvæ, was lucky enough to observe the actual emergence of this Ichneumonid grub from the parasitized larva, and writes as follows :—

"My first attempt was interrupted by the sudden emergence of an Ichneumon grub. Whilst endeavouring to draw this caterpillar a lump appeared between the 7th and 8th somites, inside which vigorous movements were seen. Presently a yellowish grub forced its way through the skin at this point. The grub has a row of rounded tubercles on each side, which it alternately protrudes and retracts during its efforts to free itself from the body of the larva. While its hinder extremity was still attached to the side of the caterpillar, the grub commenced to spin its cocoon. Bulk for bulk, the grub is little smaller than the larva from which it has emerged. Within an hour the grub has completely enclosed itself in a pale yellow silken cocoon. Meanwhile, the caterpillar had completely collapsed."

Roughly, about one-third of the larvæ collected seem to be attacked by this parasite, which emerges from its cocoon after about eight days.

I am indebted to Mr. E. Ernest Green for the drawings of figures 6 and 7.

REPORT ON THE WINDOW-PANE OYSTERS (PLACUNA PLACENTA, "MUTTUCHCHIPPI"), IN THE BACK-WATERS OF THE EASTERN PROVINCE (JUNE, 1907).

By ARTHUR WILLEY, F.R.S.

With Plate and Text-Figures.

INTRODUCTION.

THE first systematic biological survey of the Tamblegam pearl fishery grounds in recent years was carried out by Mr. James Hornell in 1905, and an account of it was published in Part II. of the Ceylon Marine Biological Reports (June, 1906).* There was no inspection of the beds in 1906.

On June 5, 1907, exactly at the break of the south-west monsoon, I proceeded to Trincomalee to examine and report upon the occurrence of window-pane oysters in the estuaries and backwaters lying to the south of Koddiyar Bay. At this time a strong wind was blowing almost incessantly day and night, rendering the harbour and great bay as well as lake Tamblegam, which lies in the midst of a flat plain, very choppy. Shortly after my arrival the Assistant Government Agent at Trincomalee, Mr. C. S. Vaughan, C.C.S.,† informed me that the open season for pearling in the Tamblegam lake had terminated on May 15, according to the terms of the lease schedule, and that it now became necessary to make a fresh inspection of the Tamblegam pearl fishery grounds; accordingly I added this work to my programme.

By the terms of the new lease of the Tamblegam placuna fishery, which commenced on January 1, 1907, window-pane oysters may not be collected during a close season extending from the middle of May to the end of the year, and during the open season, from January 1 to May 15, they may not be collected of a less size than 5½ inches in shortest diameter. As the close season is not known to coincide with the spawning season, it will be seen that these restrictions as to season and size can only have a partial effect on the restoration of the beds to their former productivity so long as there

* Also as Sessional Paper XLVI., 1905.

† I am indebted to Mr. Vaughan for the correct rendering of many of the Tamil names in this paper. The old spellings of the Sambore river and Uppu-aru are retained in the text in place of the new official spellings Sampur and Uppar, respectively. The Savaru is the same as Shava-aru on the maps.

is no ground set apart as a breeding reserve, and that without this provision they might even tend towards the virtual extinction of the spawning oysters.

The placuna beds occur in the backwaters of two neighbouring divisions of the Trincomalee District, namely, Koddiyar and Kiniyai, which are under the supervision of their respective Vanniyas, and are separated from each other by the Mahaweli-ganga. Lake Tamblegam lies within the Kiniyai boundaries, and has long been known as the headquarters of the placuna fishery in Ceylon. There are, however, two other backwaters, the Sambore river and the Uppu-aru, connected with the great bay at Trincomalee, where the nature of the bottom and the salinity of the water offer more or less favourable conditions for the window-pane oyster. The Uppu-aru lies to the west on the Kiniyai side of the Mahaweli-ganga, and is connected with this important river about 10 miles inland by a winding channel called the Savaru, a fact which has a bearing upon the well-being of the placuna beds in the Uppu estuary, owing to the likelihood of an excessive sedimentation and freshening of the water during the rainy season, both of which may act calamitously upon the placuna communities. To the east of the Mahaweli-ganga occurs the Mutur-aru, and beyond this again the Sambore river, of which the most considerable expanse is known as the Kaddaiparichchan-aru. The Mutur-aru forms part of the delta of the ganga, and the water opposite to the present resthouse at the old port of Koddiyar is nearly fresh.

SAMBORE RIVER.

After consultation with Mr. Vaughan, I took passage in a Koddiyar dhoney and crossed the bay to the Mutur estuary and resthouse, where I met the Vanniya of Koddiyar by arrangement. On the following morning (June 11) the Vanniya accompanied me nearly 2 miles along the Sambore road, across the Batticaloa road, to the Kaddaiparichchan ferry or Paikiraturai, a spot marked by a double tamarind tree and a pile of edible oyster shells perhaps destined to be calcined. This ferry leads to the Topur road across the river. Here I embarked in a large log boat which was in readiness, manned by three boatmen and two divers. A hundred yards or so below the ferry we pass the entrance to the great inlet called the Kaddaiparichchan-aru on the right bank of the river. About a quarter of a mile farther down on the same side there issues another winding ramification named Irattamaddikkali-odai. It is important to note that the main stream of the Sambore river has a fresh water connection with the ancient but recently restored Allai tank, about 6 miles from the sea.

In the lower reaches of the river where the tide runs strongest the bottom is sandy; in the more sheltered recesses there are patches of mud, some of which have been colonized by window-pane oysters. Such a recess occurs at the mouth of the Irattamaddikkali-odai, shut off from the main current by a long mangrove eyot or "nadutivu." A small quantity of shells thrown upon the bank indicated what had been taken last year. It may be stated at once that the placuna fishery is not an important industry in the Sambore river and hardly shows promise of becoming one, but the occurrence of placuna here is an important biological fact for several reasons.

In his 1905 report, to which I have referred above, Mr. Hornell describes his original investigations into the causation of pearls in *Placuna placenta*, and announces his discovery that the same larval cestode which stimulates the formation of pearls in the Mannar pearl oyster (*Margaritifera vulgaris*), also furnishes the nucleus of the pearls produced by placuna. Mr. Hornell remarks upon the singularity of this parasitological uniformity in divergent environments. The tidal Sambore river introduces us to a third class of conditions of existence, inasmuch as instead of opening to the sea by a wide and comparatively deep strait as does lake Tamblegam, the discharge of the river takes place over a shallow surf-ridden sand bar. Nevertheless, the parasitological conditions remain apparently the same in all essential respects. Later on I shall have something more to say upon the subject of the multiplication and migrations of the parasitic larvæ, which are so abundant in the liver of these bivalve molluscs. Following the usual custom I now pass on to the enumeration of the various stations where samples were collected during my first inspection.

Station I.—At the seaward extremity of Irattamaddikkali-odai; depth 2–4 feet. In spite of the shallowness the water contained so much matter in suspension that the bottom could not be seen from the boat, and the divers waded about depending upon the tactual acuity of their feet to find the shells. This method serves well enough for moderately large specimens in shallow water, but is not sufficiently delicate for the young thin-shelled stages. In the course of about half an hour only six living placunæ were taken, as shown in the subjoined table, the measurements being made with the callipers on a scale of millimetres:—

	Length.	Height.	Remarks.
1	158	143	Pearls found in the right mantle only, a cluster of small pearls inside the mantle opposite the labial tentacles. Copepod ectoparasites with bright roseate ovisacs glided rapidly over the gills.
2	148	135	Several of the red Copepod Crustacea present.

	Length.	Height.	Remarks.
3	150	139	An encysted Nematode worm* observed; one very small pearl in left mantle.
4	166	150	Two small pearls in right mantle, one in left.
5	156	135	Two Copepods present, and a minute pearl in each mantle.
6	136	117	Many liver parasites, but no pearls were found.

With reference to the above, it is to be noted that the standard height, 5½ inches, is equivalent to 139 mm., and according to Mr. Hornell's calculations, based upon observations extending over the years 1902–1905, represents an age of about two years.

Station II.—Across the river opposite to preceding; bottom consisting of a mixture of sand and mud. The search yielded one living placuna, length 117 mm., height 94 mm. When held up to the light the shell was sufficiently transparent to allow the beating of the heart to be seen; some time after removal from water the heart stopped, commencing again after being returned to the water. Fish spawn (goby eggs) and small dome-shaped, sand-encrusted Gastropod egg-capsules, from one of which I liberated 15 operculate veligers, were attached to the right valve. In the normal prone position of the window-pane oyster the flat right valve is uppermost, the shell resting upon the convex left valve as with the edible oyster, which of course adheres to the surface upon which it settles, placuna being free. When the creature is breathing and feeding, these two functions being performed simultaneously as in all lamellibranchiate mollusca, the right valve is raised slightly like a lid, usually about a quarter of an inch or less above the level of the left valve. If the thin blade of a knife be inserted between the gaping valves, touching the sensitive edge of the mantle, they will instantly close, and the entire shell can then be lifted out of the water holding on to the blade. Both large and small specimens retain this grip for many days under artificial conditions.

Station III.—On the western side of the above-mentioned mangrove eyot no placunæ were found.

Station IV.—A short distance up river off the left bank, where there were some remnants of last year's takings. Found only two dead mud-buried placunæ with mud between the valves; height of the shells about 5 inches.

Station V.—In the Irattamaddikkali-odai (so-called on account of the abundance of an edible cockle "Irattamaddi, blood-cockle,"

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* Mr. Hornell recorded the presence of *Cheiracanthus uncinatus* encysted within the adductor muscle of *Placuna*.

Arca rhombea).* The results were chiefly negative. At Marampoddaturai, on the right bank, a likely looking spot marked by a fine "pasari maram," one living placuna was picked up in very shallow water, measuring 157 by 143 mm. Nearer the head of this backwater no more were found.

Station VI.—In the Kaddaiparichchan-aru about three-quarters of a mile along this arm of the backwater, beyond the village of the same name where there is a bifurcated coconut tree and past a slight bend where weathered rocks with cleavage grooves jut out into the water. Here the divers picked up and I subsequently measured upwards of thirty dead and buried placunæ with both valves complete. This is a good example of an entire bed having been destroyed by natural though catastrophic means, namely, mud-burial. In the subjoined table I give a few selected measurements to show the range of size. The insidious nature of the disaster which overtook this bed may be imagined when it is stated that in several cases the delicate ear-like lobes of the shell which occur on either side of the hinge line, especially in young individuals, are still retained (text fig. 1).

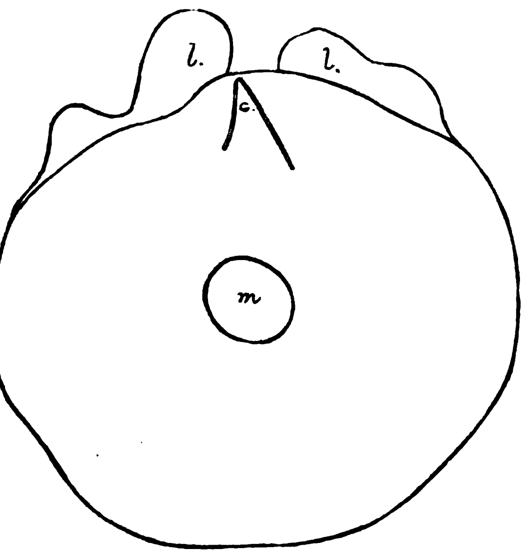

Fig. 1.—Left valve of a Placuna from the inside, from a photograph × ½
l. l. Lobes of the shell. *c.* Hinge area, the longer cardinal tooth is posterior (the figure being reversed). *m.* Muscle-impression.

	Length.	Height.		Length.	Height.
1	209	168	5	120	110
2	160	151	6	94	85
3	142	124	7	76	64†
4	134	111			

* This mollusc has red blood and dark red gills. † Left valve only.

Station VII.—On the left side of the aru, opposite to the preceding station, just above a sandbank occupied by a colony of small crabs with nearly spherical bodies and long slender curved chelæ. I sent a couple of these crabs to my friend Dr. J. R. Henderson at Madras, and he kindly identified them as *Dotilla mycteroides* (H. Milne-Edwards) belonging to the family Ocypodidæ. In Dr. Henderson's "Contribution to Indian Carcinology" (Trans. Linn. Soc. London, Vol. V., 1893, p. 390) this species is mentioned under an alternative title, *Scopimera mycteroides*, the generic name referring to the presence of thin, smooth, soft, oval areas on the meropodites of the legs and on the sterna, which have been termed "tympana." In a very large series of this species only males occurred, and Dr. Henderson tells me that he has never seen a female.

From this station I obtained seven examples of the youngest living brood met with during the entire inspection. The first specimen to be found was picked up casually in company with a dead shell; the other six were obtained by the two divers in about half an hour by the hand-trailing method, which can only be employed in very shallow water. The details are given in the following table:—

	Length.	Height.	Observations.
1	71	59	No parasites were found.
2	75	64	One cystic parasite was found in the liver containing a single contractile endogen (for explanation of the use of this term see below under Parasitic Larvæ). (Fig. 9.)*
3	65	54	One larva only was seen in the liver, without adventitious cyst. (Fig. 8.)*
4	61	58	Preserved whole in formalin.
5	59	52	Do.
6	60	52	No parasites were found.
7	58	51	Do.

The presence of a buried colony on one side of the river and a growing colony on the opposite side should presumably be considered in conjunction with the configuration of the banks at this spot, a rocky point on the one side and a sandy bight on the other, the former causing, the latter indicating, a deviation of the tidal currents and consequent alteration of deposit during the period of maximum sedimentation.

Station VIII.—In a stretch of the river known locally as the Eraiyattiwu-aru, close above the Kaddaiparichchan ferry (Paikiraturai); depth 4–5 feet. At this spot edible oysters of large size occurred, often coated with a yellow encrusting sponge. A placuna

* These refer to the figures on the plate at the end of this article.

valve had edible oysters attached to it. Only two living placunæ were taken here within half an hour, as under :—

	Length.	Height.	Observations.
1	107	98	Many cysts containing 1–12 endogens.
2	112	103	Observed in all about 15 cysts, including one bearing an endogen, another with several endogens, and one free endogen.

About 200 yards further along in a wide, shallow bight on the eastern shore, where the tide was running very slowly, four dead complete shells were taken, three measuring on the average 150 mm. long by 143 mm. high, the fourth smaller, 129 mm. by 105 mm.

The mangroves which border the lower reaches of the river presented a remarkably even line of foliage jutting out over the maze of roots some 3 feet above the level of the water, curiously like the undercut cliffs of some coral islands. Another characteristic feature, at this season, of the complex of waterways which constitute the Sambore river was afforded by the presence of great numbers of Rhizostome Medusæ ("jelly-fish") belonging to the series of forms included under the name *Himantostoma flagellatum*, the eight oral arms carrying superficial fringes and long terminal contractile streamers. In the morning they were to be seen drifting up the river with the inflowing tide against the wind; towards evening the outflowing tide left many of them stranded upon the sandbanks, which were then exposed. They varied in size from about 1½ to 5 inches in diameter, and many of them, both large and small, had a purple spotted umbrella, while others were colourless. It is furthermore worth noting that they occurred up the river as far as the Batticaloa road beyond the upper limit of the placuna beds.

Lake Tamblegam.

On June 20 I went to Niroddumunai, where the road from Trincomalee to Batticaloa abuts upon the wide channel by which this lake communicates with the sea, the village of Kiniyai lying on the opposite shore. Here, by kind permission of the District Engineer, Mr. W. Brice Gregson, I occupied the conveniently situated Public Works Department bungalow.

The object of my visit, as I have indicated at the commencement of this report, was to make the first official inspection since the passing of "The Pearl Fishery Ordinance, 1906," and since the lease concession 1907. It is currently known that much unlicensed collecting took place in 1906, and that the legitimate fishery this year has not yielded a satisfactory return. It is to be regretted that the statistical information, which is so freely forthcoming from the Mannar fishing grounds, is utterly wanting at Tamblegam, a somewhat unfortunate deficiency, where everything depends upon numbers. At the same time it is not easy to find a remedy except by the co-operation of the contractors.

Examination of the recent shell-heaps at different points of the shore showed that not less than 50 per cent. were undersized. For instance, the measurements of the heights of 10 entire left valves gathered at random from one pile were 4, 4¼, 3¾, 5¼, 4¾, 4¼, 5½, 4½, 5, 4½ inches. Evidently an undersized brood had been fished, perhaps during the previous year, and it is hard to believe that the collection can have brought any return worth naming.

I am informed by one of the contractors that during the fishing season of 1907 ten boats were engaged for four or five days only collecting daily 300–400 oysters each; then for about six weeks four boats were employed daily. The season's catch yielded forty-six rupees weight of pearls worth six hundred and ninety rupees, one rupee's weight of placuna pearls being valued at fifteen rupees.*

The topography of the lake and the position of the principal placuna beds were described and illustrated by Mr. Hornell (1905), so that I can proceed at once to record my notes for the present year in the month of June. At this time the salinity of the water, as ascertained from a sample from Nachchikuda, was approximately the same as that of the sea, a ship's salinometer showing a reading of 12, as against 10 in the Sambore backwater.

Station I.—In the mouth of the inlet called Nachchikkuda, about midway between the hill on the east side called Makilankaraimalai (exposing a broad front of rugged weathered rock surfaces) and Vellaikkallumunai (white stone point) to the west; depth about two fathoms. This station lies to the south-east of the coconut planted village of Sinnakkulam. Three divers in fifteen minutes brought up ten large living oysters and a dead one overgrown with hydroids (*Obelia*). No window-pane oysters were recorded at this spot by Mr. Hornell in 1905. In this material I noted two single endogenous larvæ. In most of the individuals patent cysts, visible without magnification, occurred in the anterior portion of

* In a statement submitted by the principal lessee, Mr. Abdul Rasool to the Assistant Government Agent and self at the Trincomalee Kachcheri in October, it is certified that this quantity of pearls was obtained from 627,672 window-pane oysters fished and opened during 125 days by 23 men. The number of oysters can be stated with such precision, because a payment of 25 cents per thousand is made for opening them. The actual yield was indeed greatly below what was anticipated from the examination at the Kachcheri in February, 1906, of a sample of 2,000 oysters, in accordance with a recommendation made by Mr. Hornell. The pearls procured from this sample were valued at six rupees.

the suspensory membrane of the gills; but the pearl yield was poor. I give the sizes for future reference :—

	Length.	Height.	Contents.
1	155	142	No pearls.
2	166	134	Do.
3	151	147	Do.
4	151	141	Do.
5	161	141	Do.
6	146	157	Do.
7	156	141	A minute pearl in each mantle-half.
8	150	133	No pearls.
9	165	148	One small pearl in right mantle.
10	172	150	A small pearl in left mantle edge and a small hinge pearl.

Sheets of encrusting Bryozoa occurred at base and apex of both valves of No. 9; the right valve of No. 10 was bored in four places, the holes being covered internally by thin nacre.

Station II.—Opposite Sinnakkulam Ur, south of the point called Mutalaippiddi "crocodile shallow," in 1½ fathom. In Mr. Hornell's sketch plan of the lake the Nachchikkuda bed is localized between Mutalaippiddi and the head of the bight. Three divers within ten minutes brought up six living and six dead well-grown placunæ. Details of the living specimens are given below :—

	Length.	Height.	Observations.
1	154	143	Many patent cysts; no pearls.
2	159	148	Right valve overgrown with yellow encrusting sponge.
3	152	150	—
4	147	147	Edge newly bordered with thin shell-substance. About a dozen small pearls, eight of which were lying close to the lower border of the adductor muscle.
5	153	149	—
6	142	134	Patent cysts present.

Station III.—Abreast of Mutalaippiddi, where there is a sandy beach with low trees in front of the coconut plantation. Three divers found eight living oysters in about 1½ fathom within five minutes :—

	Length.	Height.	Observations.
1	145	145	Large patent cysts; one hinge pearl.
2	154	148	Double hinge pearl.
3	173	162	No pearls.
4	151	144	One very small pearl.
5	166	153	One mantle and one hinge pearl.

	Length.	Height.	Observations.
6	167	156	One hinge pearl.
7	144	137	Numerous patent cysts; no pearls.
8	151	147	Two mantle pearls and a small hinge pearl.

What I have called "hinge pearls" always occur near the posterior cardinal ridge or tooth imbedded in the fleshy substance of the central triangular lobe of the mantle which lies between the cardinal teeth.

Station IV.—On the Nachchikkuda bed round Mutalaippiddi, nearly opposite to a pile of this year's shells on the beach; depth about 5 feet. From this spot and also from another diving farther up the inlet off an outstanding thicket of mangroves near the Sinnakkulam side I recorded twenty measurements. This station evidently corresponds with Mr. Hornell's station 5*a* (1905), where he found "great abundance of very young *Placuna placenta*," this being the only part of the Nachchikkuda where he obtained any placunæ at all. From this fact we may apparently draw the conclusion that placuna attains the standard size in about 2½ years:—

	Length.	Height.	Observations.
1	140	143	Capulids attached to the right valve in the umbonal region and on the inner upper posterior margin of left.
2	147	143	No pearls.
3	147	137	Do.
4	149	138	Do.
5	149	133	Two small pearls in left mantle; an invasion of mud coated by nacre.
6	153	140	One pearl.
7	157	151	No pearls.
8	160	148	One pearl.
9	163	152	Numerous patent cysts in the usual position.
10	166	151	Right valve with Capulids, left with adherent sand-tube. Many patent lymphoid cysts in the suspensory membrane of the gill.
11	166	159	Patent cysts present, some adjacent to the organ of Bojanus.
12	169	155	No pearls.
13	170	145	Do.
14	171	149	Capulids and sand-tubes on left valve.

	Length.	Height.	Observations.
15	172	157	Two pearls.
16	173	156	None.
17	175	153	None.
18	178	147	None.
19	180	152	Several patent white cysts at anterior base of gills (the usual position) each containing a normal parasitic larva surrounded by adventitia.
20	188	162	One pearl.

A sample for comparison with the above from the same place should be examined towards the end of the year before the next fishery.

The sand-tubes which adhered to several of the shells were inhabited by Polychaet worms, *Eunice indica*, all in the same immature condition, about an inch in length (after preservation), the head entire or but slightly notched in front, antennæ and cirri smooth, gills commencing on the third foot and ending on the 26th–28th feet.

Station V.—Off the Nachchikkuda (east) shore, opposite to Sinnakkulam; depth about one fathom. Many oysters of the statutory size, several slightly below it (5¼ inches). Ten specimens yielded two hinge pearls and five mantle pearls.

Station VI.—Before Kakkaimunai, "Crow Point," in one fathom; collected a sample of a dozen. Nos. 1 and 9 contained a hinge pearl apiece, that from the latter measuring 2 mm. long by nearly 1·5 mm. wide.

	Length.	Height.		Length.	Height.
1	120	115	7	109	99
2	117	106	8	123	113
3	124	116	9	120	109
4	121	124	10	116	108
5	111	100	11	122	110
6	113	110	12	136	122

This bed might make a good showing next year; it corresponds with Mr. Hornell's station 8–8 (1905). Other parts of the Kakkaimunai bed exhibit abundant crops of the sponge called "kadal-palam," referred to by Mr. Hornell, to the almost entire exclusion of placuna. Whether or not it really ousts placuna from its position on the beds is a question which could only be answered after repeated observations, the point to decide being whether placuna would settle down where the sponges now reside if it were given the chance. I think it probably would.

Station VII.—The Sembianar Velanga.* In Mr. Hornell's sketch plan this is regarded as forming part of the Kakkaimunai bed. On this ground there were living placunæ of standard size as well as dead of all sizes. Particularly the young taken at different points of the bed were all dead. I took footrule measurements of the living material, which may be omitted; in general the height ranged from 5½ to 6 inches. One specimen had two hinge pearls adjacent to each other and near to the posterior cardinal ligament; another had as many as six hinge pearls in the same position.

Station VIII.—Palampoddar bed. The Amaikkalam, "Turtle shallow," a submerged sandbank, yielded two live oysters with clean, worn valves, measuring 152 by 129 mm. and 151 by 140 mm., respectively. Steering towards the Tampalakamam-aru we find fine mud, but very few chippi, and these requiring much search. Off the Periya Palampoddar (according to the unanimous declaration of my boatmen, although it is labelled "Sinna Palampat" on Mr. Hornell's plan) only old valves were found. In fact this bed seems to be nearly exhausted. I do not know whether it has ever been notably productive, but the proximity of the rivers is againstit.

Station IX.—Kappalturai bed. Numbers of living placunæ, sparsely distributed, occurred here, the shells being mostly bent and contorted, with worm-tubes on the valves. In point of size they were, as a rule, well over the mark, ranging from about 5 inches to 6¾ inches in height. One had a very small pearl in the superficies of the mantle, a larger one at the edge, and a third still larger at the hinge. Another specimen showed two pearls near together over the gastro-hepatic region; and a third had one mantle pearl and a good hinge pearl.

The Tamblegam lake is estimated to cover an area of 5,006 acres. The beds which seem to deserve most attention are Nachchikkuda, Chempiyanar, Kakkaimunai, and Kappalturai, the first-named being especially well placed for future observation and experiment. At no great expense oyster parks could be staked out, and the course of events carefully watched and recorded. The divers can hardly be expected to discriminate under water between shells differing in one dimension by a fraction of an inch, and the lease indenture does not bind them to carry a footrule, nor are they directed to return undersized shells to the water. It is certain that large numbers ought to be returned, not however by rudely casting them overboard, but by placing them by hand the right way up (*i.e.*, resting upon the left or convex valve) on the bottom in a definite space. The heavy log boats of these parts can be moored quite securely against the strong south-west wind by means of a long pole which they carry for the purpose, driving it deeply into the mud. It would be a

* More correctly, Chempiyanar Vilakku.

comparatively simple matter to stake out rough enclosures, which could then be thickly stocked with the window-pane oysters.

Uppu-aru or Uppar.

This backwater is deeper than the Sambore, upwards of a fathom in most parts, so that genuine diving is required. Before diving, and while the divers were under water, the boatmen beat the sides of the boat to scare away sharks and crocodiles should any be in the vicinity.

The beds, such as they are, occur on the Kiniyai side of the wide bay into which the Uppu-aru expands at its mouth. On the opposite side, bordering upon the "Oopah estate" the current is too strong.

Just inside the bay, round the point of the ferry, two bivalve chippi were picked up looking quite normal, but they proved to be dead. It was indeed the common saying that the "muttu chippi" of the Uppu-aru were all dead. Nevertheless, on the north side, which is flanked by a bank of mangroves, whose lower line of foliage was flush with the surface of the water, some living placunæ were found. A sample of half a dozen ranged from 5½ by 5 inches to 7 by 6 inches. I returned all except one, which harboured the same Copepod gill parasites that I found in the Sambore river, but failed to find in the Tamblegam chippi, although I searched carefully for them.*

Proceeding along towards the head of the bay some healthy looking specimens of medium size were procured, but they also were dead; then approaching a kallam in one fathom more dead valves were found. Striking off towards the centre a diver picked up a pale grayish gelatinous sea-hare† (*Aplysiidæ*) studded with bright emerald green areolæ and with retractile pinnate tassels all over the body; they called it "kadalnatthu" (sea-foam). Nearer the shore we took three more dead bivalves.

At the head of the bight between two creeks, among dead remnants, one living placuna of medium size (5½ by 5 inches) was taken, the shell showing the marks of a fish bite. In the mid-bay, opposite to the sea-opening, only dead valves were found.

Parasitic Larvæ.

It is still uncertain how the primary infection of the liver with the flatworm larvæ, which are believed to be identical with the pearl-inducing parasites, takes place, whether they are passively ingested with the food or actively migrate from the outside. However this may be, it stands to the credit of Mr. Hornell to have shown for the first time how secondary infection may occur, namely, by the endogenous formation of a new generation of larvæ within a parent cyst.

* Since found (October).

† Perhaps *Acclesia cirrifera*.

Out of some hundreds of cysts passed in review under the microscope, Mr. Hornell tells us that he found "in three different instances a miniature reproduction of the parent within the bladder-like posterior division of the body." Mr. Hornell adds: "So far as my observations go only one secondary larva is produced at a time."

Whilst confirming Mr. Hornell's discovery, I find that the endogenously produced larvæ, or briefly the endogens, are not so rarely to be seen as might appear from the above quotations from Mr. Hornell's work, but that, on the contrary, most of the individual placunæ which I examined contained some of them; and secondly, I have to add that the multiple formation of endogens within a single cyst is a common phenomenon. One of my first preparations showed a cyst, 0·38 mm. in diameter, containing numerous (about twenty) endogens, each exhibiting small granules near the posterior end, the larger concretionary granules (calcareous corpuscles) of the parent occurring round about them in the interstices (compare fig. 1).

The encysted larvæ vary much in size, but in general two sizes may be distinguished, a small one less than 0·25 mm. in diameter (becoming greater when turgid with endogens), and a larger one ranging from 0·5 to 1·0 mm. Both forms are capable of producing endogens, and are therefore potential blastogens. For convenience of description and reference it may be useful to refer to the former as microblastogens (in short microgens), and to the latter as macroblastogens (macrogens). A parent encysted larva bearing one endogen is a phase or "instar," which may be described in one word as a monogen; with two endogens it becomes a digen; with three a trigen; with four a tetragen; with many a polygen. The utility of this terminology can perhaps only be appreciated by those engaged in practical investigations of a like nature, but whether this be so or not it happens to suit the occasion.

A complete cyst consists of an outer adventitious fibrous layer surrounding the parasite, sometimes closely investing it, sometimes with an intervening space which may be occupied by a flocculent substance. A spherical or rounded larva closely surrounded by the fibrous cyst-wall may show in its anterior hemisphere a series of backwardly directed bristles such as may sometimes be observed in the endogens (fig. 4). Another appearance occasionally met with is that of a well-defined striated cuticle, the cuticular striæ stretching at right angles between the body of the larva and the inner surface of the membrane which is in contact with the fibrous layer. The striæ are involved in the constant contractions or swaying movements of the body. I do not know what may be the significance of these different appearances, or whether they are connected in any way with the distinction which must exist between the primary and secondary larval generations.

Parasitic infection takes place at an early age, as is indicated by the observations recorded under Sambore river, Station VII. A simple larva with large granules from the smaller of the two infected specimens is shown in fig. 8. The larger (No. 2) had a monogen (fig. 9), the contained endogen undergoing continual movements of contraction and expansion. An older placuna (Sambore river, Station VIII., No. 1) exhibited many different stages, from the barren microgen to the polygen. The irregular shape of the endogens is a consequence of their soft contractile bodies.

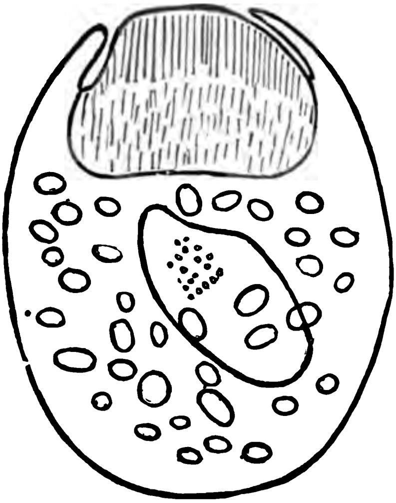

Fig. 2.—Monogen cyst of intermediate size. The large granules are outside the endogen. Zeiss. 3 C. *cam. luc.* Tamblegam.

In fig. 6 the endogen appears like an imaginal disc carved out of the substance of the parent; in this instance the cluster of small granules had not yet formed, those seen in the sketch being peripheral granules of the parent outside the endogen. Frequently when a single endogen is present it occupies the greater part of the body of the parent, but sometimes the contrast in the size of parent and offspring is very great as will be noticed below.

In another cyst from the same host (Sambore river, Station VIII., No. 2) seven endogens could be clearly distinguished, and I noted that, as a rule, the endogens were placed peripherally in the cyst, the bulk of the calcareous concretions internally. In this placuna diatomaceous ooze was seen adhering to the tip of the crystalline style, indicating the nature of the food upon which placuna subsists. Fig. 7 shows a monogen from the same host, in which the endogen appears with its anterior end retracted, and a pore is visible at the hinder end of the parent. In the preparation from which this was taken about eight larvæ were found in the field of the microscope, but only the one figured contained an endogen. In another preparation a free endogen with small granules was seen, but it may have been artificially liberated.

A trigen, *i.e.*, an encysted larva containing three equally advanced endogens, is shown in fig. 4; close by it in the preparation were two monogens, a macrogen with three endogens, and many simple microgens.

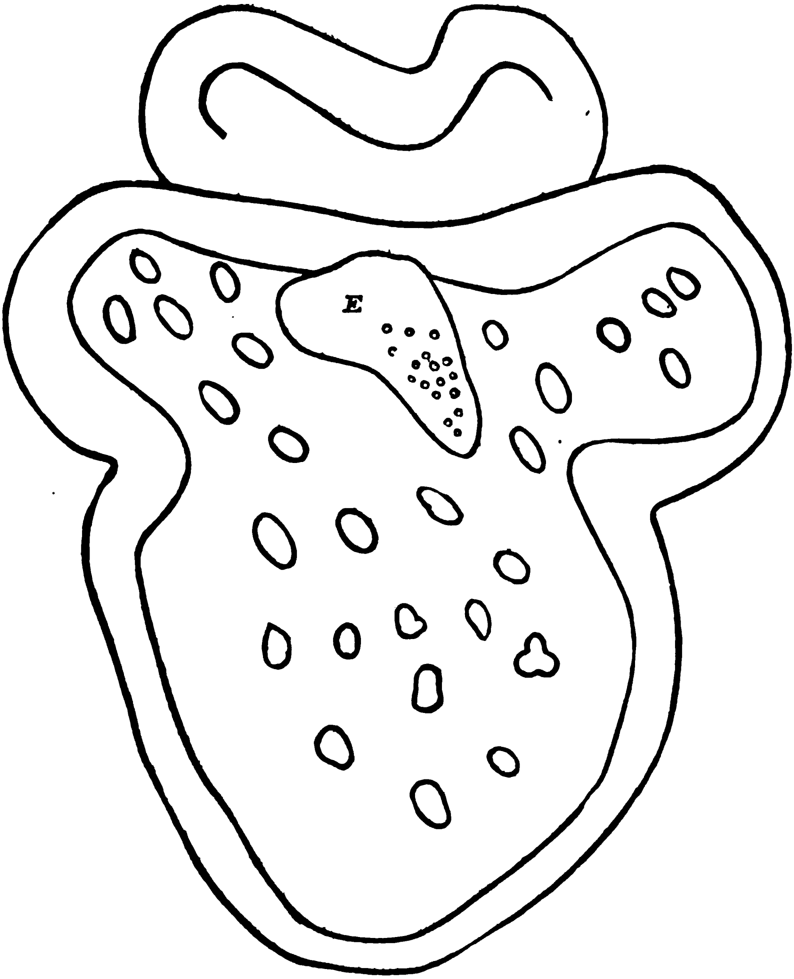

Fig. 3.—Giant monogen in optical section, or macrogen bearing a single endogen (E). Only a few of the large granules are indicated. The body is somewhat contracted and the rostellum is everted. Zeiss. 3 C. *cam. luc.* Tamblegam.

Not only are the normal larvæ contractile within their cysts, but they retain their contractility after they have become spontaneously gravid. The pentagen shown in fig. 2 was very contractile *in toto*, as also were the several endogens. In the same host a polygen with ten endogens was observed, also a spherical monogen of the ordinary type, and a motile larva in a spacious spherical adventitious cyst. The latter is the outer fibrous layer formed from the connective tissue of the liver in which the larva is imprisoned, and, as stated above, in some cases a cavity is enclosed in which the larva can enjoy a certain amount of freedom (text fig. 5).

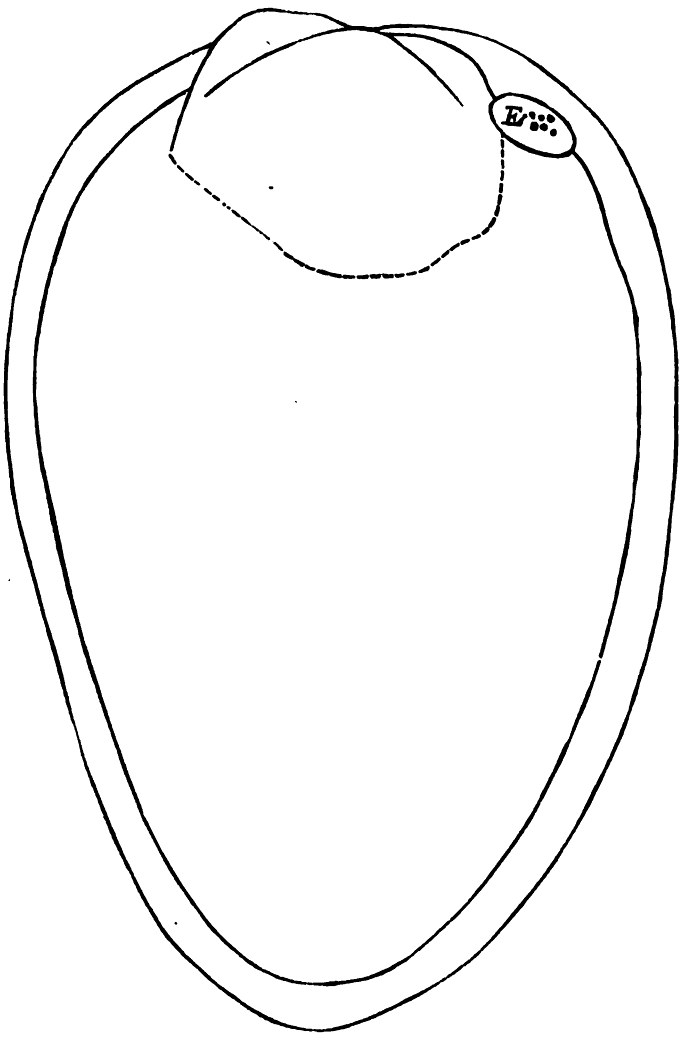

Fig. 4.—Another macrogen of large size with a single endogen (E) adjacent to the retracted rostellum. Large granules omitted; they completely fill the body. Zeiss. 3 A. *cam. luc.* Tamblegam.

When an encysted larva produces more than five endogens, it would appear from my observations and sketches that the individuality of the parent tends to become lost, and the rostellum gradually disappears. But it also seems that a microgen can grow independently and become a macrogen, with or without the formation of one or more endogens. Thus, side by side, we find microgens containing offspring, and barren macrogens; or a larva larger than the average may bear a single endogen as in text figure 2. I have also noted a mobile macrogen 0·5 mm. in length with only one endogen. But the greatest disproportion between the sizes of the parent and that of the offspring which I have seen is represented in text figures 3 and 4; in the former the contracted body with everted rostellum measured 0·9 mm. in length, the latter was over a millimetre long. In each case the body was crowded with the usual large concretions, but there was only a solitary endogen.

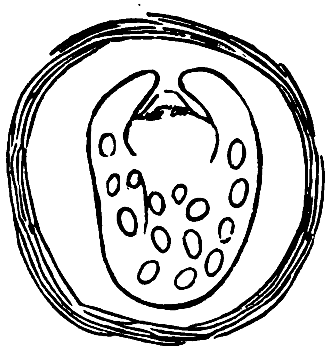

Fig. 5.—Encysted larva from liver of "pakku maddi" (*Venus* sp.). Sambore river. Zeiss. 3 C. *cam. luc.*

I should mention that I have seen a tetragen, *i.e.*, an encysted larva containing four endogens. Fig. 11 is a sketch of what I take to be an endogen having emerged from a ruptured cyst, about to give rise to a new cyst; it will be noticed that it contains both large and small granules; its greatest diameter is 0·1 mm.

The greatest number of endogens which I have counted in a single cyst is upwards of twenty (Sambore river, 12-VI.-07). The example shown in fig. 1 on the plate has fourteen endogens (Lake Tamblegam, Station IV., No. 11).

I have also found the same kind of larval forms in other bivalve molluscs which live in the sand and mud of the Sambore river, namely, in the "irattamaddi" (*Arca rhombea*) and in two species of *Venus* called pakku maddi" and "valukkal maddi" (see text fig. 5). In a liver preparation from the last-named I observed a free larva moving swiftly along by the alternate protrusion and retraction of its rostellum; on the addition of sea water it pressed itself between the lobules of the liver and became motionless.

The multiple endogeny which I have described as occurring in these parasites finds a parallel in the life-history of the common liver-fluke, where a ciliated free-swimming larva actively penetrates into the liver of a gastropod mollusc and there becomes transformed into a so-called sporocyst, which produces offspring, endogenously. All those larvæ in the liver of placuna which carry endogens are therefore in the condition of sporocysts.

The general type to which these parasitic larvæ belong is known as the Cysticercoid, and a close analogy with the phenomena noted in connection with the proliferation of the Cysticercoids of Placuna seems to be afforded by the proliferating form named *Polycercus* by Villot (1883).* This form was discovered by Metschnikoff in the earthworm *Lumbricus terrestris* in 1868, and was described without being named. An account of it, quoted from Leuckart's work on "Die Menschlichen Parasiten," is to be found in a paper by Professors Haswell and Hill,† describing a new species from the earthworm *Didymogaster sylvatica*, Fletcher, common under stones and dead timber in New South Wales. These authors say that the infested earthworms usually contain immense numbers of cysts of sizes grading up to 1 mm. in diameter, adhering in clusters to the outer surface of the alimentary canal. Each cyst contains usually 8-12, sometimes 30 Cysticercoids, which have arisen by a peculiar method of budding from a primordial larva. This species was subsequently named *Polycercus didymogastris* by Hill (1894).‡ In its earliest stages it is a solid, spheroidal mass of small-celled tissue.

Metschnikoff's larva may be called *Polycercus niloticus*, since it is now known to be the bladder stage of the tapeworm *Tænia nilotica* out of *Cursorius europæus*.§ "In its mature condition it consists of a thin-skinned bladder, which contains a varying number (up to 13) of small Cysticercoids. Although the latter lie quite free in the interior [of the cyst], and possess, like the ordinary Cysticercoids, the distinctive caudal bladder, they are of very unusual origin, inasmuch as instead of developing directly from the six-hooked embryos, they arise by proliferation of the wall of the surrounding bladder. The bladder is thus the brood-capsule of the enclosed Cysticercoids, and corresponds in some respects to the brood-capsule of the *Echinococcus*,

* Mémoire sur les cystiques des Ténias. Ann. Sci. Nat. Zool. (6), XV., 1883 (reference taken from Haswell and Hill).

† W. A. Haswell and J. P. Hill. On Polycercus, a proliferating Cystic Parasite of the earthworms. Proc. Linn. Soc. N.S.W. (2), VIII., 1893, pp. 365–376, two plates.

‡ J. P. Hill. Contribution to a further knowledge of the Cystic Cestodes. Op. cit., Vol. IX., 1894, pp. 49–84, 3 plates.

§ See W. B. Benham. Platyhelmia, &c., in Lankester's Treatise on Zoology. Part IV., 1901, pp. 142–143.

or perhaps to a *Cœnurus* bladder, and, like these, is undoubtedly to be referred to the six-hooked embryo. The first developmental stage observed by Metschnikoff appeared to be a solid ball of about 0·08 mm., with an unusually thick cuticular envelope and cellular contents. The latter subsequently became clear on attaining a diameter of 0·14 mm., when the embryo lies on the inner surface [of the cuticle] in the form of a cellular layer. Soon the buds begin to form, and that exclusively from the cellular wall, which becomes thicker at certain spots and sends little projections into the inner cavity. Although at first flat and connected by their broad bases with the cellular wall, the protuberances, as they grow larger, gradually detach themselves from the subjacent layer."

Thus although the proliferating Cysticercoid of placuna is not a *Polycercus*, yet it is an analogous form, for which the provisional name *Merocercus* may be suggested. Looked at broadly it seems to represent a type intermediate between *Monocercus* and *Polycercus*. The latter, according to Haswell and Hill, " is not nearly related to *Echinococcus*, but finds its closest ally in *Staphylocystis* " (out of *Glomeris*).

Mortality of Placuna.

The direct observation of mud-burial in the Sambore river and the collection of many prematurely dead specimens in lake Tamblegam indicate the existence of a destructive agency in the rainfall.

Mr. H. O. Barnard, Superintendent of the Meteorological Branch, has kindly supplied me with information on this matter (see the Appendix to this report), from which it appears that there was in fact an exceptional downpour of rain at Trincomalee in January, 1907, the bulk of the rain falling within the space of a few days. This is of the nature of a torrential or catastrophic cloud-burst, causing freshets and floods and boding ill to placuna.

The average rainfall for the month of January at Trincomalee for the last 37 years is 5·66 inches ; in January, 1906, the actual rainfall was 2·28 inches ; in January, 1907, 10·23 inches, of which 5·42 inches (*i.e.*, nearly the whole average) fell during the first four days of the month. The actual figures are January 1, 0·29 ; January 2, 2·27 ; January 3, 2·00 ; January 4, 0·86. The figures for the other months of the rainy season at Trincomalee are given below, the average being reckoned for the last 37 years :—

	Inches.
October average	7·83
1905	3·90
1906	8·68

	Inches.
November average	14·23
1905	15·5
1906	24·3
December average..	14·91
1905	5·39
1906	11·39

The above figures show clearly enough a disturbance of meteorological conditions in the rainy season immediately preceding the placuna fishery of 1907, and the same indications are continued during February and March :—

	Inches.
February average	2·16
1905	0·93
1906	0·00
1907	1·48
March average	1·48
1905	0·03
1906	0·22
1907	1·94

Regeneration of the Tamblegam Beds.

The main object of placuna fishery investigations in Ceylon must be to foster the Tamblegam fishery in particular. I have already pointed out that it is not enough to limit the season and the size.

In order to replenish the partially exhausted beds, some control should be exercised over the breeding facilities so as to ensure an adequate reserve of spawning oysters. It is an axiom among European and American ostreiculturists " that the amount of spat annually occurring in a region appears to be directly in proportion to the number of spawning oysters in that region."* This is evidently a safe principle.

The Nachchikkuda, being devoid of rivers opening into it, and being by its position secluded to a great extent from other outside influences, is peculiarly suitable for the introduction of simple and inexpensive cultural operations. I would recommend the immediate laying down of an enclosure about 30 feet square and thickly planting the bottom with placunæ, of which the average size has been ascertained by previous measurement. By such means information could in course of time be expected concerning actual rate of growth, natural longevity, maturation, spawning, and distribution of the fry.

It is important to note that in spite of the mortality recorded in this report, placuna is none the less a hardy mollusc, and can be

* Bashford Dean. Report on the European Methods of Oyster-culture Bull. U. S. Fish Commission for 1891, pp. 357–406. Washington, 1893.

kept for hours or overnight out of water in a cool place with imp In the excellent wide-mouthed chatties which are made at Kod they can be kept almost indefinitely in sea water renewed other day. There is, therefore, no difficulty to be met in reg the manipulation of the window-pane oysters.

Explanation of the Plate.

Fig. 1.—A polygen cyst containing 14 endogens. Tambl Sta. IV., No. 11. 22-VI.-07. Diameter 0·32 mm. Zeiss 3C, luc.*

Fig. 2.—A pentagen cyst. The whole body is mobile ind dently of the mobile endogens. Tamblegam, Sta. IV., No. 5. of the calcareous concretions are omitted from the sketch.

Fig. 3.—Another pentagen with crowded endogens. Sam Sta. VIII. ·14-VI.-07.

Fig. 4.—A trigen cyst bearing a triplet of endogens. The l show stiff cilia pointing backwards. Tamblegam, Sta. VI., No

Fig. 5.—A digen cyst. In front of the upper endogen in the fi is seen the rostellum of the parent. From same host as fig. 3.

Fig. 6.—Encysted larva containing a transparent homogen endogen surrounded by a rim of the parent sarcode. All gran seen are outside the endogen, and, upon focussing through it, t appeared a continuous sheet of concretions on the other side. Z 3D. Sambore, Sta. VIII., No. 2. *r* = rostellum of parent.

Fig. 7.—Monogen from same host as preceding, containing a m advanced endogen. Zeiss 3D.

Fig. 8.—Young larva, 0·12 mm. in longer diameter, from liver young placuna. Sambore, Sta. VII., No. 3.

Fig. 9.—Encysted larva containing an endogen (*e*) with sm granules, surrounded by the large granules of the parent. *r* rostellum of parent. Sambore, Sta. VII., No. 2.

Fig. 10.—A monogen from a Tamblegam placuna; stiff cilia o bristles are seen at the surface of the endogen. Zeiss 3D. 23-VI.-07

Fig. 11.—A microgen which may have arisen from an escape endogen since it contains both large and small granules. Thi occurred in the same host as the macrogen shown in text figure 4, and was lying close to it. Tamblegam, Sta. IV., No. 11.

Appendix.

Tables and diagram of curves illustrating the distribution of the rainfall at Trincomalee from 1900 up to date, prepared by Mr. H. O. Barnard, Superintendent of the Meteorological Branch.

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* The magnification is always the same except when otherwise stated.

Table I.—Actual and Average Rainfalls at Trincomalee from 1900 up to Date.

Year.	Jan.		Feb.		March.		April.		May.		June.		July.		Aug.		Sept.		Oct.		Nov.		Dec.		Total for the Year.	
	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.
1900 ..	5·03	12	0	0	0	0	5·41	9	1·45	5	0	0	1·04	5	5·48	5	2·41	4	9·81	20	20·66	18	7·79	18	59·08	96
Means during 31 years ..	5·68	11	2·15	4	1·40	4	2·13	6	2·37	6	1·37	3	2·12	4	4·49	8	4·50	8	7·99	16	13·63	19	15·35	20	63·18	109
1901 ..	1·90	8	2·48	6	7·79	12	2·47	6	2·10	3	1·00	2	0·58	2	1·70	4	11·39	9	2·68	9	13·67	13	9·69	14	57·45	88
Means during 32 years ..	5·56	11	2·16	4	1·60	4	2·14	6	2·36	6	1·36	3	2·07	4	4·40	8	4·72	8	7·82	15	13·63	19	15·17	20	62·99	108
1902 ..	11·06	9	3·45	9	3·19	6	0·18	3	0·36	2	2·05	4	0·30	2	1·91	6	2·04	3	10·82	23	26·67	25	15·28	18	77·31	110
Means during 33 years ..	5·73	11	2·20	5	1·65	4	2·08	6	2·30	6	1·38	3	2·02	4	4·32	8	4·64	8	7·92	16	14·04	19	15·17	20	63·45	110
1903 ..	4·21	7	4·70	3	0	0	0·60	6	5·75	9	3·24	2	1·59	4	1·55	6	10·48	10	9·62	12	6·48	13	11·05	14	59·27	86
Means during 34 years ..	5·68	11	2·28	5	1·60	4	2·04	6	2·40	6	1·43	3	2·00	4	4·24	8	4·82	8	7·97	16	13·81	19	15·06	20	63·33	110
1904 ..	11·56	17	1·70	4	0	0	0·65	3	3·35	5	0	0	3·64	7	1·42	3	0·57	4	7·28	19	16·50	11	19·84	16	66·51	89
Means during 35 years ..	5·85	11	2·26	4	1·55	4	2·00	6	2·43	6	1·39	3	2·05	4	4·16	8	4·69	8	7·95	16	13·89	19	15·19	20	63·41	109
1905 ..	2·25	8	0·93	6	0·03	1	9·25	15	1·26	5	0·11	2	2·03	2	3·64	9	3·56	8	3·90	13	15·52	21	5·39	11	47·87	101
Means during 36 years ..	5·75	11	2·22	5	1·51	4	2·20	6	2·40	6	1·36	3	2·05	4	4·14	8	4·66	8	7·83	16	13·91	19	14·91	19	62·97	109
1906 ..	2·28	9	0	0	0·22	2	2·28	4	1·50	4	0·55	3	7·82	5	6·27	12	5·92	11	8·68	19	24·33	24	11·39	17	71·24	110
Means during 37 years ..	5·66	11	2·16	4	1·48	4	2·20	6	2·37	6	1·34	3	2·21	4	4·20	8	4·69	8	7·85	16	14·23	19	14·81	19	63·20	108
1907 ..	10·23	14	1·48	4	1·94	4	4·23	7	3·20	3	0·07	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Means during 38 years ..	5·78	11	2·14	4	1·49	4	2·26	6	2·39	6	1·30	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Table II.—Groups of Heavy Rainy Days at Trincomalee from 1900 up to Date.

Year.		Month.		Dates.		Total Fall. Inches.
1900	..	January	..	29–31	..	2·84
,,	..	April	..	23–24	..	2·82
,,	..	Do.	..	29	..	1·38
,,	..	August	..	25–29	..	5·48
,,	..	September	..	4–6	..	2·37
,,	..	October	..	2–5	..	2·91
,,	..	Do.	..	28–Nov. 1	..	4·43
,,	..	November	..	16–20	..	6·12
,,	..	Do.	..	27–Dec. 1	..	5·86
,,	..	December	..	16–20	..	4·06
1901	..	March	..	3	..	2·32
,,	..	April	..	28–29	..	2·12
,,	..	August	..	18	..	1·52
,,	..	September	..	17	..	2·80
,,	..	Do.	..	26–28	..	5·32
,,	..	October	..	28–29	..	1·14
,,	..	November	..	8–12	..	5·37
,,	..	December	..	8–10	..	3·62
,,	..	Do.	..	16–19	..	3·45
1902	..	January	..	2–4	..	6·29
,,	..	Do.	..	6–7	..	3·77
,,	..	February	..	9–13	..	2·51
,,	..	March	..	8–9	..	1·43
,,	..	Do.	..	27–28	..	1·64
,	..	June	..	19–21	..	1·27
,,	..	September	..	18–19	..	1·98
,,	..	October	..	9–13	..	3·68
,,	..	Do.	..	23–27	..	3·38
,,	..	November	..	8–12	..	7·12
,,	..	Do.	..	19–23	..	6·87
,,	..	December	..	2–6	..	5·27
,,	..	Do.	..	7–11	..	7·13
1903	..	January	..	2–6	..	3·98
,,	..	February	..	10–12	..	4·70
,,	..	May	..	9–11	..	2·96
,,	..	June	..	29	..	3·06
,,	..	July	..	8	..	1·26
,,	..	September	..	7–11	..	4·83
,,	..	Do.	..	25–27	..	4·21
,,	..	October	..	23–27	..	3·89
,,	..	November	..	13–17	..	3·32
,,	..	December	..	22–26	..	6·71
1904	..	January	..	8–12	..	4·86
,,	..	Do.	..	19	..	3·90
,,	..	February	..	10–12	..	1·27
,,	..	May	..	10–11	..	1·72
,,	..	Do.	..	17–18	..	1·56
,,	..	July	..	11–13	..	3·22
,,	..	August	..	18	..	1·18

1902 — 77.31 20

Year.		Month.		Dates.		Total Fall. Inches.
1904	..	October	..	8–12	..	4·32
,,	..	Do.	..	19–23	..	1·93
,,	..	November	..	20–21	..	11·17
,,	..	December	..	2–5	..	6·99
,,	..	Do.	..	17–19	..	8·45
1905	..	January	..	6–7	..	1·79
,,	..	April	..	15–18	..	5·81
,,	..	May	..	8–12	..	1·26
,,	..	August	..	1–2	..	2·17
,,	..	Do.	..	18–19	..	1·92
,,	..	September	..	16–18	..	1·69
,,	..	October	..	12–14	..	2·70
,,	..	November	..	13–17	..	5·95
,,	..	Do.	..	21–24	..	4·55
,,	..	December	..	2–6	..	4·15
1906	..	April	..	2	..	1·10
,,	..	May	..	1	..	1·08
,,	..	Do.	..	19	..	1·20
,,	..	July	..	9–10	..	2·99
,,	..	Do.	..	12	..	2·77
,,	..	August	..	4–8	..	2·98
,,	..	Do.	..	15–17	..	2·85
,,	..	September	..	10–12	..	2·36
,,	..	Do.	..	15	..	1·67
,,	..	October	..	17–21	..	3·64
,,	..	November	..	16–20	..	9·91
,,	..	December	..	3–6	..	3·35
,,	..	Do.	..	13–14	..	4·51
1907	..	January	..	2–5	..	5·42
,,	..	Do.	..	13–17	..	3·12
,,	..	February	..	18–19	..	1·33
,,	..	March	..	9–11	..	1·90
,,	..	April	..	10–13	..	3·10
,,	..	May	..	4	..	1·08
,,	..	Do.	..	28	..	2·09

NOTE ON THE POSSIBLE TRANSMISSION OF SARCOCYSTIS BY THE BLOW-FLY.

By W. S. PERRIN, B.A., Gonville and Caius College, Cambridge.

WHEN we were examining the gullets of some sheep infected with *Sarcocystis tenella*, it occurred to Mr. Adam Sedgwick and myself that the Blow-fly (*Calliphora*) or the Flesh-fly (*Sarcophaga*) might afford a means of transmission of this parasite. Accordingly experiments were instituted to test the hypothesis, but owing, partly to pressure of other work and partly to the difficulty experienced in obtaining material richly infected with *Sarcocystis*, the experiments, which had hitherto yielded only negative results, were discontinued. At Dr. Willey's suggestion I thought, however, that it might be useful to publish the following account of our theory in *Spolia Zeylanica*, in the hope that some one may be induced thereby to test it in Ceylon, where material abundantly infected with *Sarcocystis bubali* is provided by the carcases of buffaloes slaughtered for meat.*

The experiments necessary to be performed are few and simple, and a month's work might be sufficient to prove or disprove the hypothesis; while, if the result of the experiments were to show that the hypothesis is correct, a discovery, not only of scientific, but also of considerable economic importance, would be made, as the presence of *Sarcocystis* in meat spoils it for human consumption.

As is well known, *Sarcocystis* is a Protozoan parasite which belongs to the Sporozoa, and is found in the muscles of various vertebrate hosts. Nearly all sheep† and pigs are infected, while horses, oxen, buffaloes, mice, and rabbits frequently are. The effect produced by the parasite upon the health of the host differs for different animals. *Sarcocystis* causes death in mice, the host becoming rapidly overrun with the parasite, while in other forms, *e.g.*, buffaloes and sheep, the infection although widespread gives rise apparently to no inconvenience.

Sarcocystis forms elongated, whitish cysts in the muscles of the host, which in the case of *Sarcocystis bubali* measure a half to one inch in length and about a quarter of an inch in diameter. The most frequent seats of infection are the œsophagus and the trunk muscles in the region of the stomach, although any or all of the muscles may be infected with the cysts. The cysts contain numerous minute sickle-shaped spores which in *Sarcocystis tenella* are

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* See *Spolia Zeylanica*. vol. II., part VI., 1904, p. 65.

† Bertram records that 182 of the 185 sheep he examined for *S. tenella* were infected (Zool. Jahrb. Abth. f. Anat. V.).

FIG. 1. Spore of *Sarcocystis tenella* (from Minchin, after Laveran and Mesnil).

n Nucleus with karyosome.

c Striated body (? polar capsule), not visible in stained preparations.

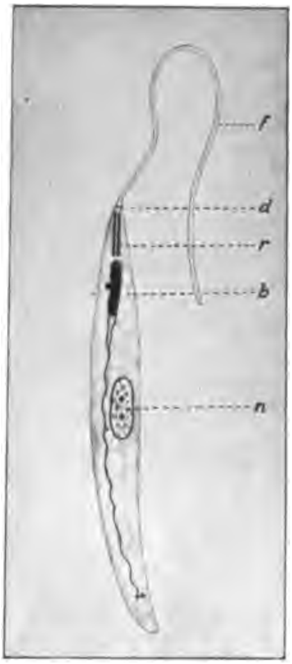

FIG. 2. *Herpetomonas muscæ domesticæ* (after Prowazek).

f Double flagellum

d Diplosome, two deeply staining granules from which the flagellum takes its origin.

r Rhizoplasts, two strands of deeply staining material running between diplosome and blepharoplast.

b Blepharoplast, the smaller of the two nuclei possessed by *Herpetomonas*.

n Main nucleus.

about 0·014 mm. long and 0·003 mm. broad. These measurements are probably the same for the spores of *S. bubali*.

The spore is rounded at one end and pointed at the other. A large nucleus containing a central deeply staining body, the karyosome, is present near the rounded end, while the faint striations at the pointed end mark the position of a body which is possibly identical with the polar capsule found among the Myxosporidia. It is these structures which presumably carry the infection. Now these spores possess no firm outer investment, which in the case of the closely allied Myxosporidia is exceedingly well developed and resistent. In fact it seems impossible to avoid the conclusion to which such authorities as Wasielewski and Laveran and Mesnil have come, that there must be an intermediate host conveying the parasite from vertebrate to vertebrate.

In the case of mice Smith* has shown that murine cannibalism may account for the conveyance, but such an explanation is impossible in the case of herbivorous forms, such as sheep and buffaloes. Might not, however, some such insect as the blow-fly be the carrier? The blow-fly lays its eggs upon meat, and the larva, which feeds upon the flesh, would, if it were infected with *Sarcocystis*, take the spores into its gut, where it is conceivable that their further development might result in the production of resistent cysts. These cysts might persist inside the larva through the metamorphosis and then gain access to the alimentary canal of the vertebrate host, either by the adult blow-fly being swallowed alive, an untimely fate which must not seldom overtake unwary individuals, or by the decomposition of dead blow-flies upon the grass. It is also possible that the adult blow-fly may transmit the infection direct by feeding upon infected carrion or upon open sores of the living animal displaying the cysts. That infection of the vertebrate host probably takes place by the alimentary canal is indicated by the fact that the most severely infected areas are always the œsophagus and trunk muscles near the stomach.

To test this hypothesis all that is necessary is to shut up a number of blow-flies in a wire cage with a small quantity of sugar for food and a piece of freshly killed buffalo meat containing ripe cysts of *Sarcocystis*. In a few hours eggs are deposited upon the carrion, and these in a warm atmosphere develop rapidly into fat, white blow-fly larvæ. After the larvæ have fed for some time upon the meat, the gut of the larva should be dissected out and examined for spores of *Sarcocystis* or possible developmental forms.

The method recommended for examining the gut contents is as follows: The gut is cut out and slit open with a fine pair of scissors, and the contents scraped out gently with a scalpel on to a coverslip. The coverslip is then rapidly placed on a glass slide, and the edges

* Theobald Smith. Journ. Exp. Med., Baltimore, VI., pp. 1-21.

sealed with wax. When the larva is large and the gut contents considerable, the fluid is divided between two or more coverslips according to the size of the gut. Stained preparations can readily be made by gently spreading the fluid over the surface of the cover-slip and allowing the film so obtained to dry. The dried film is then immersed in absolute alcohol for ten minutes, again dried, and finally stained for fifteen minutes in an aqueous solution of Giemsa's ready prepared solution of eosine and azure II., one drop of the stain to one cubic centimetre of distilled water. After staining, the film is washed in water, allowed to dry, and finally mounted in cedar wood oil. This method is very barbarous, but it has the advantage of not consuming much time. It proved very convenient for diagnosing the presence of *S. tenella* in the gullets of sheep, which did not present well-grown cysts. For accurate investigation of structure some wet method of fixation must of course be adopted.

In the one set of experiments which I performed with gullets of sheep infected with *Sarcocystis tenella* negative results were obtained with the larvæ, but as the gullets used had no cysts upon them, the parasite only having been detected by microscopic examination of teased fragments of the gullet, the results cannot be regarded as by any means conclusive. Assuming either that the spores of *Sarcocystis* or developmental forms of these are shown to be present, the next step would be to allow some of the larvæ to develop into adult flies and to examine the organs of the adult for further stages. It seems unlikely that these later stages would be found in the gut of the full-grown blow-fly, as the histolysis which takes place at the metamorphosis is so complete that the larval organs entirely disappear, the adult organs being reconstituted entirely from the imaginal discs.*

Finally, experiments upon transmission to uninfected buffaloes would be made.

There is a parasite present in the gut of the blow-fly with which any one working with blow-flies is likely to meet, and of which a short description may be useful. This is a biflagellated organism allied to the Trypanosomes and belonging to the genus *Herpetomonas*. Two allied species, *H. muscæ domesticæ* and *H. sarcophagæ*, both of which give rise to cysts, have been fully investigated by Prowazek.† It seems very improbable that this form has anything to do with the life-cycle of *Sarcocystis*, but in view of the protean transformations

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* *Vide* "The Blow-fly," Lowne, vol. I., p 4.—"If the pupa-case be opened just before it becomes black, it will be found to contain nothing apparently but a white cream-like fluid; but on careful microscopic examination some of the imaginal discs will be detected and many of the muscles of the larva still remain at the posterior end."

† Die Entwicklung von *Herpetomonas*. Arb. a. d. kais. Gesundheitsamt. Bd. XX., Heft 3, 1904.

which take place among unicellular animals, it is a possibility which should not be entirely forgotten.

Herpetomonas possesses two nuclei, one larger or the main nucleus, one smaller called the blepharoplast. From the latter two strands of deeply staining material, the rhizoplasts, pass to the diplosome, which consists of two deeply staining granules, from which the double flagellum takes its origin (see Fig. 2),

Even if, as indeed is very unlikely to be otherwise, *Sarcocystis* has no connection with *Herpetomonas*, a flagellated stage might well be present, as the structure of its spore rather indicates.

Minchin,* in his article upon the Sporozoa, mentions the blow-fly and also the burying-beetle as possible transmitters of *Sarcocystis*, though he does not state how he supposes the infection to be carried out in either case. From a consideration of the habits of the burying-beetle it does not seem likely that this form transmits the infection. The cockroach (*Periplaneta*) is far more likely to be the second host if the blow-fly is not, since cockroaches, especially in hot countries, are by no means particular as to their diet.

* Sporozoa in Lankester's Treatise on Zoology, 1903, p. 305.

NOTES.

1. *Leaves from my Log.*—

Flying Foxes (Pteropus medius) *at Barberyn.*—On February 23, 1907, I had another opportunity of landing on Barberyn Island to have a look at the flying foxes. Of thirteen specimens obtained, eleven were males and two females; of the males, only one seemed to be old by the appearance of the teeth, the others being young adults. One of the females was shot singly, the other was hanging alongside a male (? her mate), and both came down to one shot; each female contained a single well-developed fœtus in utero. The presence of these females renders necessary an amendment to my previous note on these bats (*Spolia*, IV., 36.)

Besides wishing to ascertain the sexes of the individuals in this colony, I was desirous of obtaining more specimens of the Nycteribia (*N. sykesii*) parasitic on these bats, and in this was quite successful. Not a single bat was wholly free from these insects. Some of the male bats only harboured three or four *Nycteribia*, but the average was about a dozen; of the females, one had about half a dozen, the other a single individual only. Perhaps this points to the fact that the male bat is more attractive to the parasite than the female, probably on account of the blood in the latter being temporarily poorer owing to the drain on the system caused by reproduction.

The roosting habits of these bats and crows in Barberyn has a very noticeable effect on the trees they affect. The branches of the coco-palms have a most ragged and bedraggled appearance, practically only the ribs of the leaves being left.

Cicindela biramosa.—This handsome " Tiger-beetle " seems to be abundant along the sandy beaches all round the Island. It is especially fond of running along the damp sand on the very edge of the water, having indeed to take to wing sometimes to escape a wave; but, as a rule, it does not seem to fly much. I have watched one for about half an hour, during which time it only flew twice, and then only for a few inches. A small gray muscid fly is common in the same localities as the beetle, and is often its victim. I have seen one or two beetles make a clumsy attempt at a fly, but they were always unsuccessful; usually they catch the flies on the wing, in which case their movements are too swift to follow. On several occasions I have seen a *Cicindela* crawl under a piece of wood or similar substance, which was lying on the beach, as if in search of *Gammarid* shrimps.

Cicindela trilunaris, from Madagascar, is stated to have the power of running upon water, and it occurred to me that probably

C. biramosa would be found to have some similar faculty, since it is so fond of running along the very edge of the waves. When at Trincomalee at the end of June, 1907, I watched *C. biramosa* on the beach, to find out whether I could see any running along on the water. This I failed to do, but I saw one overtaken by an incoming wave, which washed right over it, yet the beetle ran up the beach quite unhurt. I then tried to see if I could drive them over the water to make them settle on it. This was very difficult to do, as they generally flew *up* the beach, but I was able to corner them on a sandy spit, whence they had to fly over the water. Amongst numerous specimens which I made to fly over the water in this manner, I distinctly saw one settle on the water; rise and fly a few yards, settle again, then rise again and fly out of sight. A second specimen I saw settle on the water, but then lost sight of it, as the water was rough here.

I next determined to see whether they could rise up from the water if actually immersed in it, as they would be when caught by a wave on the beach. Three beetles were therefore caught and experimented with as follows :—

(*a*) Thrown into the water ;
(*b*) Held under water about half a minute ;
(*c*) Held under water for a full minute.

In all these cases the beetle flew off from the surface of the water without hesitation.

This shows, I think, that *C. biramosa* can stand an occasional wetting by an incoming wave, or even by being blown into the water.

False-warning Coloration in a Syntomid Moth.—Colombo, March 12, 1907. This morning our First Lieutenant caught a battered specimen of *Euchromia polymena*, which had flown on board the ship. One of the bluejackets advised him not to touch it, thinking it a wasp, and said it had bitten one of the men! This seems a certain amount of evidence as regards the warning nature of its colour pattern.

Swallows and Seed-dispersal.—On the evening of March 16, 1907, I was watching some swallows flying about over the ramparts at Galle, and noticed one of them with something white attached to its tail. It appeared to be some fluffy seed—such as thistledown or cotton—and was firmly attached, as it remained there, whilst the bird was rapidly hawking on the wing. This is interesting as an example of means of dispersal, particularly in the case of such a far-flying bird as a swallow.

Resting Position of a Butterfly.—On April 20, 1907, there were a good many *Limnas* (*Danais*) *chrysippus* along the ramparts at Galle, congregated together quite gregariously in one place. It was just about sunset, and they were evidently settling down for the night. I noticed that they exhibited a distinct preference for resting on small *dead* bushes, whose dry and withered leaves approximated closely in colour to that of the under surface of the butterfly.

Leaf-nesting Ants.—Trincomali, June 22, 1907. I was much interested to-day in watching the common red tree ants (*Œcophylla smaragdina*) making a new nest. They were dealing with two separate leaves, one of which they were rolling up transversely, the other one longitudinally, but the process was the same in both cases. The ants laid hold of the edge of the leaf with their jaws and hauled on it until they curved it over, a dozen or twenty working side by side according to the size of the leaf. In some cases the space between the surface of the leaf (on to which they were clinging to get a grip for their pull) and the edge of the leaf (on to which their jaws were fastened) was too great to be spanned by the body of a single ant, and in this case the ant holding on to the edge was gripped in the jaws of another standing on the leaf; if the two together could not span the gap, the second ant was gripped by a third, so that the middle ant was suspended between the two others without touching the leaf at all. I did not see more than three ants (on two occasions) hauling on to one another like this, and that only in the centre of the leaf where the space was greatest, but in many cases there were two ants, the hindmost tailing on to the fore. But if they could reach the edge themselves, they seemed strong enough to hold it.

This nest was evidently just being begun. Although, when I repassed it in the evening, the leaf seemed quite rolled up, it was still being held in position by the ants, and no larvæ had been brought down to spin it together with their silk.

Twenty-four hours later the leaf had been sewn up, but was not finished, as the ants had two or three larvæ inside still, and seemed to be still engaged on the construction of the nest.

A scarce Moth.—*Capnodes tetraspila* seems to be quite a rare moth in Ceylon collections, but it appears to be fairly common at Trincomalee, where I took it in June, 1906, and in the beginning of July, 1907. It is to be found in shady places under trees, where there are plenty of dead leaves, from amongst which it is readily disturbed.

Behaviour of Frogs when confronted with a Snake.—I have noticed a curious action of the part of some frogs (*Rana cyanophlyctis*) put into its cage as food for a "Green Keel-back" snake (*Macropisthodon plumbicolor*). As the snake was moving about, whenever its head came near a frog, the latter raised itself on its legs (whereby the rump was elevated aloft, whilst the head was almost on the ground) at the same time blowing itself out. However, the snake took no notice of the frogs; it was not hungry at the time, being about to cast its skin. Messrs. Green and Austen have recorded (*Spolia*, III., 196, and IV., 32) a similar defensive action on the part of toads, but my frogs did not "alternately raise and lower the hinder part of the body" as their toads did.

T. BAINBRIGGE FLETCHER.

H. M. S. *Sealark*,
September 13, 1907.

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2. *Rare Colombo Birds.*—On January 6 last I saw two Alpine Swifts (*Cypselus melba*) hawking within twenty feet of the ground near the General Cemetery. The appearance of these birds, which rank amongst the speediest birds in existence, in Colombo, is, I think, worthy of record, as they are not often seen as low as this. Legge says :—"It takes up its quarters amongst the upper regions of the Kandyan Province," and adds "but, being a bird of such immense powers of flight, it wanders with ease, in the course of a day's hawking, over all parts of the Island."

During last December and January a flock of seven Black-sided or Sociable Lapwings (*Chettusia gregaria*) (see *Spolia Zeylanica*, II., p. 190) were to be seen on the racecourse. They were very tame, and allowed riders to come quite close before taking wing.

I should be glad if any ornithologist can tell me whether the Wire-tailed Swallow (*Hirundo smithii*) has been observed in Ceylon. I am almost certain I saw one hawking over the sides of the Colombo lake on July 1st of this year. The bird was very much like *H. rustica*, but the length of the outer tail feathers, white underparts, and conspicuous white spots on the rectrices attracted my attention. If it was not *H. smithii* it must have been a common swallow in full summer plumage, and its presence here on the above-mentioned date is somewhat unusual, and I think worthy of record.

W. A. CAVE.

Colombo, September, 1907.

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3. *Window-tapping by Birds.*—Various species of birds have been noticed to indulge in the above habit. In the hills a species of Wagtail is a constant performer. But I do not think that the common honeysucker (*Cinnyris zeylonicus*)* has been included in the list of window-tappers.

The window of my laboratory in the Peradeniya Gardens has recently been assaulted in this manner. The birds were building in

* Now named *Arachnechthra zeylonica*, the Purple-rumped Sun bird. (Fauna Brit. Ind. Birds, vol. II., p. 364)

a shrub close by, and the male bird amused itself by repeatedly scrabbling and pecking at the windowpanes.

E. E. GREEN.

Peradeniya, May, 1907.

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4. *An Eighteenth Century Relic.*—There is an annual pilgrimage in the Jaffna peninsula to the church of St. James the Great at Kilali on the Jaffna lagoon between Chavakachcheri and Pallai, which is attended by from 1,500 to 3,000 people. It takes place in July on the festival (25th). The church possesses an image of the Saint, who is represented as a mounted warrior wearing a military cloak and in seventeenth or eighteenth century costume. There appears to have been a shrine here dedicated to the Apostle in the Portuguese period, when the village was inhabited by Parawas from Tuticorin. During the time of the Dutch the church was destroyed, but it is said that about 100 years ago, during the early years of the British occupation, a box was dug up here by Samerasekara Mudaliyar *alias* Don Louis Poothar, who acted as guide to the British forces on an expedition into the Vanni, which contained this image, a representation of it cut on a piece of wood and a gold hat belonging to the image, all of which are still preserved.

It is the hat to which I wish to draw attention. It is of the three-cornered shape characteristic of the middle of the eighteenth century, with a Portuguese inscription giving the name, I presume, of the donor: "Servo do Santiago Mayor, Ls. Ferras" (or Ferrar?), the meaning of the description being that he was a "Servant of St. James the Great." It is a curious instance of the survival of the Portuguese language among a Tamil caste.

It weighs 1⅜ ounce, the length of each side of the brim is 2⅛ inches and the diameter of the crown nearly 1½ inch. I give drawings of the exact size of the hat. While the image is of clay or pottery, the hat is of gold. The present Samerasekara family have provided a gold sword.

Samerasekara Mudaliyar rebuilt the church and founded the pilgrimage, which has gone on now for five generations.

Kilali was a stage on the old Jaffna Coast road, and had a resthouse in Dutch and early British times.

J. P. LEWIS.

Kandy, September, 1907.

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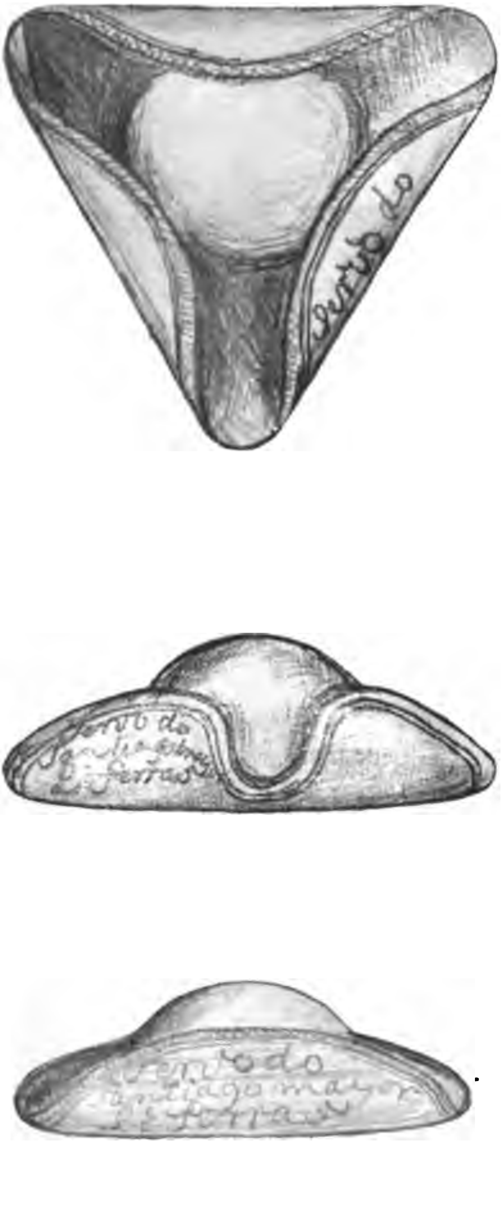
5. *Leocyma sericea.*—In November, 1906, hearing of the great number of moths coming to the electric lights round the Boer camp at Diyatalawa, I became a guest of one of the officers there for three days.



Each evening, within half an hour of the lights being lit, the moths appeared in numbers and great variety, and by a quarter past seven there were myriads whirling around the lamps. Predominant among them was *Leocyma sericea*, a pure white satin-winged Noctuid, about $1\frac{5}{8}$ inch. across the wings.

In walking from the various military quarters to dinner in the mess house, quite short distances, every one was so covered with this moth that we presented the appearance of having come through a snowstorm. The strange thing about *Leocyma sericea* on this occasion was that amongst those caught or examined I did not see a single male, and as one of the soldiers was helping me we must have seen thousands.

Most of my work was in the morning from 5.30 to 7.30 searching the ground, foliage, lamp-posts, and any buildings where the moths had pitched and rested during the night well into the morning. At one place near the hospital there must have been from five thousand to ten thousand moths, large and small, visible within a radius of twenty yards. The sentry walk was a sludge of wings and bodies, some of the former indicating rare species.

By 8 A.M. what with the crows, sparrows, swifts, frogs, and heat of the sun scarcely a moth was to be seen, and yet each evening while I was at the camp their numbers seemed as great as ever.

Ordinarily *Leocyma sericea* is not a plentiful moth in Ceylon, and at the period of emergence from the chrysalis in September to November one is fortunate in getting three or four of a night at ordinary light, and on these occasions I have not found the females outnumbering the males more than two or three to one.

F. M. MACKWOOD.

Colombo, September 17, 1907.

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6. *Singing Fish of Batticaloa.*—As one who has lately visited Batticaloa and heard the so-called singing fish in the lagoon there, I wish to give you my impressions of the phenomenon.

The sound produced (from whatever cause) is not easy to describe, but it may be said at one time to resemble, though may be remotely, that given out by a loose banjo string when struck, and at another to remind one of a distant (very distant) motor horn. I have tried to reproduce it on the piano, and find—at least to my mind—that it corresponds as nearly as possible to the discord produced by striking the notes *b* and *c* (natural) together; with the soft pedal down. I noticed that the pitch of the singing fish varied at times, going up and down by intervals I could not determine. I will not attempt to formulate a theory with regard to the origin of the musical sound, but I might mention that it recalled to me the high-pitched cry (not the exasperating guttural note) of the frog which one hears when, after a prolonged drought, there is a heavy downpour of rain. But the "song" of the fish is more subdued. Whether these observations will suggest a clue is more than I can say.

C. DRIEBERG.

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7. *Crows as Diggers and Weeders.*—At Weligama resthouse on the morning of May 15 I watched a company of crows actively engaged in digging the soil and wrenching out grass plants with their beaks, cawing lustily at the same time. This was after a heavy shower of rain. I tried to assign a purpose to this digging and weeding operation combined, but without satisfactory issue.

(1) The grass was wanted for nest making, but it was not being carried away. If it is supposed that the grass was being left to wither before use, why were the birds working fresh areas when there was so much dry grass lying about as the result of previous work?

(2) The crows were in search of bulbs of the nut grass (S. Kalanduru), *Cyperus rotundus*, but the grass on examination proved to be wild kurakkan (S. Belatana), *Eleusine indica*, and there was no nut grass about.

(3) The birds were digging for earthworms, but I did not observe any worms being unearthed and swallowed. Besides, the wholesale uprooting of grass seemed hardly necessary to get at them. The resthouse-keeper who examined the ground declared that there were no traces of worms. In the absence of direct corroboration of any of the above theories, I am inclined to think the last the most plausible, *i.e.*, that the crows were *in search of earthworms*, which are known to come up to the surface after rain and there deposit their casts. In this instance the birds might have been on the wrong track. That they have a great partiality for earthworms cannot be denied, and their behaviour on the occasion referred to may be taken as an indication of the pains they will take to get at the worms, for hoeing up the ground and wrenching out grass tufts cannot be very easy work for a crow.

Some one suggested the idea—rather far fetched to my mind—that the birds were only amusing themselves, with no other object than giving way to a sense of exhilaration.

C. DRIEBERG.

THE SUBMERGED PLATEAU SURROUNDING CEYLON: SOME CONSIDERATIONS REGARDING THE FORMATION OF THE COAST LINE.

By Commander BOYLE T. SOMERVILLE, R.N.
(Late of H.M.S. "Sealark.")

With Diagrams.

I.—GENERAL REMARKS.

THE Island of Ceylon has the peculiarity of being surrounded by a submerged plateau, which extends to an average distance of twelve miles from the land. The edge is strongly marked: first by a drop, in most places of 400 feet in about 200 yards, and then of 3,000 feet more in two miles; the oceanic depth of 6,000 feet (or 1,000 fathoms) being reached at about eight miles beyond that again. (See figs. I., II., and III.)

To the northward the plateau merges into that surrounding the south-eastern coast of India, off which a similar formation prevails; but to the southward it gradually deepens, still preserving its shelf-like form along the eastern, western, and southern coasts of the Island, and is both narrowest and deepest (as regards soundings) in the vicinity of Dondra Head.

The 100-fathom line, which may be taken as the outside edge of the plateau, follows the general trend of the coast line; but off the eastern side of the Island there are several remarkable deep and narrow notches, the two most notable of which are off Trincomalee (Koddiyar Bay) and five miles north of Batticaloa respectively, where the point of the deep water approaches to less than a mile off the shore in the first instance and to within two miles in the other.

I am unable to speak definitely of the rest of the plateau, except of that part which occurs within the limits of the "Sealark's" survey during the last two years, as represented in fig. I., and in that area but one notch occurs, namely, off Panadure, where the 100-fathom line approaches the coast to within about nine miles.

In fig. I. it will be seen that the plateau shoals progressively from the south towards the north. The average depth at the southern part is about 36 fathoms, and this continues to abreast of Barberyn lighthouse, at which point a gradual shoaling begins, until, just northward of Colombo, the plateau is covered by only 20 fathoms of water.

A characteristic feature of the plateau is that there is a slight deepening—a sort of irregular channel—running along its central line and parallel to the outer edge throughout nearly the whole of its length.

Where the plateau is of an average depth of 35 fathoms this depression is, roughly speaking, of a depth of 42 fathoms; and where, as off Moratuwa, the general depth is 23 fathoms, the depression is about 33 fathoms. Near Colombo, however, this feature becomes lost; and, instead of a depression, there is, on the other hand, a series of banks: one with a depth of but 10 fathoms, the others less shallow.

The 20-fathom line also, which gradually increases its distance from the coast between Galle and Mount Lavinia, takes a most decided bend outward at this point, and, together with the banks referred to, causes a marked general shoaling on the plateau in this neighbourhood.

Fig. II. represents a section taken from the "Haycock" (Hinidumakanda) to the coast at a spot about ten miles eastward of Galle and through the narrowest part of the plateau.

Fig. III. gives a section from the same mountain through Waal island (at the south-west corner of Ceylon), and again through the plateau into the deep water beyond, the plateau at this point being of average width and normal character. The vertical scale in each case is the same as the horizontal scale, so that the plateau and the fall into deep water are shown with their true relativity, though the central gully is scarcely realized.

A section taken through Colombo would exhibit very similar features to both figs. I. and II. as regards the plateau, but the land being low and level for many miles inland it would scarcely be apparent as an elevation on this scale, which is 6,000 feet to one inch.

The above characteristics may therefore be thus summarized:—

(1) The plateau extends on an average to a distance of twelve miles from the coast with depths slowly shoaling from the southward to the northward from 40 to 20 fathoms.

(2) In all parts a sudden and very well-marked drop into oceanic depths occurs at the outer edge.

(3) A slightly deeper channel or gully is found in the centre, tapering off to the northward, and ended by

(4) A marked shoaling, and the existence of banks, beginning off Mount Lavinia and extending to the northward.

II.—Effect of the Plateau upon Current and Swell.

It must be supposed that such a natural barrier fringing the coast would cause some considerable modification in the direction and speed of the ocean currents reaching the vicinity of Ceylon, as well as on the swell accompanying the monsoons, on each side of the Island.

Currents.—It would be beyond the scope of these remarks to discuss the ocean currents of the Indian Ocean, the Bay of Bengal, and of the Arabian Sea; but it is necessary to note that Ceylon lies within touch of all three systems; and it is probably due to their mingling near these shores that so many perplexities and discordances have been recorded by navigators approaching the Island.

The main oceanic currents alter their path (but not their direction) throughout the year, moving north and south with the sun. The change of monsoon is also occasioned by the same alterations in position of the source of heat, and it is thus convenient to refer to the currents in connection with the monsoons, for the changes in each take place, necessarily, at about the same times of year. It seems improbable that one is actually occasioned by the other: the currents by the monsoons, or *vice versâ.* The effect in either case would seem too great for the cause under such a hypothesis.

The combined general effect on the coast of Ceylon, however caused, is that the currents circulate round the Island in the direction of the hands of a watch during the north-east monsoon period, and contrary to the hands of a watch during the south-west monsoon. At the change of monsoon the currents are variable; that is, they do not alter suddenly from one direction to the other.

As regards their rates, the greatest recorded occur off the eastern coast during the months of December and January, and then vary from 1½ to 4 knots. (One knot means one nautical mile per hour.) Off the western coast the current never runs more than about one knot, being strongest in January and August.

The above statements of the direction and speed of the currents must be taken as very broad; for, in my own experience, when sounding off the western and southern coasts of the Island, or at anchor (when definite observations for current alone are possible), the surface currents were often found to be of the "wrong" character for the time of year; and not only that, but on steaming outwards on a line of soundings from the coast (which necessitates the accurate positioning of the ship by the land every few minutes), two perfectly distinct sets of the current have not infrequently been observed, running in diametrically opposite directions, within a mile or less of one another and parallel to the shore. This has also been reported on the eastern side of Ceylon.

The plateau probably has a considerable part in producing these results. The actual depth of oceanic and indeed of all currents is still a matter of great controversy; and such observations as exist for the Indian Ocean and these coasts refer solely to *surface* currents. It is very possible, and indeed probable, that the lower layers of water are moving with different speeds and directions t that of the surface, actuated by differences of temperature, salinit by the topography of the bottom over which they are travelling; and other reasons. It cannot therefore definitely be said how the outer wall of the plateau acts as a deviator of the ocean currents in this case. If the current is deep, it would of course play a very important part, but if shallow, less so. In any case the increase which would be caused in the ocean temperature by the sudden alteration in depth from 1,000 fathoms to 35 fathoms within a few miles must have a profoundly modifying effect. It may also be conjectured that the gully in the middle of the plateau may produce some alteration in the speed of the currents, if the currents reach so far down.

Swell.—As regards swell, it is possible to speak more definitely. How and where the motion *through* the water known under that name originates it would be difficult to say; but it is certain that its effect is greatly increased, and finally converted into motion *of* the water—*i.e.*, breaking waves—on coming into shallows.

This is clearly seen along the south-west coast of Ceylon, where it is no doubt aggravated by its 12-mile journey over the plateau before it reaches sufficiently shallow water to break, as it does, in enormous rollers on the beach.

The shoaling of the plateau to the northward, and especially the presence of the banks before mentioned (which lie exactly in the line of the south-west swell on its path towards Colombo), make an extremely well-marked difference in the amount of the swell, which is both higher and more constant in this locality than, say, 30 miles farther south, as at Barberyn (Bentota district).

Had this fact been known, it should have been an additional reason against the attempt to build a harbour at Colombo which should be clear of swell—an attempt which, as we see, has hitherto been attended by failure. Almost any other notch in the coast to the southward (and especially Galle, off which bay the plateau is considerably deeper and narrower) would have offered a better chance of success from this cause.

Character of the Bottom.—During the course of sounding operations it is usual to obtain specimens of the material forming the floor of the sea. On Fig. I. the general appearance of these specimens is given beneath the figures representing the depths. Dr. Willey, to whom the samples were sent, reports that the specimens from the shore plateau consist of shelly and coralline *débris*, worm tubes, bryozoa, echinoderm spines, foraminifera, &c., almost entirely calcareous. A sample from 185 fathoms, on the other hand, from outside the plateau, though on its exterior slopes, consists of caked and powdery mud, principally calcareous, with a few minute quartz grains, siliceous spicules, and organic particles. In fact the bottom in the deeper water over the edge of the plateau consists of fine mud, essentially the same at all depths and all stations, containing numerous calcareous remains of foraminifera, chiefly Pulvinulina.

The deep sea mud off the plateau of Ceylon has a greenish coloration, which Mr. M. Kelway Bamber, F.I.C., F.C.S., pronounces to be organic in nature, dissolving out in hot alcohol, and leaving an amorphous green colour on evaporation, easily soluble again in alcohol. Mr. Kelway Bamber has kindly undertaken a chemical analysis of this mud, and the results are given in the Note accompanying this paper.

It is noticeable that the area in which occurs what I have termed "green mud" is the deep water outside the plateau, whilst on the plateau we found only brown sand, broken shells, and occasionally broken coral, always in very small quantities. This would seem to point to the probability of currents existing along the bottom over the surface of the plateau, preventing the accumulation of soft material composed of light particles, such as is represented by the "green mud" of the greater depths. When at anchor in 12 fathoms on the easternmost of the three small banks off Mount Lavinia, a diver from the ship procured a specimen of the bottom for investigation. He reported the surface to be flat, smooth, and hard, without sand or any loose material lying on it. The specimen, which had to be levered up from its position with an iron bar, consists of coral, which Dr. Willey informs me to be Porites coated with nullipore in places.

The green colour above noticed is usually associated in bottom specimens with "terrigenous" material, and is found only on continental slopes. On reaching true oceanic depths the deposits are almost invariably coloured gray, or pale brown (except in the cases of recent volcanic upheavals)

More extended collection of specimens round the outside of the plateau will, no doubt, produce the correct reasons for the occurrence of the green coloured deposit, and also the outside limits at which it is found from the coast, but since the material is not of a properly constituted "oceanic" colour, but rather "terrigenous," we may suppose that its greenness is due to the finer washings of the detritus from the rivers, which, held in suspension for a considerable period in the sea water by reason of their lightness, have been carried by the surface current over the edge of the plateau and not deposited until deep water has been reached; while the coarser and heavier particles have remained behind to be acted on by bottom currents near the land and on the plateau. These conjectures refer solely to the southern and western surroundings of the Island, no specimens having yet been obtained elsewhere.

III.—The Coast Line of Ceylon.

I do not know whether the considerations which I now propose to set forth have been previously advocated, but while dealing with the plateau, the currents, and swell, I should like to point out an effect on the coasts of the Island, which is probably due to these oceanic causes, in combination with others originating in meteorological conditions affecting the land. I refer to the growth and changes in the coast line.

My attention was drawn to the matter first of all by the strange absence of coral reef the whole way round the southern half of Ceylon, from Chilaw to Trincomalee. It is true that little patches occur here and there, as at Hikkaduwa and Galle, but after a considerable experience of tropical seas, it seemed remarkable to me that there was not only no wide fringing or barrier reef to Ceylon, but that scarcely any specimens were brought up on the lead whilst sounding.

The brown colour of the sand forming the beach round the southern shores would alone point to the absence of coral, being so dissimilar to the typical glaring whiteness of the beach behind a coral reef.

The first explanation that occurred to me was when journeying by the coast railway. I saw in the vicinity of Ambalangoda the strange spectacle of natives digging coral out of an apparently not very ancient reef, which is now about half a mile from the coast, and covered by four or five feet of black humus.

It is thus apparent that the coast line, in that locality at any rate, is in process of extension outwards; and it seems possible that the following considerations point to such a process being not only continuous, but sufficiently rapid to prevent the growth of coral, except in favoured corners, such as that now to be seen by the resthouse at Hikkaduwa, or as in the case of the reef, now overcome by the accumulation of soil, that I saw from the train, which may originally have been similarly circumstanced.

Attention is now called to the existence and distribution of the lakes that fringe the coast line of Ceylon, as exhibited in fig. IV., and it will be noticed that—

(1) These lakes or lagoons occur practically all round the Island; but

(2) In much greater frequency on the east coast than on the west, and to the north than to the south;

(3) That while those to the southward are now all enclosed from the sea and become fresh, those to the northward—Negombo, Puttalam, Jaffna, and Batticaloa, for example—are still open to the sea and salt; and that

(4) While those still open to the sea on the west of the Island have been formed by bars of sand, &c., pointing to the north, those on the east of the Island have their bars pointing in the other direction, namely, to the southward.

It will further be remarked, under the above numerical headings, that—

(1) The contributing causes must be of a similar nature in all cases; but

(2) Differing in degree, not only according to the side of the Island, east or west ; but

(3) Also as between north and south ; and that

(4) One of the moving causes emanates from the south, and the other from the north.

I beg to offer the following suggested explanations :—

Firstly, in a large and general way, it is noticeable that Ceylon is constructed in two marked divisions, namely, mountain country and flat country ; there is scarcely any midway between them ; and the hills, whether isolated or taking the mountain district as a whole, appear each to be swimming in a flat ocean of soil (if one may use such a simile) from which they spring abruptly.

The next large point to be noticed is that the greater part of the flat country is spread out to the northward of the hills, tailing off in a point of lagoons and shallows ; but that there is also a spreading out of flat land to the eastward and westward, though not so extensive, and practically none at all to the extreme south.

A consideration that here intervenes is the probability that the mountain region of Ceylon has never been submerged at any time ; or if it has, not for any great length of time, and this is evidenced by the entire absence of chalk or sedimentary limestone, or of any calcareous aqueous deposit. The Ceylon mountains have existed, it may confidently be stated, in their present average condition since their first formation, giving a condition of stability and a field for the continuous action of denudation for immense ages.

What the meteorological conditions of Ceylon were at the time of its first appearance it would be hard to say ; but a good antiquity may be predicted for the monsoons, which have probably existed as long as the ocean, though modified in degree by the changes in the obliquity of the ecliptic.

And, springing from the same cause as the monsoons (namely, the annual movement of the sun and its heat focus), the ocean currents have similarly visited the Island with equal regularity and antiquity.

The point to which I am leading is this, namely, that the low-country of Ceylon has, on the whole, been derived from the denudation of the mountain country, and has been laid down on a plateau, of which we now find remaining a 12-mile fringe surrounding the Island.

Following these prefatory remarks, I now refer to the four points for consideration above stated in numerical order :—

(1) The soil of Ceylon is on the whole friable, and easy to be detached and washed down by the monsoon rains on either side.

This, one may suppose, has always happened, as it is now happening, each river carrying to the coast from the inland vast loads of detritus on every day that it is affected by the monsoon rain—material which, on reaching the coast, has been carried by the sea currents and deposited until it has formed the outline of the shore that we now see, an outline which it is still extending and altering.

The method of extension seems to be, first, the formation of bays along the coast, by the gradual banking up of sand and detritus at some little distance from the shore line, banks originally induced perhaps by some obstacle, such as a slight rocky ridge. The banking process seems to continue until the bay becomes a lake—at first salt, then more and more brackish by degrees, and finally, after many monsoons, perfectly fresh.

The succeeding process would no doubt be that such a lake would slowly fill up with vegetable humus and detritus due to the rains, until it assumed its final stage as a slight depression in the land or as a swamp.

Note should here be made of the fact that the coast extension work probably takes place chiefly during the south-west monsoon period on the western side and during the north-east monsoon on the eastern, for it is during these periods that the heaviest rainfall occurs in each case, bringing the necessary material down to the coast.

(2) There is, however, a marked difference to be noticed in the results, due to the different character of the two monsoons.

The south-west monsoon rains, speaking generally, fall steadily and constantly, and the greater amount of moisture in the air throughout the year on the western side of the Island induces a dense vegetation, which tends to hold together the particles of soil.

The north-east monsoon rains, on the other hand, though less in total amount, fall with great violence and suddenness on a soil which has for several months been exposed to the action of a fierce unclouded sun and an intensely dry air, so that it is in a defenceless condition against the momentum of the sudden torrents of water by which it is assailed.

It is probable, therefore, that a larger amount of detritus is carried down to the eastern coast than to the western, thus occasioning a larger number of lagoons on that side; and also the fact that the low-country, taken as a whole, is more extensive on the eastern side of the mountains than on the other. There are, besides, many more water-courses from the hills to the eastward to bring down material, though many of them cease to flow during the dry season.

(3) The fact that the lagoons of the northern side are still open to the sea is probably due to the much greater distance that the material has now to be carried from the hills, the freshets not being sufficiently strong to carry it, except, as it were, in loads, a bit at a

time, down to the coast line. The flatness of the course of the streams must also greatly reduce their velocity.

(4) Sufficient time and sufficient material, with transport for the same having now been provided for the formation of the low-country by denudation, it remains to be seen why the extension should have taken place chiefly to the northward. The fact is undoubted; but the explanation of it is not at all obvious. The currents, at a little distance off the shore at all events, run throughout the year to the southward just as much as to the northward, and on the eastern side with a greater velocity to the south than to the north.

The meteorological conditions in ages past and the trend of the ocean currents may have been different, when the Island of Ceylon was represented by the mountain country, from those now existing, and in any case the gradual northward growth of the land would slowly deviate the courses of the streams in the sea.

No observations have yet been made, but it seems at least possible that there is, on the western plateau at all events, a steady current *along the bottom* making to the northward. The diver employed in obtaining the bottom specimen from the 10-fathom bank off Mount Lavinia (see above) could scarcely keep his legs, owing to the strength of the north-going current over the bank, which itself had been swept bare of sand or other loose matter, no doubt from this cause.

It is this which may have formed the protecting arm of Negombo lake, and the still greater one enclosing Puttalam; and it may quite possibly be the agency that covers with sand and again uncovers the pearl banks. The only evidence of its existence is the barrenness of the plateau to the southward, and its greater depth, as compared with its sandiness northward of Colombo, and shoalness.

The shapes of the mouths of the rivers that occur on fig. I. (which are presented on fig. V. on a larger scale) may be additional evidence as to a north-going current of the present day, so far as the western coast rivers are concerned, since all are formed with sandy peninsulas across their mouths trending to the northward. This is very clear in the case of Colombo, where both the interior peninsula and the present exterior bar of the Kelani-ganga point north, and all the points in the Colombo lake have the same direction.

At Panadure-ganga the flood water breaks out at a weak spot to the southward it is true, yet the *interior* peninsula has grown to the northward; and there is a small lagoon northward of it again, which may indicate a former mouth. The land in that vicinity is at present occupied by the town of Moratuwa, and human agencies may have been at work to make the river or lake (as it really has now become) empty itself at a different spot.

The Kalu-ganga, having been gradually headed by a bar workin up from the south, has now broken out at the northern end; an the Bentota-ganga bar is a complete instance of a northwa trend.

The mouth of the Randomba lake (connected with the Madu ganga), which meets the sea at Balapitiya on the western coast, has northward pointing peninsula of beach fronting it, and so also h the Madampe lake, not far to the south of it, at Ambalangoda.

The mouths of the Hikkaduwa-ganga and of Ratgama lake (nea Dodanduwa) have sand spits directed to the southward; and th Gin-ganga, the next outlet of fresh water along the coast to th southward, has a very decided sandy bar pointing to the south-eas

This introduces another proposition as to the formation of th lagoon and river bars, namely, that when the material is brough down the rivers, it is at the time when the monsoon is blowin strongly; and there is not only a "wind-slop" of waves drivin before the wind, but also a heavy swell running in the same directio It is not at all improbable that these forces combined may form current of no great width—a forced current, as one may say—run ning along the beach to the northward up the western coast, and t the eastward and southward past Galle, towards the Basses. Thi theory may possibly suffice to explain the whole phenomenon of th growth of the coast line, but until properly systematized observation of currents with a current meter are taken at various depths ove the plateau the problem must remain in doubtfulness.

On the eastern side there is less difficulty of explanation, for th current is running most strongly to the southward at the time of th north-east monsoon and its rains, and thus all the requisite condi tions are fulfilled.

It cannot be predicted how long it will be before the coast line will have worked outwards all round to the 100-fathom line, fo there is no reason to suppose that the coast-forming work has no reached a standstill. On reaching the edge of the plateau it wil practically cease, from the great depth that would have to be fille up with detritus. This is probably beginning to be felt in the cas of the Mahaweli-ganga at Koddiyar Bay, where the edge of the grea alluvial plain which has been formed by the river now approache the head of the deep bight that there occurs in the 100-fathom line within little more than half a mile.

On fig. IV. I have included the more important of the artificia tanks scattered over the low-country. These certainly indicat depressions, which in former days may have held swamps or smal lakes, whose presence suggested to the tank builders the improve ment of their depths or dimensions. These tanks need not neces sarily have once been coastal lagoons, though it is quite within th bounds of probability to suppose so, and especially those that occu near the courses of rivers.

FIG. I.

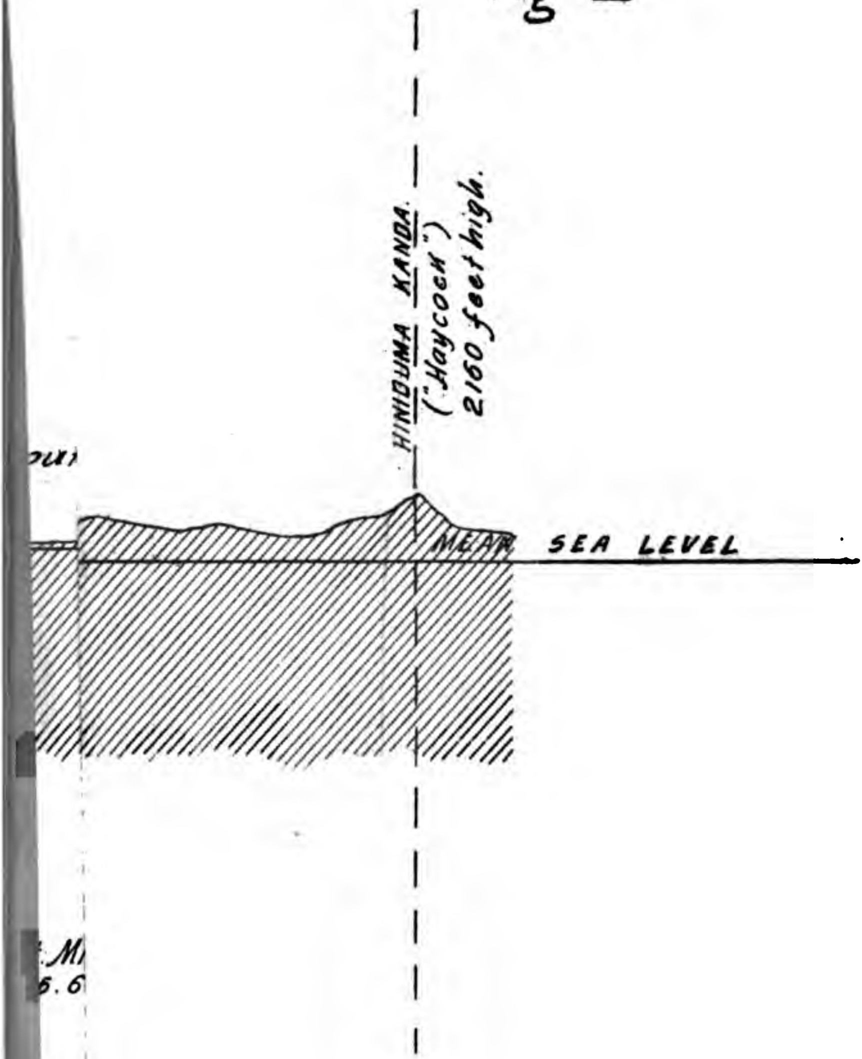

duwa
Gin Ganga
Gintota
GALLE
LINE OF 10 FATHOMS
LINE OF 20 FATHOMS
LINE OF 30 FATHOMS
EEN 40 & 45 FATHOMS
LINE OF 40 FATHOMS
133 s.
147 s.
185 gn.m.
241 s.m.
112 crl.gn.m.
355 sft.gn.m.
255 sft.gn.m.

Fig: II

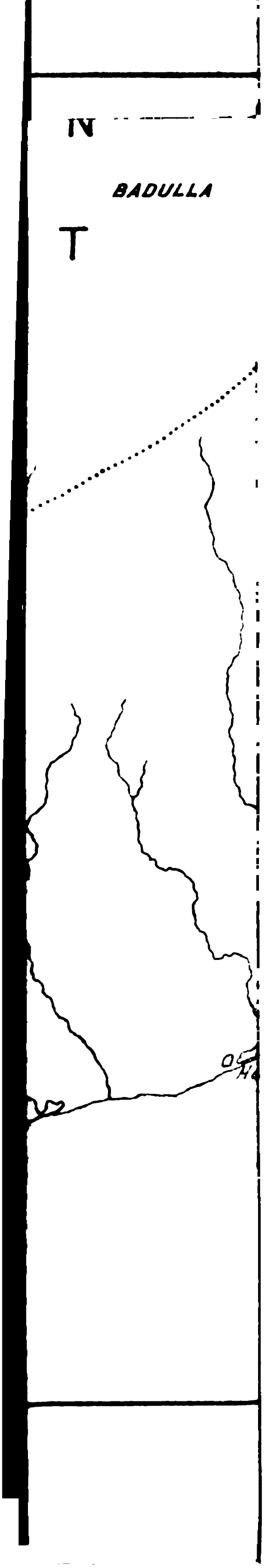
EA LEVEL

Nº 104/07

Fig III



№ 105/0



BADULLA

ga

A comparison of the species of fishes and other forms of life inhabiting these tanks, with those of the lagoons, both salt, brackish, and fresh, at present situated on or near the coast line, would be of great interest, and would possibly aid in the proof of the conjectures as to their origin, which are here put forward on other grounds.

Note to Commander Somerville's Article.

Analyses of Sea Mud Deposits, by M. Kelway Bamber, F.I.C., F.C.S., &c.

Sample No. 1 is from 615 fathoms, 18 miles west by south from Ambalangoda; No. 2 is from 1,138 fathoms; No. 3 is from 1,180 fathoms, 20 miles west from Dodanduwa. All the samples were of a gray brown colour, which became a greenish gray on drying. When dry all passed through a mesh of 90 to the linear inch, or 8,100 per square inch, the material being in an impalpable condition:—

CHEMICAL COMPOSITION.

	No. 1. Per Cent.	No. 2. Per Cent.	No. 3. Per Cent.
Moisture	4·730	4·480	4·500
Organic matter and combined water	3·850	3·250	3·600
Oxide of Iron	2·400	2·805	3·600
Oxide of Alumina	1·250	1·361	1·482
Manganese	·140	·130	·800
Lime	37·272	32·480	29·200
Magnesia	1·137	·921	1·137
Potash	·366	·550	·424
Phosphoric Acid	·089	·181	·102
Sulphuric Anhydride	19·000	24·850	31·600
Carbonic Acid	27·930	24·720	21·680
Sand and Silicates	·739	3·230	1·634
Undetermined	1·097	1·042	0·241
	100·000	100·000	100·000

	Per Cent.	Per Cent.	Per Cent.
Containing Nitrogen	·308	·336	·476
Equal to Ammonia	·374	·408	·578

Additional Note on bottom samples (see above, p. 72).—A sample from 133 fathoms taken on April 6, 1906, 14 miles west off the Clock Tower, Colombo, consists of small calcareous nodules, and shells of foraminifera and pteropoda (pelagic molluscs). Another sample from 155 fathoms, taken on the same date, 13 miles west on the northernmost line, consists of a larger ($1\frac{2}{3}'' \times 1'' \times \frac{2}{3}''$) porous calcareous nodule; this is exhibited in the Mineral Gallery at the Museum, together with dried samples of the green mud from the greater depths.

NOTES ON ADAM'S PEAK AND SOME OF THE PATHS IN THE RANGE.

By J. Still.

THE areas and paths explored by me during a fortnight spent in the Peak range in December, 1902, were as follows :—

(1) The Maskeliya-para, including all its ambalams.
(2) The cone of the Peak itself, including the caves and cliffs on the eastern and north-eastern faces.
(3) The Gilimale-para and its ambalams as far down as Palabadalla.
(4) A path which pushes under the northern cliffs of the Peak and connects Idikatu-pana ambalam on the Maskeliya-para with Andiyamalatena on the Gilimale-para.
(5) A path which connects the Heramiti-pana ambalam on the Gilimale-para with the path over the range to the north of the Peak.
(6) A small part of the Erane-para.
(7) An abandoned path connecting Dharmaraja-gala and Heramiti-pana ambalam, both on the Gilimale-para.
(8) The deep gorge below the cliffs at Nilihela on the Gilimale-para.
(9) The large cup-shaped valley between Adam's Peak on the one side and Bena Samanala-gala on the other.
(10) About 1½ mile of the bed of a stream in the jungle on the heights to the E.S.E. of Nissangala ambalam on the Maskeliya-para and above the first ambalam.

Nos. (4), (5), (6), (8), (9), and (10) were archæologically drawn blank, though they possessed other interests. I am inclined to believe that although I was unsuccessful in the last of the places mentioned, there is something there worth hunting for.

Maskeliya-para and Ambalams.

The first ambalam on the Maskeliya-para is only a boutique, and is of no interest whatever. From here to the second ambalam, which is called in Sinhalese Nissangala-lena and in Tamil Kalpodavu, must be a mile or more, and the path contains nothing of interest until it crosses a suspension bridge a few hundred yards below the second ambalam ; here a stream runs between high banks, on one side clothed with jungle, and on the other planted with tea.

In the jungle, at a height of about 20 ft. above the stream and some 50 yards below the bridge, there is a curious cave running straight into the side of the hill for about 15 ft. or rather more ; the peculiar part of the cave is that it is almost round, with a diameter of about 5 ft., and looks rather as though bored by some gigantic awl. The walls, which are of gneiss, show no signs of having been cut or worked in any way, but a number of flowering trees, evidently planted round the mouth, testify to occupation fairly recently. There are no tenants now except a few swallows, which build in the roof.

Up a steep path and on a little level slab is Nissangala-lena ; here there is supposed to be buried a great treasure, including the regalia of the king, from whom the cave takes its name [Nissanka ?]. The cave is formed by an enormous mass of rock that overhangs and shelters a space about 130 ft. long by 18 ft. wide ; the height varies from about 10 ft. in the front of the cave to 5 ft. at the back. The rock is split into two portions, one about half as big again as the other. A drip ledge runs along the entire length. There is no inscription, nor any remains of a wall.

The remainder of the path from here to the third ambalam has been described so often, and with such blood-curdling exaggerations, that I have nothing to add, except that at the foot of the Peak, where the Kehelgama-para joins the Maskeliya-para, a good new bridge has been built within the last two years, taking the place of the rather dangerous ford. A signpost and pointing hand with a burnt-in inscription, apparently in Chinese, makes the way impossible to miss.

The third and last ambalam on the Maskeliya-para is called Idikatu-pana in Sinhalese and Usimalley in Tamil. Just above it is the first set of chains, now replaced by an iron rail. The rock on which these chains are fastened contains a few short inscriptions in modern Sinhalese, but nothing old.

When last I visited this ambalam the pilgrim season had not yet begun, and the whole of the rather ramshackle buildings were buried in a cloud of yellow calceolaria, while all the rock ledges were beds of pink begonias. From this ambalam to the summit there is nothing of any archæological interest, save a few caves, &c. ; which will be described together with the eastern cliffs.

Cone of the Peak and Eastern Cliffs.

To start with, it is necessary to explain what is meant by the "cone" of the Peak. I have taken it to mean the rocky bell-shaped point that rises from the main range.

The southern and western faces of this cone seem to be too abrupt to be climbed, save where the pilgrims' path winds its way up. The northern face is a series of precipices that might possibly be climbed, but which would probably contain no caves ; my explorations were therefore confined to the eastern and north-eastern faces.

Some 70 or 80 ft. below the level of the summit, and about 20 yards to the north of the Maskeliya-para, is a cave formed by an overhanging rock, along the whole length of which is cut a drip ledge. The cave, which faces east, is 40 ft. long, 8 to 9 ft. broad, and varies from 7 ft. in height at the front to 2 ft. at the back. Part of the back wall, however, is higher, and on this there are two rock-cut inscriptions, one shorter and seemingly more modern than the other. The larger is written on ruled lines; it contains thirteen lines of writing, each 5 ft. 2½ in. in length. The smaller is unruled, and contains only seven lines, each 8 in. long. Both are in the Sinhalese character. Forbes, in his "Eleven Years in Ceylon," mentions this cave by the name of Bhagawalena.

A little below this and on the south side of the path there are three small caves, the two further of which are reached by means of notches cut in the stems of the rhododendron trees.

These caves show no sign of ancient occupation, but recently one of them was occupied by a Chinese devotee; he is said to have lived in the same cave for seven years as a penance. There are Chinese letters scraped on the wall of the cave and gilded; these are quite modern to my certain knowledge. It is possible to climb past these caves, but nothing is to be gained, as one is brought up short by a steep slope ending in a precipice.

I climbed along the ledges of the eastern cliffs wherever it was practicable and found four more small caves, none of which were of interest. In one place a ledge ceases suddenly, and to proceed it is necessary to climb along the tops of the rhododendrons.

About 150 ft. below the summit and just to the right of the path there is a pool and spring, evidently used for generations. The spring just below the summit, which is reached by a path that descends from the "belfry" in the south corner, shows no signs of workmanship either ancient or modern.

The rock on which the shrine is placed has a number of short inscriptions on it, some in Sinhalese, a few in Tamil, and some in Chinese. The latter I know to be modern; some of the Sinhalese ones may be old, but they do not look so.

There are a few stone lamps in the shrine, very similar in shape to those found in Anuradhapura, but I am told they are modern.

The only piece of stonework on the summit that seems old is one of the steps up to the shrine on the western side; this step is formed of what looks like a pillar alternately square and octagonal. The footprint is edged with cement, and two Muhammadan pilgrims told me that when they visited it several years ago the length of the footprint was 4 inches more than at present, owing to the *improvement* of the toes by cement. This would account for the various sizes different authors ascribe to it. Several writers mention a metal case which used to fit into the footprint, and which was kept there in the pilgrim season. In the course of five visits to the

Peak I have never seen this, nor heard of it, so it has probably been discontinued.

Just in front of the shrine a large iron bar, bent at an angle, is fixed in the rock. This is said to have supported the royal umbrella.

Gilimale-para and various Paths, Valleys, &c., connected with it.

The first objects of interest met with in the descent of the Gilimale-para are the chains, which are of all shapes and sizes; in places there are eight or nine sets hung one above the other in bunches. I only noticed two inscriptions on the chains, but there may be more. The two I saw were both on iron plates let in between the links; one plate measured 1 ft. long by 3 in. broad, the other measured 9½ in. by 2¼ in., and had besides its inscription, the figure of three birds engraved upon it, two at one end and one at the other. A short distance from the summit, and just below the main set of chains, there is a rock-cut inscription measuring 4 ft. by 2½ ft.; it contains twenty-three lines, and is modern.

A few hundred feet below this there is a dilapidated hut and a small flat space. Until last year this was the Menik-lena ambalam, so called from the cave of that name; but the monsoon of 1901 so loosened the rock which formed the cave that it slipped and fell into the valley half a mile below. A Sinhalese man, who knew the place well, told me that there used to be an inscription on the rock, but that now it is buried, being on the underside of the rock as it now lies. Neither Skeen nor Forbes mentions this inscription, so perhaps it did not exist.

Between this and Andiyamalatenna there is nothing of interest.

From Andiyamalatenna a path runs round the neck of the Peak, under the northern precipices, to the third ambalam on the Maskeliya-para.

I followed the path, which is very rugged and overgrown, but found nothing except masses of beautiful flowers and innumerable traces of elephants.

From Andiyamalatenna to Heramiti-pana ambalam the path, though steep, is in no way dangerous.

Even above Menik-lena, where the chains are, no part of the path is in the least difficult or dangerous in ordinary weather; but most people who have written accounts of the ascent of the Peak from this side describe it as little better than the Matterhorn. The fact that women frequently climb it with children astride their hips is sufficient to disprove this; I have seen a man with one leg swollen to an enormous size, two blind men, and numerous very old men and women make this climb at night, and a cooly with a 60 lb. weight on his head by daylight.

From Heramiti-pana four paths start. First the path to the summit just described; second, the main path down to Ratnapura, the Gilimale-para; third, an abandoned path that crosses the Ganguli-helli gorge and again joins the Gilimale-para at Dharmaraja-gala; fourth, the Erane-para, which branches at about a mile from the ambalam, one branch crossing over into Maskeliya and cutting into the Maskeliya-para at its junction with the Kehelgama-para, and the other descending rapidly towards Kunudiya-parawida and Higgashena. This last I only explored for a mile or two and found nothing. In one place, just off the path, I found a space about 20 ft. square beaten quite flat and hard by elephants; it was like a small room, being walled with thick bamboos.

The abandoned path descends very steeply below a cliff called Yaku-at-awa to the Sitala-ganga, which is crossed by a very rocky ford, where tradition says many lives have been lost in rainy weather; certainly nothing seems more probable, and it is possible that this may have been the reason for the newer and easier route being substituted. From the ford the path rises a little and then proceeds along a level ridge for some distance before descending to the two caves known as Telehi-lena or Sanguli-galge.

Below this level ridge and to the south of the path a small stream runs, on the other side of which there is a jumbled mass of rocks containing many hollows and a few caves. One of these caves, though it has no drip ledge, has at one time been inhabited, as can be told from the floor being roughly levelled, stones being jammed into the hollows between the rocks.

Telehi-lena consists of two caves. One formed by an overhanging rock is 21 ft. long, 12 ft. wide, and quite high enough to stand up in; it has a drip ledge all along its length. The floor is roughly paved with different sized dressed stones, and just outside the cave is one short wedge-marked stone pillar. From the mouth of the cave a good view may be had of the Peak. The other cave, which is formed by one large boulder lying across two others, measures 16 ft. by 6 ft., and varies from 9 ft. to 3 ft. in height. Several flat dressed stones lie in it, one of which looks like a curry stone.

From here the path lies through a fairly level piece of ground overgrown with thick bamboos, and crossed and re-crossed by elephant tracks. It joins the main path at the top of the Dharmaraja-gala flight of steps.

This abandoned path, which is known as Ganguliheli-para, is entirely overgrown and has trees lying across it; if it were not for the cut steps in all the steep rocky places, it would be hard to find and harder to climb.

I tried to climb the Yaku-at-awa cliff, but only succeeded in reaching a ledge about 20 ft. up, where water was standing in a little pond.

Dharmaraja-gala has been described by various writers, some of whom say that the inscription on the side of the path is modern. It looks old, and a Sinhalese who was with me could not read it, though he could read ordinary Sinhalese. The inscription contains sixteen ruled lines, each 4½ ft. in length. The figure of a man which is traced in the rock just below the inscription is 5 ft. 5 in. in height; from the waist to the ankles a cloth is depicted, and the hands hold a rosary up before the face. The figure is neither sunk nor in relief, but merely outlined. From here down to Gatanetula the path passes two abandoned ambalams, both of which, with their legends, are described by Skeen. At Gatanetula there are the remains of an ambalam, and on a stone there, just by the side of the path, there is a curious design traced. It consists of a pointing hand with five fingers and a thumb, a circle, and something that might have been meant for an elephant; the length of the hand is 4½ in., that of the "elephant" 6½ in., and the diameter of the circle 4 in.

Shortly below this is Nilihela ambalam, perched on a high narrow tongue of the hills, where they run into the low-country. To the south-west the pilgrims' path follows along the ridge down to Palabadalla. To the north the hill slopes steeply down to a river; while to the south is a great cliff opposed by another greater cliff, with a deep valley between them. It is from a legend concerning these cliffs that the place takes its name, viz., Niliakka was a young mother of the dhoby caste, and she lived on the verge of the cliff. One day, having put some clothes to dry on a bush that grew near the precipice, she sent her little son to bring them in. He could not reach the clothes, and in stretching up the bush he fell over the cliff into the valley more than 1,000 feet below. The distracted mother rushed to the edge and plunged after her child. The Sinhalese say that to this day that if one shouts across the cañon, Niliakka will answer. Certainly there is a wonderful echo.

Just below the ambalam, on the south side, there is a small cave, which has not been improved by art in any way. A path in the same direction leads to a spring; to the north, in the jungle, there is another spring, but neither of them seems to have been built in, though doubtless they are old. I explored a good deal of the jungle to the north, but found nothing.

The tremendously deep valley below Nilihela on the south contains a great number of boulders, under some of which are caves. Two have been occupied recently, but none shows signs of ancient workmanship. The "fierce leech" here flourishes.

I followed the pilgrims' path down as far as the outskirts of Palabadalla, but found nothing of interest.

There still remains to be described the valley between Adam's Peak and Bena Samanala-gala and the stream on the hills above the first ambalam. The valley is full of caves, especially under

Bena Samanala; but none of them have been occupied. I must have examined scores, some of them very suitable for building up.

I followed the main stream to its source, worked along the ridge, and broke back through the bamboo, but found nothing. The undergrowth is very thick indeed, and is composed of tough wiry bamboo. Except where there are elephant paths, it is hard to make one's way. Altogether, exploring this valley, five days were spent in vain.

The last place, the bed of the stream on the heights above the first ambalam on the Maskeliya-para, was nothing but a series of enormous slab rocks and waterfalls; stretches of rock 50 yards square rose in terraces, divided one from another by broad waterfalls some 20 ft. high. These are where the princesses of old used to bathe. This legend possibly refers to the Veddas. After leaving this place I was told by an old Sinhalese man that there is a stone ruin in the jungle there and a cave with an inscription. My guide knew nothing of it.

There still remains to be explored the Kehelgama-para and the Erane-para. I am told, both by Englishmen resident in the neighbourhood and by natives, that the former of these contains both ruins and inscriptions.

MIMICRY IN INSECT LIFE, AS EXEMPLIFIED BY CEYLON INSECTS.*

By E. Ernest Green, F.E.S., Government Entomologist,
Royal Botanic Gardens, Peradeniya.

With Illustrations.

BEFORE describing some of the more interesting instances of so-called mimicry in insect life, I must ask you to disabuse your minds of the idea that such mimicry is in any way conscious. One frequently hears the epithets "wise," "clever," and "ingenious" employed in connection with some particularly successful case of adaptation, and it is often difficult to avoid such misleading terms in ordinary conversation.

As a matter of fact it is probable that these wonderful arrangements of form and colour are the result of natural selection unconsciously working upon accidental variations or mutations through countless generations, those favourable to the organism having the better chance of being perpetuated and accentuated.

The word "mimicry" itself is unscientific in this connection, but is the term that has been generally adopted for the phenomena in question.

In studying animal mimicry, two main classes or purposes may be at once distinguished, *protective* and *aggressive*, though the latter may—and often does—serve both purposes. Protection may again be subdivided into *protective resemblance*, where the insect simulates some inanimate object, and *protective mimicry* proper, in which the insect assumes the appearance of some other species that is naturally protected either by some weapon, such as a poisonous sting, or by some unpleasant taste or odour. Of the former class—protective resemblance—we have abundant beautiful instances in Ceylon. The best known is that of the leaf insects.

(*Fig.* 1.) Our more common Ceylon species (*Pulchriphyllium crurifolium*) carries its disguise throughout every stage of its existence. The eggs are remarkably like the seed of some plants, and they are shed upon the ground, and lie amongst the dead leaves just as might the seeds of any tree. I must confess that I have never found the particular seed that matches them, but I am confident that such exists. If I were to send a packet of these eggs to

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* This article is the substance of a lecture delivered by the author in Kandy in 1907.

some horticultural friend in Europe, he would almost certainly plant them carefully and expect to raise some interesting tropical plant from them. When first hatched the young insects are of a bright reddish colour, harmonizing with the young leaves of many of our shrubs and plants, and it is upon such tender leaves that they feed during this early stage. As they grow older they prefer the more mature leaves, and at the same time the red tints are gradually changed to green. The upper surface of most leaves is darker and more glossy than the underside. In the half-grown insect we find a reverse arrangement of the tints. The back of the insect is of a dull pale green tint, while the underside is of a deeper colour and more shining surface. This at first sight would appear to be faulty adaptation; but such is far from being the case, for the habitual attitude of the insect in this stage is head downwards, with the hinder leaf-like part of the body re-curved over its back, in which position the under surface of the body is uppermost. So perfectly leaf-like are the full-grown insects that they may be said to partially defeat the purpose of their disguise, for they are sometimes mistaken by their fellows for actual leaves, and may have parts of their wings nibbled off before they realize what is happening. Perhaps, though, this accident may really enhance their disguise, for the ragged insect looks like a leaf that has been partially devoured by a caterpillar.

(*Fig.* 2.) The allied "Stick Insects" (*Phasmidæ*) resemble the stalks of grasses or the thin twigs of bamboos and shrubs. One species frequents the common yellow-stemmed bamboo. It has a smooth cylindrical yellowish body, jointed at intervals like the bamboo upon which it lives. Another is covered with thorn-like processes and simulates a piece of bramble. Their eggs, like those of the leaf insects, resemble seeds of various kinds. They are either attached to the leaves of plants or shed upon the ground.

Another small insect (belonging to the family *Membracidæ*) apparently relies upon its similarity to the thorns of the plant upon which it is most frequently found. Both the young and the mature insects resemble thorns, but in a different manner. The young insect is green, and has a single erect-pointed prominence on the back. It frequents the young shoots where the natural thorns are soft and green. The adult insect has a pair of backwardly directed curved black horns, and may often be found on the older shoots where the thorns are dark coloured. To obtain the highest degree of imitation the young insects should rest with their heads towards the base of the stem, while the adult insects should adopt the opposite position. And this is most frequently found to be the case. By so doing the curve of the horns of the insects takes up the direction of the thorns of the plant. This thorn-like Membracid is named *Leptocentrus substitutus*, Wlk., and the thorny plant upon which it lives is *Capparis sepiaria*, L.

(*Fig.* 3.) The "Leaf Butterfly" (*Kallima philarchus*) is a very beautiful example of protective resemblance. While it is on the wing the bright blue tints of the upper surface render it a conspicuous insect, but when the wings are folded together in the resting position, their form and colouring exactly imitates a withered leaf. The markings take the form of the midrib and veins of the natural leaf, while the resemblance is heightened by a blunt tail-like process from the hind wing, which takes the place of the stalk of the leaf. It even copies the frequent blemishes that are found on a dead leaf. There are often irregular dark-coloured blotches, such as are caused by fungus diseases of the plant, and in some examples there is a small transparent spot suggesting a hole in the leaf. In natural history books this insect is usually represented perched on a leafy branch, in which position the brown tints of the wings would not harmonize with their surroundings. But in nature the insect more usually settles head downwards on the trunk of a tree, and it has acquired the habit of swaying gently from side to side. It might then be mistaken very easily for a detached leaf that in its fall has hitched up in a cobweb and is being shaken by the breeze.

Then there are many insects that habitually rest on the bark of trees. These have assimilated themselves most perfectly to such surroundings. And as bark is very frequently spotted and mottled with gray and greenish lichens, so these particular insects are usually variegated with similar markings. Moths of various kinds, certain beetles, several Homoptera, and a few grasshoppers exhibit this form of protective resemblance.

(*Fig.* 4.) Even such a large and bulky insect as our large Wood-boring Moth (*Duomitus leuconotus*), which has a wing expanse of nearly 8 inches, can conceal itself very successfully by its resemblance to a patch of lichen-covered bark. Its wings are closely mottled with gray and black. Another large moth (*Elphos hymenaria*), with similar markings, rests with outstretched wings on the trunks of trees, where it is in perfect harmony with its surroundings.

The large "Hawk Moth" (*Pseudosphinx discistriga*) becomes practically invisible when resting in similar situations.

A large beetle, common in the Kandy districts, is ornamented with irregular streaks of light and dark brown, and looks curiously like the fibrous surface of wood where some branch has been torn off.

(*Fig.* 5.) Another beetle (*Alaus speciosus*), which, when seen by itself, appears to be most conspicuously marked, when resting—as it frequently does—on the charred stump of some tree in a newly burned clearing, would be mistaken for an irregular patch of white ash. But in this case it is doubtful if the apparent adaptation is real, for the insect cannot of necessity confine itself to recently charred stumps, and the gradual evolution of this pattern must date back to a period long before the clearing of our forests commenced. Possibly the scheme of colóration was unconsciously modelled upon the form taken by some of the shapeless white fungi that grow upon decaying wood.

(*Fig.* 6.) There is a common long-horned grasshopper with mottled brownish wings, which clings close against the branches of the trees upon the leaves of which it feeds. Its wings partially encircle the branch, and its back is rugged like the bark. When at rest in this position it looks merely like some natural excrescence of the branch itself.

(*Fig.* 7.) And a small Homopterous insect (*Atracis neitneri*) is so like—in texture and colouring—to a patch of gray-green lichen that it is indistinguishable until it is disturbed and flies off.

Another common form of protective resemblance, in which the insect imitates a small lump of earth, has been adopted by many members of the beetle tribe. Such species are of a dull brown colour, and have a rough granular or warty surface. They do not necessarily live in the soil, but have acquired the habit—when alarmed—of suddenly dropping from their perch and falling to the ground, where they lie perfectly motionless, with limbs close pressed to the body, until the danger has passed. The habit of feigning death is itself a form of protective mimicry.

As a general rule, predatory animals will not touch even their natural prey when it is dead or motionless. A preying mantis, one of the most voracious of insects, will take no notice of a motionless insect, but will seize it as soon as it shows any signs of life. Many defenceless insects, therefore, have acquired the habit of lying inert and to all appearances dead when alarmed.

Insects that inhabit grass land have very generally assumed an elongate narrow shape that assimilates itself to the form of the stems and blades of the grasses amongst which they conceal themselves. Examples of many different families may be found exhibiting this device. We find in the patanas long narrow grasshoppers, stick insects, mantises, bugs, caterpillars, and even moths of the same general form.

The caterpillar of a small green moth (*Thalassodes*, sp.) disguises itself by fastening pieces of leaves and withered blossoms to the fleshy spines on its back.

The phenomenon of protective mimicry proper is closely involved with that of warning colours, in which an insect has assumed conspicuous colours or markings that are recognized by insectivorous birds and other animals as associated with something dangerous or distasteful. In contradistinction to *protective resemblance*, which results in rendering the object inconspicuous, *protective mimicry* usually tends in the direction of conspicuousness. The wasp tribe are usually brightly banded with orange and black, and any bird that had once been stung by a wasp would instinctively avoid another insect similarly coloured. We consequently find that many harmless insects have acquired this type of marking, and so escape molestation by their resemblance to their self-protected models. Thus, there are certain moths and flies with banded bodies, and beetles in which the same pattern is produced on the closed wing cases. Even members of the spider tribe have found the advantage of mimicking better protected insects. That very pugnacious insect, the "red ant" (*Œcophylla*), is naturally protected not only by its powerful jaws, but by the copious secretion of pungent formic acid, which renders it obnoxious to most insectivorous creatures. It is imitated both in form and colour by several other insects, more especially by a slender "hunting-spider." So close is this resemblance that most persons to whom I have pointed out the spider have declared unhesitatingly that it was verily the red ant itself. We have in Ceylon a whole series of such ant-like spiders, each apparently modelled upon some particular species of ant. Spiders are possessed of eight legs, while ants have only six apiece; but this does not interfere with the resemblance, for the first pair of the limbs of the spider take the place of the antennæ of the ant. The deception is only noticeable when the spider becomes alarmed by a close inspection and lets itself down by a silken thread—a feat that is impossible to any kind of ant.

While on a recent tour in the neighbourhood of Trincomalee I saw on the ground what I supposed to be a species of *Mutilla*—a peculiar genus of wasp, the females of which are apterous and brilliantly coloured. Knowing that these insects are armed with a powerful sting, I was careful to pick it up with a pair of forceps, and it was not until I had bottled it that I realized that my capture was of much greater interest. It was a species of spider that had adopted the characteristic form and colouring of a *Mutilla*. I subsequently captured a second specimen, of the opposite sex, which apparently mimicked yet another species of *Mutilla*.

Large groups of insects, containing many widely distinct species, genera, and even families, are sometimes found to have acquired a type of coloration and pattern common to all of them. Such an association is distinguished by the term "Müllerian," after the famous naturalist (Fritz Müller) who first drew attention to the phenomenon. Each individual of such a group is usually itself protected by some disagreeable property, but by their common likeness to each other it is supposed that they contribute to the safety of the other members. This may require a little explanation. Every animal has to learn for itself what is good, wholesome food, and what is injurious or distasteful. An inexperienced young bird or lizard would not know that a certain gaudily coloured insect had an unpleasant taste until it had discovered the fact by actual experiment. But once learned, the lesson is never forgotten. The victim of the experiment itself is none the better off for its warning colouring, but its sacrifice has probably saved the lives of many others. The more general the particular type of coloration, the fewer subjects for experiment are required, whereas, if each separate species adopted a distinctive danger signal, they would each have to pay toll for the education of their mutual enemies.

Such Müllerian associations of self-protected insects are not quite so conspicuous in Ceylon as in some other countries, notably in Africa and South America, but we have a few instances.

Thus, amongst the butterflies we find two species (*Danais chrysippus* and *Hypolimnas misippus*) belonging to distinct families (the *Danainæ* and *Nymphalinæ* respectively) that are practically indistinguishable except by the most close examination. In the second species it is curiously the female only that has adopted the warning colour. The male is such a different looking insect that the relationship of the two sexes would never be suspected. A still more remarkable fact is that there are two varieties of the *Danais* and two corresponding varieties of the female *Hypolimnas*.

Yet another species of another family (*Telchinia violæ*) has somewhat the same general appearance. Though the similarity is not so complete, this insect probably reaps some advantage from its partial resemblance to the other two.

Four other Danaine butterflies (all different species of *Euplœa*) and a species of *Papilio* form another associated group. Here, again, we have the remarkable coincidence that the *Papilio* has two very distinct varieties, one of which resembles the *Euplœas*, while the other has the likeness of another self-protected species (*Danais septentrionis*).

A common type of warning colour, found in nearly all parts of the world, consists of a uniform reddish tint in front, followed by a more or less sharply defined hinder part. The members of this group comprise various species of beetles, bugs, wasps, flies, and moths.

Under protective mimicry may be classed the menacing markings that have been adopted by many insects.

(*Fig.* 8.) The most common form of this is the development of eye-like markings on various parts of the body. The true eyes of an insect are usually inconspicuous, but the ocellated spots—the sham eyes—found on the wings of so many butterflies and moths attract attention at once by their intense colouring and disproportionate size. Though in some cases these specialized markings may serve the purpose of distracting the attention of a formidable enemy from a vital to a non-vital part, as by allowing an insect to escape from a bird with the comparatively unimportant loss of a fragment of wing, in others the eye-spots have a more directly protective function. We have in Ceylon a particular kind of praying mantis that preys principally upon butterflies. I have kept a living specimen of this mantis in a cage for some time, and have fed it upon a small species of butterfly that happens to be very abundant in the immediate neighbourhood—a species that is ornamented with several conspicuous eye-spots. I have noticed that while one of these butterflies is walking quietly about the cage, when its markings are clearly visible, the mantis seems to be afraid of it: but as soon as it commences to flutter and the markings are obscured by the rapid movement of the wings, it is promptly seized and devoured.

The caterpillars of many of our large "Hawk Moths" show a pair of large and brilliantly coloured false eyes on the front part of the body that gives them a very alert and formidable appearance. These markings must be distinctly protective.

(*Fig.* 9.) Akin to this form of protection is that in which the markings simulate a sham head at the opposite end of the body, while the real head may be much less conspicuous than the false one. This is found in some small hopping insects, whose principal enemies are the "hunting-spiders" that spin no snare, but stalk their prey, endeavouring to take it unawares and seize it from behind. These hunters would be puzzled—when stalking one of these double-headed creatures—to know which was its blind side, and might be likely to approach it from the wrong end, and so give it timely warning of its danger.

Aggressive mimicry is adopted by predaceous insects, and usually takes the form of some disguise that enables them to approach their prey without alarming it. The disguise at the same time affords the wearer protection from its own enemies.

All the disguises that we have seen adopted for protection are repeated for the purposes of aggression. Thus, we find praying mantises that simulate leaves, others that frequent the trunks of trees and resemble lichen-covered bark; and one peculiar species (*Gongylus gongylodes*) with leaf-like body and wings, while just behind its head is a hood with brightly coloured lining that is thought to imitate a flower. This is the species that has already been described as feeding upon small butterflies. It takes its stand on some leafy branch and awaits its opportunity. The head is elevated to display the coloured area. Presently a passing butterfly is attracted by the patch of pink, it approaches in expectation of finding a honey-laden flower, and finds itself seized by a pair of cruel arms arrayed with formidable teeth like a steel rat-trap. "And the subsequent proceedings interested it no more." The juicy body is soon devoured, and the unnutritious wings are dropped.

There are several small hunting-spiders that have adopted the same kind of manœuvre. They are of a bright yellow colour, and lurk among the yellow stamens of flowers. From this coign of concealment they pounce upon small flies and moths that come to feed at the flower. When insect hunting I have on several occasions been deceived by some moth that appeared to be busily engaged in sipping honey, but on attempting to capture it I have found myself forestalled, and the specimen already in the jaws of one of these little spiders.

Other predaceous insects assume the proverbial "sheep's clothing," and imitate the form of the creature upon which they prey. (*Fig.* 10.) An interesting example is that of a large fly (*Hyperechia xylocopiformis*), which so closely resembles a species of "Carpenter Bee" (*Xylocopa fenestrata*) as to completely deceive its victim. I have watched one of these flies mount into the air to meet a passing bee, which appears to welcome it as a mate, with fatal results to the bee. One might suppose that the bee could protect itself with its powerful sting, but it discovers its mistake too late, when the fly is firmly perched on its back and has driven its sharp beak into the body of its victim.

It is possibly the same purpose that has led to the similarity of colour and pattern between two distinct insects of the bug tribe (*Antilochus nigripes* and *Serinetha augur*), for the former preys upon the latter.

Another device employed by one family of predaceous bugs is to cover their bodies with dust and small particles of rubbish until they look like anything but living insects. In this disguise they lie in wait and pounce upon their prey—other small insects—or are able to creep up within striking distance without being observed.

In these few examples of mimicry that I have described I have touched but the fringe of a most interesting and complicated subject. There are endless other instances to be seen around us by any intelligent observer. In fact it is probable that fully one-half of the insects that exist in Ceylon exhibit in some degree one or other of the several forms of mimicry.

FIG. 1. Leaf Insects feeding upon guava leaves.

FIG. 2. Stick Insects on a dried twig.

FIG. 3. Leaf Butterfly at rest, head downward, on the trunk of a tree.

FIG. 4. Wood-boring Moth on tree-trunk.

Fig. 5. An Elaterid Beetle, *Alaus speciosus*, on a charred stump.

Fig. 6. Long-horned Grasshopper, *Sathrophyllia rugosa*, at rest on twig and on the wing.

Fig. 7. *Atracis nietneri* on lichen-covered trunk.

Fig. 8. Butterflies and Moths with ocellated markings on the wings.

FIG. 9. *Armachanus monoceros*, Distant.
An insect showing false eyes behind.
The natural size is shown on the left of the figure.

FIG. 10. The upper figure is a Bee; the lower a two-winged Fly, which mimics the former.

ON THE LARVA OF "PRODENIA SYNSTICTIS,"

Hampson.

By T. Bainbrigge Fletcher, R.N., F.E.S.

On August 3, 1907, whilst searching on plants of *Drosera burmanni*, Vahl., at Diyatalawa, for the immature stages of *Trichoptilus paludicola*, I found a small dark noctuid larva beside a *Drosera* plant, on which it was feeding. It was placed on sundew, and on the next day was observed to have taken up a position on the underside of a grass stem preparatory to undergoing an ecdysis.

On August 7 it was noted as feeding on the red glands of the *Drosera*. It was then naked and nearly black in colour; each abdominal segment bore a square black dorsal spot; the thoracic segments bore a narrow interrupted dorsal line; each segment had a black sub-dorsal spot bordered below by two contiguous yellow dots; there were also numerous minute yellow dots scattered over the larva. The head was nearly black, with a paler Λ-shaped mark, and the mouth parts of a dirty orange colour. Legs all present, the same colour as the body—a very dark fuscous, almost black. On the head and prothorax were numerous short black hairs; probably these, as in the case of *T. paludicola*, act as "feelers" to prevent too close contact with the *Drosera* gum.

On August 10 the larva is noted as being 9 mm. long and proportionately stout. When not feeding it liked to rest on a grass stem, especially if the stem was within reach of a *Drosera* plant.

On August 12 it was feeding on the flower buds and unripe seeds of the *Drosera*, and at a casual glance it looked quite black.

By August 18 it had attained a length of 19 mm., and was eating the *Drosera* flower stems.

On August 20 the larva was about 20 mm. long, stoutly built, almost black in colour, sprinkled with minute yellowish dots (which were not distinguishable except under a lens), with a series of creamy yellow dots along the latero-dorsal region, these last giving to the naked eye the appearance of a narrow yellow stripe. "The larva is very voracious, and prefers to feed on the seed pods and buds of the *Drosera*, though it will also eat the leaves, and has now apparently little fear of the gum."

On August 23 the larva had just undergone an ecdysis and assumed a very handsome appearance. "It is 23 mm. long, stout, jet black, interstices of segments whitish. The dorsum of each segment bears two or three minute yellow dots, which do not form a dorsal stripe. A fairly narrow latero-dorsal stripe may be described as composed of a series of yellow spots almost united to form a stripe. Just below the spiracles passes a similar stripe composed of a row of yellow dots, but it is not so distinct as the upper stripe. Below the sub-spiracular stripe the black surface is sprinkled over with minute white dots, most numerous along the lower edge of the yellow stripe. Legs black. Prolegs black, feet and claspers yellowish, head black."

On August 29 this larva was very nearly full-fed, and presented a very handsome appearance. A description made at the time reads as follows :—

"It is 30 mm. long and 5·5 mm. broad. Its colour is jet black, the segmental interstices (except between head and prothorax) broadly creamy white. The prothorax has anteriorly three bright yellow spots, one medio-dorsal, the other two sub-dorsal; the other segments bear a few scattered medio-dorsal pale yellow spots, which hardly make a line; a fairly broad latero-dorsal longitudinal line is seen to be composed of numerous irregular pale yellow markings on each segment behind the prothorax; just below the spiracles runs a similar pale yellow stripe, a little broader and less sharply defined than the latero-dorsal one; this sub-spiracular stripe is bordered below by small white dots scattered irregularly over the whole ventral surface, which is of a very dark glaucous green, almost black. The margins of the anus are of a bright orange. Legs black; prolegs greenish yellow, the upper exterior parts black. Head black, with a narrow obsolescent creamy Λ-shaped mark across the face and an obsolescent orange spot just above the jaws; the head is thickly studded with short, black, bristly hairs. There are a few very short black hairs scattered over the body segments, but they are so inconspicuous that their positions cannot be distinguished even under a strong lens, as they are only visible when viewed against the light. This larva is very voracious, and feeds indiscriminately on the *Drosera* leaves, but seems to prefer the stems, eating buds, seeds, stem, and all."

On the afternoon of August 31 the larva excavated a chamber in the earth beneath a small clump of *Drosera*, but it did not pupate until the night of September 3/4. A slight but regular cocoon was formed. The pupa seems very small in comparison with the bulk of the larva; it is black, the abdominal segmental interstices yellowish.

The moth emerged about 7.30 A.M. on September 22 and proved to be *Prodenia synstictis*, Hmpsn.

Although there is little doubt but that this particular larva of *P. synstictis* was actually feeding on *Drosera burmanni* when found, and that it throve exceedingly well on a diet of this insectivorous plant, yet it seems to me improbable that this forms its usual pabulum. One of my reasons for this conclusion lies in the fact that no other specimens of this larva were found during a close search, on probably several hundreds of plants, for larvæ of *Trichoptilus paludicola*; but perhaps other searchers may be more successful. At any rate a certain interest is attached to any insect which subsists with impunity on so essentially entomophagous a plant as sundew.

NOTES ON SNAKES FROM DIYATALAWA, CEYLON.

By T. Bainbrigge Fletcher, R.N., F.E.S.

DURING a stay in camp at Diyatalawa (4,000 feet) between July 27 and October 9, 1907, I obtained a few specimens of various species of snakes, and as all information concerning the distribution of even the commonest snakes in Ceylon seems to be rather a desideratum, it may be of interest to give a list of them here.

Rhinophis blythii.

One specimen, $10\frac{3}{4}$ inches long, was taken on October 2, amongst flood refuse washed down by a small stream after heavy rain on the previous night. The ventrals in this example number 192, and the proportion of its length to diameter is as thirty-seven to one, so that its length is comparatively greater than usual, as shown both by its greater slenderness and by the increased number of ventrals. This specimen is now in the Colombo Museum.

Aspidura trachyprocta.

One specimen, taken in June on Craig estate, Bandarawela (about 5,000 feet), was given to me by Mr. J. F. Jowitt. Although this is probably not an inhabitant of Diyatalawa in the strict sense of the word (*i.e.*, " water plain "), yet this specimen seems sufficiently interesting to record here; the head scales are asymmetrical, the præocular being present on the left side of the head but totally absent on the right side. The other scale peculiarities (much broader frontal, &c.) leave no doubt that this specimen is *trachyprocta.* Wall records a specimen with no præocular ("*Spolia,*" III., 145), but in his example the variation was presumably symmetrical.

Oligodon sublineatus.

One specimen was taken on August 12, just below the Railway station.

Zamenis mucosus.

Common all round the camp, and large individuals are often seen on the rifle range. During the forenoon of August 27 a rat-snake shed its skin in the drain just outside our hut; the cast skin was quite perfect, and measured 6 feet 5 inches.

Tropidonotus stolatus.

(1) One (15⅝ inches + 5⅜ inches) on September 3.

(2) One (about 18 inches) seen on the range on September 6.

(3) A mangled example (about 18 inches) found on a path on October 4.

Fairly common; found on the dry hillsides as well as in the marshy valleys.

Tropidonotus asperrimus.

A hatchling (8½ inches) was brought to me on September 3. It is a fairly common snake at Diyatalawa.

Macropisthodon plumbicolor.

On August 19, just before 8 A.M., I noticed a crow on the hillside a couple of hundred yards away. The crow seemed to be attracted by something on the ground but appeared afraid of it, as it kept jumping about around the object of attraction. I thought it was probably a snake, so took a stick and went over to investigate; sure enough, when I got to the place (the crow having flown off at my approach), I found a fine example of this snake there. It did not seem to have been hurt by the crow, but was defending itself by flattening itself out along the ground in a most peculiar manner. The head was raised slightly off the ground, and the whole of the body (especially the forepart just behind the neck) was flattened out so as to appear very broad. The snake did not attempt to bite, or even hiss, when I picked it up. It was a fairly large specimen, 22 inches long.

This snake ate three small frogs and a young *Calotes* on August 23, but refused to take any more frogs or lizards, although both were kept constantly in its cage. On October 5, however, a large toad (*Bufo melanostictus*) on being introduced, was at once attacked and ingested.

On October 8 I caught a second and smaller specimen of this snake; this was also taken in the early morning. This individual did not flatten itself out at all when caught, nor make any attempt or threat to bite.

In spite of its particularly gentle disposition and harmless character the natives appear to be very much afraid of this snake, and I think that they are quite unable to discriminate between this species and the "green tic-polonga" (*Lachesis trigonocephalus*). The local name for it is "pala-polonga"; *pala* apparently means "a herb," so the name may be translated "herb-green viper." I was told a strange tale of a native who had "pinched one of these snakes and afterwards rubbed his eye with his fingers, with the result that he had a very bad eye for some days." Any foundation of fact in this yarn might be explained by the possibility that the snake communicated some secretion from the parietal gland of a toad with which it had recently had an encounter.

M. plumbicolor appears to be fairly common on the patana around Diyatalawa.

Naja tripudians.

On September 21 a native brought along a cobra which had been killed in the camp. Its length was 29½ inches + 6 inches. On dissection its stomach was found to contain a frog. The head scales were quite normal.

On October 4 another example (31 inches long) was killed in the Naval camp.

Probably the cobra is fairly common at Diyatalawa, but not often identified as such. A planter, resident in the neighbourhood, who saw the first-mentioned specimen when it was brought in was positive that it was " only a rat-snake," because the hood was not expanded.

Vipera russellii.

In spite of the local inhabitants' assertions to the contrary, the " tic-polonga " appears to be quite a common snake at Diyatalawa.

(1) On August 21 an example about 3 feet long was brought in by the natives.

(2) On September 4 a baby specimen, only 9½ inches long, was caught near the Railway station. Even at this early stage the fangs are well developed, and there is a reserve fang almost as large as the first one.

(3) On the evening of September 12, when it was getting dark, my companion, who was walking just in front of me on our way back to the camp, stepped right over an individual which was lying on the path. Luckily for him it had just swallowed a shrewmouse, and so was too torpid to strike at him. It measured 16¾ inches + 2¾ inches.

(4) On September 20 one of our men (W. Humphreys, able seaman) brought along the skin of a Russell's viper which he had just killed close to the camp. This specimen was a female, about forty inches long, and in skinning it he had removed twelve fully-formed young ones *in utero*. Each fœtus was enclosed in a roughly oval membranous packet about 43 mm. long by 20 mm. broad, the membrane being liberally supplied with blood vessels filled with red blood. Nearly half of the packet was filled with a glairy opaque whitish albuminous matter; in the other half the young viper was coiled up, the tail in the middle of the coil, ventral surface of tail next enveloping membrane; further up the body took a half turn, and the dorsal surface was appressed to the membrane; the head

was not visible, and was apparently next to the albuminous matter. The immature males had the usual double set of genitalia fully extended.

As brought to me, there was one string of five membranous envelopes, one of three, a single one detached, and three small vipers which had been freed. The dimensions of these last were: (i.) male, 7 inches; (ii.) male, 7¼ inches; (iii.) female, 7¾ inches. The fangs were quite developed in these unborn vipers, being about 3 mm. (⅛ inch) long.

(5) Humphreys told me that he had killed a number of snakes around the camp lately, finding them driven out on the paths when the hillside vegetation is set on fire. A short time before he had got a larger *V. russellii* and showed me the skin, which measured 40 + 5 inches, the extremity of the tail being absent.

(6) A male (34½ + 5½ inches) was brought in by a native on September 24. On dissection the stomach was found to be empty.

NOTES.

1.—*A new Species of Hesperiidæ in Ceylon.*—At the end of 1902, when I was leaving Ceylon for England, Mr. F. M. Mackwood handed to me a species of *Abaratha* which he was unable to name, and which he wished presented to the British Museum. The Museum had one other similar specimen, captured by the late Major Watson in the Shan States. These insects have recently (Ann. Mag. Nat. Hist., ser. 7, vol. xx., p. 432) been named by Colonel Swinhoe *Abaratha siamica*, Swinhoe, the type being Watson's insect. I remember Mr. E. Ernest Green showing me a similar specimen to Mr. Mackwood's in his collection, which I believe was captured somewhere in the Kandy district; and I have seen a third specimen in Mr. Oswin Wickwar's collection captured at Ratigalla. Mr. Mackwood's was taken at Haldummulla; it is therefore widely distributed and apparently very scarce. Its geographical range is very extraordinary, and the Shan States, so far as I know them, have a far more temperate climate than the Ceylon hills. In all probability, however, it will eventually be discovered in the hill districts of India.

London, November 30, 1907. N. MANDERS.

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2. *Re Mr. F. M. Mackwood's Note in "Spolia Zeylanica," November* 17, 1907, *p.* 67.—There must be some error in the date. The electric plant was dismounted some time before the year 1906.

On an earlier visit I collected a large series of *Leocyma*, and upon examination of the frenulum found that both males and females were almost equally represented. As the male of *L. sericea* is readily distinguished from its female by the peculiar form of the front wing, I came to the conclusion that the Diyatalawa species must be *L. cygnus*, Walk. (now referred to *tibialis*, Fabr.), a species in which the two sexes have similarly shaped wings, and on reference to Sir Geo. Hampson my surmise was confirmed. There is apparently no character by which the females of *sericea* and *tibialis* can be distinguished from each other. *L. sericea* proper (or at any rate the male of the species) appears to be extremely scarce. During twenty-six years' collecting in Ceylon I have taken only a single specimen, and that one was captured in Colombo. What I take to be *L. tibialis* is abundant at certain seasons in Kandy.

E. E. GREEN.

3. *Mr. Drieberg's Note on Crows* (*ibid*, *p.* 68).—It is possible that the fleshy grubs of a cockchafer were the object of the attention of the crows. These grubs are often found in localized areas of grass land, and are known to be preyed upon by crows and minahs. When grass has been attacked by the grubs, the roots are often so completely destroyed that the plants can be lifted with very little effort.

E. E. GREEN.

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4. *Note on the death of a Cooly from Snake-bite.*—The number of reported deaths from snake-bite is so great, and the cases in which the snake has been identified so few, that any authentic records are of especial value. Hearing of a recent fatality on an estate in the Gampola district, and learning that the snake had been killed and preserved, I applied for the loan of the specimen. It proved to be a male of the Ceylon krait or karawala (*Bungarus ceylonicus*), measuring without its head (which had been cut off) 25½ inches. The total length must have been about 27 inches. There were 22 white rings on the body, and the black areas were continued—as well-defined dark bands—across the under surface. It is noticeable that this dark banding of the under surface is found in all of our terrestrial Colubrine venomous snakes: the cobra, the karawala, and the scarce *Callophis*, and, as far as I know, in none of the harmless species.

The particulars of this case have been kindly supplied by the superintendent of the estate. It appears that the man went outside his lines at 4 A.M. and was bitten on the left foot. He went back to his room, brought a lamp and a stick, and killed the snake. He is said to have recognized the snake as a deadly one, but returned to his lines and discussed the matter with his relatives until about 5.30, when it was time to start for muster. The man at this time felt sleepy and did not attend muster. The drowsiness increased until 10 A.M., when the case was reported to the Superintendent, who immediately went down armed with a bottle of whisky. But the man was able to swallow very little and was sick after each dose, the vomit being of a yellow colour. The patient was walked about until his legs refused to move. He was very cold. Artificial respiration (as applied in cases of drowning) was kept up until the arrival of the medical officer. The doctor's treatment consisted of whisky and ammonia, every half hour. At 2 P.M. the man was very feverish and quite insensible. At 4 P.M. he was reported dead, exactly twelve hours after the occurrence of the bite.

E. E. GREEN.

5. *Another fatality from Snake-bite.*—A visitor to my laboratory, while handling one of my caged snakes, was bitten on the thumb by a small specimen of *Dipsas ceylonensis.* This is one of those interesting species that, while possessing grooved fangs, have apparently no poison gland in connection with them. The bite drew blood, but the patient suffered no subsequent inconvenience whatever. On the other hand, the snake was found dead next morning, without any signs of injury to account for its decease. To paraphrase the well-known rhyme, "The man recovered of his bite, the snake it was that died."

E. E. GREEN.

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6. *The Bite of the "Brahminy Lizard."*—Year by year the Registrar-General's annual mortality report includes one or more cases of "death from bite of the Brahminy lizard." The Brahminy lizard is the common skink (*Mabuia carinata*), the bite of which is firmly believed by the natives of the country to be of a most venomous character. Dissection reveals no poison glands. The teeth of the animal are not grooved, nor are they even sharply pointed, their crowns being obliquely truncate. I have however received at first hand particulars that seem to show that the bite of this lizard can be followed by slight symptoms of poisoning. A lady tells me that, happening to place her hand on the floor under a table, she felt a distinct bite on the finger, and one of these skinks ran out. The wound was scarcely appreciable and drew no blood; but in three hours' time that finger was very swollen and tense. There was some tenderness on pressure, but no general disturbance. The only remedy adopted was the dipping of the injured finger in raw whisky at intervals. The swelling gradually abated and had almost disappeared by the following morning.

It seems probable, therefore, that the ordinary saliva of this lizard has some poisonous quality, in which case it might be possible for a person in weak health to be so seriously affected as to succumb from the effects of the bite.

E. E. GREEN.

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7. *Vitality of Dragonfly Larvæ.*—I recently received by post a match box containing several specimens of the aquatic larvæ of a dragonfly (*Libellulid*). To my surprise the insects, though they must have been out of the water for nearly twenty-four hours, were alive and very active. When placed in their native element they were so dry and so full of air that they were quite unable to sink below the surface. One of them managed to crawl down a stick to the bottom of the vessel, but upon releasing its hold it promptly rose to the surface again.

The larva of the dragonfly is purely aquatic; it breathes water, and never of its own free will leaves the water until it emerges in preparation for the final change into the winged insect. Under such circumstances it is astonishing that these larvæ were able to survive without apparent injury so prolonged an absence from their proper element. On dissection their tracheæ were found to be completely filled with air.

E. E. GREEN.

8. *Capture of a Butterfly by a Hunting Spider.*—While I was watching a small group of butterflies on a sandbank at Haragama, I was fortunate enough to see the capture of one of them by a large Lycosid spider.

The spider suddenly rushed out from some leaves, and seizing an outlying member of *Huphina remba* made for the water. Wishing to secure the specimens I netted them, or it would have been interesting to see whether the spider would actually have taken to the water. On examining the spider later it was found to be a female with a large number of young crowded on the back of its abdomen. The body of the spider measured approximately ¾ of an inch in length. While in captivity it finished its meal, completely dismembering the butterfly and entirely consuming only the softer parts of the body.

February, 1908. F. E. WEST.

9.—*Mosquitoes and Eyeflies.*—Have entomologists noticed how these pests seem to be getting prevalent at higher and higher elevations? I remember when there were no mosquitoes at an estate in this neighbourhood about 4,500 feet elevation; it was pleasant to be able to sleep without a mosquito curtain, now a necessity.

The eyefly is another pest that seems to be getting worse up-country, and I know of no really effective means of destroying them. I think there must be some particular tree or shrub that brings them, otherwise why is it that they are conspicuous by their absence in some bungalows and swarming in others, even though every attention is paid to clean surroundings in the latter?

Perhaps Mr. Green could throw a light on the problem. If he could tell us how to get rid of them, he would earn the gratitude of many. As usual, Nature seems to be moving to the rescue, though somewhat slowly. One sees everywhere now a small green flycatcher, about the size of the "white-eye," a friendly little bird. He will sit on a bough quite close to you and suddenly dart down on a fly a few inches away from one's face. It would be interesting to know the proper name for this little friend,* he certainly seems to keep down the eyeflies.

R. MACLURE.

Maskeliya, January 13, 1908.

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10. *Mosquitoes and Eyeflies.*—The distribution of mosquitoes depends principally upon facilities for breeding. Most of the species are dependent upon stagnant or approximately still water. I have found certain species abundant at all elevations in the Island, though the bite of those frequenting the higher altitudes does not appear to be so virulent. I remember experiencing considerable trouble from mosquitoes in a bungalow in the Dikoya district at an elevation of over 4,000 feet in the year 1881. The greater frequency of mosquitoes on up-country estates in recent years may possibly be attributed to the greater attention now paid to horticulture. Small pieces of ornamental water are more common, and pits to catch water for irrigation purposes. The presence of large numbers of pot plants in a verandah is often a source of mosquitoes. If water is allowed to accumulate in the saucers of the pots, it will soon become infested with the small wriggling larvæ of several species of mosquito, particularly of the vicious little "tiger mosquito" (*Stegomyia scutellaris*).

The life-history of the so-called "eyefly" of Ceylon is still unknown, and I have so far been unable to obtain even its scientific name. Its greater abundance round up-country bungalows seems to be associated (whether coincidentally or otherwise) with the increase of ornamental trees, and I have thought that it may possibly breed amongst the accumulation of fallen and decaying leaves. But until the early stages of the insect have been discovered any explanation must be merely guesswork. Eyeflies can be excluded from a bungalow by keeping the premises darkened. Bamboo tats lined with green cloth will afford almost complete relief from this pest. They should be let down a little before midday and can be rolled up after 4 o'clock.

E. E. GREEN.

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11. *Migration of Butterflies.*—While travelling from Sirigala in Uva to Liangolla in the Eastern Province for four days (October 18 to 21, 1907), I noticed large number of butterflies migrating towards the east.

* This will be the Gray-headed Flycatcher, *Culicicapa ceylonensis.*

Catopsilia crocale and *Papilio polytes* were very abundant, but amongst the captured were :—

Papilio nomius	Ergolis ariadne	Danais limniace
Papilio crino	Hebomoia australis	Danais aglea
Papilio demoleus	Appias paulina	Bindahara sugriva
Junonia iphita	Catopsilia pyranthe	Telchinia violæ
Junonia almana	Castalius rosimon	Euplœa asela

The migration was not noticed while travelling from Liangolla to Pottuvil.

JOSEPH A. DANIEL,
Assistant Mineral Surveyor.

December 23, 1907.

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12. *A visit to the Nitre Cave ot Wellawaya, Uva.*—On September 12 last I visited the Nitre Cave at Wellawaya, mentioned by Dr. John Davy in his "Account of the Interior of Ceylon," pp. 429 *et seq.* (1821).

The surroundings of the cave are scarcely changed at all. The cave is in the heart of forest about 2½ miles from the Koslanda-Wellawaya road. We observed evidences of elephants visiting the vicinity of the cave. We struck the entrance into the cave after searching for some time.

The cave is situated on the side of a hill. It is formed in a band of limestone running across the hill in S.W. and N.E. direction. The limestone band dips about 45° to the west. The limestone collected from the sides of the cave is made up of fairly pure good-sized crystals of calcite. I am inclined to think that the cave is primarily formed by natural causes. The solvent action of waters and the decomposition of the rocks owing to chemical and physical actions are the chief agencies which wrought this cave. The limestone might have been subjected just at this place to unequal strain, which would then favour solubility. It is very probable that this cave was formed before the surface features of the surrounding district were fully developed.

The entrance into the cave was steep, and a loathsome smell emanated from it owing to damp, as we found later on owing to the excreta of bats. We lit our lanterns and candles and began to descend into the gloom of the cave. Then we heard a sound like that of gushing waters, and I thought there was a stream flowing through the cave. But this was a delusion, as I quickly discovered. We had already disturbed the bats, and they were flitting about like shadows in the gloomy cavern. The gushing sound was caused by the fluttering of thousands of bats.

After descending about thirty feet we found ourselves at the entrance of a huge hall. The sides were rugged, but the roof at this place had apparently a smooth surface. Where the bats had settled on the roof from time to time little white patches were left, which gave one an impression of a curiously patterned ceiling. There were similar patches on the sides of the cave. The roof dipped towards the west, evidently along a certain weak foliation, or may be along the junction plane of limestone and gneiss, which I could not ascertain. Huge blocks of rock had fallen down and were scattered on the floor. At other places the roof was irregular and rugged, but covered with white patches. Fine blackish dust and bats' dung lay evenly over the blocks lying on the floor, so that we had to move very cautiously. The dust in several places I found more than 5 feet thick, and lying so loose that one might have sunk through it if one had walked unwarily. In some places it was thicker than 5 feet. It was easily disturbed, and our walking had raised quite a large amount; but it was stifling when we started digging.

The number of bats here was enormous. Like a whirlwind they hovered round us. They constantly dashed against us, settling on us, one even clinging to the mouth of a cooly.

Very high in the roof of some parts of the cave were funnel-shaped openings communicating with the surface. Light streamed in and dimly lit up the rugged sides of these openings and the part of cave immediately below. It gave one an impression of a deep dark dungeon only lit up from a side window from a tower high above. This, with the bats flitting aimlessly in the sombre light, made a most melancholy and gloomy impression.

We crossed the hall, which I believe is more than 200 yards long and more than 150 yards broad, for the further end. Here we had to climb on all fours about 20 feet, when we found ourselves at the entrance of small tunnels which opened into chambers. These appear to have been worked by men.

Here the stench was overpowering. We worked up a small tunnel. It was very low and narrow, so that only one person can pass at a time in a stooping posture. The bats having perhaps no other egress from the passage dashed against us in a continuous stream. We dug in one of the chambers. By the time we finished it was simply stifling, also the heat was tremendous. So we returned to the entrance of the cave.

The economic value of the tons of manure found in this and several other caves is yet to be proved. Davy states that this cave was worked for many years for saltpetre by "natives, a party of whom, whose express occupation and duty it was, came annually from the neighbourhood of Passara for the purpose."

The formation of saltpetre in the cave is due to the decomposition of alkali-bearing silicates, such as the felspars, in contact with bats' dung. It does not occur in the bats' excreta.

Davy gives a very interesting account of the manufacture of saltpetre by the ancient Sinhalese in his book, pp. 265 *et seq.*, which should interest many a reader.

January 4, 1908. JOSEPH A. DANIEL.

Geocichla wardi (the male bird on the right). From Talawakele (J. Ryan, Coll.).

13. *Destruction of Deer.*—I desire to bring to the notice of all interested in sport and in the beautiful wild animals of Ceylon the heartless destruction of deer in the Island. Recently, when on an extended tour in the western part of the Island, I stopped at Wellawaya and Telulla for some time, and regretfully noticed the terrible slaughter of the deer at the time of close season for sport. Every cart coming from Hambantota way had deer skins, especially the spotted deer (*Cervus axis*), hanging out, and venison was usually procurable. Every night I heard the report of guns in the jungle close by, and knew too well that that usually meant a deer wounded or killed.

The villagers take advantage of the condition of the female deer during the close season to kill them. This fact can be borne out by a well-known sportsman who was staying at the resthouses mentioned above about the same time as myself. This gentleman, on tracking some villagers in the jungle, discovered the uterus of a deer containing a live fawn, which would probably have been born in a few days. A little further in the jungle he found bags of venison hidden away.

I noticed on several occasions during my tour in Uva in September male deer wandering alone, which to my mind tends to prove that a good many of the females with the young had fallen victims to the guns of the villagers. I may mention that it is a common sight to see villagers wandering with guns.

The game laws, I may mention, are practically a dead letter. The sportsman who probably would be content with the head of a male deer as a trophy is debarred from shooting during the close season, but villagers, actuated by commercial or selfish motives, shoot what they will with impunity, sparing neither male nor female, old or young.

I write purely in the interest of the Ceylon fauna, and trust this note may attract attention, and that greater vigilance may be ensured for the protection of the wild animals, and of deer in particular. I feel sure that unless the latter are protected they will not take long to be extinct.

December 16, 1907. JOSEPH A. DANIEL.

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14. *Further Note on the Birds of Dimbula.*—In sending in the original list I was a little doubtful about inserting Ward's Ground Thrush* (*Geocichla wardi*), but on January 17, 1908, I was able to shoot both male and female and to send the specimens in first class condition to the Museum (see figure).

* Jerdon called it Ward's Pied Blackbird.

I was able to observe the characteristic grounding habit of this bird in a ravine where a driblet of water was running over rock and sand. When shot its mouth was full of oose. *Cichla* is the Greek for a bird generally identified with the Ousel, and *Geo cichla* means Ground Ousel.

In the first list I unaccountably left out the up-country Minah, with his starling plumage and yellow ear lappets. They used to be quite common, nesting in the woodpecker holes and other hollows in the giant doon trees, which are now, alas ! of the past in Dimbula. They fed a good deal on the fruit of the wild nutmeg (Malaboda), and I have shot them with their crops full of the fruit—not a bad swallow for a bird not much bigger than a starling.

The scientific name of the hill Minah is an amusing example of the turgidity of the classic chamber-naturalist—literally translated *Eulabes ptilogenys* means the "cunning (fellow) with a feathery lower jaw."

À propos of the general ignorance on the subject of birds, one of our oldest planters recently made the statement to me that hardly any of the birds now visible were in Dimbula in the jungle days. It is seldom worth arguing out an abstract question like this verbally, but it is interesting to note that nearly every bird in my list had been identified fifty years ago by that keen observer Kelaart.

Very little has been added to our numbers since then, although the labours of Legge, Bligh, Layard, Lewis, and others have added much to our general knowledge of habits, nidification, &c.

Classical Nomenclature.—This is from either a naturalist's or a scholar's point of view rather a woful hash, but in the first place it is a mistake to call it classical; and in the second place to complain of it is merely to betray want of familiarity with the principles of zoological nomenclature. In many cases the literal translation of the Linnæan name leads to an absurdity. In rare instances it may be considered an improvement on the common name, as with the common Kestrel, *Tinnunculus alaudariu*, literally the lark-hunting kestrel.

Talawakele. JAMES RYAN.

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15. *The Purple-rumped Sunbird.*—Mr. Ernest Green has recently drawn attention to the well-known habit of this bird of fluttering continuously against window panes. Its scientific name being "Spiderhater" (*Arachnecthra*), I had the idea that possibly it came to window panes in search of spiders or the flies in their webs. As, however, they frequently allow an approach to within a few inches of the inner side of the glass, I am convinced that they are merely attacking their own reflection in the glass, and that therefore the advancing observer is hidden from them by reflection.

This window tapping habit is shared by the Gray Wagtail. By the way, I notice the Gray Wagtail is almost invariably solitary in his habits. However many one sees of a morning, they are always alone. So perhaps he is driving away an imaginary rival.

The Sunbird must be one of our lightest birds, as they may frequently be observed swinging on the stigma of the common *Abutilon* (Chinese Lantern flower) in search of insects, on which, in spite of their common name (*Nectarinidæ*), they mainly feed.

It may be worth noting that the Gray Wagtail came in this year to a day with the Autumn Equinox, but I fancy the phase of the moon coinciding had something to do with this. Most migratory birds prefer a full moon when not hustled by frost and consequent want of food. Then they fly at any time, but mostly by night—in the daytime so high as often to be invisible, except to highly posted observers.

A criticism has been recently made that I have confined my list of birds to those in my own neighbourhood. This is incorrect. Of 74 birds identified, 33 may be said to be found everywhere, 16 are only seen in jungle or on patana, paddy field, and marsh, while the remaining 25 are mainly based on single specimens shot or observed on six other estates covering an area of upwards of two miles square.

No bird has been put in unless shot or identified by a competent observer. Several specimens reported by witnesses of doubtful credibility, or not identifiable from the description given, have been kept out.

Talawakele. JAMES RYAN.

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16. *Binomial Nomenclature.*—This is the method of naming animals and plants by a Latin form of words, one for the genus and one for the species, which was introduced by Linnæus a century and a half ago. It is not a very good method, but it is the best that is known. In many instances a classical or a personal name is adopted for the genus, *e.g.*, Nereis, Argonauta, &c., while the specific term may indicate a character or the distribution, or may again commemorate the name of a person, as *Vesperugo tickelli*, commemorating Mr. Tickell. Often, however, the etymology of a name will not bear looking into, frank nonsense being sometimes employed. But it ceases to be nonsense as soon as it is used to designate a particular species of animals or of plants. It is commonly a mistake to read a meaning into an artificial term.

Very often the same species has been named twice by two different observers, and in such an event the name first given is that which stands by rule of priority. Frequently, alas, names which have been sanctioned by long usage of fifty or a hundred years are suddenly discovered by some too diligent inquirer to have no legal title, and they are forthwith abolished by a stroke of the pen, or at least the stroke is not omitted. This rigorous application of an arbitrary rule, which allows no latitude, leads to pedantic discussions of the utmost triviality, and exposes systematic zoology to the suspicion of dilettantism. The effect of it is to close the door to many who might otherwise have been willing to enter ; and the lesson which it teaches is that one should respect names, but use them as seldom as possible, and not pry too closely into their hidden meanings, confounding zoology with philology. It is quite possible to invent a better system of nomenclature, and this will probably be done in the course of another century, but it will be a laborious task, and moreover will not help us.

On this matter of nomenclature, it may be useful to repeat the words of Professor T. H. Huxley, one of the foremost British biologists of the nineteenth century. Speaking of the lobster and crayfish (neither of which occurs in this country), he notes that then (1880) " the recognized technical name of the crayfish is *Astacus fluviatilis*, that of the lobster is *Homarus vulgaris*. And as this nomenclature is generally received, it is desirable that it should not be altered. Science is cosmopolitan, and the difficulties of the study of zoology would be prodigiously increased if zoologists of different nationalities used different technical terms for the same thing. Thus, we have a nomenclature which is exceedingly simple in principle and free from confusion in practice. *And I may add that the less attention is paid to the original meaning of the substantive and adjective terms of this binomial nomenclature the better.* Very good reasons for using a term may exist when it is first invented, which lose their validity with the progress of knowledge. Thus, *Astacus fluviatilis* was a significant name so long as we knew of only one kind of crayfish ; but now that we are acquainted with a number of kinds, all of which inhabit rivers, it is meaningless. Nevertheless, as changing it would involve endless confusion, and the object of nomenclature is simply to have a definite name for a definite thing, nobody dreams of proposing to alter it."

All the same the lobster and the crayfish do not carry the same technical names as they did in Professor Huxley's time.

Of course, as has been indicated above, all this trouble, which arises from a laudable attempt to control half a million natural species by half a dozen strictly logical rules, will amount to nothing in a hundred years' time.

Ed. " S. Z."

A NEW CEYLONESE TETTIGID (ORTHOPTERA) OF THE GENUS EURYMORPHOPUS.

By J. L. Hancock.

With one Figure.

THE following description of a new Tettigid is based on four specimens recently received from Mr. E. Ernest Green, Government Entomologist of Ceylon. These interesting little Orthoptera belong to the genus *Eurymorphopus*, which was first described by the author in Genera Insectorum.* Only one other species is known, namely, *E. cunctatus*, Bolivar, which is from the Island of New Caledonia. The latter species forms the type of the genus, and is like the present species in being small and apterous, but unlike it in several specific characters. Owing to these differences it may be necessary to modify the definition of the genus slightly to receive both species. Mr. Green informs the author that the new species, *E. latilobus*, here described, " frequents the surface of dry rocks in the shade of the jungle." They were taken at Undugoda in September, 1907.

In a previous work by the present author, on the " Tettigidæ of Ceylon," sixteen Ceylonese genera were recognized.† To this number the genus *Eurymorphopus*, Hancock, may now be added. It belongs in the third sub-tribe " Metrodorinæ " of my table there presented.

Eurymorphopus latilobus, sp. nov. (Fig. 1.)

Body small, apterous, depressed, conspersed with granulations, the lateral lobes very widely dilated; the hind femora proportionately stout; colour fuscous or fusco-ferrugineous variegated with light ochreous yellow, especially on the lateral lobes of pronotum and legs. Vertex barely produced beyond the eyes, viewed from above very narrow, strongly narrowed forward, tricarinate, subacuminate, and slightly longitudinally canaliculate on either side of the small, abbreviated, median carina; at the middle of vertex between the eyes the width scarcely more than one-half that of one of the eyes. Head but very slightly elevated above the dorsum of pronotum; eyes globose, the occiput behind only little exposed; face oblique, the frontal costa depressed and but little roundly elevated between the antennæ; posterior ocelli situated opposite the lower third of the eyes; antennæ short, filiform, not so long as the vertical facial diameter of the head, inserted little below the eyes. Pronotum

* 48th Fasciculе, pp. 35–36, 1906. † *Spolia Zeylanica*, Vol. II., 1904.

depressed, granulate, truncate anteriorly, the apical process scarcely or not extended backward to the apices of the posterior femora, cuneate, backward toward the acute apex subemarginate and slightly turned downward; dorsum somewhat bifossulate behind the shoulders on each side of the median carina; between the shoulders provided with two short, abbreviated, supernumerary carinæ; humeral angles wanting, the lateral carinæ inconspicuous and convex; median carina more distinct, percurrent, subundulate in profile. Elytra and wings wanting; lateral lobes of pronotum widely ampliate, the margins externally rounded, posteriorly distinctly truncate, and here the posterior angles formed in prominent subacute apices, not so acute in the female, the transverse diameter between the angles being the widest part of the body. Anterior femora compressed, above convexo-carinate, inferior carinæ lobate at the outer third; middle femora compressed, the outer face carinate, inferior carinæ biundate, or lobate at the outer third part; posterior femora stout, the longitudinal carinæ below the middle of the external pagina strongly expressed, viewed from above arcuate, entire, the oblique rugæ prominent; the femoral and genicular spines of ordinary form and size; posterior tibial margins minutely serrulate and spinose; first and third articles of the posterior tarsi equal in length.

Length of body female (to end of ovipositor) 7 mm., pronotum 6 mm.; post. fem. 4·5 mm. Male 6 mm.; pronot. 5 mm.; post. femora 4 mm. Two males and two females from Undugoda, Ceylon; collected by E. Ernest Green.

Eurymorphopus latilobus, n. sp.

Dorsal view of pronotum and head.
Male, enlarged eight times.

HYMENOPTERA NEW TO CEYLON, WITH DESCRIPTIONS OF NEW SPECIES.

By O. S. WICKWAR, F.E.S.

With Plate; and Appendix by Col. Bingham.

THESE notes will deal with the tribes and families described in Col. Bingham's work on the Hymenoptera of British India, Vols. I. and II. (Fauna of British India Series).

The following list, compiled from the volumes in question, gives four tribes with their respective families and relative number of species, showing a total of 193 species recorded from Ceylon, 59 of which are endemic, against a total of 30 species recorded in Sir Emerson Tennent's work on Ceylon about fifty years ago.

The fact that many of our commonest species are not recorded from Ceylon will show what little attention has hitherto been given by collectors to Ceylonese Hymenoptera.

I have to thank Dr. A. Willey, the Director of the Colombo Museum, who has kindly placed at my disposal the Museum collection. My thanks are also due to Messrs. E. E. Green, F. M. Mackwood, Col. N. Manders, R.A.M.C., and Mr. Thos. Bainbrigge Fletcher for the gift of several specimens. Above all, I am indebted to Col. C. T. Bingham for his generous assistance at all times, and for ready help proffered in verifying my identifications and checking several descriptions. It is proposed to continue these notes from time to time when sufficient information and material have accumulated.

The abbreviations " Col. Mus. " mean in Colombo Museum.

Table of recorded Families and Species.

	Already recorded from Ceylon. Number of Species.	Already recorded from Ceylon. Endemic.	Now recorded for First Time.	New Species.
Tribe: FOSSORES :—				
Fam. Mutillidæ	26	14	8	2
Fam. Thynnidæ	1	1	—	—
Fam. Scoliidæ	9	4	—	—
Fam. Pompilidæ	30	15	9	—
Fam. Sphegidæ	48	10	10	1
Tribe: DIPLOPTERA :—				
Fam. Eumenidæ	15*	5	5	4
Fam. Vespidæ	6	1	—	—
Tribe: ANTHOPHILA :—				
Fam. Colletidæ	1	1	—	—
Fam. Apidæ	45	8	—	1
Tribe: TUBULIFERA :—				
Fam. Chrysididæ	—	—	—	1
Sub-Fam. Chrysidinæ	12	3	—	—
Total	193	62	32	9

From the above table it will be seen that 32 species have been added to the number previously recorded from Ceylon (according to Bingham's latest work), and the short note on each in the following list is all the available information I can obtain up to the present. The new species, marked with an asterisk, are, so far as I know, described for the first time. To these must be added *Nomia basipicta*, n. sp., and *Chrysis spectrum*, n. sp.

List of Species now recorded for the First Time from Ceylon.

Mutillidæ.

Mutilla cicatricifera (André), Nos. 82, 83, 84, Col. Mus. Females, locality unknown.

Mutilla placida (Smith), No. 245, Col. Mus. ♀ taken in Northern Province, April, 1904.

Mutilla interrupta (Oliv.), No. 86, Col. Mus. ♀ from Matale.

Mutilla soror (Sauss.), Nos. 87, 90, Col. Mus.; No. 87 from Pundaluoya; No. 90, locality unknown.

Mutilla pulchriceps (Cam.), No. 91, Col. Mus. ♀, locality unknown.

Mutilla subanalis (Mayr.), No. 93, Col. Mus. ♂, locality unknown.

*Mutilla indostana (Sauss.), No. 96, Col. Mus. ♂ from Pomparippu, April, 1887. The ♀, which was previously unknown, is now described for the first time with the other new species.

Mutilla pilosella (Mayr.), No. 98, Col. Mus. ♂ from Kayts, Northern Province, August, 1903.

*Mutilla willeyi, n. sp.; ♀ No. 94, Col. Mus., from Delft.

Pompilidæ.

Salius.

Salius cæruleopennis (Sauss.), No. 38, Col. Mus. Locality unknown. Regarding this specimen Col. Bingham writes: "I have never seen this species before; answers the description, but is not of slender form, and the wings are lighter in colour." Although the difference is considerable, it would be premature to separate it until further local specimens are available and the difference found to be constant.

Salius nicevellii (Bing.), No. 39 ♀, No. 40 ♂, both in Col. Mus., from Balangoda.

Salius sericosoma (Smith), No. 47, in Col. Mus., from Matale.

Pompilus.

Macromeris violacea (Lepel), No. 2, Col. Mus. ♀ from Northern Province, July, 1887; another ♀ from Mamadu, Northern Province, April, 1904. A ♂ in Coll. O. S. W., from Habarana, North-Central Province, October, 1902. This very handsome species may be easily mistaken for *Salius madraspatanus*, the females especially closely resembling each other in size and colouration.

Pompilus unifasciatus (Smith), No. 29, ♀ Col. Mus., from Tissamaharama, February, 1903. Col. Bingham is now of opinion that *P. bioculatus* (Bing.) and *P. unifasciatus* are one and the same, the former being a variety of the latter. The specimen in question, No. 29, was examined by him, and has some of the characters of both. *P. bioculatus* will therefore be a synonym.

Pompilus acceptus (Bing.), No. 44, ♀ in Col. Mus. labelled "Ceylon."

Pompilus ilus (Bing.). ♀ in Coll. O. S. W. differs from Bingham's description in having the apical halves of the wings *purple effulgent*, as well as fuscous. Taken at Kandy, August, 1902.

Pompilus subsericeus (Sauss.), in Coll. O. S. W. from Colombo, April, 1903, a common species. I have often watched the females burrowing, generally in dry sandy places, but before descending any depth they would leave off and start again in another place.

Pompilus canifrons (Smith), No. 265, Col. Mus. ♀ from Nambapana, April, 1904.

SPHEGIDÆ.

Tachytes sinensis (Smith), No. 128, ♀ Col. Mus., locality unknown.

Tachytes modesta (Smith), No. 129, Col. Mus. Common in Colombo, especially in May, June, and July. A very variable insect in size.

Larra fuscipennis (Cam.), No. 15, Col. Mus., from Deltota. Common in Colombo in March.

Liris nigripennis (Cam.), No. 60, Col. Mus., locality unknown.

Piagetia ruficornis (Cam.), No. 130 in Col. Mus., from Palatupana, January, 1902. This species has been common in Colombo in March for three successive years, but I have not observed it here during any other month. I have taken specimens at Ganawatta, north of Kurunegala, in April, 1904. Nothing is on record of its nesting habits. I have often watched it for a long time running about the walls of mud huts as though in search of prey. The only other species recorded from British India, *P. fasciatipennis*, has been recorded from Ceylon.

*Ammophila basalis (Smith), No. 73 ♂, No. 72 ♀, in Col. Mus. The former taken at Colombo in November, 1903, and the latter at Henegama (below Balangoda) in April, 1902. I have in my collection four males, two taken in Colombo in November, 1903, and two at Henegama in April, 1902, and two females from Henegama in April, 1902. It is interesting to note that the male of this species was previously unknown. It nearly answers the description of *A. atripes*, but is much smaller and slighter in build—length 15 to 18 mm., exp. 16 to 20 mm.—and is easily distinguished from *A. atripes* by the much lighter colour of the wings, which are very pale fusco-hyaline against the dark fuscous and purple effulgent wings of *A. atripes* ♂.

Sceliphron coromandelicum (Lepel), Nos. 147, 148, in Col. Mus., locality unknown. I have in my collection specimens from Henegama, Ganawatta, and Matale, and have seen it in Colombo.

Sphex splendidus (Fabr.), No. 24. ♀ in Col. Mus. taken at Kalpitiya. A very handsome species, probably confined to the dry hot districts.

Sphex ægyptus (Lepel), No. 54, in Col. Mus., from Puttalam.

Sphex xanthopterus (Cam.), Nos. 141, 142, in Col. Mus., from Colombo, January–February, 1902. Very common in Colombo. I have watched a ♀ burrowing in the sand, but she did not complete the nest. It set to work at great speed, scraping with its fore legs and kicking back the sand for some distance behind with its hind legs.

EUMENIDÆ.

Montezumia impavida (Bing.), No. 260, ♀ in Col. Mus. (variety), from Nedunkerni, Northern Province, April, 1904. This is the only specimen I have seen.

*Montezumia rufipetiolata, n. sp. ♂ from Mamadu, Northern Province, in Col. Mus.

Eumenes edwardsii (Sauss.), No. 3, ♂ in Col. Mus., taken at Ritigala rock (2,500 ft.), North-Central Province, July, 1887. Another in Coll. O. S. W. from Madulsima, August, 1904. This last varies slightly, and I doubtfully identify it as *E. edwardsii*. Probably a local race.

Eumenes punctata (Sauss.), No. 52 (variety) in Col. Mus., from Matale, is the only specimen I have seen.

Eumenes esuriens (Fabr.), Nos. 158, 159, ♀ ♀ in Col. Mus., one from Delft island, June, 1903, and the other from Battulu-oya, October, 1902. These vary slightly with the descriptions of the Indian and Burmese forms, but are probably varieties, as the species is variable.

*Eumenes ichnogastroides, n. sp. ♀. Fig. 9. From Nedunkerni, April, 1904, in Col. Mus.

Rhynchium abdominale (Illig.), No. 21, ♀ in Col. Mus. from Puttalam, another from Nedunkerni, Northern Province, April, 1904, No. 267. A ♂ in Coll. O. S. W. from Ganewatta, April, 1903.

*Labus campanulatus ♀ n. sp. Figs. 10, 11, 12, 13, Col. Mus. No. 226.

*Odynerus subfistulosus, n. sp. Fig. 8, Col. Mus. No. 224.

Descriptions of New Species.

***Mutilla indostana* (Smith). Fig. 6. Col. Mus. No. 222.**

♀ New. ♂ Known.

Taken in cop. with typical *M. indostana* ♂. (Second abdominal segment with two pubescent white spots.) Head and thorax very closely and coarsely punctured, coarser and deeper on the thorax and running into furrows on median segment. Abdomen closely and finely punctured under the black velvety pubescence. Vertex cheeks and emargination of the thorax covered with recumbent, downy, silvery pile. The whole covered with sparse erect pubescence, thickest on the abdomen, median segment, and vertex. Head and thorax dark ferruginous red, merging into black on the lateral edges of thorax, pronotum, lower portion of face, and behind the eyes. Median segment has a prominent lateral tubercle—similar to male—black, shining, and inclined posteriorly. Abdomen above covered with black pubescence ; a large central spot at apex of first segment, two similar spots, one on each side of the centre of second segment, two quadrate spots—their lower corners converging towards the centre—on the third segment, silvery white. Apical segment and ventral portion of abdomen with long whitish pubescence. Length 13 mm. Described from one specimen caught at Nedunkerni, Northern Province, in Colombo Museum No. 222.

**Mutilla willeyi*, n. sp. ♀. Fig. 7. Col. Mus. No. 94.

Head, thorax, and abdomen very coarsely punctured and granular ; head a little narrower than the thorax, the last rather narrowed towards median segment, transverse in front. Black. The whole covered with close recumbent pile golden on the thorax (except the anterior margin, where it is black), first and basal two-thirds of second abdominal segment above. The head, anterior lateral angles of pronotum, lateral round spots on segments 2–5, and medial round spots on posterior margins of second, fourth, fifth segments, the legs, sides, and a thin medial line on first and second segments above—of glistening silvery pile. Profusely studded with long, stiff, erect hairs, which are black on the black and silvery portions, and brown on the golden portions. A prominent sharp keel, ending in a sharp tubercle, dividing the emargination of the sides, the keel fringed with long thin white hairs. Length 12 mm.

This gorgeous little Mutilla, the only one I have seen, was captured by Dr. Willey on the little island of Delft off the north-western coast of Ceylon.

**Eumenes ichnogastroides*, n. sp. Fig. 9. Col. Mus. No. 228.

Head and thorax closely and evenly punctured, finer on the clypeus ; petiole and basal segment smooth, polished, and shining ; the petiole as long as head and thorax united, gradually broadening towards the apex, a short transverse sulcation just before the apex of same, giving it a flattened appearance. Clypeus convex and widely emarginate. Thorax globular ; a fine central longitudinal carina the whole length of the mesonotum. The whole covered with short golden pubescence. Reddish brown. The mesonotum with a black patch anteriorly and a broad black semicircular band interrupted above. Petiole above black with two rather indistinct yellow streaks on the sides and a yellowish band just before apex. Basal segment with two oval spots laterally and a broad sharply defined band along the basal portion yellow; above this band the segment is black, merging into reddish brown towards petiole; following segments reddish brown touched with yellow on the apical margins. Wings flavo-hyaline along the costal margins, the rest fusco-hyaline with a dark fuscous spot covering half the radial cell and extending down into the cubital cell.

This species may be easily mistaken for *Ichnogaster fraterna* (Bing.), which it resembles in form and especially colouration, but an examination will at once reveal the genus, and the intermediate legs will be found to bear only one tibial calcar, besides the claws of tarsi being dentate, which at once separates it from *Ichnogaster*. Length to anterior margin of basal segment 13 to 14 mm. Expanse 20 to 22 mm. *

Nedunkerni, April, 1904.

***Montezumia rufipetiolata*, n. sp. ♂. Figs. 14, 15.
Col. Mus. No. 223.

Head, thorax, and abdomen smooth, shining, and punctured; the punctures close and even on the front, thorax, basal, and anterior margins of segments 2 and 3; vertex and petiole shining, with few scattered shallow punctures. Median segment rounded and steeply sloped with a deep longitudinal groove; petiole with two lateral blunt teeth about the middle. Clypeus convex and emarginate. Glossy black; the clypeus, except the anterior margin narrowly, a line on the scape in front, a club-shaped mark between the antennæ, the sinus of the eye, a narrow spot behind it, a line along the anterior margin of the pronotum, interrupted in the middle, a marginal band on the basal segment—twice interrupted—and a central spot on margin of second segment, pale yellow. Legs testaceous red, touched with black on the femora. Basal two-thirds of petiole red, apical one-third black; a shallow longitudinal groove on petiole above, rising about the middle and ending abruptly in a hollow, just before reaching the apex. Wings fusco-hyaline, hind wings paler. Length (to margin of first basal segment) 10 mm. Expanse 20 mm.

This species can at once be distinguished from its only ally *M. impavida* by the red on the petiole.

Taken at Mamadu, Ceylon, April, 1904.

* *Odynerus subfistulosus*, n. sp. Fig. 8. Col. Mus. No. 224.

This species differs structurally from typical *O. fistulosus* in the following important respects. The basal three segments as coarsely punctured as head and thorax, the apical two segments without punctures. Clypeus emarginate, scutellum without a furrow, medium segment produced sharply into a waved ridge, the truncation shining and punctured, not striate. The yellow markings in the sinus of the eyes and behind the latter, the lines on the pronotum, tegulæ, mesopleuræ, the marginal lines of all segments except the second, and the lateral spots and markings on legs, median segment, and ventral segment *absent*. It appears to me that the above differences are sufficient to separate this from *O. fistulosus*.

**Labus campanulatus*. ♀ n. sp. Figs. 10, 11, 12, 13.
Col. Mus. No. 226.

This species may at once be distinguished from *L. humbertianus* by its larger and heavier build and by the much larger and distinct coarse punctures covering the whole.

Head, thorax, petiole, and basal segment of abdomen very coarsely and evenly punctured, the punctures on the head finer and closer. Clypeus convex deeply emarginate. The pronotum in front laterally toothed. Median segment deeply incised forming a hollow for the petiole, the lateral margins of the incision with two teeth. The petiole broad and heavy, abruptly truncate at its base with a raised ridge at the verge of the truncation above. Basal segment of the abdomen long and campanulate. Black and glossy; the head with obscure silvery pile. The anterior half of the clypeus, the mandibles, the scape beneath, a minute spot between the bases of the antennæ, the apical margins of the petiole and first segment, yellow.

**Chrysis spectrum*, n. sp., Fig. 3. Col. Mus. No. 227.

Division C, Bingham's Key A, b^1, b^3, a^5—close to *C. singalensis*.

Metallic green with golden effulgence. The region of the ocelli, the medial areas of the mesonotum, scutellum, first, second, and third segments of the abdomen above, and the bases of the last two, purplish blue. The blue markings on the head and thorax centrally touched with black. Sides of the mesonotum golden red with fine longitudinal carinæ. First, second, and third segments of the abdomen, laterally, with bright cupreous golden spots extending in a band along the posterior margins of the second segment; the spot on this segment largest and brightest and of deep ruby red. Pronotum touched with golden red. Antennæ black, about as long as pro- and mesonotum united, first two joints of the flagellum touched with golden brown above; the scape in front, and legs more golden than green; the tarsi brown. Pilosity, short, erect, and whitish, fairly abundant; facial hollow finely transversely striate, with rather long whitish recumbent hairs on the sides; head, thorax, and abdomen densely and somewhat evenly punctured, finer and closer on the second and third segments. Head, from the front, about twice as broad as long, widely emarginate posteriorly; eyes large, prominent; clypeus broad, very narrow, sub-porrect and emarginate in the middle. Anterior ocellus enclosed in a curved indistinct carina, the two ends of which terminate at the verge of the facial hollow. Thorax and medial area rectangular, the anterior lateral angles prominent. Median segment vertical, almost hidden, its posterior lateral angles produced and toothed. Wings hyaline, nervures dark brown, tegulæ dark blue. Abdomen, medially distinctly carinate; the first segment with a medial short broad groove at base with a slight hollow on each side; the third segment with the medial and lateral angles dentate, the margins between the teeth straight, not sinuate, an antiapical series of six foveae on each side of the medial tooth. A magnificently marked species possessing every colour of the rainbow, which its name indicates. Length 7 mm. Expanse 10 to 11 mm. (Four specimens, Colombo.)

**Nomia basipicta*, n. sp. Figs. 1, 2. Col. Mus. No. 225.

I would place this species in Bingham's Key Class B, Division b, a^1, and close to his description of *N. pilipes*, from which it differs in the following respects. Vertex, front, mesonotum, and scutellum without pubescence. Abdomen very finely and closely punctured throughout, the punctures coarser on the margins of the segments. The enclosed space at base of median segment longitudinally rugose. Black, the basal segment red with a dark brownish patch in the centre reaching the margin and a deep V-shaped hollow at base, which is smooth and shining; remaining segments dark brown merging into black on the last three. Post-scutellum and margins of second to fifth abdominal segments thickly covered with very fine white plumose pile having a waxy appearance. Legs dull ferruginous brown; posterior femora with a tubercle beneath. Clypeus and front, from just above bases of antennæ, cheeks, sides of thorax, median segment (except the enclosed space at base), and legs covered with long silvery pubescence. A variety of the above has the whole abdomen brownish black, no red on basal segment. Abundant at Colombo. Length 10 to 12 mm. Expanse 13 to 14 mm.

Appendix to Mr. Wickwar's Paper by Col. C. T. Bingham.

Podalirius wickwari, form. nov.

♂ Head thorax, and abdomen very dark brown, almost black; legs dark castaneous brown, a narrow transverse band on the anterior margin of the clypeus and the tegulæ of the wings dull yellowish white, the apical margins of the segments of the abdomen very narrowly testaceous. Head clothed with white pubescence, which is long and comparatively dense on the front, on the occiput, behind the eyes and on the under parts of the head, while on the clypeus at the sides and front and on the labrum it forms a thin fringe. Thorax covered somewhat densely with long brown hairs above, on the sides below extending on to the sides and posterior face of the median segment. Legs almost bare, the tibiæ and tarsi clothed and outwardly fringed with long whitish hairs; tibial calcaria yellowish white, preceded on the inner side of the tibiæ of the anterior and intermediate legs by a yellowish white curved robust hook and on the tibiæ of the posterior legs by a similar larger brown process or hook. There is a further armature on the inner side of the femora at base of a short thick blunt tooth. Claws bifid. Wings hyaline, nervures dark brown. Abdomen in the two males before me almost bare of pubescence, only the basal face of the abdomen, the sides, and apical margins of all the segments above and below fringed with brownish hairs. This absence of pubescence is evidently due to attrition; in fresh specimens the pubescence is probably fairly abundant. The whole head, thorax, legs, and abdomen beneath the covering of hair very minutely and closely punctured.

Length ♂ 10; exp. 19 mm. Habitat, Colombo, Ceylon.

This is a very distinct form, not closely allied to any Indian *Podalirius* known to me. It more nearly resembles the European *P. senescens* (Lepel) in general appearance, but the armature of the legs distinguishes it at once from any form known to me.

Oryssus (*Mocsarya*) *metallicus*, Mocsary.

Oryssus metallicus, Mocsary, Termesz. Fuzetek, XIX., 1896, pl. 1, fig. 2 ♀.

Mocsarya metallica, Konow, Termesz. Fuzetek, XX., 1897, p. 608 ♀.

It seems strange that this beautiful insect, described from the Sunda Islands by Mocsary, should occur also in Ceylon, but a Ceylon specimen of an Oryssus kindly submitted to me for examination by Mr. O. S. Wickwar corresponds so closely to Mocsary's description of *O. metallicus* that without an actual comparison with Mocsary's type I do not like to describe it as new.

So far as I can make out from Mocsary's description and plate, the Ceylon insect differs only as follows:—

Forewing: the fuscous cloud much paler, without purple reflections and limited to the apex of the wing extending into the apex of the radial cell, but not into the cubital cells. Legs nearly black, tarsi of all the legs bright orange red, posterior femora and tibiæ dull dark, not bright, red.

Professor Konow has split up Latreille's genus *Oryssus* into four genera, making *O. metallicus* the type of his new genus *Mocsarya*.

Explanation of Plate.

Fig. 1.—Nomia basipicta.

Fig. 2.—Nomia basipicta, showing tubercle on posterior femora.

Fig. 3.—Chrysis spectrum.

Fig. 4.—Oryssus metallicus (Mocs.).

Fig. 5.—Oryssus metallicus, front view of head.

Fig. 6.—Mutilla indostana (Sauss.), ♀ new.

Fig. 7.—Mutilla willeyi.

Fig. 8.—Odynerus subfistulosus.

Fig. 9.—Eumenes ichnogastroides.

Fig. 10.—Labus campanulatus.

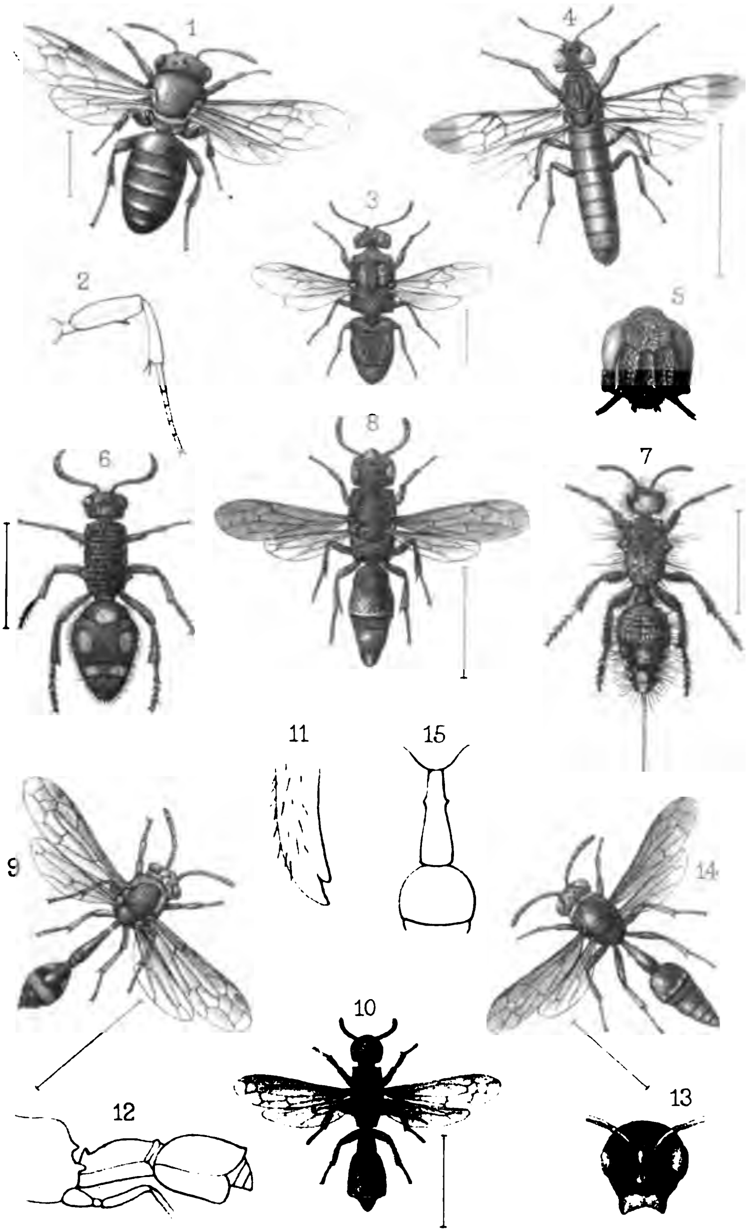
Fig. 11.—Labus campanulatus, mandible.

Fig. 12.—Labus campanulatus, showing median segment in profile.

Fig. 13.—Labus campanulatus, front view of head.

Fig. 14.—Montezumia rufipetiolata.

Fig. 15.—Montezumia rufipetiolata, enlarged view of petiole, seen from above.



West, Newman del.et lith.

WICKWAR. ACULEATE HYMENOPTERA.
Fig.4. Oryssus metallicus *(Bingham.)*

THRESHING-FLOOR CEREMONIES IN UVA.

By James Parsons.

CERTAIN protective offerings were found buried in the threshing-floor of a paddy field in the village of Dehiwinna, Yatipalata division, Uva, a week or two after the *yala** threshing and winnowing had taken place. The stone or *arak-gala* covering the offerings was found concealed beneath some straw.

From below upwards, *i.e.*, in the order in which they were placed in the hole or *arak-wala*, the following were noted :—

(1) Two stalks of *iluk* grass (*Imperata arundinacea*).
(2) Two leaves of *tolambo* (*Crinum asiaticum*).
(3) Seven *bó* leaves (*Ficus religiosa*).
(4) A piece of *rambuk* stalk (*Saccharum arundinaceum*).
(5) Two stalks of *iluk* grass.
(6) A piece of the creeper *maduwela* (*Ipomœa obscura*).
(7) Five stalks of paddy with the ears.

The *iluk*, *maduwela*, and paddy were tied into rough rings about 10 cm. in diameter. Resting on the offerings and half projecting from the ground was the *arak-gala*, a roughly ellipsoidal stone of quartz rock measuring about 18, 12, and 10 cm. along its axes, obviously shaped by natural agencies and probably obtained from the nearest stream.

It is interesting to compare this list of offerings with those that should, at least theoretically, be placed in the threshing-floor according to the threshing-floor song translated by Dr. Coomaraswamy in his paper on "Paddy Cultivation Ceremonies in the Ratnapura District."†

Here seven *pilila* (*i.e.*, the parasitic plants) from different sorts of trees or plants are recommended. It was suggested to me that one at least of the *iluk* offerings was intended to be *iluk pilila*, a plant which is said to be exceedingly rare, and would appear to share the sanctity attached to parasitic plants in most primitive religions. The parasitic plants of the genus Loanthus are known as *pilila*, but as these plants are shrub-like and have woody stems, the *iluk pilila*, supposing it actually exists, can hardly belong to this genus. Assuming that the *iluk* represents its *pilila*, the reasons for the use of the other ingredients of the offering are fairly obvious.

* The second paddy harvest of the year, or autumn crop.
† Journal R.A.S., C.B., Vol. XVIII., 1905.

The blossom of the *tolambo* has a sweet smell; the *bó* leaves have evident religious value, and it is interesting to note that *seven* leaves were used, that ever-recurring number in Oriental mysticism.

The piece of *rambuk* stalk may have been placed as a substitute for sugar-cane, and *maduwela* is used in Sinhalese medicine. The paddy ears are the first that are gathered in the field after the threshing-floor has been reaped and the sheaves piled on the sides of the floor. It thus constitutes a sort of first fruit. It is, however, the paddy cut from the threshing-floor* which is the first to be threshed.

Certain objects are placed on the floor, but not in it at the time of threshing, viz., a shell, presumably the *arak-bellá* mentioned by Dr. Coomaraswamy, a piece of gold, iron, or other metal, and a piece of *kohomba* wood (*Azadirachta indica*). Also, if it can be obtained, the *góróchanna*, or hair ball (= the *gore* of Dr. Coomaraswamy) of a buffalo. According to the Ratnapura threshing-floor song seven *góróchannas* should be used.

These objects are kept in the paddy while it is being trodden and removed when the threshing is finished. They therefore seem to be simply talismans, while the leaves, &c., from the fact that they are buried and allowed to remain in the ground, would rather lead one to consider them as propitiatory offerings to evil spirits.

The word *arak*, or in its Sanskrit form *áraksha*, means preservation or protection.

A distinct set of offerings is made to the gods (*déwas*). These, consisting of betel leaves and various flowers, are placed in a *malpela* or rude shrine erected on the margin of the floor, and usually made of cadjan, but in this case of *rambuk*, on account of the scarcity of coconut trees in the neighbourhood.

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* It is to be noted, according to the Ratnapura threshing-floor song, that, in addition to the paddy *pilila*, paddy from the last year's crop should be placed in the hole.

THE KANDYAN DOOR.

By J. P. Lewis, Government Agent, Kandy.

THE Kandyan door is of a much more massive character than the modern *quasi*-European construction that is everywhere supplanting it, and in a short time the old Kandyan pattern of door and doorway will probably have ceased to be copied. The latest example of it is one that has just been constructed for the Kandyan Art Museum building, which also contains five old doorways of excellent workmanship *in situ*.

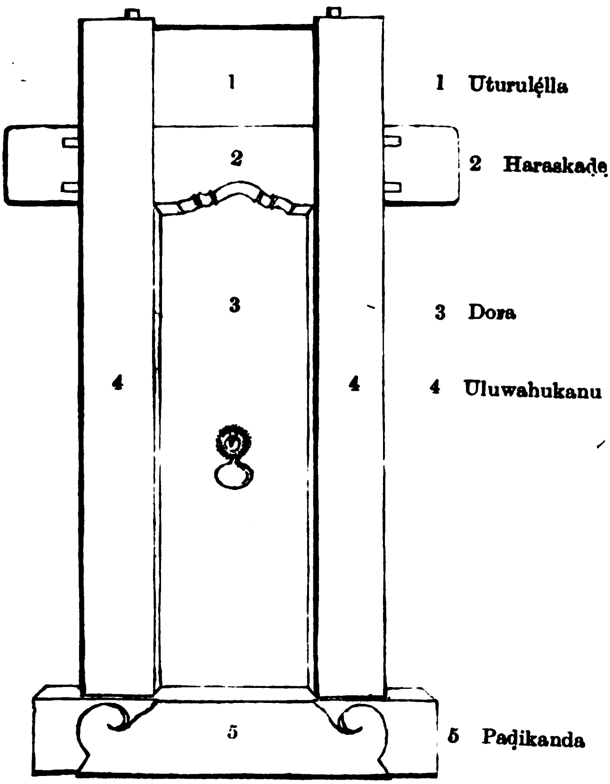


Plate I.—Exterior view of Kandyan door (the projecting ends must be imagined as hidden by the wall)

The same pattern of door frame and door is always followed, so that it may be said to have become stereotyped. Doors are of two kinds, single (*tani-doruwa*) and double (*depiyan-doruwa*). I send herewith a very accurate model of a single door and door frame, which will help to explain its design and construction.

The chief peculiarity of a Kandyan door is that it has no hinges. One might say of the Kandyan what Browning says of Sordello's builders (who are referred to I have been unable to fathom), that he

> " dreams and shapes
> His dream into a door post, just escapes
> The mystery of hinges."

Instead of hinges, the door, which is very thick, is rounded off on the side where, if there were hinges, the hinges would be, and the ends of this rounded portion project slightly at top and bottom and fit into holes, so that the door swings on these ends. These rounded ends are called *waṭaw* (singular *waṭawuwa*, not in Clough).

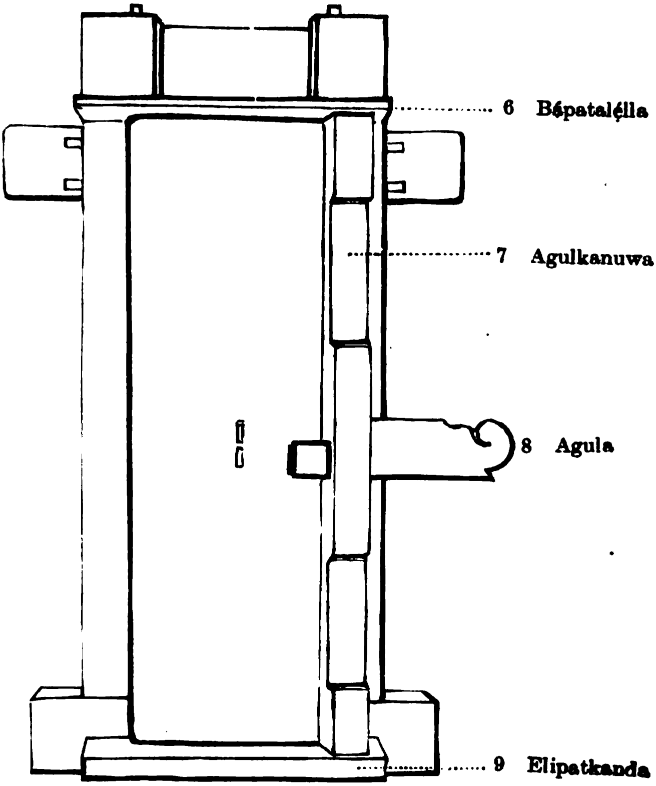


Plate II.—Interior view.

A single door with its door frame consists of nine parts, which are indicated in the accompanying diagrams showing the door from the exterior and interior.

The whole door frame is called *uluwassa*. The two perpendicular posts are the *uluwahukanu*. The *agulkanuwa* is the post on the inside into which the big wooden bolt (*agula*) fits. There is sometimes an ornamental border round the door frame on the outside. This is called *lissara* or *lissarapati*. The lintel (*haraskade*), which is usually of the pattern shown above (though sometimes it is more elaborate or has a double arch), is also called *udilipatkanda*. These Kandyan terms, however, are beginning to be forgotten, and the ordinary low-country word *rámuwa* to take their place.

The door handle is called *kayipudiwalalu*, which by the way is a Tamil word. The circular metal plate round it is called *bókkálé* (a word which does not occur in Clough); the key is *yaturumudda;* the key plate *múnattahaḍuwa* (in Clough), and the iron bolt on the outside, which has a lion's head, *narissayatura* or *nárassara*. It is unnecessary to enlarge on the artistic character of this metal work, as everybody is familiar with it.

The inner bolt is *agula*, and the iron rod used to move it from outside *agultattuwa*. The hole through which this is inserted is *káppakaṭa*, which is not in Clough and sounds like Tamil.

The only difference between this door and a double door (*depiyan-doruwa*) is that the latter is divided down the middle, and therefore is rounded at the two sides and requires two sets of *waṭaw*. The bolt is also, of course, different; it is a double bolt in the centre of the door, and keeps the two halves together (see Plate III.). Both single and double bolts and the *kanuwa* into which the former is set are usually artistic in design.

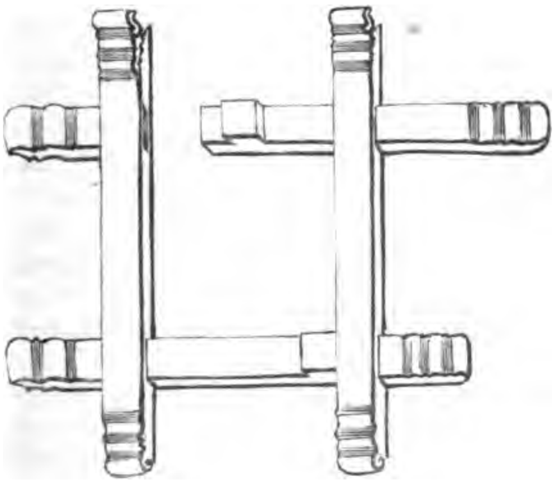


PLATE III.—Bolt of double door. The upper bolt is shown open, and the lower closed. One opens in one direction, and the other in the opposite.

In a Kandyan building the horizontal beam that supports the roof is called *dẹwa* (in Clough), and the carved end of it (it always has a carved end) *dẹwasuliya*. The transverse beams that rest on these under the edge of the rough are called *waḍimbu* (in Clough).

PLACUNA FISHERY: INSPECTION OF MARCH, 1908.

By A. WILLEY.

I.—OVULATION AND MATURATION OF PLACUNA.

THE Tamblegam pearl fishery, which has recently come to an end, has been conducted by contractors under a lease from Government, and was the second out of a series of five annual fisheries contemplated by the terms of a quinquennial lease. Indiscriminate fishing is reported to have occurred during the years 1905–1906; this ceased when the lease came into force at the beginning of 1907.

It was naturally supposed that the oyster beds would be automatically re-stocked at least once a year during the course of the lease; but this expectation has not been fulfilled, since *the oysters which have been taken this year belonged to the same generation as those of last year*, so that the end of the fishery means the end for industrial purposes of that generation. It is fortunately impossible, with the best efforts, to collect all the oysters; some few are certain to escape the vigilance of the divers; and these are the sole hope of the future, unless measures are taken, as they have been, to keep a special stock of oysters in reserve for breeding.

During my first inspection of the beds in June, 1907, I was unable to determine the sexes of any of the oysters examined fresh, owing to the immaturity of the gonads; and upon my second visit in October, 1907, I was not able to gather much further information on this matter for the same reason, even the largest specimens measuring more than seven inches in long diameter and more than six inches in height, being quite immature. I was able to detect the presence of occasional nests of developing ova amidst an abundant stroma; but this was not sufficient to determine whether the sexes were distinct, or whether the individuals were hermaphrodites; it was enough, however, to establish the fact of the commencement of ovulation. In some preparations there appeared an ovarian reticulum associated with an aggregation of the brown pigment, which is more or less diffused throughout the substance of the gonad. The alcoholic extract of the gonads has a clear yellow colour like a solution of picric acid.

At the same time (October) I examined the gonads of other Lamellibranchiate Molluscs, *e.g.*, *Venus*, &c., and found them to be perfectly mature, male and female in separate individuals, the ovaries packed full of microscopic eggs, each in its own follicle, to the wall of which it was attached by a stalk. I looked in vain for this condition in *Placuna* in June and October (1907), *but found it prevailing on all the beds in March (1908).* Male and female gonads are in separate individuals, as they are in the Mannar pearl oyster (*Margaritifera*),* and are either quite mature or submature in this month of March.

I am not aware that there exists any previous statement regarding the periodicity of the maturation of the gonads in the window-pane oyster, so that this definite observation may be regarded as a significant contribution to our knowledge of the natural history of this species; and, moreover, it yields information which will relieve future fisheries from arbitrary restrictions, affording a biological basis for whatever regulations may be drafted. The fact that the largest oysters examined in October last were immature (this does not mean that they were spent) was somewhat surprising, and seems to indicate that *Placuna* does not produce an annual brood, but that one generation succeeds another at intervals longer than one year, the exact period remaining for future discovery; and that sexual maturity is only attained after the completion of the superficial growth of the shell.

In the specimens examined in October I noted evidence of new growth at the shell-margin, chiefly in the form of a delicate lace-like fringe on the left valve. This was not conspicuous in March, and although the cessation of peripheral growth of the shell cannot be timed exactly, yet it would appear, from the evidence at hand, to coincide with the period of sexual maturity. In this respect, therefore, *Placuna* offers a striking contrast to the true pearl oyster, which attains sexual maturity at a very early age.†

The gonad of *Placuna* is a single organ chiefly connected with the right half of the mantle, and, contrary to what is observed in the common pelecypod (axe-footed) lamellibranchs, is mainly independent of the foot, which, in *Placuna*, has an acetabular structure at the end, is very protrusible, and remarkably like a proboscis in position and superficial appearance. Its action is probably like that of a contractile muscular proboscis when the animal imbeds itself in the mud; but I have not observed this directly. In the fresh condition the colour of the gonad varies commonly from a very pale, almost whitish yellow, to rich orange, the average colour being a creamy yellow. The differences in colour are not related

* W. A. Herdman. Observations and Experiments on the Life-history and Habits of the Pearl Oyster: in Herdman, "Ceylon Pearl Fisheries," Part I., p. 125, 1903.

† J. Hornell. Biological Results of the Ceylon Pearl Fishery of 1904; in Reports from the Ceylon Mar. Biol. Lab., No. 1, p. 8, 1905. Also printed in Sessional Paper XIII. of 1904.

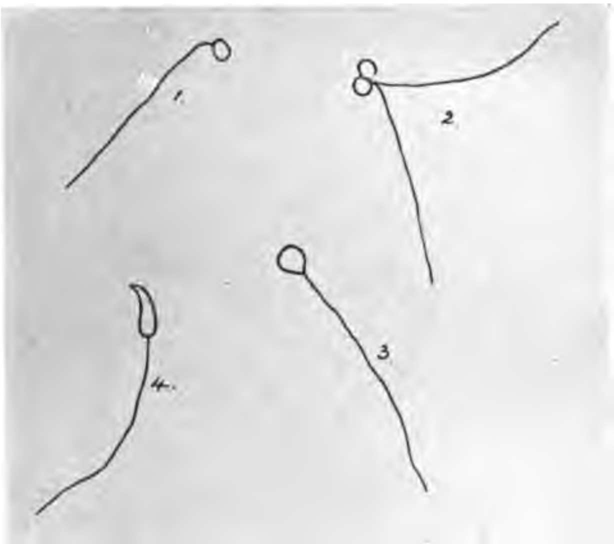
to distinctions of sex, but are to some extent correlated with individual variations in the black pigmentation of the mantle. In some cases the mantle round the adductor muscle up to the apex of the median hinge lobe is intensely black, the free peripheral portion being destitute of the black pigment, unless there happens to be a peripheral mantle pearl present, in which case, after removal of the pearl, the pigmented sac in which it was contained shows up clearly in the middle of the colourless tract. The dwarfed oysters of Kakkaimunai were noted in general to be pale throughout, often very little pigment being present in the mantle. Occasionally the gonad has a dark smoky brown tint; this was first observed in March in an individual which proved to be a female.

In both sexes the gonad is smooth externally, but internally a fine sacculation may be seen with a lens. Frequently, when the sacculation is coarse and even visible without a lens, the individual turns out to be a male; when the sacculation is so fine as to give a minutely spotted appearance when viewed with a lens, the individual may be a female; but this distinction is not absolute, and the only ultimate criterion is afforded by microscopic examination. Out of twenty individuals thus examined in March (1908), nine were male, eleven female. One of the Kakkaimunai oysters, though of small size, 4⅝ by 4⅛ inches, gave an impression of being old, and was in fact a mature female.

If an incision be made into the gonad of a mature female, a quantity of minute brown-coloured ova will stream out; but in a mature or submature male the contents are viscid.

The spermatozoa, as they appeared at this time, had round heads and very delicate tails (fig. 1). They moved, on the addition of sea water, in a jerky, spasmodic manner. The morulæ, from which they originated, had in very many instances not yet become dissociated, and in these cases the long tails could be seen, under high magnification, radiating on all sides from a mass of heads. Often two or several spermatozoa were seen with heads still agglutinated together (fig. 2). By way of comparison the ripe spermatozoa of a species of *Cardium*, common at Niroddumunai (where it is called "pakku maddi," this term being differently applied at Koddiyar), were sketched. These have elongate heads with hooked extremity and broad base, from which the tail proceeds (fig. 4). I have not yet had an opportunity to study the finer structure of the reproductive organs by means of sections.

The observations described above lead to the conclusion that the window-pane oysters living in lake Tamblegam in the first quarter of 1908 displayed synchronous maturation of the gonads; and that *Placuna* is a periodic spawner, or at any rate does not become continuously reproductive until a late age, in contrast with the chronic maturity of other burrowing bivalves, such as *Venus*, *Cardium*, and *Arca*.



Figs. 1–3, Spermatozoa of *Placuna*.
Fig. 4, Spermatozoon of *Cardium*.

II.—AGE OF THE OYSTERS.

I take it that my inspection of the Tamblegam beds in June and October, 1907, allows me to assert positively that there was no effective fall of spat in that year; and I found no evidence of any having taken place in 1906. In June I did find yearling oysters in the Sambore river, but not in lake Tamblegam.*

The following tables show the growth of the oysters on the various beds since Mr. Hornell's inspection of 1905.† The term "plants" is applied to those oysters which I placed in an enclosure in Nachchikkuda in October, 1907, as will be mentioned later. Oysters taken from their natural positions on the beds are distinguished, when necessary, as "topotypes":—

Table I.—Nachchikkuda.

The dimensions given in this and subsequent tables are the averages of numbers of individuals, the numbers in each case being stated for the sake of completeness, although the actual number makes no appreciable difference to the average in a normal series. The standard height is 5½ inches or 139 mm. In the measurements given below the length precedes the height.

Date.		Observations.
May, 1905 (Hornell)	..	The bed "consists of very young individuals, none exceeding the size of a crown piece," *i.e.*, 1¾ to 2 inches in diameter, or about 50 mm.
June, 1907	..	Average of 44 specimens: 159 by 147 mm., decimal points being omitted.
October, 1907	..	Average of 66 specimens: 168 by 154 mm.
March, 1908	..	Average of 9 "plants": 173 by 163 mm.
Do.	..	Average of 15 topotypes: 171 by 162 mm.

The averages taken in March of this year show that the transplanted oysters behaved normally.

Table II.—Kapalturai.

May, 1905 (Hornell)	..	"The bed off Kapalturai is also composed of young individuals, older by some three months than those of Nachchikkuda. The average size is 3·33 inches by 2·92 inches (83·25 by 73 mm.), and over the greater part of the bed they lie in great profusion, from 10 to 22 being commonly brought up at one dive." These may be estimated at not less than one year old.
June, 1907	..	Average of 16 specimens: 6·6 by 6·1 inches, or 165 by 152 mm. These would be three years old.
October, 1907	..	Average of 15: 169 by 153 mm. This is nearly the same as the June average, and just double the 1905 average; about 3½ years old.

* A. Willey. Report on the Window-pane Oysters (June, 1907). *Spolia Zeylanica*, Vol. V., November, 1907, p. 38.

† J. Hornell. Report on the *Placuna placenta* Pearl Fishery of lake Tampalakamam (May, 1905). Ceylon Mar. Biol. Lab. Rep., Part II., June, 1906.

Date.		Observations.
March, 1908	..	Average of 22: 181 by 165 mm. These are large scattered individuals living under conditions favourable to growth; and the apparent average increase of size since October may depend as much upon individual variation as upon the general growth of the colony; about 4 years old.

Table III.—Kakkaimunai.

The Kakkaimunai oysters are in general dwarfed and of unequal growth, hence the averages are only approximately comparable. The observations indicate that this bed is a favourable spot for the settlement and rapid, though limited and stunted, growth of *Placuna*. The oysters are crowded side by side, thus prejudicing their bodily growth, and perhaps also their total pearl productivity, but not affecting their sexual maturity; hence the Kakkaimunai bed acts as a natural reserve.

May, 1905 (Hornell)	..	Of two samples, one estimated at 1½ year old gave an average size of 111·4 by 102 mm.; the other estimated at 1¾ year old gave an average of 125·2 by 114·96 mm. Combining these two sets we obtain an average of 118·3 by 108·48 mm.
June, 1907	..	Average of 12 specimens: 119·3 by 111 mm. It seems certain that these oysters belong to the same generation as those seen by Mr. Hornell in 1905. It would follow, therefore, that there had been practically no growth in superficial area, but only in the thickness of the shell.
October, 1907	..	Average of first sample of 30 (October 17), 131·5 by 123·5 mm. A total of 79 oysters was measured on this date: the smallest 106·25 by 92·75 mm.; the largest 159·4 by 146·9 mm. This is an extreme variation tending to vitiate the average. Second sample of 30 (October 22): 135 by 124·25 mm.
March, 1908	..	Average of 16 topotypes: 129·2 by 122·1 mm. This is nearly identical with the average of the October topotypes.
Do.	..	Average of 16 plants (*i.e.*, oysters transplanted in October, 1907, from Kakkaimunai to Nachchikkuda): 141·8 by 130·1 mm.

Table IV.—Sembian-aar.

It will be noticed that while the oysters on this bed show a larger growth than those on the Kakkaimunai bed, yet they resemble the latter in having made little increase in size since 1905.

May, 1905 (Hornell)	..	This bed "was particularly prolific in fine, well-grown oysters from 10 to 16 to a dive." Average size: 155 by 142·25 mm. (6⅛ by 5⅝ inches); "probably over 2 years old."

Date.	Observations.
June, 1907	.. Average of 12: 150·5 by 142·5 mm. The difference in average long diameter between this and the 1905 sample is negligible and the height is the same. I assume that they belonged to the same generation, and were therefore more than 4 years old.
October, 1907	.. Average of 20: 154 by 149 mm.
March, 1908	.. Average of 20: 166·4 by 154·75 mm. Shells very old, heavy, and mostly worn at the edges; some blackened (" micaceous ") about the hinge area.

Table V.—Polokarai-aru.

This bed lies rather near the shore, between Sembian-aar and Kakkaimunai.

October, 1907	.. Oysters scattered like those of Sembian-aar. Average of 18: 154·7 by 149·6 mm.

Table VI.—Uppu-aru.

I inspected this bed in March, 1908, with an entirely negative result, apparently due to an excessive deposition of mud during the recent rains. This backwater is a simple estuary, whereas the Tamblegam lake is to a great extent an arm of the sea.

III.—The Fishery of 1908.

The measurements tabulated above show that the oysters living in the lake at the time of the 1908 fishery were to all intents and purposes of the same age. There was not one too young to be taken by the divers, no fall of spat being known since 1904–1905. It follows from the facts which have been brought forward that the fishery of this year has not been an independent fishery like the annual Mannar fisheries, but it has been the conclusion of the industrial collection of one growth, or, to use an agricultural expression, one crop of *Placuna*.

The fishery commenced on February 3 and ended on March 17. Although short it went briskly, being better organized than in the previous year; and it gave better results in consequence of this fact, and also because of the increased average size of the pearls.

Arrangements had been made for the filling in of forms of daily return signed by the manager of the fishery on behalf of the lessees. These offered no difficulty of any kind and yielded just the information that was wanted and would otherwise have been lacking. Their use should be made an indispensable condition of future fisheries.

The total number of oysters recorded as having been taken in 1907 was 1,255,344. Of these, one-half belonged to the lessees, the other half to the divers; and the half share of pearls secured by the former amounted to the weight of 46 rupees, valued by weight at Rs. 690. But many of the pearls have a definite qualitative value in native jewellery, so that the weight gives no reliable indication of the true worth of the pearl-yield.

The numbers of oysters entered on the schedules represent half the total quantity taken on each day. The half share of the entire catch this year aggregated 130,568 oysters, the number actually taken being therefore twice this amount, namely, 261,136.

The total number of days occupied by the fishery was 38, no diving being undertaken on Fridays, in accordance with Muhammadan custom.

Daily Returns of February, 1908.

Date.	Boats.	Divers.	Oysters.	Place.
3	15	58	15,100	Kakkaimunai
4	26	91	31,463	do.
5	32	95	27,009	do.
6	39	99	28,015	do.
8	37	99	2,313	do.
9	40	109	2,846	do.
10	18	48	1,289	Saliyatuwai
11	12	33	630	do.
12	14	40	767	do.
13	14	37	679	do.
15	6	17	360	do.
16	7	20	536	Mukkikallu
17	14	60	1,060	do.
18	23	74	592	do.
19	28	86	1,115	do.
20	8	25	205	do.
22	17	61	545	Nachchikkuda
23	12	49	681	do.
24	4	11	62	do.
25	19	63	1,114	Saliyatuwai and Nachchikkuda
26	22	70	891	Sembian-aar
27	15	64	1,096	do.
29	21	80	2,159	Polokarai-aru

March, 1908.

Date.	Boats.	Divers.	Oysters.	Place.
1	13	51	984	Polokarai-aru
2	12	56	1,130	Polokarai and Setukuda
3	17	67	1,540	Setukuda
4	20	75	1,655	do.
5	13	29	250	do.
7	15	50	435	do.
8	11	40	494	do.
9	14	45	672	do.
10	10	29	853	Sembian-aar
11	11	32	536	Nachchikkuda
12	9	25	360	do.
14	3	10	201	do.
15	5	15	375	Polokarai-aru
16	3	10	207	Saliyatuwai
17	5	15	349	do.
			130,568	

IV.—Pearl-yield.

During the course of the 1908 fishery it became clear that the crop of pearls was a great deal better than that of last year, and the actual figures show a disproportionate increase. For, whereas in 1908 the lessees' half share of oysters numbered only 130,568, or a little more than one-fifth of their share (627,672) in 1907, the weight of pearls secured in 1908 is returned at 92 rupees, double the quantity recorded in the preceding year.* This result is somewhat surprising, and can only be attributed to the continued growth of the pearls. After a pearl has reached a certain size, its further growth by the apposition of fresh layers of nacre must add greatly to its volume and value as compared with the earlier stages in its formation.

As this is the first occasion on which a comparison of the pearl-yield in successive years has been possible, it may be tabulated as under:—

Date.		Lessees' Share of Oysters.		Rupee Weight of Pearls.
1907	..	627,672	..	46
1908	..	130,568	..	92

The practical conclusion to be drawn is that in the case of *Placuna* the maximum pearl-yield coincides with the period of sexual maturity. If subsequent observations should confirm this conclusion, it will become an economic fact of controlling importance.

From what has been said it will be clear that a short lease is a pitfall, fatal to the spawning oysters. It is not to the interest of contractors holding a lease of only five years' duration to spare the spawners, but, on the contrary, it is their business to take as many as they can get, to which in fact they are legally entitled.

Moreover, seeing that superficial dimensions give no safe index to the state of maturity of the oysters, it follows that the provision as to size limit can only be a very crude approximation, especially when it is considered that size depends upon a dozen environmental conditions. The three-year theory of the longevity of *Placuna* seems to be based at least, in part, upon the length of life permitted by boring whelks, sponges, and human enterprise. When dead shells are brought to the surface with the two valves still adhering together, it is generally found that one of the valves, usually the convex valve near to the cardinal teeth, has been perforated by some enemy ; and I attribute the mortality on the Nachchikkuda bed chiefly to the whelks, whose erect, subcylindrical egg-capsules are attached in dense clusters to dead valves of *Placuna* lying upon the bottom of the lake; each capsule contains a multitude of embryos, and oviposition appears to be chronic.

V.—Rainfall.

In my former report I urged the desirability of noting the rainfall in connection with the annual condition of the *Placuna* beds. In

* *Cf.* my June report, *op. cit.*, 1907, p. 40.

the Sambore river, the Uppu-aru, and the Palampat-aar the freshening of the water appears to have a direct and injurious effect upon the health of the oysters. The greater portion of the Tamblegam lake seems to be much more independent of the rainfall than the localities named, and successfully withstood the last rainy season.

The following table, kindly prepared at my request by Mr. H. O. Barnard, F.R.A.S., F.R.Met.S., Superintendent of the Meteorological Branch, shows the frequency of the rainfall in the Trincomalee District during the months October, 1907, to March, 1908, inclusive :—

Rainfall at Trincomalee.

1907.	Inches.	Days.
October	13·57	20
November	22·13	17
December	6·07	13
1908.		
January	4·99	11
February	6·85	5
March	2·06	6

VI.—Placuniculture.

It is only necessary to state here that the first steps have been taken towards placing the *Placuna* beds of the Tamblegam lake under conditions of culture. In October, 1907, a limited number (about 450) of oysters was transplanted by hand from the natural beds to a reserved enclosure marked off by stakes in Nachchikkuda. In March, 1908, these "plants" were found to be in good condition, and to have achieved their maturation in a normal manner.

There is a strong theoretical reason in favour of planting the oysters close together in a confined space. The effect of a fishery is necessarily to thin out the beds, so that the few surviving individuals become isolated and more or less widely separated. As the sexes are distinct the chances of fertilization are correspondingly reduced after a fishery, and transplantation may therefore be supposed to counteract the effects of depletion.

In March, 1908, a further experiment was set on foot. Twelve baskets of special construction were suspended from crossed poles in mid-water and stocked with mature oysters. It is hoped that some result will manifest itself before the end of the year.

Finally, one of the most necessary precautions in cultural operations, namely, the surveillance of the protected areas, has not been neglected. Three watchers have been appointed by the Assistant Government Agent at Trincomalee to look after the beds until the next fishery takes place.

Samples of the Plankton (floating micro-organisms) were collected and preserved in October and March, chiefly with the object of overtaking the free-swimming embryos of *Placuna;* so far, however, without success in this respect. Observations on other animals associated with *Placuna* have been made, but these do not at present affect the practical issues.

MOONSTONE FROM HANGURANKETA.
From a photograph taken by Mr. J. H. de Saram, C.M.G.

NOTES.

1. *Hanguranketa Moonstone.*—Readers of Fergusson's History of Eastern Architecture will not need to be told that the ornate semicircular threshold stones, commonly known as moonstones, which occur at the bases of flights of steps leading into the pansalas and viharas of Ceylon, are an exclusive character of the ancient architecture of this Island, and are not found in India nor elsewhere on the Asiatic continent. Crossing the threshold must have formed a solemn part of the daily routine in the old days of militant Buddhism.

The stone here portrayed has been lying at the Museum for many years (see *Spolia Zeylanica*, III., p. 26, "Floral Moonstone"), but it has never been illustrated before. It is unique of its kind, and the extremely conventionalized nature of the decorative scrolls may point to the fact that it belongs to a somewhat later period than the zoophorous or processional moonstones (with representations of animals in procession).

The disc, which might serve equally well as a lotus emblem or as a sun emblem, is framed within a succession of what may either be flower vases or water pots, terminating on each side in the sign of the blessed footprints of Buddha. Outside these there is a complicated terminal scroll, which appears to be a makara derivative; and behind these scrolls there is an actual makara with open mouth, from which a minor scroll issues surmounted by a small uplifted trunk; behind the head the legs are seen, and the body ends in a coiled tail.

It has been said that when an object expressive of an artistic conception and having the character of a sacred emblem is removed from its original environment and brought to a Museum it loses all its significance. Such a reproach, however, only proceeds from one point of view, since, in addition to the original motive of the design, which nothing can alter, it acquires a new meaning. The conversion of a *res sacra*, even though it may have become obsolete, into a Museum specimen may seem a cruel turn of fortune's wheel, but it may be urged that its ethnographic value becomes accentuated.

This moonstone is said to have belonged to the palace of a Kandyan king at Hanguranketa. It is a great slab of gneiss with roughly dressed edges and finely sculptured upper surface, measuring 7 feet across the straight border, about 4 feet 8 inches from the middle of the latter to the middle of the convex border; the diameter of the disc is 2 feet 8 inches, and the thickness of the slab about 8 inches. It is lying flat upon the ground, and is not easy to photograph, but Mr. J. H. de Saram, C.M.G., whose effort is here reproduced, succeeded admirably.

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2. *Stone Pillar from Gampola.*—A handsome stone pillar has been recently unearthed and presented to the Colombo Museum by Mr. T. B. Yatawara, Ratemahatmaya. It is carved differently on the four sides. The shaft of the pillar is octagonal, the base and capital square. The basal carvings represent a trisul ornament, a tom-tom beater, a flower vase, and a sedent lion ; at the top there are dancing figures and a peacock.

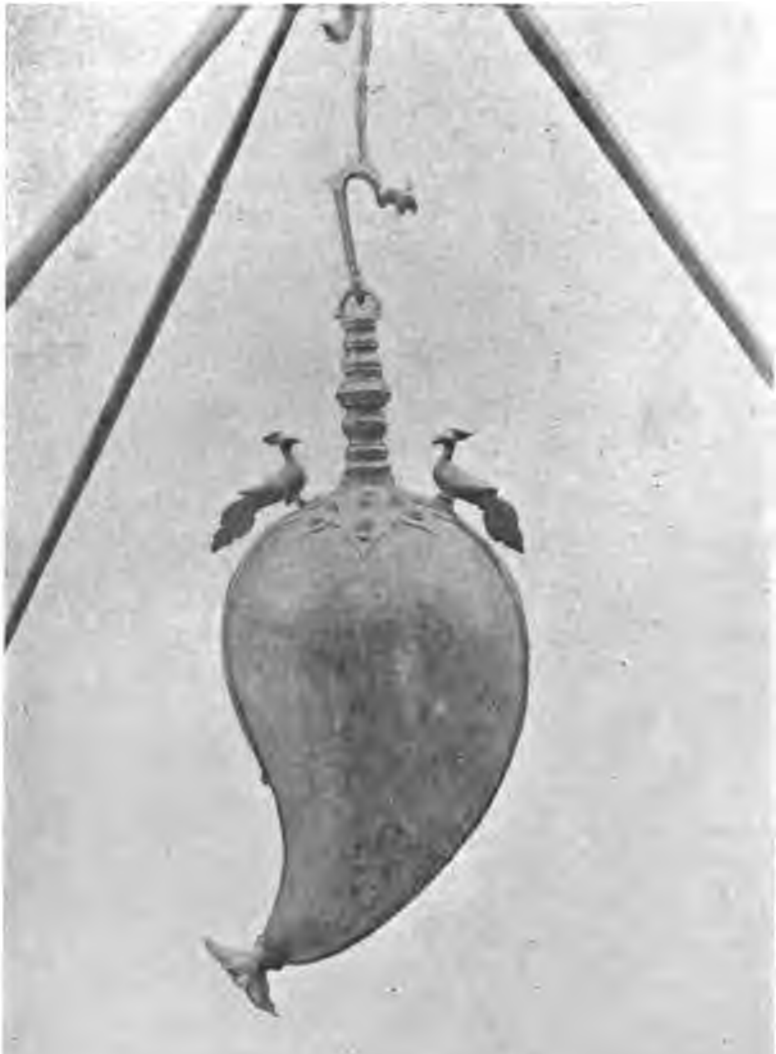
The following further information has been kindly supplied by Mr. J. P. Lewis, Government Agent of the Central Province, who was instrumental in securing the presentation :—

"One tradition is that Bhuvaneka Bahu V. transferred the seat of government to Kotte (1410), leaving the other members of the royal family at Gampola; and Raja Sinha I. of Nilambe, when on his way to Sabaragamuwa from Nilambe, received information of the sojourn at Gampola of these royal people, and fearing that they might kill him and take the kingdom had them killed. But one of them, Konnappu Bandara, escaped death, and remained at Gampola disguised as a Buddhist priest, and started to build a palace on a hill at Tiyambara-ambe, commanding a view of the low-country as well as the hill country. Whilst he was building it the king heard of it, and sent ministers to inquire into the matter. Konappu in consequence fled to Colombo, and from thence to Goa. He returned after the death of Raja Sinha, and became king under the title of Wimala Dharmasuriya I. (1592).

"Another tradition is that a prince of Gampola, who was occupying the palace at Sinhapitiya, found that Raja Sinha's visits to Gampola were too frequent for his safety, and, fearing death, started to build a palace at a spot not easily accessible. For this he chose the hill Eraminiyagammana at Tiyambara-ambe, and removed thither the materials of the old palace ; and when the king heard of it he sent emissaries to kill him. The prince was warned of this by somebody, and he fled from the place. The king's men pulled down what was erected and went away.

"This pillar is one of the four that have been found at the spot.

"Tiyambara-ambe is a village situated 9 miles from Gampola on the Gampola-Kurunduwatta road in Gangaihala korale."



CEREMONIAL MANGO.

Lent to the Colombo Museum by Mr. Paul Pieris.

3. *Ceremonial Mango.*—A fine example of a large brazen mango has recently been deposited in this Museum on loan by Mr. P. E. Pieris, M.A., C.C.S. It is made with a pale alloy crowned by a mounting of yellow brass bedecked with crystals and terminated by a high knob carrying a hook. On each side there is a figure of a mythical bird called Garuda, and below these an incised Bo leaf design. The mango ends in a lotus flower with crystal (glass) centre. It is hollow and contains loose metal pellets, which rattle when carried about. Along the lower concave border there is a cleft, as in the Pattini bangles, armlets, and anklets, through which the pellets can be seen.

The following is the story of Pattini devi or the birth of the goddess Pattini out of a mango :—

"In the garden of the King of Pandya was a well-grown mango tree which bore a remarkable mango, out of which Pattini devi was born.

"This mango was more beautiful and larger than the other mangoes on the tree. It was arranged to pluck this mango by arrow shots. Headed by the King of Pandya, all the archers of the place tried in vain to shoot it down. Seeing this the god Sakra in the form of an old man with an arrow in his hand came to the spot. The King of Pandya said: 'Oh! old man, how can you shoot this mango after all these renowned archers, including myself, have failed?' The old man replied: 'Although I am old, there is no one among you who can lift my arrow.' Thereupon, knowing his power, the king asked him to shoot the fruit, so that the mango should not fall to the ground. A cloth being held up, the old man taking aim shot the mango. The fruit, separated from the stalk, began to fly round in the air. Whilst beholding this wonder, a drop of sap from the fruit fell into the eye of the king and blinded it. Thenceforth, the king being afraid to keep the wonderful mango in his country or to harm or eat it, ordered his people to put it into a pot, place the pot in a small boat on the water, and let it drift away. The boat was found by a Moorish queen, who carried off the pot with the green mango to her palace. A few days afterwards Sakra, chief of the seven heavens, came as an old beggar asking alms. The queen remembered the mango, and thinking to give a part of it to the old man looked in the pot. There she saw instead of the mango a female infant, more beautiful than a golden image, sucking her fingers. Sakra then disappeared.

"This strange infant, born from the mango, was named Pattini devi. Having grown up, she is said to have performed various marvels and supernatural acts. The story of the miracles she wrought is fully told in the Ambawidamana, Walalukathawa Salambasantiya, Wesamedima, and Ankeliupata."

The total length of the mango image and hook is about 22 inches, the mango alone measuring about one foot in length. It is said to have come from the Seven Korales, and to have been used at the Pattini dewales, being carried in procession by the Kapuralas or Pattini Hamis in a lacquered box. At dewal maduwas they still perform the ceremony of shooting the mango.

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4. *A Note on Kallima philarchus.*—Whilst on a visit to an estate in the Uda Pussellawa district (5,200 feet) I had a good opportunity of watching the habits of *Kallima philarchus*. This interesting "Oakleaf" butterfly is one of those remarkable instances of colour protection, for, although the prevailing colour of the wings above is a brilliant blue, the under parts resemble a dead leaf, so that when the butterfly has settled with closed wings it is extremely difficult to distinguish it from a dead leaf. For two days a butterfly frequented a certain spot on the trunk of a tree quite close to a footpath, and thus I was able to watch it at close quarters. I noticed with much curiosity that as soon as the butterfly settled, which it did in the usual way, it immediately turned round so that its head pointed downwards. I was much puzzled over this proceeding, which occurred every time the butterfly settled, until I discovered the reason. The butterfly turned round so that the "tail" of its two hind wings would almost come into contact with the trunk of the tree, thus representing a stalk, and the apparently dead leaf would hang in a perfectly natural way, drooping downwards, or, as Mr. Green remarks (*Spolia Zeylanica*, Vol. V., Part XVIII., p. 89), "it might be mistaken very easily for a detached leaf, that in its fall has hitched up in a cobweb......"

W. A. CAVE.

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5. *Parasite from the Gall-bladder of Ceratophora.*—Whilst dissecting a specimen of the Unicorn Lizard (*Ceratophora stoddarti*) from Nuwara Eliya in April, 1905, a parasitic flat worm was found in the gall-bladder. It was forwarded through Mr. A. E. Shipley to Professor A. Looss at the School of Medicine, Cairo, who kindly furnished the following provisional report. A second specimen was taken from the same species at Hakgala in January, 1906. The lizard is one of those which are peculiar to Ceylon, occurring at the highest elevations, and the occasional presence of a fluke in its gall-bladder is rather an interesting case of parasitism to put on record.

Dr. Looss's report :—

"I have examined your specimen, and am herewith sending you a sketch of what I have been able to make out (see text-figure). The worm is a Distome, as I had surmised, but its organization rather differs from what I believed to see in your sketches (made in Ceylon). There is as yet no genus established for this structural type, but ***Distomum mutabile***, Molin, from the gall-bladder of *Lacerta muralis*, so closely resembles your form that there can be no doubt that both forms are congeneric. The most recent description of *D. mutabile* is given by Lühe in Centrbl. Bakt., &c., XXVIII., 1900, p. 563. A comparison of that description with my sketch will show you this resemblance, which extends also to the habitat (*i.e.*, the gall-bladder). You might therefore safely establish a new genus for your parasite. I should not, however, advise you to do so, since the state of preservation of the specimen does not admit of giving a full diagnosis of the genus.

Distomid parasite from gall-bladder of Ceratophora.

"The details in the organization of the worm which I have not succeeded in settling are the following :—(1) The length of the intestinal cœca : they disappear from view at the anterior border of the testicles, but apparently do not terminate there. (2) The structure of the copulatory organs : they are present, but so faintly outlined that nothing more is visible. (3) The shape and extent of the excretory vesicle, the pore being alone discernible. (4) Finally, the skin has fallen off, and the question whether it is or is not armed with spines remains an open one. These four points ought to be mentioned in the diagnosis of the new genus (speaking from a strictly scientific point of view) ; but practically it will be recognizable without them."

School of Medicine, A. Looss.
Cairo, December 14, 1905.

6. *The Lula's Enemy and the Adventurous Squirrel.*—I was out at Horana last week and noticed a black and white snake about two feet long and as thick as a man's thumb holding a lula in its mouth sideways by its back. The fish was about eight inches long, and twice the thickness of the snake. It was bleeding freely where the snake had hold of it with widely distended jaws. I got the fish away and put it back in a part about 10 feet off, when it immediately dived beneath the mud. The snake remained stationary, even refusing to move on being pushed with a stick, and seemed either exhausted or stupefied.

Another rather curious incident occurred in a bungalow I was staying at. There is a stuffed crocodile in the verandah, with its mouth wide open. It lies well inside the house. A squirrel came in and walked up to the crocodile, looked inside its distended jaws, and then bolted. It seemed fully to realize that the beast was stuffed.

Colombo, April 14, 1908. A. L. HINE-HAYCOCK.

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7. *Fishery Observations.*—A knowledge of the breeding and swarming habits and periods of marine, estuarine, and fresh water fishes must form the basis of intelligent action in regard to fish preservation and culture, and it is from this point of view that the following notes are offered.

I.—Shoal of Plotosus Fry.

Plotosus is a genus of Siluroid fishes (sometimes called Cat-fishes) represented in Ceylon waters by two species, *P. canius*, which may be the same as "Kalapu-anguluwa," although I am not certain about this; and *P. arab*, which has been called "Mudu-hunga." The respective Tamil names for these species are given by Mr. A. Haly in his list of fishes likely to be found on the coasts of Ceylon (Colombo, 1890) as "Kelura" and "Kadalsungen."* The former is an estuarine fish not found in the Red Sea; the latter ranges from the Red Sea to Japan and Polynesia.

Whilst I was inspecting the Tamblegam window-pane oyster beds on June 24, 1907, and passing a point called Peyaddumunai, near the mouth of the Periya Palampat-aar, I noticed, at a distance, a dense black mass floating close to the surface, which looked like drifting seaweed, and was actually pronounced to be "pasi" by the boatmen. Upon approaching it, however, it resolved itself into a

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* At Niroddumunai the general term for these fishes is "kelethi," and they distinguish between Nāgalam or Māmpalam kelethi and Muttei or Arthu kelethi, the latter being a species of *Macrones* (*M. gulio*).

vast multitude of small tadpole-like fishes, moving in unison, each one characterized by two longitudinal white stripes commencing from the head between the eyes and converging backwards to either side of the dorsal fin. A diver jumped overboard and secured a quantity of them in a bucket. Subsequent examination proved them to be the fry of *Plotosus*, by reason of their many-rayed ventral fins and confluent second dorsal, caudal, and anal fins.

At first I concluded from their habitat that they were the fry of *P. canius*, but the proportions of the eyes and of the eight barbels to the length of the head afterwards led me to assign them to *P. arab*.

Their size varied very slightly from about 18 to 19·5 mm. in extreme length from the snout to the tip of the rounded tail fin. Just in front of the origin of the anal fin and behind the vent there is a pair of disc-like organs with sinuous margins. Between them occurs the urogenital papilla. The character which would seem to clinch their specific identification, namely, the total number of rays in the conjoined vertical fins, was not available, inasmuch as the anterior portion of the second dorsal fin membrane is destitute of rays at this early stage.

I do not know of any previous records of the pelagic swarming habit of the fry of *Plotosus*. They formed, in the mass, a conspicuous object, and might easily have been passed by as seaweed had not curiosity prompted nearer acquaintance. Whether or not this casual resemblance can really afford them an effective screen from their enemies seems questionable.

II.—Lula Fry.

The lula (*Ophiocephalus striatus*) is the most important fresh water food fish of Ceylon, both as regards quality and quantity. It is also known by its Hindustani name "murral," according to Mr. H. S. Thomas's latest spelling of the word, and by its Tamil name "viral." The Hindustani name is the one most currently employed outside Ceylon.

It is what Dr. Day calls a compound breather, being more essentially an air-breathing fish. The Ophiocephali "never obtain oxygen for any length of time from the air in solution in the surrounding water, but inspire it direct from the atmosphere, no matter how cool and charged with air the water may be"; and they "expire in a longer or shorter interval if unable to reach the atmospheric air." They are thus independent of the state of the water in which they are living, and "in carrying live specimens from the plains to the Nilgiri hills, this was most successfully accomplished in water largely mixed with mud."*

* Day, F. Report on the Fresh Water Fish and Fisheries of India and Burma. Calcutta, 1873, p. 25.

The adult lula feeds upon smaller fishes and frogs. In Ceylon it is known to be particularly partial to a near relative, the "pandaral kanaya" (*Ophiocephalus gachua*), whose recognition marks are the barred yellow and black pectoral fins and the tubular nostrils; it also likes "issu" (fresh water prawns) and "dandiya" (the Ceylon minnow, *Rasbora daniconius*).

Mr. H. S. Thomas (Rod in India, 3rd edit., 1897, p. 234) says that "murral are the easiest of all Indian fish to introduce"; they will "thrive in ponds and at various altitudes, so you can easily stock a pond if you desire, but they will speedily depopulate it of other sorts of fish.* The natives frequently put them into their wells, from which they can take them fresh as they want them." This last practice does not seem to be common in Ceylon, but is occasionally met with, as in the resthouse well at Alut-oya in the Tamankaduwa district, North-Central Province. They are kept here, however, merely for show, being fed artificially once or twice a week with small fish.

Dr. Theodore Gill notes that the Ophiocephalids are in prime condition when perfectly fresh and throbbing. It would appear that they cannot be salted or dried successfully, and therefore that, however plentiful they may be, they cannot compete with the customary dried fish in curry.

The habit of brood-nursing or parental care of the eggs and young has been often described, as, for example, by Day, Thomas, and others, and more recently, from a comparative standpoint, by Gill.† In Mysore it was observed by Colonel Puckle (quoted by Day) that *O. striatus* breeds twice a year, in June and December, the males constructing their nests amongst the vegetation at the edges of the tanks. In South Canara it is said to breed in December and January.

Although I have not yet had an opportunity of witnessing the nidification and brood-nursing of the lula, I have on two occasions secured samples of the fry. Part of a swarm was taken from the Galelawala, Barawe, near Hanwella, in the late afternoon on February 19, 1908. The total length (from snout to tip of caudal fin) varied from 32 to 37 mm.‡ The ground colour, especially at the sides of the body, was pellucid red, and the upper half of the eyes was bright red. The general shape was that of a tadpole, and there is reason to think that this is a fundamental form.

They were poured into a bath, where they were kept over night, restored to the chatty next day, and brought to Colombo (18 miles) by bullock coach arriving at 1 P.M. All except one or two were alive on arrival; many dead "kuni," small fresh water shrimp-like

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* See below.

† Gill, Th. Parental care among Fresh Water Fishes. Ann. Rep. (1905). Smithsonian Inst., Washington, 1906, p. 492.

‡ About 1¼ to 1½ inch.

crustacea belonging to the genus *Caridina*, were in the chatty with them, which they were not eating. These "kuni" thrive equally well in running water, as low-country rivers and mountain streams, where they retreat under stones, &c., and in still water, as tanks and ponds, where they flourish among the vegetation near the edge. In some places they occur in such quantity as to make it worth while to dry them for use in curry. Their presence in water is a good sign, and they constitute an important source of fish food. Those which had been put into the chatty with the lula fry were perhaps too large. I was unable to keep a running supply of live "kuni," and did not succeed in finding out definitely the best food for the young fishes, but I kept some of them alive in an aquarium for more than 5 months, during which time I put in various nutrient substances, water plants, chironomus larvæ (*i.e.*, lake-fly larvæ), roast gram, rice, chopped hard-boiled egg-yolk, &c., the principal pabulum being gram and yolk.

These substances promoted a luxuriant multiplication of micro-organisms, more especially ciliate infusoria of the genera *Stentor*, *Paramœcium*, *Blepharisma* (with hook-shaped rostrum), and *Spirostomum*.* The water became absolutely milky with *Spirostomum*, a protozoan animalcule, which is easily visible to the unaided eye, and is in fact the longest of the Ciliata. Gram which had been placed over night in the aquarium sometimes appeared like large flakes of snow in the morning, owing to the enormous aggregation of Spirostoma about the grains. I cannot say whether the young lulu fed upon the protozoa, but those which survived were vigorous to the end. They were actually seen to nibble at the particles of yolk, but the truth is that to this day I do not know precisely what is the best vehicle of nutrition for lula fry when kept in close confinement under artificial conditions not even approximating to nature. The experiment, however, is useful in so far as it demonstrates their great viability.

The water supplied to the tank was well-water, and it was kept at a depth of 1½ to 3 inches. At the outset a great many died owing to the too abrupt change. After the initial mortality more deaths occurred from time to time for which I was unable to account, except on the supposition that they were starving. On March 25, however, more than a month since the beginning of the experiment, I noticed one floundering helplessly amongst the floating weeds on the surface. It presented a meagre, starved appearance, but on opening it a prominent white fat-like mass was found in the body cavity partially concealing the viscera. This turned out to consist of two soft writhing *Cestode* worms (possibly *Schistocephalus* larvæ). Exploring farther forwards in the body cavity, I found another worm of the

* On April 11 a pair of *Stentor* was seen in conjugation. On April 19 *Paramœcium* was noted as conjugating, *Blepharisma* dividing.

same kind encysted; this also writhed inside its envelope. Other fry, which had died previously and had been preserved, were then examined and found to be similarly infected.

The body of the parasitic worm is shortly segmented, and the elongate head or scolex has a groove along each side and a terminal exserted sucker or rostellum. The integument contains numerous scattered oval calcareous corpuscles. Larval cestodes which are found in young fishes usually achieve maturity in the intestine of fish-eating birds.

On April 19 a vigorous young lula was caught and measured. It had distinctly grown both in bulk and in length. The eyes reflected a delicate red flush from the lens; iris pale golden; a slight reddish tinge was still apparent along the sides of the caudal region; the definite markings had commenced to appear as about nine short black vertical demi-stripes on either side of the dorsal fin. It was very strong, active, and erect, not easily put on one side. The total length was 41·5 mm.; body length (excluding the tail fin) 34·5 mm. At this time the aquarium contained, besides the protozoa named above, some Rotifers and some Naiid worms.

Two dead lulu removed from the aquarium on May 21 and 22 measured 43 and 40 mm. respectively. Another in full vigour, with the definitive body-markings well indicated, was taken from the aquarium on June 1; it measured no more than 38 mm. in total length; body length (excluding tail fin) 32 mm.; diameter across the branchial region 6·5 mm., across the projecting eyes 7 mm. At first I missed the red flush of the eyes which is so characteristic of young lulu, particularly after they have attained a length of 4 or 5 inches, but upon placing the specimen in dilute alcohol the red colour developed. On July 8 seven of the healthy young fishes were caught, measured, and returned to the tank; their total lengths (including the tail fin) were 42·5, 44, 44·5, 45, 46, 47, and 48 mm.

Another sample of lula fry of the same age, or rather younger than those taken in February, was brought from Hanwella on May 22. They measured 30 to 31 mm. in length, and showed the same sub-translucent reddish or golden red colour throughout when seen from above. The sides of the body were of a pure roseate hue, the uppermost dorsal region being darkened in varying degree according to circumstances by the presence of scattered chromatophores capable of expansion and contraction, producing a more or less smoky appearance.

The occurrence of this second brood indicates an extended period of spawning during the first few months of the year, both before and after the rains. The first brood was taken towards the end of a period of drought, the second after heavy floods.

The predaceous habits of the adult lula, which seem to debar it from association with other fishes in stock ponds, do not apply in the same degree to the fry, nor to the adolescent stages up to a minimum length of 6 inches, and it would be possible, sooner or later, to establish reserves for rearing the young in places where the supply shows signs of diminution.

The laboratory experiment described above shows that the transition from a late postlarval stage (without any trace of the definitive body-markings) to an early adolescent stage takes place slowly, and that during this transition period they are exposed not only to the rapacity of avowed enemies, but also to the more insidious attacks of internal parasites.

III.—Fry of Mada-karaya.

Madaya or mada-karaya (*Ophiocephalus punctatus*) is a near relative of the lula, from which it differs in colour, scale-rows, fin-rays, and in habits. A young lula compared with a madaya of approximately the same length (5–6 inches) had 46 dorsal fin-rays, as against 31 in the latter; the lateral line dipped down two rows of scales below the twelfth dorsal ray in the lula, whereas it dipped to the next row only in madaya; anal fin of lula with 28 rays, of madaya 22; about 57 scales along the lateral line in lula, about 40 in madaya; ventral fins of lula below the pectorals, in madaya nearly reaching the vent.

The madaya is a mud-burrowing fish, extensively eaten, and also used as live bait for "moda" (*Lates calcarifer*) and other large river fish, which are caught with a special bamboo rod supported over crossed sticks from the bank after sundown, for example, in the Kalu-ganga at Tebuwana.

On April 15, 1908, during rainy weather with intervals of sunshine, I observed a couple of mada-karaya in a clear shallow "wala" in the paddy fields at Bellana on the Matugama-Badureliya road in Pasdun Korale East. They were guarding a small brood of very young fry, a sample of which I secured with the assistance of Mr. John Dassenaike of Bellana, who accompanied me. One of the elders, rather smaller than the other (estimated about 6 inches long) and more brightly spotted, was probably the male. They were frightened away at our approach, but returned to the brood, which was advancing slowly in unison.

The young fry were all of one age, and measured only 6 millimetres in total length. They present (after preservation) three longitudinal white bands, namely, one median dorsal band with two spindle-shaped enlargements in front (see figure) and a pair of broad lateral bands commencing from the eyes.

They were moving about freely exposed in very shallow water under bright sunlight, in contrast with the usual habits of the adults, which are intensely cryptozoic. My sample consisted of upwards of 130 individuals, perhaps about one-tenth of the entire brood.

Some much older madaya fry were brought from Hanwella on May 22 in company with the second lot of lula mentioned above, and some very young kavaiya (*Anabas scandens*, the climbing perch). They evidently did not belong to one brood, since they varied in length from 21 to 39 mm. One of about 32 mm., which may be selected for description, showed only a faint indication of a median dorsal golden line in front of the dorsal fin; this, however, is more distinct at a younger stage (21–26 mm.), where both the lateral and dorsal bands have a brilliant greenish golden tinge. A bright golden band commences from the snout, passes through the upper part of the eye and above the pectoral fin to the tail fin. The rest of the back is dark, the ground colour being resolved into about five close-set dark stripes on each side between the dorsal fin and the lateral golden band, and three or four similar stripes below the latter. The ventral surface in front of the anal fin is whitish, as it is also in lula fry. At the age represented by a length of 36–39 mm. the dorsal band has gone and the lateral bands have faded, merging into the ground colour and losing the golden sheen. The general arrangement of pigment in longitudinal stripes shows up very clearly after preservation. The madaya fry seemed to be rather less hardy than the lula fry.

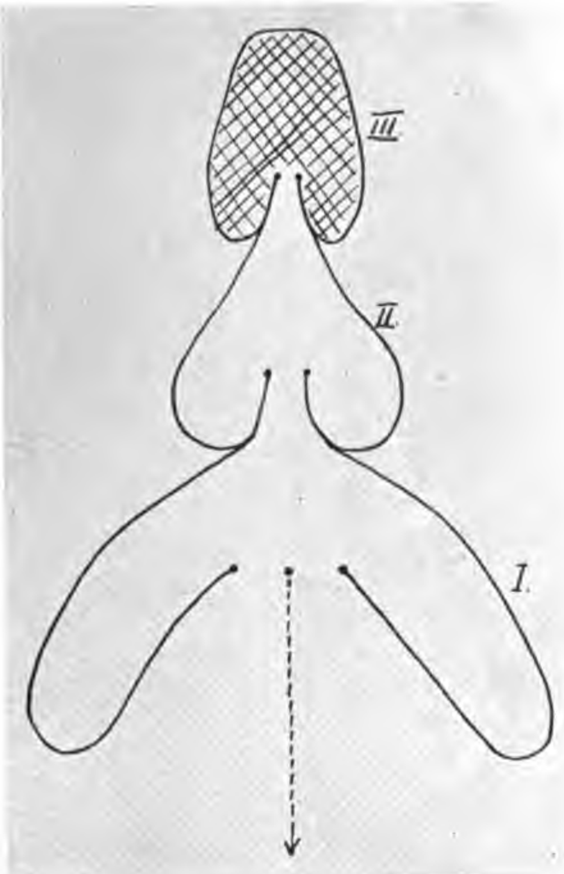
IV.—The Jakotuwa Fishery in the Panadure River.

When crossing the bridge on the coast railway over the Panadure river one may notice that the river is traversed as far as the eye can reach by a series of fences, which stretch a short distance from the shore, or half-way across the river, or right across with but slight interruption. It is to be feared that the interruption in an otherwise continuous fence barricading the river is not made primarily in the interests of the migrating fishes, for a net is often bent across it, as will be seen later. Connected with each fence and forming part of its construction is an elaborate fish-trap; sometimes several traps are intercalated in the course of a single fence. The whole is called a jakotuwa, or fish-weir.

A typical jakotuwa consists of a wattle fence of split bamboo (batta-li) extending nearly half-way across the river from one side, and a similar fence on the opposite side, leaving a passage between them guarded by high bamboo scaffolding, which serves as watch towers. At the shore end on each side of the river there is another passage with coir ropes stretched across it under water, between the strands of which the bleached leaflets of the coconut palm are looped, forming a white fringe in the water, called "pan-rena" or "pan-adinawa."* This is said to direct the fish alongside the fence

* In Clough's Sinhalese Dictionary "pan-adinawa" is defined as the operation of drawing an extended rope on the water on which white strips of coconut leaflets are suspended for the purpose of driving fish into nets. It is thus employed as an aid to netting in the Kuda-ganga, a tributary of the Kalu-ganga.

Fry of *Ophiocephalus punctatus*, seen from above.
× about 5.



PLAN OF A JAKOTUWA FISH-TRAP.

The dotted line represents the fence, and the arrow points to the shore. I., II., and III. are the successive chambers of the trap, the last covered with coir netting.

towards the mouths of the traps. The latter have two entrances, one on either side of the fence, as shown in the diagram.

In each half fence of the typical jakotuwa which I have selected for description three traps are inserted at intervals. Each trap consists of an ingenious triple cone-in-cone arrangement rising from the bottom and projecting above the surface of the water, strengthened by upright poles and horizontal bars. The trap acts as a maze, and the fish which penetrate into the terminal chamber (III.) find themselves in a blind alley, from which there is practically no escape. In order to remove them a man climbs over the top and drops into the water in the middle compartment (II.), from whence he lets himself into the end chamber under water; this chamber is covered over by coarse coir-netting to prevent the fish from leaping out. Another man in a boat stands by with a hand net called "atanguwa," by which the diver catches the entrapped fishes. This being done, the opening into the inner chamber is made secure, and the diver, having first returned to the middle chamber, re-enters the boat.

The apices of the cones point towards mid-stream. At the central end of the fence on the north side there was another trace of coconut leaves before the bamboo watch tower of that side. Between the two watch towers (guarding the central channel) was stretched a large net called "atoniya," held up-stream by the two watchers, the corners of the net being attached on each side of the passage to a long pointed pole driven into the bottom; the opposite or sea end of the net was held above water by two men in a boat; the up-stream border of the net is below water; it is a plain net, not a bag. As soon as the watchers see fish passing over the line of demarcation they quickly raise the poles, thus lifting the forward leach of the net out of water, and so the fish are netted. The boatmen then haul in the net and secure the fish, of which I saw only three or four caught at a time, half-sized gray mullet. The jakotuwa is what is termed a "fixed engine"; the atoniya was at work at dawn, early afternoon, and again towards sundown.

The fish which were taken out of a jakotuwa in my presence in December last included marine, estuarine, and fresh water forms, *e.g.*, "eliyalu" (*Platycephalus*), "kalanda" (*Sillago*), "parattiya" (*Caranx*), "anguluwa" (*Arius*), "koraliya" (*Etroplus*), "godaya" (*Mugil*).

The jakotuwas are lighted up at the mid-river end of each fence by a lantern at night; this burns all night, and the netting and diving operations are repeated at about 5 A.M. on the following morning.

A small or single jakotuwa consists of a single cone-in-cone trap at the end of a fence projecting a longer or shorter distance into the river from the shore, always with the guiding trace of coconut leaves at the shore end. In this case there is often an arrangement with rope attachment permitting the entire terminal chamber to be raised up bodily. The movable cages of the single jakotuwas were in fact raised in the early morning and appeared like huge funnels or chimneys; at night a lamp is suspended inside these cages, on the principle of the moth trap.

Sometimes the shoreward coconut traces are made fast to a "polkotuwa" for soaking coconut husks. A great quantity of coir yarn is required in the making of the fences for binding the horizontal slips to the upright poles.

The jakotuwas are numerous, extending far up the river, being very thick about the Gorakapola ferry, beyond the 16th milestone from Colombo; about the 14th milestone they become rarer, and are usually only single, on account of the width of the river here. Not many were visible from the Moratuwa bridge near the 12th milestone in December, but when crossing the bridge again at the end of May I saw a large one above the bridge close to the spot, where there is a permanent wooden hut for fish watchers in the river.

The jakotuwa system is the chief method of fishery in the Panadure river, and constitutes a remarkably brisk industry. Even the stretching of the "atoniya" across the central channel need not be objected to, so long as men are in attendance; but nothing should be allowed to block this channel when fishermen are not standing by. The Panadure river, together with the Bolgoda lake, is a great tidal backwater, sometimes nearly fresh, sometimes brackish, without any direct mountain source. It is connected by canals with the Kelani-ganga to the north and the Kalu-ganga to the south. The Lunawa lake, between Colombo and Panadure, which joins the sea (during the north-east season) at Angulana, is a separate sheet of water, and is also the seat of a jakotuwa fishery.

Colombo Museum, A. WILLEY.
July 20, 1908.

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8. *A Cobra on the Threshing-floor.*—On February 27 last while watching the threshing of paddy in a field near Rayigama, not far from Horana, a cobra of immense proportions formed one of the party, gliding about near the threshing-floor quite calmly, in spite of the presence of over a dozen persons and the usual clamour that accompanies the operation of threshing in this country. As the reptile moved about it passed between the legs of one of the men, who stood his ground as unconcernedly as the Colossus at Rhodes. I endeavoured to convince the company of the unwisdom of allowing the reptile to go free, but no one was enthusiastic about a hunt and slaughter. Their attitude was said to have arisen from a belief that the snake was an incarnation of a deceased owner of, or claimant to, the field, and that so far from doing it injury it was their duty to welcome the visitor and take advantage of the opportunity offered

of propitiating it. The more reasonable, if unromantic, explanation would seem to be that the cobra was after field rats which frequent the neighbourhood of threshing-floors.

March 7, 1908. C. DRIEBERG.

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9. *The Moorman's Dagger* (see *Spolia Zeylanica*, Vol. III., p. 213).—The dagger or " kathar " is undoubtedly the same as is used by Charans and Bhats in Gujarat, Kathiawad, and Rajputana. By them it is commonly used for purposes of suicide, to which they resort when they have stood surety for a chief and the chief breaks his word. It also always accompanies their signature on documents as a mark, usually drawn as under :—

 *or* 

A note on it will be found in Forbes's Rasmala. There is a very well-known Gujarat (Kathiawad) tradition of voyages to Ceylon, especially from Saurashtra, *i.e.*, the modern Junagahd, &c. Java is definitely stated by all Gujarat tradition to have been colonized from there by a cadet of one of the Rajput houses. Query :— Can this dagger have thus been acclimatized in Ceylon, and is it known in Java ?

December, 1907. OTTO ROTHFELD, I.C.S.

7(8)08

AN ITINERARY OF THE VEDDÁ COUNTRY.

By C. G. Seligmann, M.D., and Brenda Z. Seligmann.

Before describing the route followed and some of the incidents that occurred during a recent sojourn in the Vęddá country, it is perhaps worth while to refer, for the benefit of others who may be engaged in similar work in the East (*e.g.*, in the Malay Peninsula), to the great assistance derived from a preliminary survey of the country conducted from a motor car and without going further on foot from the main road than ten miles. Opinions at Colombo and Kandy varied greatly as to the prospect of successful work among the Vęddás; two views were generally held: the first asserted that there were no genuine Vęddás left—half-breeds and Village Vęddás there were, and with these it would no doubt be possible to make friends; the other view referred to the extreme shyness of the hosts of Vęddás who, clad only in leaves, still roamed about the wilder parts of the Island. It was pointed out that not only should we be unable to find these, but that this was really as well, for should we chance to surprise them we might expect to be riddled with arrows. As might have been anticipated, the truth as to the existence of "wild" Vęddás lay between these two extremes, and it was by quickly visiting a number of settled Vęddás by means of a motor car, and ascertaining the direction from which they had come, that a route was plotted which enabled the greater number of existing Vęddá groups to be visited, and ultimately led to satisfactory intercourse with a number of the few Vęddás uncontaminated by recent Siṇhalese or Tamil influence.

After leaving Banḍárawela the first halt was made at Bibile, where, among a number of coins and pebbles collected by the rest-house keeper and brought by him for sale, there was noted a moderately good example of the type of quartz implement discovered by Messrs. Green and Pole. An early start the next morning permitted of an interview with a number of the Vęddás and half-breeds settled on the big chena at Rerenkada in the neighbourhood of Kallodi; of fifteen folk seen here only one man and woman appeared to be even moderately pure-blooded Vęddás: the woman was only 53½ inches tall, while the man measured 63 inches. The next stop was made a few miles further on at Maha-oya, and the afternoon was spent in talking to three Vęddás from Omuni; these men were too poor to pay the tax of a rupee and a half due from each of them, and had just been brought down to spend a week working on the road in lieu of their tax. They were not pure-blooded Vęddás. In spite of this, their thin hungry appearance pointed to the truth of their story that they were really short of food, and that if they were kept from home for a week their wives and families would be reduced to a condition of starvation. Luckily Mr. G. W. Woodhouse, the District Judge, believed their story and sent them back to their village, for when we visited Omuni about a week later, although we were met with the customary gift of honey, to which were added a few berries, it was obvious that even the small number of folk left in the settlement were really short of food, and this in spite of a number of families having left some time before to wander into Tamankaḍuwa, where they hoped to get yams, and perhaps some game. Indeed, so short of food were these people that, in spite of the interest one of us (B. Z. S.) inspired, a number of women left the village immediately after our arrival, explaining that if they did not go and find some yams they and their children would get nothing to eat that night.

The folk of Omuni share with the people of Mudugala, now living at Unuwatura Bubule, about four miles from Maha-oya, the possession of some most interesting beads, the like of which we did not see elsewhere among the Vęddás. At Omuni they are worn by the women and regarded as heirlooms, and descend from grandmother to granddaughter; or, when a woman dies before a granddaughter is born, from mother to daughter; and it appears to be usual for a grandmother to give a number of her beads to a granddaughter soon after the latter's birth, and again at her marriage. At Unuwatura Bubule these beads are not worn, as they are regarded as too precious—indeed they are considered *quasi*-sacred, at least as the property of the *yakku*, and are used in the ceremonial dances in which the *yakku* are invoked. The beads themselves, which are much worn, are of glass, generally red or green, and have been identified at the British Museum as Venetian beads of the sixteenth or seventeenth century—indeed most of the actual patterns are identical with the beads in a traveller's sample book preserved in the Museum.

From Maha-oya our route lay to Batticaloa, where, after a delay to pick up an interpreter kindly put at our disposal by Mr. Freeman, we went on to Kalkudah in order to visit the coast Vęddás to the north of Batticaloa. Although these coast Vęddás, or Vęrdás as they call themselves, have intermarried with the Tamils and have adopted many Tamil customs, they still have remains of the old clan system of the Vęddás, and although they usually speak Tamil, the majority of them say they have a language of their own which they consider to be the old Vęddá language, and which was found to be Siṇhalese. They have roughly built temples, and we were told independently in two settlements that the chief agency worshipped was called Kapalpé or Kabalpé, *i.e.*, "ship spirit." At first we feared some misunderstanding, but when one of us was shown within one of their temples, into which after some trouble he was allowed to penetrate, a small model of a ship partly square rigged was seen, and it was stated that at a special ceremony this was hoisted to the top of a pole some thirty feet tall which stood outside the temple; it appeared that there was no reason to doubt the substantial accuracy of the information given, and the matter is brought forward here in the hope that some of the readers of *Spolia* may be able and willing to give some details of this worship, and perhaps trace its origin. On the way back from Batticaloa we stopped at Kallodi, and here, from the remains of the folk of Unapane and Idipola we obtained the first hint of the possible existence of the remains of a hunting language, for an informant, of whom we asked the words for bear and deer, showed considerable hesitation before he would give these words.

We reached Banḍárawela with some hours to spare, which were spent on the patanas quite close to the town, where we were delighted to find a number of flakes and worked fragments of quartz.

We returned to Colombo, and after a certain amount of delay, caused, first, by the necessity of overhauling gear and going through the collections in the Colombo and Kandy Museums, and subsequently by the wet weather, work was begun with Bibile as base. Through lack of appreciation of the amount of fresh food that was always obtainable in the jungle, we were unduly hampered at the outset by the amount of tinned food and biscuit that we carried, and the number of our *tavalam* bulls was unnecessarily great. The first day's march was to the Public Works Department bungalow at Nilgala, where, owing to the unexpectedly wet weather, several days were spent. On the way to Nilgala we passed a number of graves of the village Sinhalese, usually occurring in groups of two or three; the litter, ornamented with red and white, on which the body is carried to the grave, being left to decay by the side of the burial mound. Mr. Bibile, who had been attached to us as interpreter and assistant, told us that usually each family had its own burial area. In spite of the wet the time spent at Nilgala bungalow was not wasted, for we were kept busy making colour and other tests upon the local Sinhalese for comparison with the results which we hoped later to obtain from the Veddás. A number of optical illusions were also shown these people, who were most interested, and saw nearly all the illusions well, afterwards explaining the reason of parallel line illusions to each other with much excitement and illustrating their reasoning on their fingers.

On the first fine morning we started early for the Danigala Veddás, about eighteen of whom are all that remain of the Nilgala Veddás, who in 1858 numbered 72 souls.* The road was interesting, for it

* J. Bailey: "Wild Tribes of the Veddás of Ceylon." Trans. Ethn. Soc., 1863, p. 28.

soon crossed the Kalugalbęmma, with its extraordinary surface of rounded and spherical masses of stone. This is figured on the maps and usually described as an old road leading from Anurádhapura eastwards, but, as pointed out by Mr. James Parsons, the Chief Mineral Surveyor, this alleged road is a natural dyke of dolerite which extends for many miles across the country. About six miles from Nilgala we reached the site of one of the camps of the Drs. Sarasin, and we soon plunged down the face of a wooded rocky hill, descending some 450 feet in twenty minutes. Then, crossing a small *talawa* and a stream our way led up a similar but loftier hill, till at a height of about 1,200 feet we came on a rounded shoulder of rock, on which stood the skeleton hut of the Danigala Vęddás, built on the pattern of the ordinary village Vęddá habitation, but entirely lacking the slats of bark which make the sides of these moderately weather-proof. By its side there was an even rougher shelter consisting of a large bough with the smaller branches overlaid with banana leaves. Near the hut were the "patriarch" Kaira and three other men; there were also present three women and a boy of about twelve and two much younger children, and although both of the latter had many teeth they suckled persistently.

Kaira, who is the *vidáné* of the group, has a number of swellings on the abdomen which are adherent to the skin and firm to the touch; the largest is hemispherical and as big as half an orange. He attributes these to stings of *bambara*, the rock bee, but since we saw no similar masses subsequently, although we met many Vęddás who must have been frequently stung while honey-taking, this does not seem very likely, and these masses are almost certainly fatty tumours.

We did not get much information from the Danigala Vęddás, who were, however, perfectly ready to be photographed and to discuss generalities, but who did not speak unless addressed. We put this down to shyness, and so, after a short visit, returned to the bungalow, having, after obtaining permission to do so from Kaira, determined to make our first camp at the foot of the hill on which the hut was perched. Accordingly on our next visit a small camp was made, and the next morning we reached the top of the hill in good time, and found the same folk there, but after a little talk we discovered that it was not possible to learn anything of their customs from them, for they lied freely in answer to all genealogical questions, maintaining that there were no more members of their group. We then proposed that we should go and see their other houses on a *chena*, said to be less than an hour's walk from their look-out hut. This request was met with a blank refusal, and Mr. Bibile explained that the old man asked him not to tell the white folk about their affairs, and the cultivation they did, and the grain they had stored; in fact, from what we learnt on that morning and subsequently from peasant Siṇhalese of the neighbourhood, it is clear that the Danigala community have adopted the *rôle* of professional primitive men. Quite a number of the village Siṇhalese have dealings with these folk, who herd their cattle, the Veḍdás receiving in return every fifth calf that is born. Synthesising what we heard, it appears that in the ordinary course of events the Nilgala headman sends word when strangers are expected; then the folk we saw repair to their very striking hut on the rock dome and post a look-out on a big rock about half way up, and on our second visit the leading man of our party who was carrying the camera stated that he saw a Veḍdá bolting from this rock as we came up. These folk, who, when we saw them, wore their Veḍdá loin-cloths and were smeared with ashes, are reported to wear ordinary Siṇhalese clothes when not in their professional pose, and Mr. Bibile, who has himself seen one or more of them in sarongs, points out that the imposture is kept up for two main reasons: firstly, they fear that their cultivation might be stopped (evidently an echo of the *chena* difficulty of the Eastern Province), or that they might be taxed if they did not appear to be poor fellows living on hardly-won jungle produce; and secondly, their pose of poverty interests strangers and procures them visitors, whose generosity varies directly as the degree of primitiveness with which appeal is made to them.

Under these circumstances, it did not take long for us to decide to move to Ambilinne, whence we should be able to reach the Henebeḍda and Kolombeḍda Veḍdás. These folk occupy the land immediately to the east of the Danigala rock *massif*, but as it was quite impossible to get our baggage across the hills, it was thought best to return to Nilgala and thence follow the track to the Public Works Department bungalow at Ambilinne. Here we had the opportunity of getting to know four of the younger men of the Henebeḍda community. We gave them rice and curry materials, and it was interesting to find how extremely pungent they made their curry, which suggests that they have long been acquainted with Siṇhalese cookery, for previous experience in the Pacific and in Borneo had seemed to show that folk unaccustomed to hot and spicy food considered even a slight amount of pungency most objectionable. They passed the night on sacking on our verandah and were immensely interested in everything that went on, being especially pleased with a little boxwood top which they learned to spin immediately. About nine they quite spontaneously began to sing and dance, the rhythm being supplied by their song and the slapping of their hands on their chests and flanks; but beyond this there was very little regularity in the performance. In one figure, in which an arrow was struck in the ground, the performers began to move round it clockwise with their right hands inwards, but very soon one dancer was circling in the opposite direction between the other two, who were still moving clockwise. The two performers who had not struck their arrows into the ground held these in front of them in their hands, which were separated by the length of the shaft, while their bodies were somewhat bent forward over the arrows, which were moved from side to side as they danced. The steps were taken with the legs tolerably wide apart, the weight of the body being supported on one leg while the other was scraped along the ground by somewhat tilting the pelvis. This movement took place on the two legs alternately, a double step (somewhat as in polka) being sometimes substituted for the scrape. After a little time, when the circling movement had been entirely broken up, and all three men were dancing more or less independently, they shouted Ah-h, and pointing their arrows at the sky, waved them furiously before suddenly falling supine in a condition of pretended exhaustion and unconsciousness. The fallen men were at once lifted up and supported by a number of Siṇhalese, who had by this time been attracted to the bungalow, and the Vẹddás then came to us and promised game in abundance, giving, as we subsequently discovered, a remarkably good imitation of the ritual of their shaman when he is possessed by the *yakku*.

When they were shown the phonograph, comparatively little persuasion was required to get them to sing into it, though some of the English songs which we gave them impressed them not at all; but when the song was reproduced which one of them, Sitawanniya by name, had sung into the machine, they were greatly amazed, though they were neither so scared nor so shy as a Papuan would have been. Their astonishment was expressed by placing one hand over the mouth and chin with its palmar surface towards the face, the fingers spread on either side of the nose and mouth so as to cover the more or less nervous grin which was to be seen on all their faces.

At the time of our visit the Henebẹdda and Kolombẹdda Vẹddás were gathered in two caves, or more properly shallow rock shelters, called Bendiagalgé, in that portion of the jungle known as Henebẹdda, and our camp was formed about 200 yards from these caves. We stayed in this camp for some time and found the Vẹddás excellent informants, the only difficulty we experienced being to prevent them wandering away when the novelty of our visit had worn off after the first two or three days. This was overcome partly by small presents, but more we think by making them free of our camp—a freedom which they never abused—and by keeping a constant supply of chewing materials (arecanut, betel, tobacco, and lime) at their disposal. It was, of course, necessary to feed our informants, who had no store of food to fall back upon, and as we had not expected to meet so many folk, a part of the *tavalam* was sent back to Bibile to fetch an extra supply of kurakkan (millet), which, with smaller amounts of coconut and rice, kept them reasonably contented. It may be well to record, for the possible benefit of others, that an effort which had been made to retain a small number of the best informants in our camp and to allow the others to go did not succeed. The less desirable, because less knowledgeable, individuals would return to the caves and the camp after short absences to see how we

Fig. 1.—Bendiagalgé (page 161).

were getting on, and it was soon obvious that these also must be fed if any regular work was to be done. The extreme courtesy and consideration of these somewhat sophisticated Veddás, although not so great as that of the wilder groups we were to meet later, made all our dealings, including the serving out of supplies, easy, slight awkwardnesses or mistakes being often hailed with roars of almost childish merriment. We record these facts deliberately, as they are contrary to the statements that have so often been made concerning the Veddás, and we may point out that all the Veddás we met, although somewhat shy, were merry, courteous, kindly, generous, and truthful folk, the only exceptions being found among the members of communities such as Danigala and Dambani, who are accustomed to pose to visitors as primitive Veddás.

It is not the purpose of this slight sketch to describe our work or the results we obtained, but in view of the recent discussion on quartz implements discovered by Messrs. Green and Pole, and lately described in the *Ceylon Observer* and in this journal by the Drs. Sarasin, we give here a short account of the results of our exploration of the Bendiagalgé caves. These consist of two rock shelters formed by a single mass of rock, broadly speaking rectangular in shape, with its long axis running roughly in a N.-S. direction. The rock mass is somewhat tilted, so that its southern edge is high above the *talawa*, towards which its northern extremity slopes, and the whole rock somewhat resembles an immense wedge. Its eastern face has weathered so as to form two rock shelters; each of these has a well-cut drip ledge in no respect differing from those admittedly cut by the Siṇhalese about the time that Buddhism was introduced to the Island, and the lower cave has in addition two square sockets cut in its roof resembling those discovered by Mr. F. Lewis at Nuwaragala and figured by him, and such as we afterwards saw at Mullegamagalgé. Further, there are three steps cut in the solid rock between the two rock shelters and other smaller steps, and signs of ancient working are to be found about the rock mass. Figure 1 is a photograph of the upper of the two caves showing the drip ledge; the figure also shows two sets of steps hewn from the rock. There is no inscription on the rocks of either of these caves, but below the drip ledge of a rock shelter used by the same community of Veddás, and not more than an hour's walk from Bendiagalgé, there is an inscription, of which Mr. H. C. P. Bell says:—"The Brâhmi (characters) are of the oldest type, therefore B.C." This inscription has been read by the same authority, to whom my best thanks are due, as "(cave of) the chief........son of the chief Vela." There is thus reason to suppose that the Bendiagalgé caves were used by the Siṇhalese some 2,000 years ago, and this together with the present occupancy by the Veddás makes it worth while to record the results of our excavation, although we had not time to make it complete.

The nature of its bottom made the lower cave the easier to examine, and so a longitudinal trench was dug in the longer axis of the cave. The results of the excavation of the first two feet may at present be ignored; massive rock, which was taken to be the bed rock of the cave, was reached at about 2½ feet, and the interest of the excavation centres in the lowest few inches immediately above the cave floor under a deposit roughly 2 feet in thickness. In this zone just above the bed rock there were found many fragments of quartz, some milky, some ice-clear, some faintly opalescent, some smoky, and some amethystine. A few of these were as big as hen's eggs, the majority varied from the size of an apricot to a haricot bean, some were even smaller. From the larger number of pieces of quartz—nearly 300—collected at the depth mentioned from this trench, and a small trench driven at right angles to it, as well as the absence of pieces of country rock, there can be no doubt that these pieces of quartz were brought to the site in which they were found by man. They were not waterworn, and the variety of colour and opacity they presented make it certain that they had not weathered out *in situ*, in spite of the fact that quartz (but not as far as we could determine ice-clear quartz) occurs in segregation masses in the gneissic rock of the neighbourhood. When all the fragments were carefully washed and examined it was found that some 3 per cent. of the pieces of quartz obtained from this cave showed signs of working. They are in fact implements similar to those shown me by Messrs. Green and Pole.

Additional proof that the fragments of quartz had been brought by man to the site on which they were found, was afforded by some irregular digging done in the upper cave formed by the same rock mass as the lower cave, and separated from it only by a few feet. The floor of this cave was so rocky that a regular trench could not be dug, but a number of holes—the largest perhaps 6 feet by 4 feet—were dug down to what was apparently the country rock at the bottom of the cave. Fragments of pottery and the bones of animals were found in plenty in these holes, but altogether they yielded only four pieces of quartz, namely, two waterworn pebbles and two broken pieces of clear glassy quartz.

A well-marked bulb of percussion is present in a number of the quartz implements; this applies both to those in Mr. Pole's collection and to those we collected: some are worked on both edges, others on one side only. In the majority the working is somewhat rough, though this is not to be wondered at considering the refractory nature of the material, but a few of the best in the Pole collection would be considered pretty specimens had they been produced in soft stone.

As regards the type of these quartz implements, there seems no good reason to consider them other than neolithic; and except for the material of which they are composed, many of the specimens

FIG. 2.—Mullegamagalgé, showing the arch leading into the hall of the cave (page 163).

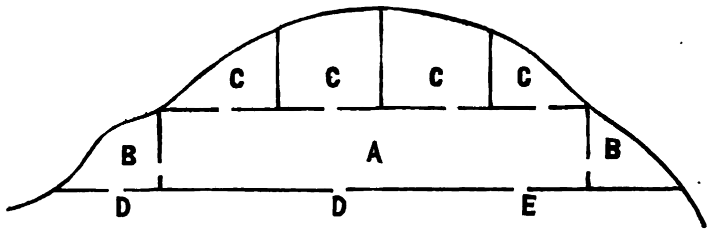
FIG. 3.—Mullegamagalgé: the under surface of the overhang (page 163).

differ in no respect from implements of the neolithic age found in Europe.

Although the folk of Bendiagalgé have bows, they do not seem to use them very much. Some of the younger men are certainly accustomed to guns, and as their stalking is magnificent they kill a good deal of game when they have a gun of their own or can borrow one from the Siṇhalese. But in spite of the little use of the bow, the arrow is still their almost universal tool, and as there was no knife in the community we had the opportunity of seeing the remarkable skill with which a deer was skinned and cut up with an arrow. The Vẹddás certainly desired no better tool, and when we pressed a butcher's knife on one of them in order to see how he would handle the unaccustomed tool, it was interesting to note how slowly he worked and how poor the result was compared with that he obtained with the arrow, which he held just above the blade somewhat as a European holds a penholder. No less astonishing was the skill employed in removing the skull cap with a few strokes of the axe: not only was the brain lifted out entire, but it was removed so neatly and cleanly that the result was more suggestive of an anatomical preparation than a piece of butcher's work.

On our return to Ambilinne a day was devoted to a visit to a big cave, Mullegamagalgé, which lies less than a mile to the north of the Ambilinne-Namal-oya road. The character of the scenery changes some 3½ miles from Ambilinne, the open park country giving place to thicker jungle. About four or perhaps five miles from Ambilinne we left the track and worked our way through jungle uphill for about three quarters of a mile until we reached the cave situated on a rock ledge. The front of the cave had been closed by a brick wall about 2½ feet thick and about 25 yards long, the bricks being covered with a stucco-like casing, apparently of rough plaster. There are two doors in the wall with hard wood frames, which have been attacked by wood-boring bees, and there is also an open arch with no evidence of a door having been fitted to it which opens into the cave (figure 2). The inclined rock which forms the roof of the cave overhangs the wall by 10 feet or more, and a drip-ledge is cut out in this which at one end is continuous with a second drip-ledge cut almost vertically down the face of the cliff, the two forming a system admirably arranged so as to carry off to one end of the ledge the water, which, even when we visited the cave after a few days of dry weather, dropped continuously from the rock forming its roof. The under surface of the highest part of the overhang of the rock is shown in figure 3, but we do not feel capable of pronouncing whether the step-like arrangement of the rock is due to natural planes of fission or whether the rock has in part been worked smooth. A number of square holes, judged to be some 9 inches deep, had been cut into the solid rock of the overhang about 3 feet above the junction of the wall and the rock; three of these can be seen dimly in figure 3.

On entering the cave we disturbed an immense number of bats who had taken it for their own. The whole place literally swarmed with them, and as the floor had a covering of two or three inches of their dung, the odour was most oppressive. Entering by the arch we found ourselves in a hall about 14 yards long by about 8 broad, the back of which, consisting of a brick wall, is pierced by four doors, each leading into a separate cell, the sloping roof of the cave forming the back walls of them all, as well as the outer side walls of the two outer cells. The partition walls between the cells are made of brick covered with a layer of mud or plaster. The two ends of the cave are separated from the main hall by low mud walls, which do not reach to the top of the cave; both present a rectangular gap through which the hall communicates with the small antechamber which these walls cut off, one of which has a door communicating with the exterior. On a " table " built up of bricks and mud in the hall there is a large flat stone with a circular excavation on its upper surface about 2 feet in diameter and half an inch deep. A similar stone was found lying on the floor in that antechamber which communicates with the outside of the cave. Figure 4, reproduced from a flashlight photograph, shows a number of these features. It was taken with the camera pointed obliquely down the length of the hall, and shows the inner wall and the doorway leading into one of the cells. The stone with the circular depression is also shown against this wall, while the low wall with its rectangular opening leading into one of the small end chambers, into which daylight streams through a gap in the outer wall of the cave, occupies the background of the photograph. The subjoined plan will make clear the arrangement of the chambers of this cave.



Plan, not to Scale, of Mullegamagalgé.
A, main hall; B, antechambers; C, cells; D, doors; E, arch.

At one end of the wall closing in the front of the cave, where some bricks had worked loose, it could be seen that the lowest tier of bricks was laid on the face of the rock separated only by a layer of cement, formed of crushed pieces of quartz set in some adhesive substance, and part of the floor of the central and largest chamber of the cave seemed to be covered with the same substance. The local ideas concerning this cave are, that long ago it was the habitation of Vęddá chiefs, and that it was used again in 1818 by refugees during the Rebellion, to whom the bricked-in front and the brick walls of the cells within the cave are attributed.

FIG. 4.—Mullegamagalgé: view inside the hall of the cave, showing the stone with circular depression on a brick table against the wall (page 164).

FIG. 5.—Hemberawa. A buffalo skull is seen at the base of a betel vine (page 169).

Our next camp was formed at Koṭalinda in the Eastern Province, beyond Namal-oya. On our way there we met a community of gypsies. These folk travel with large herds of cattle and goats, and appear to subsist by doing a trade in these, and by begging, snake-charming, thieving, and blackmailing. Their camp consisted of a number of scattered shelters, more or less circular in outline and formed of leaves of the talipot palm. Many of the men have medium brown or hazel coloured eyes and are very good-looking, some having distinctly aquiline noses. The women, who are less good-looking, would pass as Tamils, but were immediately differentiated from all the Tamil women we had seen by the masses of ornaments they wore, many of them being literally covered with bangles and necklaces, the former made of silver, brass, and some silver-like alloy, and the necklaces composed of glass or shell beads. They were said to speak a dialect of Telegu, and they told us that their ancestors had come from the neighbourhood of Madras, though the members of the community we saw had all been born in Ceylon. They say they worship and dance the god at Kataragam, whom they call *Yelnoth*, identifying him with the Tamil's *Kanda Sámi*. The fore-arms of the majority of the women were tattooed, the patterns looking as though they might have been flower derivatives; there were also small tattoo marks on the foreheads and temples of most of the women.

We were detained in the neighbourhood of Koṭalinda for some days, partly owing to wet weather, but more to the determination of the villagers to assist us as little and as slowly as possible in clearing away the trees that had fallen across the track during the cyclone of the year before, so that they might make us believe that there was a great deal to do and be paid accordingly. It was not till a week after we had left Namal-oya that we reached Banḍáradúwa, where there was a large Siṇhalese *chena* settlement with two Veḍdá houses on it. These Banḍáradúwa folk and a few scattered families living in the neighbourhood are all that remain of the Kóvil Vanamai Veḍdás, a group of whom we had heard a good deal, and who twenty years ago appear to have been very much in the condition of the present Henebeḍda Veḍdás, that is to say, a community making rough chenas and building good chena huts, but still passing part of their time in caves and living to a certain extent on game and honey. It was, however, immediately clear that these Veḍdás had much foreign blood in their veins, for all the men were over five feet high.

The day after our arrival a Veḍdá called Kaira came to our camp sobbing and shaking, and protested that he could not stay with us as his brother was dead. He seemed deeply affected, though another brother, Kaurála, who was with him, appeared quite calm, which led us to suspect that his uncontrollable agitation was due to something more than mere affection for the dead man, and we soon discovered that his brother had died in his hut, and it was therefore his duty to make an offering to the Buddhist priest and to provide the necessities foı a dance to the *Ne Yaká*, and that he had not the wherewithal to fulfil these duties. If these matters were neglected the spirit of the dead man would be angry, and after seven days, when the spirit had become a *yaka*, would cause sickness, and probably kill him. His manifest relief when we offered him the money needed to purchase the offerings, showed that his sorrow for the loss of his brother was the least of his troubles, and he was quite gay when he started on his twenty-mile walk to the nearest boutique with Rs. 3·50 in his betel pouch, and readily assented to our condition that he must return and perform the *Ne Yaku* dance near our camp. He declared that the place of the dance was immaterial, but that it must occur on the seventh day after death, because on the third day the spirit visited the Kataragam god, who, on the seventh day, gave it permission to receive offerings and to exercise power for good or evil over its living relatives.

The things which it was necessary to present to the Buddhist priest and their price in cents at the native boutique were :—Three measures of rice, 60; two coconuts, 20; five balls of jaggery, 15; twenty-five arecanuts, 6; five tobacco leaves, 12; 100 betel leaves, 18; one plate, 30; one cup, 25; one mat, 25; one handkerchief, 36; half bottle of coconut oil, 50; total, Rs. 2·97. On the other hand, the offering to the *Ne Yaku* consisting of rice, betelnuts, and a coconut, costing less than 50 cents. Notwithstanding this unpromising beginning the *Ne Yaku* dance they performed seemed to be entirely Vęddá in purpose and feeling, agreeing closely with that seen later among the " wild " Vęddás near Nuwaragala, the chief feature of both dances being that the dancer possessed by the spirit of the dead man, on seeing the good things provided by his relatives, showed his lovingkindness to them by feeding them with part of the offering and promising them protection and good hunting.

While at Banḍáradúwa we also had the opportunity of seeing a Siṇhalese " devil " ceremony at the village of Gonagola, some four miles from Banḍáradúwa. The ceremony was got up to cure a woman and child of what seemed to be chronic malaria, though the woman also had a number of chronic sores which suggested multiple granulomata. The ceremony, which began about 2.30 P.M., lasted about six hours, the *kaṭṭadirála* being possessed by a number of demons in turn, to all of whom offerings of various foods were made. A living fowl was offered to one of the demons, *Riṛi Yaká* by name, but no masks were worn, and the ceremony could not begin until fresh blood, other than the blood of a fowl, of which there were many running about the village, had been obtained. To this end the villagers borrowed a gun from a member of our party, and although nominal Buddhists, having shot a monkey but not quite killed it, they could not be persuaded to kill it until the rice with which the blood was to be mixed was cooked, since the fresher its blood the more pleasing it would be to the spirits invoked.

From Bandáradúwa a long day's walk brought us to Uniche, where we arrived tired and in advance of our carriers, to be most hospitably entertained by the Engineer in charge of the construction of the bund of the big new tank. After sleeping that night in unwonted luxury in the Irrigation bungalow, we went on to Tumpalamcholai, and from there to Maha-oya, whence, with the resthouse as our base, we made a number of trips to the Veddá communities in the neighbourhood. The most interesting of these was a visit to four families that lived in the wild country to the south of Nuwaragala. These folk make no *chena* and have no huts, but live a wandering existence, spending their time in caves and rock shelters and living entirely on game, yams, and honey. We had heard vaguely of this group of Veddás for some time past, and had tried to reach them from the neighbourhood of Bandáradúwa, as, if this had been possible, it would have saved us the long and wearisome tramp to Tumpalamcholai, but there had been illicit *chena* making in the neighbourhood, and every effort had been made to lead us off by the local *árachchi*, and it was only after the matter had been taken up by Mr. G. D. Templer of the Forest Department that we were able to reach them. Among the most interesting things we saw among these people were the rough drawings of men, dogs, elephants, and leopards with which the walls of their caves were decorated. These drawings are made by moistening wood-ash with saliva, and drawing on the walls of the cave with the finger dipped in the paste thus produced; the spots of the leopards being indicated by dots of black made by working up charcoal with a little saliva. These drawings were extremely crude and rougher than the Australian cave drawings, which have been described by many observers, though they did not compare unfavourably in artistic skill with some of the rock drawings of the North Queensland aborigines, of which, indeed, one of us was strongly reminded.

There are a number of other small Veddá communities within a few miles of Maha-oya, who, though more sophisticated than the Nuwaragala community, well repaid visiting. Those of Mudugala, now settled at the hot water springs (Unuwatura-bubule) within a couple of miles of Maha-oya, although socially much influenced by the surrounding Sinhalese, must be regarded as tolerably pure blooded, for they are all extremely short men—the shortest member of this community being only 53½ inches—while two other men who seemed about the average height of the people were 56 and 56¾ inches respectively.

From Maha-oya we went on to Kallodi, where we were detained for a couple of days by the temporary loss of three of our bulls, that were finally caught some ten miles from where they had got away from our *tavalam* leader. Part of this time was spent in the partial excavation of a cave on the slopes of Kokagala hill. The roof of this cave was horizontal, the shelter having been formed by the wearing away of a soft horizontal stratum. A trench, some 12 feet long, was first cut; immediately under the superficial soil were two layers of bricks, directly below which there lay a flat worked stone with a flange cut on one surface of it. The stone itself was nearly 3 feet long by some 15 inches broad and about 5 inches thick. So far no bone or fragments of pottery had been found, and it was not until a depth of about 30 inches was reached that fragments of pottery appeared. Nearly a foot lower we found a considerable quantity of coral, some bones, a couple of pieces of very poor iron ore or very rich slag, fragments of pots, and a number of badly preserved pieces of wood charcoal. Below this there was a fine gray layer of ashes about six inches thick, resting upon what appeared to be the bedrock floor of the cave. Only a very few pieces of quartz, and these such as might easily have got there without human assistance, were found, so that there was nothing to show that this cave was ever inhabited by the same folk who at one time occupied the Bendiagalgé caves and left their worked quartz implements behind them. A good drip-ledge is cut on the rock above the mouth of the cave, on the roof of which, some 5 or 6 feet above the present floor level, there are a few traces of a whitish substance which may be the remains of rotten plaster.

From Maha-oya we walked to Alutnuwara, stopping on the way at several settlements of Village Vẹddás. These are the people visited and so well described by Deschamps, and we are able to confirm all he says as to their unpleasant behaviour. They live in well-built huts and have good chenas, and do a considerable traffic with Siṇhalese hawkers, a couple of whom were staying in the village of Dambani at the time of our visit. These folk have been utterly spoilt by being sent for to dance and make sport for visitors, generally more or less distinguished. They ask for presents every five minutes, and when one man is given a present for any assistance rendered, every member of the village clamours to receive the same. They have preserved a number of words, which are not obviously Siṇhalese, or are Siṇhalese periphrases, and speak in a loud, harsh tone; this being very largely a matter of pose got up to impress the visitors, though the singularly helpful and kindly Árachchi of Beligala seems unintentionally to have fostered the habit. He is the usual guide to visitors who come to see these Vẹddás, having, as he says, known them well for thirty years, and he always speaks to them in the same harsh tone of voice.

We slept a night at Dambani, and early the next morning started the phonograph, against which even these disagreeable people were not proof, and with its aid were able to collect a good deal of information about the *yaku* and obtain a number of their songs and incantations. Warned by our experience at Dambani we did not visit the other big Village Vẹddá settlement of Bulugahalandena, but sent for some of these men to visit us at Beligala, where for a couple of days we made a most comfortable camp in the outhouses belonging to the Gamarála, whose courtesy was very marked. From here, after a brief visit to the *chena* settlement of Welanpelle, which was certainly not worth the detour we made to reach it, we went on to Alutnuwara, where we found the main part of our baggage which had been sent on by the good track from Kallodi.

The Siṇhalese new year now made it necessary to give our men a holiday, so, after a couple of days of quiet spent in working up notes, we crossed the Mahawęli-gaṇga and walked to Madugoḍa, climbing *en route* the Gallepadahulla, or pass of one thousand steps, the old pilgrim route to Alutnuwara. A zig-zag road up the hill, which is practicable for bulls, has been made, but in spite of this and the disrepair into which the stone steps of the pass have fallen, we met a fair number of pilgrims, and, tiring though the climb was, the view from the top of the pass over Uva and the valley of the Mahawęli-gaṇga was certainly worth the effort. After a pleasant week spent at Kandy we returned by the same route to Alutnuwara, where we encountered considerable trouble in obtaining coolies, which would have been really serious if it had not been for the kindness of Mr. C. Herft, District Engineer, who lent us a batch of road Tamils. From here we started to walk down the valley of the Mahawęli-gaṇga to visit the Vęddá communities which were said to exist stretching northwards and eastwards into Tamankaḍuwa. Although we expected to find these Vęddás had come much under Siṇhalese and Tamil influence, it was necessary to do this in order to obtain a full list of the Vęddá clans (*warge*), for there were a number of clans of which we had obtained the names without being able to verify the existence. Our first halt was made at Hemberawa, about eighteen miles from Alutnuwara, a compact village of potters who are considered of so low a caste that the *Árachchi*, who is theoretically in charge of them, lives at or in the neighbourhood of Alutnuwara, one of their own men being appointed Vidáné, and making an extremely efficient village headman. This man told us that he and his people were the descendants of Vęddás; whether this accounts for the greater energy than usual displayed by the villagers seems doubtful, but we had little difficulty in persuading this man and a number of his villagers to act as guides and carriers to Poḷonnaruwa in place of the Alutnuwara men, who were already clamouring to be sent back. The houses of the village of Hemberawa are rather unusually closely crowded together; very many of them have a potter's wheel in front of them under a lightly built thatch, and between the houses there are many fragments of broken pots, some of them of extremely good design and evidently portions of vessels of unusual dimensions. There were a number of young betel vines growing about the village, and one of these was protected from the evil eye in an interesting and, as we believe, infrequent manner. Instead of the usual blackened inverted pot with white designs on it, the skull of a buffalo was carefully placed at the foot of the prop up which the vine was climbing, in order, as we were assured, to exert the protective influence already alluded to (figure 5).

As the folk of Girandura, the nearest Vęddá settlement, were hopelessly sophisticated and entirely resembled the local Siŋhalese, we walked on next day to Elakoţaliya, where it had been alleged that there were true wild Vęddás, but as we did not think this likely we were not disappointed when the Elakoţaliya folk turned out to be a small group of pleasant, well-nourished people, living on a good *chena*, who remembered only a few of their Vęddá customs. Passing the night at Elakoţaliya we started in the dusk of the dawn next morning for Yakure, leaving ourselves time and opportunity to spend whatever time was desirable at Kalukalaeba, where there is a Vęddá *chena*. These folk still remember the *warge* to which they belonged, but have adopted a Siŋhalese mode of life; so, after a few hours we went on to Yakure, a large and populous village doing a big cattle breeding trade and inhabited by folk resembling Tamils and worshipping Hindú gods, but who still call themselves Vęddás and are of the Vęddá clans and observe clan exogamy.

These folk told us that there were Vęddás less sophisticated than themselves at Ulpota and Kohombane, some ten or twelve miles distant, so we sent for some of these. The headman of these people knew a few words of the "Vęddá" or "jungle" dialect which has been already referred to, but when asked on what occasions he used these, replied: "When sent for by visitors and Government officers." He, however, confirmed the information concerning the clans that we had already obtained from the folk at Yakure. The next morning we walked to Poļonnaruwa, where we heard of a group of descendants of Vęddás living at a place called Roţáwęwa, who make rice fields in the same way as do their admittedly Siŋhalese neighbours, and a small community who at one time lived near Sígiri. It appeared that these were the people who have been spoken of as Poļonnaruwa Vęddás, but we did not visit their village. After a couple of days at Poļonnaruwa we went on to Sígiri, where we were for the first time able to approach near enough to a colony of *bambara* to obtain good photographs. There ended our journey in the Vęddá country, a journey leaving, amidst many pleasant recollections, two dominant remembrances—the extraordinary beauty of the park country and the charming courtesy of the still unsophisticated remnants of its inhabitants.

THE MODES OF OCCURRENCE OF QUARTZ IN CEYLON.

By JAMES PARSONS, B.Sc., F.G.S.

IN view of the attention which has recently been directed to the occurrence of ancient quartz implements in Ceylon, it may be of interest to indicate the nature of the varieties of quartz which have been found in the Island, and the special physical characteristics of these varieties with reference to their mode of origin.

Quartz may be defined as silica or silicon oxide crystallizing in the trapezohedral group of the hexagonal system. Its specific gravity is 2·65 ; its hardness on Mohs' scale 7, thus easily scratching ordinary window glass. It melts at a temperature of over 1,400° C., but in igneous rocks it is, as a rule, the last constituent to solidify, being moulded by and filling the interstices between other minerals which in the laboratory have been shown to melt at lowert emperatures. This reduction of the fusion point is probably due to the presence of water vapour under great pressure.

Quartz when quite pure is colourless and transparent, but when impure may be found of all colours from white to black, and be translucent or opaque.*

The white colour is due, as a rule, to minute inclusion of gas or liquid. Shades of green, yellow, red, and blue are due to traces of metallic oxides, and when dark brown or black it has been shown that it often contains organic compounds.

When in the form of crystals, these commonly appear as hexagonal prisms with pointed terminations, which approximate to hexagonal pyramids. There are usually transverse striations on the prism faces. The conchoidal nature of its fracture may be well seen in any artificially chipped piece of crystalline quartz or flint, when it gives rise to what is known as the " bulb of percussion." It has practically no crystal cleavage, *i.e.*, shows no disposition to split along any definite plane in relation to its crystal outline.†

The term quartz will be here taken to include the vitreous or phenocrystalline forms, to which it is popularly and perhaps correctly confined, as well as the cryptocrystalline or chalcedonic forms, including chalcedony and impure forms, such as flint, chert, and jasper. There is some question whether the cryptocrystalline form should be considered hexagonal, part at least of the silica in chalcedony appearing to be triclinic.

* Clear quartz is known in Sinhalese as *palinguwa* and the white translucent variety as *tiruwana*.

† As shown later a schistosity or slaty cleavage may be developed in quartz masses.

Opal is an amorphous, hydrous form of silica. It occurs in Ceylon in some cherts, and occasionally forms independent masses. Precious opal is not known to occur in the Island.

Quartz is the most abundant mineral in Ceylon, as indeed it is in the whole crust of the earth. Taking first the vitreous varieties known to occur, these have a wide distribution in the series of crystalline schists or gneiss, of which practically the whole of Ceylon is composed. In the majority of these it forms an essential constituent, and may even be present as an accessory in the crystalline limestones which occur interfoliated with the gneiss. In the gneiss it occurs usually in irregular grains moulded by the other rock constituents and interlocked with them. It may also be intergrown with the felspar in micropegmatitic fashion or extended in parallel rods. The characteristic colour of charnockite is largely due to the dark quartz, which is an important constituent of the rock, but the cause of this colour in the quartz is obscure. The different divisions of the gneiss have very varying quartz contents, and bands may be found ranging from almost quartz-free rocks through types containing only isolated grains of felspar and garnet to rocks entirely composed of quartz. These granular quartz rocks attain considerable development over the central part of the Island, forming bands which may have a thickness of several yards. It is important to note that the quartz rocks are simply highly siliceous foliæ of the gneiss, and not quartz veins. Casual gold prospectors in Ceylon have often referred to them as "lode quartz," and many assays have been made of the rock, which has only ccasionally shown traces of gold, due probably to the introduction of the metal by infiltration along cracks.

When unaffected by earth movements, the rock is more or less friable, and consists of interlocking grains of white quartz, sometimes with occasional grains of kaolinized felspar and garnet. Recent observations have, however, shown that this granular white quartz is the source of the greater part of the glass clear quartz and quartz crystals which are common, but not often observed *in situ*. It is the clear quartz derived from the granular quartz which probably forms the greater part of the material from which the ancient implements have been made. The rock is more readily than any other in Ceylon affected by comparatively slight earth movements. The earliest stage in this dynamo-metamorphism is to shatter the rock, rendering it exceedingly friable. This may be seen on a considerable scale in the mountain ridges dividing Uva from the Central Province, where the friable character of the quartz caused some difficulty in tunnelling operations during the construction of the Nanu-oya-Bandarawela section of the railway. It may also be seen about Passara and several other localities. The next stage is the development of a regular cleavage, which was first observed by me near the Badulla-Passara road on the flanks of Namunakulakanda. The most beautiful and striking case, however, has been lately noted at Crystal Hill estate near Matale. In one place where the quartz rock has been thrown into a small low anticline, a regular fine cleavage has been set up radially to the fold, and the quartz has been entirely re-crystallized, becoming glass-clear, and, in places, hypidiomorphic crystals of quartz have been developed, irregularly intergrown with their long axes parallel to the cleavage. This longitudinal intergrowth of the crystals sometimes produces forms approaching "sceptre quartz," *i.e.*, long crystals bearing at one end a stumpy crystal. A good example of "sceptre quartz" may be seen in the mineral gallery of the Colombo Museum, though the origin of that actual specimen is not known. In the clear quartz are discontinuous faint milky lines at right angles to the cleavage, which represent the partings of the original foliation. I would not suggest that all the idiomorphic and hypidiomorphic quartz crystals found in river gravels, especially in the Ratnapura District, originate from the metamorphism of quartz rock, but it is certainly a mode of origin which has previously been overlooked.

The passage of granular quartz into homogeneous transparent quartz may also be well observed on the Passara-Madulsima road, where the rocks are thrown into undulations at right angles to the general foliation strike. Here it is the pink or rose quartz that is developed. In places the rock is full of iron ore, probably ilmenite. On examination of a hand specimen with a lens abundant grains of garnets are seen. These show no crystal outline, but appear as pale pink blotches, fading almost insensibly into the surrounding pink quartz. Under the microscope these garnets are seen to be elliptical in section, with their long axes parallel. They show obvious signs of crushing. The quartz is traversed by faint parallel lines or cracks, also parallel to the long axes of the garnets and marked by some pale green decomposition product. These cracks appear to indicate the original grains. Between crossed nicols the whole of the quartz in the slide, except one grain, extinguishes parallel to these cracks and to the garnets, indicating that the quartz has been re-crystallized and oriented in this direction, which would be the direction normal to that in which the metamorphosing strain occurred. The one grain which is not parallel to the others extinguishes at an angle of 45° with the general direction.

Under a high power, especially by oblique substage illumination, the quartz is seen to be crowded with rutile needles, of which a large number are parallel, arranged at right angles to the garnet axes. One or two beautifully developed little idiomorphic crystals of rutile are also seen. The colour of rose quartz is usually attributed to the presence of titanium dioxide, and the abundant presence of rutile would confirm the supposition in this case.

Rose quartz is fairly common in the Island, but seldom seen *in situ*. When in uncracked pieces of sufficient size it may be cut *en cabochon* as a gem and used for decorative purposes. A good example, showing a star by reflected light, similar to a star sapphire, may be seen in the mineral collection of the Colombo Museum, to which it was presented by Mr. W. C. Wild. Cleaved transparent quartz is found *in situ* in several places (*e.g.*, near Morawaka) besides the Matale District, forming knots in the granular quartz. Its comparative scarcity, however, *in situ* may be attributed to the fact that the surrounding granular quartz disintegrates readily, the homogeneous transparent portion being left intact.

It is of course possible that cleaved quartz may sometimes arise from the dynamo-metamorphism of pegmatite or infiltration veins, but I have seen no example of this ; the effect of earth movements on small masses of quartz being rather to shatter the mineral than effect any re-arrangement of its particles. Since writing the above I have observed near Naula, 18 miles north of Matale, an occurrence of idiomorphic and hypidiomorphic transparent quartz associated with a pegmatite (graphic granite). The crystals were intergrown, and faces were found as much as 2 ft. long. They were not actually *in situ*, but the quartz was undoubtedly that of the pegmatite. I am inclined to think that their origin was due to re-crystallization, as near the locality cleaved granular quartz was found, and other rocks near showed clear signs of strong earth movements.

The series of crystalline schists or gneiss is invaded by intrusive pegmatites, in which the quartz is often intergrown with orthoclase and microperthite, forming graphic granite. The quartz in coarse varieties of these pegmatites may sometimes form masses of considerable size. It is, as a rule, translucent, and is fairly homogeneous in structure.

Fine quartz veins also occur filling fissures in the gneiss. These in many cases can be shown to be genetically related to the pegmatites. That they were sometimes injected at a considerable temperature is seen by the metamorphism they occasionally produce in the gneiss; invading it, silicifying it, and giving rise to the formation of iron ores (*e.g.*, at Morahela near Balangoda). The quartz of these veins is, as a rule, white, and has a loosely crystalline structure. It often bears hornblende (*e.g.*, at Rambuke near Rakwana), iron ores, especially ilmenite, also tourmaline, which occurs in needles, or is sometimes seen intergrown with the quartz in graphic fashion. A fine example of this curious rock is exhibited in the Mineral Gallery. To be distinguished from these quartz veins, which are magmatic, or at least solfataric in origin, are the later infiltrations of silica, following rock decomposition, filling fissures and cavities. The quartz may crystallize in idiomorphic forms, and in one observed case, near Rakwana, was amethystine.

Veins of quartz are often seen associated with basic lenticles in the gneiss. These veins often appear to be the result of crush due to earth movements, and follow lines of thrust and faulting. The basic lenticles and pinched bands with associated quartz segregations, in my experience, only occur in regions affected by earth movements, and may result from later metamorphism rather than original magmatic segregation. In some cases the veins resemble pegmatite intrusions. The quartz weathers out in small fragments, which may be opaque or transparent.

Quartz of all varieties in more or less rounded shapes naturally forms the bulk of the river gravels. Granular quartz pebbles are most common, and transparent cleaved quartz can with some certainty be referred to the same rock which has been subjected to dynamo-metamorphism. The transparent crystals in the river gravels sometimes attain a considerable size, and may be colourless, yellow, or brown. Such crystals are occasionally sold in the Ratnapura District to Chinese merchants, and fetch a rupee or seventy-five cents a pound. The coloured varieties are also cut as gems, when the stone may be described as citrine or cairngorm, good specimens of which when well cut show a beautiful transparency and depth of colour.

Crystals of amethystine quartz are often found when gemming. The colour, which is due to traces of manganese, is not, as a rule, evenly distributed throughout the crystal, but confined to the central portion. Hence almost all cut gems of Ceylon amethyst are parti-coloured, but on account of their fine deep purple are highly esteemed, indeed the only other important locality for amethyst is Brazil, since the supply at Oberstein is exhausted. Brazil crystal of all colours is, however, cut at Oberstein.

Clear quartz containing needles of rutile or tourmaline is known as sagenitic quartz. It is sometimes found in gravels, and may be cut *en cabochon* to form ornaments that are more curious than beautiful.

Mention should be made of the quartz cat's-eye or "tiger's-eye," which contains numbers of minute fibres of asbestos or siliceous pseudomorphs after that mineral, showing when cut *en cabochon* a ray of light similar, though inferior, to that of the true cat's-eye, which is a variety of chrysoberyl. Ceylon is referred to in text books as a locality for the stone, and examples may sometimes be seen in local jewellers' shops. I have however never seen it in the field.

Recent sandstones and pits of quartz grains with quartz cement occur near the sea coast at Puttalam, Negombo, and other places.

Coming now to the cryptocrystalline varieties of quartz, excellent examples of chalcedony are sometimes found in the river gravels, doubtless washed from the cavities in decomposed gneiss where they were formed. It also occurs, but rarely, as a thin coating on the joint faces of rocks (Nildandahena).

Of special interest with relation to stone implements are the cherts. Chert is an impure siliceous rock containing chalcedony and sometimes opaline silica stained with iron oxides. As a rule, the silica of cherts is derived from an organic source, such as sponge spicules and the tests of radiolaria and diatoms. The Ceylon cherts, however, are entirely inorganic in origin, and may be described as silicified rocks. Dr. A. K. Coomaraswamy* has shown that the original rock was, in all the cases he investigated, crystalline limestone, in which the carbonates have been replaced by silica introduced in solution by percolating water. Thin sections of the rock, which commonly occurs in the neighbourhood of crystalline limestone, when examined under the microscope, show that it consists of spherulitic aggregates of chalcedony or structureless opal, or both, which may enclose individuals of phlogopite, graphite, and spinel, characteristic minerals in crystalline limestones. In one case corroded dolomite crystals were observed. It was doubtful at the time of Dr. Coomaraswamy's observations if these silicified rocks could originate except from limestones, but since then similar rocks have been found (*e.g.*, near Dodanduwa) which are far from any exposures of limestone, and bear unmistakable evidence in the form of decomposed felspar individuals of their origin from some siliceous rock by decomposition and silicification. The cherts are most commonly shades of brown and red, but are also white and green. The green varieties consist principally of opal, and are softer than the brown. Brown chert was formerly worked for gun flints and strike-a-lights, and is known in Siṇhalese as *gonapitta* or *ginigala*.

Pebbles stained brown with iron oxide, and wholly or partly siliceous, are often dredged up in gemming operations from the beds of rivers, and are known as *kahánda*. They appear to be water-worn pieces of orthoclase or micropegmatite which have been decomposed and silicified.

It is hoped that these notes on the different forms of quartz in Ceylon, and their modes of origin, may be some guide to local collectors of stone implements in forming an opinion as to the nature and probable source of the material used for implements or brought from rock or stream for purposes of ornament.

Implements of white quartz have been found in South Africa and elsewhere, but those of clear vitreous quartz are of extreme rarity in all other parts of the world, except Ceylon, where it was the chief material used, and where implements of that material are found in abundance in certain localities.

For the manufacture of implements the transparent cleaved quartz, which has been shown to be of metamorphic origin, was admirably adapted, as it split naturally into more or less flat flakes which could be easily worked to an edge. Implements showing a cleavage face or fractures are common. Crystals were also worked. The white translucent forms of quartz do not appear to have found so much favour among the ancient artificers in Ceylon, but this may

* Geological Magazine, Decade V., Vol. I., 1904, pp. 16–19.

e more apparent than actual, as the somewhat hackly fracture of
is variety cannot so indubitably show signs of work as the glass-
ear quartz.

In the case of the finds at Maskeliya, Bandarawela, and in certain
ves, the material used was often obtained from derived pebbles,
hich must have been carefully searched for, as pebbles of clear
artz are certainly not common in the neighbouring streams.

Only a few implements formed of chert have hitherto been found
Ceylon, and as the clear quartz cannot be said to be distributed
great abundance in the localities where the implements have been
und, and could then only be obtained in comparatively small
fractured pieces, it is somewhat remarkable that chert was not
ore widely employed, but still more so that one of the compact
iceous varieties of gneiss, such as the common charnockite rock,
s not fashioned to form the larger and ruder tools.

A PRELIMINARY NOTE ON HÆMATOZOA FROM SOME CEYLON REPTILES.

By MURIEL ROBERTSON.

With Plate.

DURING a recent visit to Ceylon I had the opportunity of coming across a number of blood-inhabiting protozoa. I chiefly confined my attention to the examination of the blood of reptiles, and obtained a number of positive results. The following paper gives a very brief preliminary account of the infections met with.

It gives me much pleasure to have this opportunity of expressing my recognition of Dr. Willey's kindness in forwarding the work in every possible way.

I propose for the present to treat the parasites according to their occurrence in the vertebrate host, rather than according to their classification in the Protozoon System.

The two common tortoises in Ceylon are the lake tortoise—*Nicoria trijuga*, and the milk tortoise or kiri-ibba—*Emyda vittata*.

Nicoria trijuga is very generally infected with *Hæmogregarina nicoriæ*, described in 1905 by Dr. Castellani and Dr. Willey. This particular tortoise has two habits; it either lives in ponds or lakes, and these individuals, in even such different parts of the Island as Colombo, Kandy, and Trincomalee, are almost always infected by the same parasite; or it lives an almost dry land existence in ditches. Generally speaking, the dry-land tortoises are not infected. I have often found ticks upon these last, but they never showed any sign of protozoon life.

The water-living tortoise carries a little water leech, an apparently undescribed species of *Branchellion*. The leech lives on the tortoise and lays its eggs on the carapace in large numbers, and although the leech takes up its abode on its host in a much more permanent way than is the case with most of its kind, it nevertheless will wander off it at apparently very slight provocation. This Branchellion appears to me to be the transmitting host for the Hæmogregarine in the blood of the Nicoria.

The Hæmogregarine is of a very ordinary type; it shows multiplication in the vertebrate host, but the details of the process have not yet been quite made out. It also shows the two endocorpuscular types of Hæmogregarines—one a broad type with a large nucleus, the other a slender recurved type with a dense nucleus. In the alimentary tract of the leech the Hæmogregarine is easily to be distinguished; it becomes motile in the intestine, and at a later stage the parasites disappear. They may perhaps pierce through the intestinal wall as described by Siegel, but I am not as yet at all certain upon the point.

The other tortoise, *Emyda vittata*, is a true aquatic creature; it harbours in its blood both a Trypanosome and an interesting Hæmogregarine—I propose to call these provisionally *Trypanosoma vittatæ* and *Hæmogregarina vittatæ*, as this confuses their ultimate classification less than any other method of nomenclature.

The Trypanosome is a large creature, rather reminiscent of *Trypanosoma raiæ* in its general appearance. The kinetonucleus is rod-shaped, and lies at a considerable distance from the non-flagellate tip of the animal; there is a very well developed frilled membrane. The trophonucleus generally lies rather near to the kinetonucleus, but in some specimens is much further forward. The myonemata of this species are to be seen with remarkable clearness, particularly in the live state during certain phases. The analysis of its various methods of locomotion is interesting, but I do not propose to go into it just now; suffice it to say that it shows at times a very characteristic spiral movement. In fact, although this is a distinctly massive trypanosome, it frequently executes the corkscrew figure backwards and forwards, so characteristic of such a spirochæt as, for instance, *Spirochæta anodontæ*, only, of course, the movement is much slower. If a slide with infected blood is sealed and kept for from 12 to 24 hours, small chrythidial flagellates are seen to appear. The first time I came upon these I was much surprised, and hoped not unnaturally that they had arisen from the many hæmogregarines which were also present in the blood. The conditions were repeated, and I was able to follow on the live specimens the development of these small forms from the large trypanosome.*

I can only, in a paper of this type, give the barest sketch of the process. The trypanosome rolls itself up and the flagellum breaks free, but generally still remains attached at the kinetonucleus end. The flagellum is motile for a long time, but finally comes to rest, lying often in an untidy tangle round the creature. The trypanosome divides into two, the daughter individuals generally remaining more or less in contact; a further division into two occurs; the divisions in every case involve both the tropho and the kinetonucleus.

The result of these divisions is a group of four often very irregular little creatures. They become pear-shaped, and put out each

* A somewhat similar multiplication of trypanosomes has been already observed by França (Bull. Soc. Port. Sciences Nat.) and by Dutton, Todd, and Tobey, Ann. of Trop. Med. and Parasit. 1, No. 3, 1907. Both these cases deal with the trypanosomes of frogs, but I have not as yet had the opportunity of seeing the original papers.

a flagellum from their blunt ends. I have over and over again watched this part of the development under an immersion lens, and all that I can say is that a little blunt stiff process simply appears. This gradually lengthens and becomes motile, but at first it is quite unable to move the body of the creature. Finally, it can be observed that the attachment of the flagellum is no longer quite at the blunt end, but has shifted slightly to one side, and a small protoplasmic ridge, which I take to be the first sign of the membrane, is to be detected. The four little flagellates separate and move actively about. This short description does not take into account the considerable variation in detail which occurs. This trypanosome is true to the versatile traditions of the genus, and many slight differences, especially in the relative times at which the processes occur, are to be observed.

The intermediate host for this species is another little water leech. The trypanosome undergoes the above development at once upon being taken into the crop of the leech, and further divisions after the two mentioned seem to occur. The creature finally develops into a slender trypanosome of very varying size with a narrow membrane and a short flagellum; the kinetonucleus very generally lies very close and just anterior to the trophonucleus. It is, I think, important to note that they are to be found in large numbers in infected leeches at the close of digestion, when there is no blood left in the alimentary tract.

Many interesting experiments were tried with the big horse leech, but I have not space to describe them here. The horse leech, by the way, has distinctly catholic tastes, as one specimen started to feed eagerly upon my own hand, and upon being persuaded to desist, took equally kindly to the tortoise. In the blood of the *Emyda vittata*, the trypanosome infection is almost invariably associated with a hæmogregarine infection.

The hæmogregarine shows two distinct types—a long slender recurved individual with pale faintly reticulate protoplasm and a dense nucleus; and a broad type with deep blue staining protoplasm and a very characteristic loose meshed nucleus. This nucleus is not like that of any other hæmogregarine that I have ever seen, and is much more suggestive of the nucleus of a large resting trypanosome, not that I wish to imply that there is a connection between the two infections.

These broad hæmogregarines show a very interesting feature, namely, two large oval bodies which stain from a pale pink to a deep slightly brown red with Giemsa's stain. They are not present in all the broad specimens, especially not in the smaller ones, but they are a very characteristic feature of the larger broad forms. At first they were very suggestive of structures with kinetonuclear affinities, but from their highly refractive appearance in the live tate and the variability in their staining properties, I am rather inclined to consider them as of the nature of plastids. However, I do not wish to make any very definite statement just at present. Besides these "red bodies," as I have called them, there may be many staining granules present in certain cases.

The slender recurved type is much less numerous in the blood than the broad type. It is tempting to consider the recurved type with the pale protoplasm and the dense nucleus as a male gametocyte, and the broad form as the female gametocyte, but I do not at present see any very striking evidence to support such a view.

Multiplication occurs in the spleen and to a lesser extent in the liver, the parent organism giving rise to eight reproductive bodies. These, it is interesting to note, are found to lie in pairs, each pair being enclosed in a delicate boat-shaped capsule. This is very well seen in the live specimen.

In the alimentary canal of the little water leech both the endocorpuscular forms become motile, but I have not as yet got the details of their further development.

The Ceylon lizards do not seem to harbour protozoon parasites to any great extent—a circumstance contrasting with the conditions obtaining in other countries. Thus the common Calotes and the beautiful Brahminy lizard, which the ancient Siṇhalese naturalists firmly believed to be hatched out of cobra eggs, and the skink and the horned up-country lizard were all negative, so also the common little house gecko who lives on the walls and eats flies.

Two species of forest gecko, however—*Hemidactylus triedrus* and *Hemidactylus leschenaultii*—certainly made up for the deficiencies of the other members of the group. These geckoes, by the way, come from the Trincomalee side of the Island; it is all very jungly country with very little cultivation of any kind.

Hemidactylus triedrus harbours a large hæmogregarine with a double capsule. I have called this *Hæmogregarina triedri*. Associated with it in one case was a very delicate trypanosome with a compact circular nucleus; the small kinetonucleus lies immediately behind the trophonucleus, and the body extends for some distance behind the two nuclei. This trypanosome has a very characteristic appearance. I propose to call it *Trypanosoma pertenue;* it is found curiously enough in both *Hemidactylus triedrus* and *Hemidactylus leschenaultii.*

Hemidactylus leschenaultii shows, besides this last-mentioned trypanosome, three other protozoon parasites, which may be found singly or in any combination. The first of these is the Hæmocystidium described in 1905 by Drs. Castellani and Willey. This is a pigmented organism showing a very marked differentiation into a pale form and a deep form; the nucleus is a very delicate structure, rather difficult to demonstrate satisfactorily. There is little doubt that in this case the differentiation marks off the male and female gametes or gametocytes.

The second parasite is a Hæmogregarine (*Hæmogregarina leschenaultii*).—This creature has two free motile forms always present in the blood and two endocorpuscular forms. The one free form is a slender creature with the power of carrying out a truly amazing set of gregarine movements; it is also able to bend double and to execute swimming or gliding movements. This creature has a dense nucleus and pale protoplasm without granules; it has an exactly corresponding endocorpuscular form, which lies with one end slightly curled up.

The other motile form is massive and granular. This creature moves much less actively than the slender form, and its periods of rest alternate with periods of movements something after the fashion of *Coccidium Schubergi*, Schaudinn.

There is a massive endocorpuscular form which is always rather scarce; I think it corresponds to the broad free form, but the nucleus differs slightly.

The third parasite of this gecko is a trypanosome (*Trypanosoma leschenaultii*).—This trypanosome differs very markedly from *Trypanosoma pertenue;* I never found them together in one individual. *Cf.* figs. 8, 9, and 13.

All these gecko parasites were first sent me from Niroddumunai, near Trincomalee, by Dr. Willey. Later on, when I went over to Trincomalee myself, I had the opportunity of studying them all in the live state. The transmitting hosts were not discovered.

Among the snakes only hæmogregarines were found. *Zamenis mucosus*, the common rat snake, which lives on the roofs of houses, and *Chrysopelea ornata* both showed a species with a very marked capsule thickened at both ends. The hæmogregarine lies in the capsule, and often shows a deep red staining area at either end; the nucleus is rather delicate.

Fig. 12.—I have not named this, as I notice that there is a *Hæmogregarina zamenis* named by Laveran, and I have not yet had the opportunity of seeing his description. There is a young endocorpuscular phase without a capsule, and a free motile form also without a capsule.

The cobra also showed a hæmogregarine; possibly it will prove to correspond with some of the already named species found in this snake.

A large python harboured a hæmogregarine, which was most interesting on account of its extraordinary activity. The free form moved with a rapid swimming motion, and was repeatedly seen to enter a blood corpuscle by simply piercing it, to swim round between the nucleus and the corpuscle wall, and burst the corpuscle by curling itself up and suddenly straightening itself. The process takes only a very few seconds; it also can be seen to injure corpuscles which it touches in passing, the corpuscle losing all its hæmoglobin immediately.

The rapidity and the business-like precision of the animal's movements were positively amazing. I was able to make out that the animal swims by means of rapid shallow waves of contraction passing backwards down its body, a slightly spiral twisting of the whole creature often taking place at the same time. This hæmogregarine shows an endocorpuscular stage very closely resembling the free form.

I do not wish it to be inferred that I have in any way made an exhaustive search through the Ceylon reptiles. I examined the animals I met, but it was more to my purpose to try and follow up the positive cases than to spend the time reviewing the reptilian fauna. In a later publication I hope to deal with these forms in much greater detail.

I subjoin the diagnoses of the new species mentioned in this paper.

Trypanosoma vittatæ, mihi. Fig. 1.

Massive trypanosome, body about 50–56 μ in length, and about 6 μ well developed membrane. Free flagellum 22–30 μ in length. Rod-shaped kinetonucleus body behind kinetonucleus very variable in length. Trophonucleus generally about 6–8 μ in front of kinetonucleus, but sometimes much further forward. Characteristic spiral movement, very small forms present in the blood of vertebrate host. Divides in transmitting host into four (also on sealed slide); small flagellated individuals with kinetonucleus anterior to the trophonucleus. These develop later in slender trypanosomes. Transmitting host, a small water leech, Glossiphonia (sp. ?); vertebrate host, *Emyda vittata*. Infection found all over Ceylon.

Hæmogregarina vittatæ, mihi. Figs. 2 and 3.

Hæmogregarine infection associated almost invariably with *T. vittatæ*. Two forms present: (1) broad massive form; (2) recurved form with pale protoplasm; the two limbs are equally long, dense nucleus, length when uncurled 22–26 μ. Broad form shows reticulate dense protoplasm, rather delicate loose nucleus; the larger forms have two red staining plastid (?) like bodies at one end. Schizogony occurs in the spleen and liver; 8 reproductive bodies are formed; these are enclosed in pairs in a delicate boat-shaped capsule. Transmitting host probably Glossiphonia, as above; vertebrate host, *Emyda vittata*. Infection found all over Ceylon.

Hæmogregarina leschenaultii, mihi. Figs. 4, 5, 6, 7.

Hæmogregarine with two free motile forms always present in the blood. (1) Slender free form with dense nucleus rather actively motile; no granules in the protoplasm; length 26–28 μ. (2) Broad massive granular form; less active periods of movement succeeded by periods of rest; length about 26–28 μ. Two endocorpuscular forms also present: (1) long recurved form corresponding exactly with the slender free form, causes hypertrophy of blood corpuscle; this is always the prevailing type in any infection; (2) broad form with reticulate nucleus, grows to a large size, as much as 30 μ (specimen in the figure is not full grown); never very numerous even in good infection. Schizogony occurs in the blood. Transmitting host not known. Parasitic in the blood of *Hemidactylus leschenaultii*. Found at Trincomalee, Ceylon, October, 1907.

Trypanosoma leschenaultii, mihi. Figs. 8 and 9.

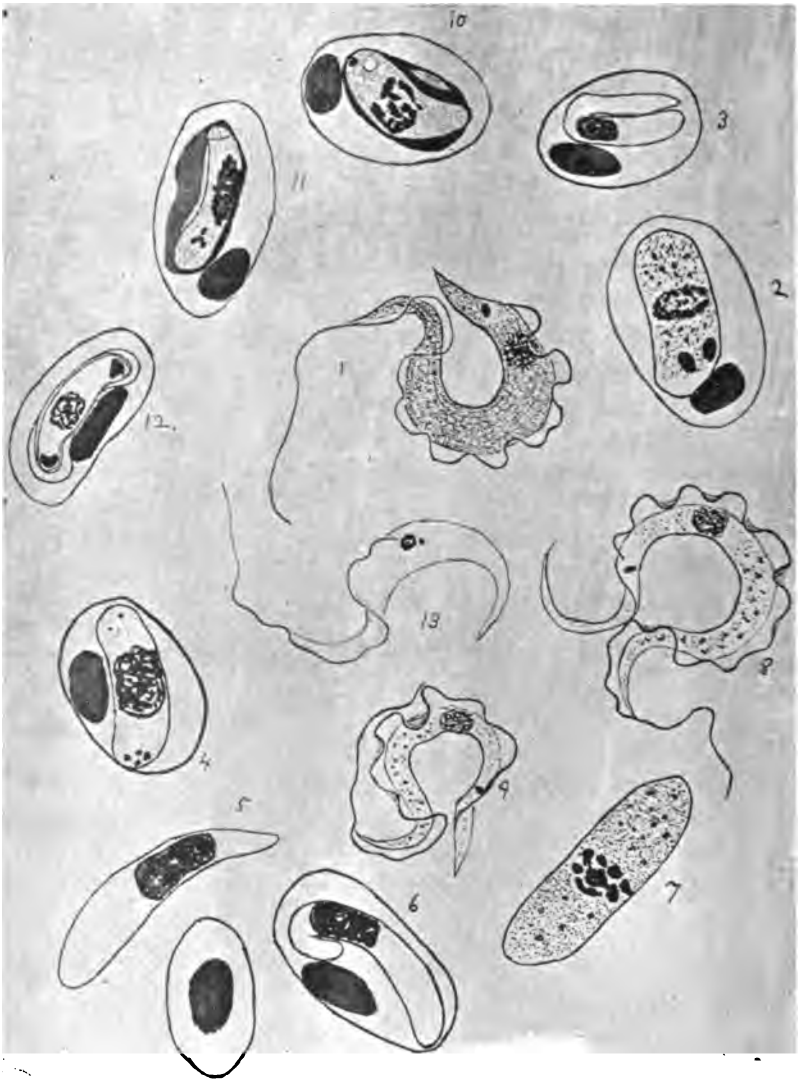
Length of body of larger specimens 56–60 μ, length of free flagellum, 17–22 μ. Many specimens much smaller; rod-shaped kinetonucleus, well-developed membrane. Body extends a long way behind the kinetonucleus; actively motile, often revolving in the figure of a wheel; body very flexible. Parasitic in *H. leschenaultii*. Transmitting host not known. Found at Trincomalee Ceylon, October, 1907.

Trypanosoma pertenue, mihi. Fig. 13.

Very delicate trypanosome; length of body 30–35 μ, length of free flagellum 15–20 μ. Body very thin with very little protoplasm; no granules; small compact circular nucleus lying about half way from the non-flagellate tip. Kinetonucleus very minute, situated immediately behind the trophonucleus membrane, not sharply marked off from body. Parasitic in both *Hemidactylus triedri* and *Hemidactylus leschenaultii*. Got at Trincomalee, in Ceylon, October, 1907. Transmitting host not known.

Hæmogregarina triedri, mihi. Figs. 10 and 11.

Hæmogregarine with double capsule, delicate inner capsule, and loose outer capsule, with tendency to stain very deeply with Giemsa's stain. The inner capsule has an opercular lid at one end. Long slightly recurved specimens with elongated nuclei present, so also broader rather bean-shaped forms. Both forms frequently show an irregularly shaped body at one end, which stains a bright red with Giemsa's stain. The young forms have no capsule. Parasitic in *Hemidactylus triedri*. Got at Trincomalee in Ceylon, October, 1907. Transmitting host not known. The length of this form is from 13-15 μ.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Description of Figures.

1. *Trypanosoma vittatæ*, M. R.

2. Broad form of *Hæmogregarina vittatæ*, M. R. Note the two "red bodies" at the one end.

3. Slender recurved form of *H. vittatæ*.

4. *H. leschenaultii*, M. R., broad endocorpuscular form; this specimen is not full grown.

5. Free slender form of *H. leschenaultii*.

6. Slender recurved endocorpuscular form of *H. leschenaultii*.

7. Broad free form of *H. leschenaultii*. Note granular protoplasm.

8. *Trypanosoma leschenaultii*, M. R., large form.

9. *T. leschenaultii*, smaller specimen.

10. Broad endocorpuscular form of *Hæmogregarina triedri*, M. R. Note the deeply staining outer capsule.

11. Slender endocorpuscular form of *H. triedri*. Note the dark outer capsule and the delicate inner capsule with the operculum.

12. Hæmogregarine from *Zamenis mucosus* and *Chrysopelea ornata*. Note the highly refringent capsule thickened at either end. Note also the deep staining area at either end of the hæmogregarine.

13. *Trypanosoma pertenue*, M.R. Note characteristic appearance of the trophonucleus and the kinetonucleus, and absence of granules of any kind.

NOTES.

1. *Miscellaneous Records. Callophis trimaculatus.*—This small snake is so rarely met with in Ceylon that the capture of a specimen is something of an event to a naturalist. Whilst riding along the road from Niroddumunai to Trincomalee, shortly after sunrise on October 4 last, I came upon a very slender snake lying across the track, and rode over it without injuring it, so slim is its body. Upon picking it up I recognized it at once by its black head relieved by two pale round occipital spots behind the parietal shields. Besides the black upper surface of head and nape, there is a more or less interrupted band of black behind the vent and another similar fenestrated band before the tip of the tail. The specific name doubtless refers to these three patches of black, which are conspicuous upon an otherwise uniform pale grayish brown ground colour. The nearly white occipital spots are sharply defined, about half a millimètre in diameter, and evidently an important element in the scheme of coloration. They may possibly belong to the category of the so-called "false eyes,"* which may produce a terrifying effect on certain enemies, and thus act as warning signals. They can only be faintly discerned in specimens preserved in alcohol.

Another feature which disappears in alcohol is the orange colour of the ventral surface. Beginning in the anterior region as a pale yellowish median tract, it gradually widens and becomes denser, until it occupies the whole extent of the ventral shields as a bright orange yellow band until it reaches the end of the abdomen, where the anal and preanal shields are dark orange red, almost scarlet. This brilliantly coloured preanal tract is immediately followed by the post-anal black belt. The subcaudals are pale bluish, with a few irregularly distributed orange red spots.

It is a venomous snake allied to the cobra and bungarum, but is too small to be dangerous, and can be handled with impunity, making no attempt to bite. In captivity it seeks to hide its head under whatever cover may be afforded.

The length of the specimen under description is 12 inches, the diameter 4 mm. The previous records of the occurrence of this species in Ceylon are summarized in this Journal, Vol. I., p. 85. From these it appears that the snake is a characteristic member of the eastern fauna of the Island.

Flight of Butterflies at Trincomalee.—Between 11 A.M. and 1 P.M. on last October 4, I witnessed an extraordinary flight of brown and speckled butterflies at Trincomalee, comparable in

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* See this Volume, p. 92.

intensity to the November flight of the yellow *Catopsilia* which occurs annually northwards over Colombo. The great majority consisted of the brown *Euplœa asela*, but perhaps two or three per cent. (this small percentage representing a goodly number, so vast was the total swarm) were the speckled *Danais septentrionis*, the male of which has a peculiar pouch on the hind wing. They were passing in a southerly direction over Trincomalee.

The brown *Euplœa* is a very common species occurring diffusely throughout the country, often met with in considerable companies settling upon damp places by the roadside. This time, however, there was no such casual meeting of individuals alternately flitting low and resting, but a high concerted and sustained movement over the trees and houses and along the seashore in incredible numbers.

It is a seasonal flight, and is recognized as such by the inhabitants of the district, who aver that the butterflies are going to Kataragam, a famous Hindú sanctuary in the south of the Island, a few miles from Tissamaharama.

Small samples of each kind were taken for examination. Of 16 examples of *Euplœa asela*, 12 were males, 4 females; of 14 *Danais septentrionis*, 10 were males, 4 females.

The suddenness with which the apparition vanished was remarkable. Looking out over the maidan in front of the resthouse at 1.25 P.M. not a butterfly was to be seen. It was essentially a mid-day fight. During the afternoon a few isolated stragglers were noticed, but the main advance ended sharply as described. It is not difficult to assign a climatic reason for this flight. The date at which it occurred was during the lull which succeeded a strong access of the south-west wind, preceding the onset of the north-east rains, the clouds for which were already banking up to burst in a blind squall the next evening. In this part of the Island the south-west and north-east monsoons coincide accurately with the dry and rainy seasons respectively. This is not the case in the Western Province. The south-west blow which freshened during the last ten days of September was accompanied on the west coast by heavy rain, but not in the neighbourhood of Trincomalee.

Probably the swarm had been travelling in a column for miles along the seaboard. No enemy was following them. I do not know whether a corresponding flight had taken place at noon on the day previous, but I do know that on the day following, which happened to be the occasion of the annual Kumbom or Flower Festival, there was no repetition of it.

The fact of the simultaneous emergence of the butterflies in myriads in powerful flight in a fixed direction gives to it an appearance of objectivity which it may not possess in reality. It may be nothing more than a static seasonal brood, not an actual migration from one place to another. One is reminded of the story of the Catopsilias heading towards Adam's Peak to dash themselves to death against the Samanalakanda or Butterfly Rock. I have seen them, however, in the month of December (1907) flying across the Labugama Reservoir away from the direction of Adam's Peak, being pursued by numerous Philippine Bee-eaters at noontime. Owing to their rapid zigzag flight the birds found considerable difficulty in catching them on the wing, often missing. When one had been caught, the bird would fly away with it to a tree, not bolting it outright. Amongst the bee-eaters was to be seen an occasional Ashy Wood Swallow, also hawking over the reservoir.

A. WILLEY.

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2. *Review: Fisheries of New South Wales.*—In view of the interest which is being displayed in the local fisheries, it may be useful to append some extracts from the report of the Board of Fisheries of New South Wales for the year 1907, which has been received at the Museum by the courtesy of the authorities.

The subject matter may be divided into three main sections: statistical, restrictive, and constructive. As in all cases where the State takes cognizance of the fisheries, the utility of recording returns of the catches is recognized. A return compiled from "Weekly Statements furnished by Fish Agents in the Metropolitan Markets" shows the quantity of fish received by them for sale. The form of return includes the following headings:—Name of Water, Name of Market, Description of Fish (classified as fish; "crayfish," by which is meant the spiny lobster or *Langouste*, *Palinurus hugelii*; lastly, prawns). The total quantities for 1906 and 1907 are—

	Baskets of Fish.	Dozens of Crayfish.	Baskets of Prawns.
1906 ..	128,854 ..	4,916 ..	2,984
1907 ..	124,078 ..	7,075 ..	4,678

Clarence river is the leading water, with an output of 23,737 baskets of fish; Port Jackson and Parramatta river yielded only 3,559 baskets of fish, 61 dozens of crayfish, and 228 baskets of prawns in 1907. Lake Illawarra contributed 5,294 baskets of fish, 3 dozens of crayfish, and 2,916 baskets of prawns. Hastings river furnished 3,037 baskets of fish, 2,833 dozens of crayfish, and 20 baskets of prawns. The average price of crayfish in the market is estimated at 8 shillings per dozen.

The numbers quoted above are from the Sydney market returns, and do not include quantities consumed elsewhere. Thus, the report of the Inspector of Fisheries for the Northern District shows that the total catch from the Hastings river waters was 5,451 baskets of fish in 1907, as against 2,167 in 1906. A table on page 48 shows the quantities of different kinds of fish taken in each month of the year, the most productive months being March and September–November, November leading. The sub-totals for the year are the following :—

Hastings River Returns, 1907.

	Baskets.
Mullet	2,319
Whiting	897
Bream	838
Blackfish	684
Schnapper	253
Garfish	219
Jewfish	113
Miscellaneous	164
Total ...	5,451

Besides this grand total, the Hastings river yielded 4,085 dozens of crayfish (of which 2,833 dozens were put upon the Sydney markets). "This industry has at length been systematically established at Port Macquarie, and has been carried on during the year by two steam smacks from 15 to 20 tons, each working from 35 to 40 pots." The smacks at the same time were employed in line-fishing for schnapper or red fish, which were very plentiful, but when sent to market they failed to bring satisfactory prices, "and consequently, when the crayfish season ended, they gave up the line-fishing and returned to Newcastle." As numbers of crayfish died in transit in the hot weather, the divisional inspector recommended that they should be carried in ships' tanks, "preferably of wood, fed with a constant supply of salt water, and subdivided fore and aft and athwart them with perforated parting boards to prevent damage to the fish by the wash in heavy weather."

Restrictive measures depend partly upon the conflict between line-fishing and net-fishing. Certain waters are closed to net-fishing for a specified term, ranging from eighteen months to three years.

Mr. H. C. Dannevig, Superintendent of Fisheries Investigations and Fish Hatcheries, proceeded to Hobart on July 21 to obtain a stock of Tasmanian flounder, during the spawning season, for transfer to Gunnamatta Hatchery. About 1,500 fishes of various sizes were placed in fish-tanks on board a steamer which conveyed them to the hatchery. When placed in the pond at the hatchery, they commenced to spawn almost immediately. About fifteen million fry were hatched out and liberated in suitable localities at Port Hacking, Botany Bay, Middle Harbour, Lane Cove, and Brisbane Water.

In the month of July Mr. H. Dawson, Representative of Inland

Fisheries, visited Melbourne to arrange for the introduction of live roach in New South Wales. It was intended to strip the fish, and after fertilization to convey the eggs in suitable vessels from Melbourne to Sydney. Unfortunately they were not able to secure any fish for stripping, "as the roach shoal passed from the lower to the upper waters of the Yarra river without being observed by the scouts who were on the look out for them, and they were therefore compelled to collect eggs which were deposited in weeds in the river." About 30,000 eggs were collected in this manner, and were hurriedly despatched in wooden buckets to Sydney; but on arrival at Prospect Hatchery on the following day, all but about 100 were dead, and the survivors were so low in condition as to give no hope of fry being obtained for any practical purpose. "The eggs were evidently in too advanced a stage of development when obtained from the river to ensure success, and this was evidenced by the bulk of them hatching out on the journey, and the fry dying at once on account of the unsuitable conditions."

Other work in connection with inland fisheries chiefly concerned river pollution and trout acclimatization.

A conference of fisheries experts, convened by the Federal Government in connection with the Australian fisheries, was held at Melbourne in August, 1907. It was agreed that the first duty was to ascertain the nature and extent of the native fish. For this purpose it was decided to equip a vessel, and to appoint a person of practical acquaintance with fish and fisheries to be Commissioner of Fisheries, whose duty would be to engage upon a systematic investigation of waters off the coasts of Australia and Tasmania and of the biological and physical problems which they present, "with the object of determining the character, abundance, distribution, and economic value of the inhabitants of the waters, as also their migrations and the causes influencing or regulating the same, the object being to arrive at the life-history of all species having economic value, as well as those species to which they are intimately and essentially related."

The report from which the preceding selections have been made is a lengthy one of 71 pages. It will be seen that the Australian Commonwealth have quite recently inaugurated a system of fishery investigation in no niggardly spirit.

ED.

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3. *Spider Mimicry.*—Last year Mr. E. E. Green described a remarkable case of mimicry on the part of an Attid spider which resembled a Mutillid wasp (see *Spolia Zeylanica*, vol. IV., p. 181;

and V., p. 91). The spider has recently been identified by Mr. R. I. Pocock as belonging to the species *Cœnoptychus pulchellus*, Simon, 1885. Some years later it was described and figured by another arachnologist, Dr. F. Karsch, who gave it the synonym *Onychocryptus mutillarius*, not knowing that it had been already recorded under another name (*cf*. E. Simon, Hist. nat. des Araignées, 2nd edit., vol. 2, p. 174, 1897; and F. Karsch, Arachniden von Ceylon und Minikoy gesammelt von Drs. P. und F. Sarasin, Berliner Entom. Zeit. XXXVI., 1891, pl. XI., fig. 17).

From the specific name given by Karsch it is clear, as Mr. Pocock points out in a letter, that he too had noticed its similarity to a Mutillid wasp. Mr. Green's confirmation of this case of mimicry is therefore very interesting.

ED.

Erratum.

On page 110 of this volume, instead of *Tinnunculus alaudariu* read *Tinnunculus alaudarius*.

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SPOLIA ZEYLANICA.

THE PLUME-MOTHS OF CEYLON.

Part I.—The Pterophoridæ.

By T. BAINBRIGGE FLETCHER, R.N., F.E.S.

(With 5 Plates and a Map.)

INTRODUCTORY.

IN popular language the term "Plume Moths" generally includes the members of two families, the Pterophoridæ or true plumes and the Orneodidæ or 24-plumes, whose common peculiarity lies in the fact that their wings are more or less split into segments resembling feathers or plumes. Both these families are doubtless very ancient forms, as is shown by their universal distribution and the absence of any other nearly allied groups. Nor must it be imagined that the Pterophoridæ and Orneodidæ are at all closely related, merely because they are both included under the popular term of "Plume Moths"; as a matter of fact, they seem as little related to one another as either is to any other group of the Micro-lepidoptera.

Fission of the wings, indeed, occurs sporadically in many other groups of the Lepidoptera: for example, the Syntomidæ (which have been held to be the most specialized of all moths) include the curious *Trichæta pterophorina*, Mab., from Natal and Mashonaland, in which the fore wing is deeply cleft; the Arctiadæ include *Rhagophanes tortriciformis*, Z., from Java, in which the hind wing is cleft to its middle; whilst amongst the Oxychirotidæ we find *Cenoloba obliteralis*, Wlk. (specimens of which I possess from Trincomalee), in which both wings are cleft into two segments.

As regards any advantages conferred by this fission of the wings nothing is known, but it seems probable that some advantage will be found in considering the mechanics of flight amongst these species. Where rapidity of flight is not a desideratum it appears reasonable to suppose that a light framework of wing (so to speak), supplemented by a large surface of long cilia, will be of advantage as compared with the ordinary type of lepidopterous wing by giving an equal measure of aërial support for less weight, and consequently less expenditure of muscular energy; the same device is seen in many of the minute species of *Tineina*, in which the cilia are enormously developed. As regards the origin of the clefts, it has been suggested that these have been developed along lines of weakness caused originally by the folding of the wings when at rest.

The Pterophoridæ may be described roughly as small, slim moths with long legs; the fore wings usually cleft into two segments, the hindwings into three; maxillary palpi obsolete; the rows of specialized scales near the dorsal margin on the basal half of the second segment of the hind wings are also characteristic. They are often attracted to light at night, or may be disturbed from low-growing herbage in the day time, when they usually fly only a short distance and alight on a stem or the upper surface of a leaf, where they rest with their wings nearly horizontal and held out at right angles with the body, the hind wings being folded up under the fore wings. But they are best obtained by breeding the larvæ, which are readily found once the food plant is known.

Bibliography.

Until within the last three or four years the Plume-moths of Ceylon have suffered neglect at the hands of collectors and systematists alike. In 1864, in his "List of Insects in the British Museum," Francis Walker enumerated four species (*argyriodactyla*, *anisodactylus*, *oxydactylus*, and *leucadactylus*), collected by Dr. Templeton and Mr. Nietner, all of which were described as new; in 1875 Felder figured and named *taprobanes*, which had been brought back by the Austrian Scientific Expedition in the frigate "Novara;" in 1887, in his "Lepidoptera of Ceylon," F. Moore quoted Walker's descriptions and Felder's figure and described as new one species (*serindibanus*) which has since proved identical with a well-known European species; and in 1891 Lord Walsingham described and figured *concursa*.

During a period of forty years, then, only seven species had been found to occur in Ceylon; in 1905 Mr. E. Meyrick commenced his descriptions of Indian Micro-Lepidoptera in the "Journal of the Bombay Natural History Society," and in the three years, 1905-1907, the former number has represented about the average annual additions to the list, thanks to the energies of our local lepidopterists, and to this number again I now add another eight species or "forms." Although there is no reason to believe that no further additions will be made to our list—indeed, I venture to suppose that our local Pterophorid fauna will eventually be found to include at least fifty species or forms—yet it has seemed to me that a useful end will be served by collecting together the various items that have been published or discovered regarding the Plume-moths of Ceylon. A review of what is already known will at least clear the ground for further work.

IDENTIFICATION.

One of the great difficulties of all local workers at zoology in the tropics lies in the identification of their specimens. "Si nomina nescis, perit et cognitio rerum," and nowhere is this truer than in entomology. Considerations of space have prevented my giving a detailed description of all the species, but the tables will facilitate determination, which may then be confirmed by reference to the descriptions and figures cited under each species.

There should be little difficulty in identification by means of the analytical keys to the genera and species, but a few words of explanation may be advisable. Each key is dichotomous throughout, that is to say, each heading is subdivided into two until the final results are reached. Each head is numbered consecutively, and each subdivision of a head is made to refer either to a final result or to a following head. There are two stages in the identification of any species, the finding first of its genus and secondly of its specific name.

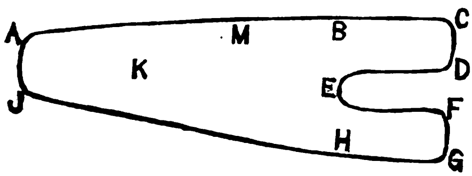
To take an actual example. Firstly, we have to note whether the wings are fissured or not; we find they are fissured, and are referred to the number 3 on the right of the page. Now, turning to the number 3 lower down on the left of the page, we see that the fore wings have two lobes and are referred to the number 4, which we follow down in the same way. The cilia contain distinct scale-tufts, which brings us to number 5. The dorsal cilia of third segment of the hind wing contain a distinct scale-tuft, which refers us to number 9. The second segment of the fore wing is distinctly broad, so that the specimen must fall under number 10 and, as the segments of the hind wing are differently shaped, it must be a *Platyptilia*.

The second stage is to find the specific name. We turn to the Synopsis of the Species of *Platyptilia* and note that our specimen has the abdomen shorter than the dorsum of the fore wing, its pectus is not yellow, and the large scale-tooth on dorsum of third segment of the hind wing touches the apex, so that the moth must be *P. pusillidactyla*, an identification whose accuracy is strengthened on turning to that species by the fact that we bred it from a boxful of flower and seed heads picked off a *Lantana* bush.

In drawing up the key to the genera some difficulties have presented themselves, due to the fact that I have endeavoured to make use only of characters easily made out by means of a simple lens at most, without the aid of the microscopic manipulation necessary to determine details of neuration, &c.; however, it is hoped that local collectors will find the table quite workable. Should examination of the neuration be necessary the following method may be adopted: take a glass slide and smear on its centre a thin layer of clove oil with a fine brush, remove the wings and place them in position on the slide, lightly smearing them over with clove oil, carefully cover them with a drop or two of Canada balsam, and apply over them a cover-glass, which may be held down by a clip or small weight for a few days until the balsam is hard. By adjusting the mirror of the microscope, so that the rays fall a little obliquely, the nervures show up fairly well. Descaling by means of a very fine brush or by immersion in "Eau de Javelle" is not, as a rule, satisfactory, except in the case of large specimens.

Structure.

For the convenience of local collectors I give a diagram showing the terms used in descriptions of the parts of a wing :—



AJ	..	Base.
ABC	..	Costa.
C	..	Apex.
BCDE	..	First segment or lobe.
CD	..	Termen or outer margin.
D	..	Posterior or anal angle.
DE	..	Posterior margin of first segment.
DEF	..	Cleft or fissure.
E	..	Base of cleft.
EF	..	Anterior margin of second segment.
F	..	Anterior angle of second segment.
EFGH	..	Second segment or lobe.
FG	..	Termen or outer margin.
G	..	Tornus, tornal or anal angle.
JHG	..	Dorsum, dorsal or inner margin.

Positions in the wing are reckoned from the base outwards; for example, a marking at position B in the figure would be described as a marking on costa at $\frac{2}{3}$; one at position K would be in disc at $\frac{1}{3}$; one at M would be a subcostal marking at $\frac{1}{2}$.

Apical	..	Touching the apex.
Anterior	..	Nearer to the head.
Posterior	..	Further from the head.
Cilia	..	The fine hairs composing the fringes of the wings.
Falcate	..	Hooked or bent like a sickle.
Ferruginous	..	Rust-coloured.
Fissured	..	Cleft, divided into lobes.
Fuscous	..	Grey-brown.
Linear	..	Having no apparent breadth nor any outer angles.
Sub-	..	Nearly or rather.
Pectus	..	The lower surface of the thorax.

Synonyms and Citations.

The more important of these will be found quoted under the various species, but I regret to say that many of these papers are inaccessible to the ordinary student in Ceylon, *i.e.*, no copies are to be found in any public or scientific library in the Island. The most generally useful papers are those on the family by Mr. Meyrick in Trans. Entom. Soc., London, for 1886 and 1907, and in the Bombay Society's Journal, vol. XVI., part 4, *et seq.* The descriptions in Walker's Catalogue are hopeless without reference to the type-specimens, and Moore's "Lepidoptera of Ceylon" and Cotes' and Swinhoe's "Catalogue of the Moths of India" may safely be ignored by workers in this group.

Contractions.

The following contractions are employed :—

B. J.	..	Journal of the Bombay Natural History Society.
E. M. M.	..	Entomologists' Monthly Magazine.
Entom.	..	The Entomologist.
f.w.	..	fore wing.
h.w.	..	hind wing.
Linn. Ent. VI.	..	Linnæa Entomologica, Vol. VI. (1852).
Meyr.	..	E. Meyrick.
Pag.	..	A. Pagenstecher.
P. Z. S.	..	Proc. Zoological Society of London.
T. E. S.	..	Trans. Entomological Society of London.
Wlk., Cat. XXX	.	F. Walker, List of the Lepidopterous Insects in the British Museum, Part XXX. (London, 1864).
Wlsm.	..	Lord Walsingham.
Zell.	..	P. C. Zeller.

Localities. (See Map.)

Parts of the Island have been fairly well worked, *e.g.*, the districts around Kandy, Maskeliya, Maḍulsíma, and Diyataláwa ; of other parts we know a little, *e.g.*, Puttalam, Trincomalee, and the coast line between Colombo and Hambantota ; the rest of Ceylon is as yet practically a *terra incognita*. As places likely to yield novelties I would especially indicate the Ratnapura District, the Kẹlani Valley, and that part of the Island lying north of a line drawn from Puttalam to Trincomalee.

Times of Appearance.

As a rule, I have thought it unnecessary to enumerate exact dates of capture, as my experience has led me to conclude that nearly all our Ceylon plumes are continuously-brooded, and that some individuals may be found at almost any time of the year. I would impress upon collectors, however, the desirability of recording exact dates of capture on the labels of all their specimens.

Faunal Resemblances.

As the geographical distribution is given under each species, I do not propose to enter into the subject here. Of the thirty-seven species enumerated, however, twelve (or 32 per cent.) are at present only known from Ceylon; seventeen (or 46 per cent.) are wide-ranging forms which occur in at least two other localities; four (or 11 per cent.) have only been found hitherto in the Khasi Hills (Assam); and Java, India, the South Indian Hills, and Australia each produces one species which is only known otherwise from Ceylon.

At present we know too little of the distribution of the Pterophoridæ in general to permit of any useful deductions being drawn, but a point which has especially struck me is the great resemblance shown by the plume fauna of Ceylon to those of the Khasi Hills (Assam) and Java. The fact of finding such forms as *P. citropleura* and *A. melanopoda* in localities so widely separated as the Khasi Hills and the central districts of Ceylon seems to me either to argue the immense antiquity of a specific existence which reaches back to a time when Ceylon and Assam were connected (if ever they were) or else to point to the wonderful powers of dispersal (? by the monsoon winds) possessed by these little moths. The latter supposition appears the more probable.

Acknowledgments.

One of the most pleasing duties in writing a paper like the present lies in the fact that some acknowledgment can be made for the many instances of help freely rendered by friends and correspondents. To Mr. E. Meyrick my thanks are due for the ready and courteous way in which he has replied to the innumerable queries which have arisen in working at this subject away from type-collections and libraries; his published papers must also form the basis of all work on the plume moths of India and Ceylon. Messrs. E. E. Green, W. Vaughan, J. Pole, F. M. Mackwood, W. Ormiston, and O. S. Wickwar have most generously helped with specimens collected by themselves, and I am also indebted to Mr. G. B. de Mowbray, who kindly sent me his collection for inspection. Dr. J. C. Willis has assisted most substantially by the identification of the various plants on which larvæ have been found.

Synoptic Table of Genera of the Pterophoridæ of Ceylon.

1	Wings not fissured ..	.. 2
	Wings fissured ..	.. 3
2	Outer margin of f.w. not falcate	.. Agdistis
	Outer margin of f.w. strongly falcate	.. Steganodactyla

3	Fore wing four-lobed ..	.. Heptaloba
	Fore wing three-lobed ..	.. Deuterocopus
	Fore wing two-lobed ..	.. 4
4	Cilia with scale-tufts or specially modified scales, or either segment of f.w. banded transversely, or second segment of f.w. with distinct tornal angle ; any or all of these characters may co-exist	.. 5
	Cilia with no scale-tufts or specially modified scales, neither segment of f.w. banded transversely, second segment of f.w. without any tornal angle ; all these characters must co-exist	.. 12
5	Third segment of h.w. with no scale-tuft in dorsal cilia ..	.. 6
	Third segment of h.w. with a scale-tuft in dorsal cilia ..	.. 9
6	Cleft of f.w. less than half wing-length	.. 7
	Cleft of f.w. at least half wing-length	.. 8
7	Dorsal cilia of f.w. with scattered large black scales ..	.. Exelastis
	Dorsal cilia of f.w. without scattered large black scales ..	.. Stenoptilia
8	Only one nervure in first segment of f.w. ;* abdomen usually very large and stout, often strikingly ornamented dorsally ; resting position in life with wings spread out and closely appressed to the resting-surface ..	.. Diacrotricha
	More than one nervure in first segment of f.w. ;* abdomen usually rather small, slender, and dull-coloured, and, if ornamented, the pattern is generally lateral ; resting position in life with wings folded up and held well clear of the resting-surface ..	.. Trichoptilus (part)
9	Second segment of f.w. linear	.. Trichoptilus (part)
	Second segment of f.w. not linear	.. 10
10	Segments of h.w. differently shaped	.. Platyptilia
	Segments of h.w. similarly shaped	.. 11
11	Ground-colour of wings pale ochreous	.. Sphenarches
	Ground-colour of wings not pale ochreous	Oxyptilus
12	F.w. with dark blotch before cleft	.. Pterophorus
	F.w. without dark blotch before cleft	.. Alucita

* Compare figures D and E in Plate C.

FAMILY.—PTEROPHORIDÆ.

SUB-FAMILY.—*AGDISTINÆ.*

AGDISTIS, *Hb.*

Synopsis of the Species.

Expanse 24 mm.	F.w. with an oblique apical white streak	.. sinhala
Expanse 15–16 mm.	No apical white streak	.. nanodes

AGDISTIS NANODES, *Meyr.*

B. J., XVII., 136.

Locality.—Puttalam. The four specimens, on which the species is founded, were taken between August and November.

This species is unknown to me, except from the description quoted above.

AGDISTIS SINHALA, *n.s.*

♂. Expanse 24 mm. Antennæ ciliated (1), gray. Palpi densely scaled, gray, faintly irrorated with fuscous; projecting nearly length of head beyond it. Fore legs gray irrorated above with fuscous and with a conspicuous dilation at end of tibia. (Second pair of legs wanting.) Hind legs very long light, gray, spurs minute, first pair at about two-thirds, second pair apical. Head gray, with a faint fuscous median line. Thorax pale fuscous, with a sub-dorsal grayish longitudinal line. Abdomen very long and slender, pale gray, darkening apically; a pale fuscous dorsal line on first three abdominal segments; anal tuft pale gray. Fore wing elongate, narrow, widening exteriorly, with a slightly falcate apex and distinct tornal angle; grayish fuscous; a dark fuscous bar along dorsum from base to about ⅓; outer third of wing (except costa) irrorated with dark fuscous and traversed by an oblique white streak most conspicuous in apex. Cilia grayish-fuscous. Hind wing triangular, apex acute, outer margin undulate with two very shallow excavations in normal positions of clefts; fuscous. Cilia fuscous, rather long in vicinity of anal angle.

Type ♂ (No. 6,900) in Coll. Bainbrigge Fletcher.

Locality.—A single specimen was taken at Kandy on December 22, 1907, by Mr. E. Ernest Green, to whose kind assistance in working at the Pterophoridæ of Ceylon I am much indebted.

Observation.—Unfortunately this specimen is in poor condition, but I have carefully compared it with examples of eight Agdistid species in my collection and with the descriptions of all the other species described in this genus, and have no doubt of its distinctness.

STEGANODACTYLA, *Wlsm.*

STEGANODACTYLA CONCURSA, *Wlsm.*

E. M. M., 1891, 241 ; Novitates Lepidopt., t. xii., f. 3.

Distribution.—Colombo, Galle, Węligama, Kandy, Punḍalu-oya, Maḍulsíma, Diyataláwa, Haputalé.

Early Stages.—The larva feeds between the young unexpanded leaves of a common climbing *Argyreia* and also of *Ipomœa populifolia*, eating the upper cuticular surface of the leaf into tell-tale patches.

The full-grown larva may be described as stout, rather flattened. Head pale yellow. Other segments a pale grayish-green, interstices of segments (only visible when expanded) darker green. Dorsal surface pale ; warts with a little orange-yellow about their bases, often forming a distinct orange-yellow or reddish median stripe. An ill-defined broad dark lateral shade appears to be caused by the contents of the alimentary canal, as it disappears towards the anal extremity when frass is voided. Hairs white, usually very conspicuous. (Plate E, figure 1.)

In confinement the larva generally wanders off the food plant to pupate, but occasionally attaches itself to the upper surface of the midrib of a leaf. I have never found the pupa in nature.

The pupa is usually suspended horizontally to a vertical support, being closely appressed ventrally to the resting-surface by the double set of cremastral hooks. Its colour, which is variable, is some shade of pale green, but it always has a broad reddish medio-dorsal stripe. These colours fade into a greenish-brown shortly before emergence, which takes place after about six days, the moth generally appearing in the late evening, quite contrary to the ordinary habits of plume moths. The pupa is comparatively extremely small, and it seems marvellous how such a large moth can emerge from a pupa-case which does not seem sufficiently large to contain its abdomen alone. (Plate E, figure 2.)

Habits.—Although the larvæ are common and easy to find and rear up, the moth itself appears to be of a very retiring nature and is rarely seen in a wild state, although it occasionally comes into light. It is very difficult to beat from the food plant and, when it is disturbed, the flight is rapid and the moth easily overlooked.

Observation.—It is noteworthy that up-country specimens—*i.e.*, from Kandy and above—are distinctly larger than those from the coast districts, the former having an average expanse of about 16–17 mm. as against about 12–13 mm. in the case of the latter. It may be permissible to conjecture that this difference is due directly to climate, the up-country specimens having had longer-feeding larvæ which, as a rule, produce larger imagines than larvæ which feed for a shorter period of time ; but, of course, this is one of the innumerable problems in Siṇhalese entomology in which we require actual experiments instead of theoretic deductions, which can at best be only guesses at the truth.

SUB-FAMILY.—*PLATYPTILINÆ.*

STENOPTILIA, *Hb.*

Synopsis of the Species.

First segment of f.w. with anal angle .. zophodactyla
First segment of f.w. without anal angle .. petræa

STENOPTILIA ZOPHODACTYLA, *Dup.*

Duponchel, Hist. Nat. Lep., XI., 668, t. 314, 4; Leech, Brit. Pyral. 60; Meyr., Handbk, 440; Tutt, Brit. Lep., V., 319; Meyr., E. M. M., 1907, 146; Meyr., T. E. S., 1907, 504.

Distribution.—Diyataláwa, Hakgala, Maḍulsíma.

In Ceylon this is decidedly a hill species, being found on dry patana hillsides at a height of about 4,000 feet and over.

Its recorded distribution outside Ceylon includes Argentina, Eastern Australia, India, Central and Southern Europe, Asia Minor, and Armenia.

Early Stages.—The egg is quite of the Platyptilid type, being oval, with both ends equal and rounded off. In colour it is of a uniform pale green, the surface delicately reticulated.

The early stages of the larva have not yet been observed in Ceylon, but the following is a description of a full-fed larva found at Diyataláwa on September 17, 1907 :—

" The larva, at rest and apparently about full-fed, is about 10 mm. long, stout, stoutest about third segment and tapering thence gradually. Head pale yellow with black ocelli. Colour a pale green, the spiracles narrowly ringed with black ; they are situated about half way up the segments but do not seem raised above the skin-surface at all. There is a broad medio-dorsal stripe, purple at the edges, but very dark internally. This is narrowly and obscurely edged by a narrow whitish-green longitudinal stripe, of a tint slightly paler than the ground-colour. Half way between the lower edge of this stripe and the spiracle is a second similar whitish-green stripe, and a third similar stripe occurs on the latero-ventral surface at a distance below the spiracle, equal to that of the second stripe above it. The two latero-dorsal setigerous tubercles are situated at a horizontal distance apart, equal to about one-third of the width of the segment; the foremost one bears a short black hair,. the aftermost a similar white hair ; the tubercles themselves are very small and inconspicuous. Just above the spiracle occurs a short white hair, directed outwards. Just below the spiracle are (i.) a very short white hair directed forward, (ii.) a short white hair directed backward. The whole body, particularly on the dorsal and ventral regions, is thickly covered with minute short, black, bristly hairs. The legs are fairly large and are yellowish in colour ;

prolegs rather small, greenish-yellow. The larva feeds on the flowers and seeds of *Sopubia trifida*."

In the case of another larva, the 6th and 11th segments had a round pale spot in the purple dorsal stripe on each side of its central darker line. (Plate E, figure 3.)

The pupa is long and narrow, of a pale yellowish-green colour with a broad purplish-red dorsal stripe; the usual white hairs are so short that they are only just perceptible under a lens. The larval skin is discarded entirely and is shrunk up into a minute pellet. The pupa is capable of rapid and violent motions in the ventro-dorsal plane, the head being bent backwards dorsally until it touches the anal extremity. The pupa is suspended head downwards, ventral surface against support.

STENOPTILIA PETRÆA, *Meyr.*

T. E. S., 1907, 504.

Distribution.—Diyatalâwa. The only specimen that I have seen was beaten from a clump of bushes in a marshy valley near the Rifle Range on August 19, 1907.

Originally described from the Palni and Nilgiri Hills in Southern India.

Observation.—Superficially very similar to *zophodactyla*, but structurally distinct by the shape of the first segment of the fore wings, which is narrower and with lower margin straight to apex, so that there is no lower angle. This pecularity is very distinct and striking, once attention is directed to it.

PLATYPTILIA, *Hb.*

Synopsis of the Species.

1	Abdomen as long as dorsum of fore wing ..	brachymorpha
	Abdomen shorter than dorsum of fore wing	2
2	Pectus and ventral surface of abdomen canary-yellow	3
	Pectus and ventral surface of abdomen not canary-yellow	4
3	Base of cleft of f.w. is outside of a line drawn to costa from outer scale-tuft on dorsum	citropleura
	Base of cleft of f.w. is directly over outer dorsal scale-tuft	taprobanes
4	Large scale-tooth on dorsum of third segment of h.w. is apical or nearly so ..	pusillidactyla
	Large scale-tooth on dorsum of third segment of h.w. does not reach beyond $\frac{3}{4}$ ..	molopias

Note.—I have seen no specimens of *P. direptalis*, Wlk., and from the descriptions only I am unable to separate it from *P. molopias*, which latter is a most variable species.

Platyptilia brachymorpha, *Meyr.*

(Plate A., figure 3.)

Brachymorpha.—Meyr., T. E. S., 1888, 240; B. J., XVII., 135; T. E. S., 1907, 483.

Seeboldi.—Hofmann, Iris, XI., 33.

Distribution.—Puttalam, Galle, Trincomalee, Dambulla, Maḍulsíma, Aráwa, Alutnuwara, Mánkuḷam, Anurádhapura, Kégalla, Haldummulla.

Apparently confined to the low-country. Outside of Ceylon, it has been recorded from Syria, India, South Africa, and Hawaii.

Early Stages.—The life-history is quite unknown. The larva may be looked for on the flowers of some composite plant growing in dry, sandy places.

Platyptilia direptalis, *Wlk.*

Wlk., Cat. XXX., 934; Meyr., T. E. S., 1907, 485.

Distribution.—Paṭṭipola. I have not seen this species. It occurs also in India, and has been recorded from Cape Colony and the Congo. In India and Ceylon it seems to be essentially a hill species, all the records being from localities with an elevation of 6,000 feet or over.

Platyptilia molopias, *Meyr.*

(Plate A., figure 1.)

Molopias.—Meyr., B. J., XVII., 135.

Mesopterna.—Meyr., M. S. S. (*ined.*).

Distribution.—Maskeliya, Kandy, Péradeniya, Nuwara Eliya, Hakgala, Paṭṭipola, Diyataláwa, Maḍulsíma.

Not yet recorded, except from Ceylon, where it is fairly common in the hill districts.

Early Stages.—*Ovum.*—The egg is about ·47 mm. long by about ·3 mm. broad, the micropylar end distinctly the larger and flattened; in colour it is of a very pale green, the surface reticulated with large but shallow rounded depressions.

Larva.—Larvæ were found on May 18, 1908, at Maḍulsíma, feeding on the flowers and unripe seeds of *Teucrium tomentosum*, Hey. The larva is of a very pale green colour, and is very difficult to discern when *in situ* on the food plant. Half-grown examples often seem to have a narrow reddish medio-dorsal stripe, lacking in adults, which latter have sometimes some lateral reddish markings on the thoracic segments. Like all "plume" larvæ, however, this one is very variable in colour, and some examples might be described as reddish with a greenish latero-dorsal suffusion on the abdominal segments. The head is yellowish or pale green, the ocelli very distinctly marked in black. The segmental divisions are sharply distinct. All primary hairs are white; the longest hairs are a little longer than the diameter of the segments on which they arise. The legs are yellowish-green, extremities of claws reddish. Prolegs very transparent pale green, hooks reddish. Spiracles very inconspicuous. Secondary hairs short, black. (Plate E, figure 4.)

Parasites.—Of some fifty or sixty larvæ collected, about 75 per cent. were found to be attacked by a small black ichneumonid fly.

Pupa.—The pupa is suspended freely by the tail from an empty flower-sheath of the food plant. It is rather short, the appendage sheaths very long and well separated. Colour a pale flesh-pink, mottled longitudinally with brown; head and wing-sheaths pale greenish, the latter with longitudinal brown shading. Dorsal prominences small, distinct, subequal, directed forward, except the first, which is extremely large, directed backwards, blunt, but tipped anteriorly with a sharp spine whose point is bent forward. This large prominence is sharply outlined by a deep brown shading which reaches obliquely anteriorly half way across the wing-cover. A second brown shade, parallel to the first but less intense and narrower, occurs on the 6th segment, but barely reaches on to the wing-sheath.

Imago.—The moth emerges from the pupa after about a week.

PLATYPTILIA PUSILLIDACTYLA, *Wlk.*

(Plate A., figure 2.)

Pusillidactyla.—Wlk., Cat. XXX., 933; Wlsm., P. Z. S., 1891, 495; l. c., 1897, 57; Meyr., T. E. S., 1907, 483.

Tecnidion.—Zeller, Hor. Soc. Ent. Ross., XIII., 468 (1877).

Hemimetra.—Meyr., T. E. S., 1886, 18; B. J., XVII., 135.

Distribution.—Anurádhapura, Kurunȩgala, Kȩgalla, Galle, Wȩligama, Trincomalee, Puttalam, Colombo, Mátalé, Maturaṭa, Kandy, Pérádeniya, Maskeliya, Diyataláwa, Bandárawela, Passara, Maḍulsíma, Badulla, Haldummulla.

Abundant throughout Ceylon in every district that has been invaded by *Lantana.*

Early Stages.—Ovum.—The egg is about ·4 mm. long by about ·22 mm. broad, and is of a very pale greenish-yellow colour (almost colourless); one end seems larger than the other and this larger end is studded with little prominences, especially noticeable in the micropylar area.

Oviposition.—On the evening of January 4, 1908, I watched a female ovipositing on *Lantana* at Galle. She flew about slowly and pitched on a terminal shoot enclosing a small green unexpanded flower bud. This she seemed to examine by bending down her head and antennæ and then, apparently satisfied, she bent her abdomen downwards and right forward (until the ovipositor must have extended at least as far forward as her head) and deposited a single, small, oval, greenish-white ovum. She then flew to another bud and repeated the operation. The process of selecting the bud and depositing the egg took perhaps thirty seconds.

Larva.—The larva itself is stout, pale yellow, and naked—at least, no hairs are visible to the unaided eye. The larva is usually found coiled round at the base of the flower-tubes in the interior of a *Lantana* flower. (Plate E, figure 5.)

Pupa.—The pale yellow pupa is to bè found in a sort of chamber gnawed into the side of the fruit receptacle, a regular cocoon being formed of bits of vegetable matter spun together with silk. The emerged pupæ are usually found projecting half way out of the cocoon amongst the ripening fruit, such bunches of fruit being far less productive than unattacked ones. This little plume, then, must form a factor of some importance in considering the increase of *Lantana* in the Island. (Plate E., figure 6.)

Observation.—I understand that *Lantana* was originally a South American plant and was introduced into Ceylon about eighty years ago, and it appears probable that *P. pusillidactyla* is also an introduced species, as its distribution is very wide. Originally described from the West Indies, it has been recorded from Réunion, India, and Ceylon, and I possess a specimen taken by myself in Mahé (Seychelles Islands), and have lately received an example from Honolulu.

Platyptilia taprobanes, *Felder*.

Taprobanes.—Felder, Reise "Novara," t. cxl., f. 54 ; Moore, Lep. Ceylon, III., 527 ; Meyr., T. E. S., 1907, 482.

Sythoffi.—Snellen, Tijd. Ent., XLVI., 54, t. v., ff. 15, 16.

Tranota.—Meyr., M. S. S. (*ined.*).

Distribution.—Maskeliya, Paṭṭipola, Nuwara Eliya, Maḍulsíma, (?) Péràdeniya.

Confined to the higher hill districts above 4,000 feet. Mr. Meyrick has recorded a specimen from Péràdeniya, but this is possibly an error in labelling on the part of the captor, or more probably an importation with its food plant into the Botanic Gardens.

P. taprobanes seems to be always a hill species, its distribution outside Ceylon being South India (Palni Hills), Assam (Khasi Hills), and West Java (Preanger, 1500–1600 met.).

Early Stages.—The early stages and food plant are quite unknown.

Observation.—Snellen's figure of *sythoffi* is very good, and is unmistakably this species. The same cannot be said for Felder's figure, which is very poor and doubtful ; in my copy of his Plate 140, figure 54 appears to be engraved after *sythoffi* and coloured with a longitudinal ochreous streak near the apex of the fore wing in a manner only characteristic of *H. argyriodactyla* amongst our Siṇhalese species. The scale-tufts in the figure might apply to either of these species. Under these circumstances I have thought it best to follow Mr. Meyrick's identification.

PLATYPTILIA CITROPLEURA, *Meyr.*

T. E. S. 1907, 482.

Distribution.—Maskeliya. Also found in Assam (Khasi Hills).

Early Stages.—Early stages and food plant unknown.

Observation.—Quite distinct from *taprobanes*, being smaller and blacker ; moreover, the cleft in the forewing is so shallow that it does not reach to a position immediately over the outer scale-tuft on the hinder margin of the wing ; in *taprobanes* the base of the cleft is directly over this tuft.

I have examined a specimen, taken at Maskeliya in June, in the collection of Mr. J. Pole, and two examples (both Maskeliya, January, 1908), in that of Mr. G. B. de Mowbray, and am further indebted to Mr. Pole for a specimen taken at Maskeliya in November, 1908, and which he has kindly added to my collection.

HEPTALOBA, *Wlsm.*

On its inception this genus was considered by Lord Walsingham as most nearly allied to *Amblyptilia* (*Platyptilia*), but the linear, similarly-shaped segments of the hind wing seem to me to place it much nearer to *Oxyptilus*.

Plate B., figure B., shows the neuration of the only known species. It will be noted that vein 3 of the fore wing has apparently been rendered obsolete by the development of the cleft between veins 2 and 4; at least, I have been unable to observe its presence after a careful examination of four specimens specially prepared for the microscope.

The neuration of the hind wing (not shown in the figure) is as follows :—1*b* to apex of third segment ; 2 short, running into hinder margin of second segment near base ; 3 out of 4 at angle of cell, long, parallel, running into hinder margin of second segment at ½ ; 4 to apex of second segment ; 5 and 6 apparently absent ; 7 to apex of first segment ; 8 parallel to 7, running into costa at half.

HEPTALOBA ARGYRIODACTYLA, *Wlk.*

Wlk., Cat. XXX., 929 ; Wlsm., E. M. M., 1885, 175 (fig.) ; Moore, Lep. Ceylon, III., 527, t. 209, f. 13 (unrecognizable).

Distribution.—Kandy. Both species and genus are peculiar to Ceylon.

Early Stages.—The life-history is quite unknown.

Observation.—Easily distinguished from all other Ceylon plumes by the fissure of the fore wing into *four* segments.

It was originally described by Francis Walker from specimens given to the British Museum by Dr. Templeton, but no exact locality is stated. I have seen examples from nowhere except Kandy, but in the immediate vicinity of that town it seems to be fairly common.

DEUTEROCOPUS, *Zeller*.

This interesting little genus, which was founded by Zeller in 1852 (Linn. Ent. VI., 402) for the reception of *tengstrœmi*, may at once be recognized by the fact that the fore wing is split into three segments, the normal second segment being itself subdivided to about half its length. (See Plate B., figure C.)

Five "species" have been described: *tengstrœmi*, Z.; *ritsemæ*, Wlsm.; *rubrodactylus*, Pag.; *planeta*, Meyr.; *famulus*, Meyr.; but as a rule these little moths seem scarce in collections, and the specific characters have therefore been taken from short series or even from single specimens. Working in this way, it is easy enough to divide up the available specimens into species or forms or races, but the extraordinary amount of individual variation renders this grouping useless when larger series of examples of this genus are being dealt with. A few months ago I possessed seven specimens of *Deuterocopus* from Ceylon, and these were clearly separable into four "species"; in June, 1908, I caught or bred 19 other examples from Galle, and I have lately been able to see a specimen in the collection of Mr. G. B. de Mowbray; an examination of these 27 specimens has convinced me that we have only one real "species" of this genus in Ceylon. It is true that this species is divisible into four forms, each with its distinct facies; these I have shown in the table and synopsis, but the differences shown in the table must be taken as typical of the extremes of the various forms, and must certainly not be considered as invariable. Indeed, there appear to be no characters which do not vary from an appearance typical of one form into that characteristic of any of the others; perhaps the colour of the pectus and ventral surface of the abdomen may be taken as a character as constant as any.

My opinion of these forms is that all the Ceylon specimens belong to one highly variable species which has already broken up into several well-marked subspecific forms, still fused by syngamy into a single species, and that these forms may be regarded as species in the making, ready to break away from the parent stock by the development of asyngamy through the effects of isolation or pronounced preferential mating. Meanwhile, it is convenient to treat the different forms as distinct for the purpose of identification of their specimens by local collectors.

Since writing the above I have found *D. tengstrœmi* abundantly at Hambantota, and an examination of some sixty specimens of this form shows that it is on the whole more constant within certain limits of variation than appears to be the case in the other three. In this case isolation, by the larval habit of feeding on a plant typical of the very dry districts, seems to have separated off this form from the other three characteristic of the wetter parts of the Island, and I am now inclined to consider it a true species although I am unable to perceive any distinguishing characters between the male genital armatures of *tengstræmi* and *rubrodactylus*, in both of which forms this latter structure is highly complex and characteristic. In spite of the similarity in the genitalia, however, the difference in habitat appears sufficient to secure asyngamy.

Observation.—Zeller named this genus *Deuterocopus*, giving the derivation of the name, and this is obviously not a misprint as the same spelling is seen on pages 319 and 415 of Volume VI. of "Linnæa Entomologica." Some later authors however (*e.g.*, Hofmann, Deutsche Ent. Zeit., 1898, p. 329; Pagenstecher, Zoologica, XXIX., p. 241) have altered Zeller's name to *Deuteroscopus*. This latter spelling is quite inadmissible, since a generic name, once published, is inviolable, except where it is a mere printer's error, for which there is evidence.

Tabular Comparison of some points in the Ceylon forms of *Deuterocopus*.

Name.	Pectus and Ventral Surface of Abdomen.	Abdomen.	Whorls of Scales on posterior Tibiæ.	Spurs on posterior Tibiæ.	Posterior Tibiæ.
Atrapex ..	Whitish ..	Ferruginous: basal segment slightly irrorated with whitish; third segment with a longitudinal narrow black stripe, edged posteriorly with a bar of intermixed yellowish-white and ferruginous scales; or Uniform blackish ferruginous, the second segment with a whitish subdorsal spot	Strong	Distinctly thickened with scales	Uniformly ferruginous or blackish ferruginous
Tengstrœmi ..	Whitish .	Ferruginous brown: first and second segments mottled with white; third segment with a darker median line and a sub-dorsal spot on basal margin, posterior margin edged with a narrow bar of light ferruginous scales; fourth, sixth, and seventh segments with two narrow longitudinal white dorsal lines	Strong	Smooth	Ferruginous brown, obscurely and incompletely banded with white
Rubrodactylus ..	Sulphur-yellow..	Basal and second segments dorsally sulphur-yellow, other segments ferruginous; third segment edged posteriorly with a narrow bar of glistening yellowish-white scales; sixth segment suffused with whitish; fourth segment with a lateral white spot	Weak	Smooth	Ferruginous, more or less banded with pale yellow
Ritsemæ ..	Sulphur-yellow..	Ferruginous: first and second segments dorsally sulphur-yellow; third segment posteriorly with a raised flap of glistening white scales; sixth segment with a conspicuous square yellow dorsal spot	Weak	Smooth	Bright ferruginous, conspicuously banded with white or pale yellow

Synopsis of the named Forms of Deuterocopus.

1	Pectus and ventral surface of abdomen whitish	2
	Pectus and ventral surface of abdomen yellow	3
2	Apical third of fore wing black ..	atrapex
	Apical third of fore wing not black ..	tengstrœmi
3	Abdomen with a broad transverse pure white band	ritsemæ
	Band on abdomen (if present) not pure white	rubrodactylus

DEUTEROCOPUS ATRAPEX, *forma nova.*

Distribution.—Galle, Kandy, Maskeliya.

Size and shape of wings, cilial scale-tufts, antennæ, palpi, and abdomen the same as in the other three forms (*tengstrœmi*, *ritsemæ*, and *rubrodactylus*). Thorax ferruginous, often suffused with black ; pectus and ventral surface of abdomen whitish. Abdomen : (see column 3 in Table of Species). Legs ferruginous, often suffused with black ; large whorls of ferruginous or black scales on posterior tibiæ at origin of spurs and smaller whorls on base of tibiæ and apices of tarsal joints, the last decreasing posteriorly ; spurs distinctly thickened with scales, sometimes broadly banded with white in centre and towards apex.

Wings bright ferruginous, sometimes almost wholly suffused with blackish or dark fuscous, but the *exterior third of the fore wing* (from just beyond the base of the first segment and including the whole of the second and third segments) *deep black*, with two inconspicuous preapical costal suffusions of ferruginous scales.

DEUTEROCOPUS TENGSTRŒMI, *Zell.*

Zeller, Linn. Entom., VI., 402; Meyr., T. E. S., 1907, 474.

Distribution.—Maḍulsíma, Hambantota.

Originally described from Java ; this species has also been recorded from Assam and the Kei Islands.

Early Stages.—The larva feeds on the flowers of the square-stemmed jungle vine (*Vitis quadrangularis*) so characteristic of the dry districts, and the pupa is attached to a flower, flower-stalk, or stem of the food plant, or more rarely to a leaf of the same. A description of the early stages is reserved to another occasion.

The moth is readily disturbed by day from bushes over which the vine is climbing, but its flight is then swift, and it is difficult to secure, as it often retreats within thorny bushes. In the evening it may be taken plentifully around the flowers of its food plant and also on those of *Capparis*, &c.

Observation.—Examples from Ceylon seem to agree fairly well with Zeller's description of *tengstrœmi* and are, I think, identical. The fore-tibia is thickened apically with scales, and carries two small points which seem to be composed of acuminate scale-tufts; I should scarcely describe these as "long whitish spines"* which, by Zeller's description, should project from this scale-thickening.

DEUTEROCOPUS RUBRODACTYLUS, *Pag.*

Rubrodactylus.—Pag., Zoologica, XXIX., 241; Meyr., T. E. S., 1907, 473.

Tengstrœmi.—Meyr. (nec Zell.), B. J., XVII., 134.

Distribution.—Puttalam, Galle.

Recorded also from South Africa, India, New Guinea, and the Bismarck Archipelago.

Early Stages.—*Ovum.*—The egg is about ·44 mm. long by about ·20 mm. broad; in shape it is ovo-cylindrical, the ends rounded and subequal, the micropylar area distinctly depressed; the surface is very smooth and shining, of a very pale orange colour, suffused with red at either pole.

Larva.—A larva found at Galle on June 18, 1908, feeding on the flowers of *Leea sambucina* (Sinh. "Bóuroula") was described as—"Pale green without any markings, except red suffusion at either extremity. The skin is roughened into minute knobs (like shark skin) everywhere, but especially on the ventral region. A distinct subsegment is formed on the posterior ventral region of abdominal segments. The hairs, except (i.), are very short and inconspicuous; (i.) is short, less than breadth of segments. The hairs are transparent whitish (glassy) and the tubercles very indistinct. The hairs are longest on thoracic and anal regions. The legs are extremely short and inconspicuous. There are no secondary hairs, these seeming to be reduced to skin-points or rather rugosities of the skin." (Plate E., figure 7.)

Pupa.—A pupa found on the same occasion was brown with a broad lighter ochreous-fuscous central band; very few hairs or projections. It was suspended anally to a flower stalk within a slight attempt at a cocoon—a few silken threads spun around it to form a spacious but flimsy enclosure, in which the pupa was fully visible. The cast larval skin remained at the anal extremity of the pupa. Another pupa was green.

Observation.—This seems to be the commonest form in Ceylon, and gradually runs into the more brightly-coloured *ritsemæ*, Wlsm. In spite of Pagenstecher's observation, "Die Art dürfte .... leicht zu erkennen sein," his description is very brief and poor.

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* "......aus dem Knoten ragen die langen, weisslichen, auf einer Seite schwärzlichen Dornen hervor "......(Zeller, Linn. Entom., VI., p. 403.)

DEUTEROCOPUS RITSEMÆ, *Wlsm.*

Notes Leyden Mus., VI., 243.

Distribution.—Galle, Pérádeniya.

Outside of Ceylon, it has hitherto only been recorded from Java.

Early Stages.—Examples were bred from pupæ found suspended anally from the upper surface of leaves of *Leea sambucina*, which is evidently the food plant. On the same bush I found a larva feeding inside an unopened flower bud; it appeared exactly similar to that of *rubrodactylus*, except in wanting the terminal red suffusion; unfortunately I failed to rear it.

Observation.—The most brightly coloured Ceylon specimens agree exactly with Lord Walsingham's description of *D. ritsemæ*, except that the bands on the posterior tibiæ are pale yellow instead of being white as there described.

SPHENARCHES, *Meyr.*

SPHENARCHES CAFFER, *Zell.*

Caffer.—Zeller, Linn. Ent., VI., 348; Zell., Lep. Micropt. Caffr., p. 118; Wlk., Cat. XXX., 934; Wlsm., T. E. S., 1881, 279; Meyr., T. E. S., 1887, 268; Wlsm., Indian Mus. Notes, II., 20 (figures); Cotes, l. c. 163; Wlsm., P. Z. S., 1897, 56; Meyr. Fauna Geogr. Maldives, I., ii., 125; Lefroy, Mem. Agric. India Entom., I., 220.

Anisodactylus.—Wlk., Cat. XXX., 934; Moore, Lep. Ceylon, III., 528; Swinh., Cat. Moths India, p. 668.

Diffusalis.—Wlk., Cat. XXX., 945.

Walkeri.—Wlsm., T. E. S., 1881, 279.

Synophrys.—Meyr., T. E. S., 1886, 17.

Distribution.—Colombo, Jaffna, Kęgalla, Galle, Węligama, Hambantota, Trincomalee, Pérádeniya, Maskeliya, Diyataláwa, Maḍulsíma, Alutnuwara.

Widely distributed in the low-country, but only moderately common as a rule. Mr. W. Vaughan, however, reports it as extremely abundant at Alutnuwara in January, 1908. In India it sometimes attains the status of a pest on cultivated Cucurbitaceæ, and it has also been recorded as damaging *Dolichos lablab*.

Its distribution extends from Africa through India to Burma, Australia, and Japan. It is the only plume moth as yet recorded from the Maldives.

Early Stages.—A short description of a larva, about half-grown, reads—"Head yellow. Other segments pale brownish yellow. A narrow dorsal, latero-dorsal, and spiracular reddish stripe. Legs pale yellow, prolegs and claspers dark. Hairs white, except the short clubbed hairs which are black."

I have found the larva on *Averrhoa bilimbi* ("Bilimbi") at Galle, and on the flowers of *Biophytum sensitivum* at Maḍulsíma, so that it seems to be decidedly polyphagous. The following description was made from a full-grown larva found at Maḍulsíma on August 24, 1908 :—

" It is about 7 mm. long, cylindrical, rather stout, the segmental interstices well marked. Legs and prolegs long and slender ; pale greenish-yellow. Head unicolorous, very pale, transparent, greenish-yellow ; mouth parts darker. Other segments pale greenish-yellow ; a narrow darker green dorsal line ; each segment with a large but ill-defined, pinkish-red, latero-dorsal spot, the series of these spots forming an interrupted longitudinal line. Two conjoined latero-dorsal tubercles emit a very long white hair directed upwards and a shorter white palmate hair directed upwards and forwards ; a supraspiracular tubercle emits a brown palmate hair directed upwards and forwards ; two conjoined subspiracular tubercles emit a short white hair directed forward and a long white hair directed downwards ; there are also one or two latero-ventral tubercles emitting white hairs. The whole surface of the segments is also closely studded with short white clubbed secondary hairs." Figure 10 on Plate E was drawn from this living larva under the microscope, and figure 8 on the same Plate gives a rather more detailed view of one of the peculiar palmate hairs.

The following description was made from the pupa produced by the larva described above :—" The pupa is about 7 mm. long and is attached to the under-surface of the midrib of a leaf of the food plant. The appendage sheaths and anal portion are of a yellowish-green colour, the remainder of a very pale pinkish-red. The dorsal surface bears a system of highly specialized tubercles, the nature of which will be best understood by a reference to the figure." (Plate F., figure 11.)

OXYPTILUS, *Zell.*

Synopsis of the Species.

1	Abdomen with a transverse white band ..	vaughani
	Abdomen without a transverse white band	2
2	Scale-tooth or tuft on dorsum of h.w. touches apex of third segment ..	regulus
	Scale-tooth or tuft on dorsum of h.w. does not touch apex of third segment ..	3
3	First segment of f.w. with a distinct anal angle	causodes
	First segment of f.w. with no anal angle ..	4
4	Dorsum of h.w. with a small scale-tooth not extending beyond $\frac{2}{3}$	epidectes
	Dorsum of h.w. with a large scale-tooth beyond $\frac{2}{3}$	regalis

Oxyptilus Vaughani, *n. s.*

♂. Expanse 10·5 mm. Palpi long, slender, curved, sickle-shaped, smooth; white, irregularly mottled with fuscous ferruginous; terminal joint acute, longer than second. (Antennæ wanting.) Head dark ferruginous fuscous, vertex covered with a loose tuft of elongated erected scales which do not form a regular cone. Thorax dark ferruginous fuscous; pectus pale sulphur-yellow. Abdomen; first segment and base of second segment pale sulphur-yellow, second, third, and fourth segments deep chestnut-bronze-brown, apical margin of fourth segment edged with a narrow transverse band of brilliant white scales, fifth segment thickly irrorated with white scales so as to form a distinct broad transverse bar across the abdomen, terminal segments deep reddish-purple; anal tuft long, apex yellowish-white. Legs dark ferruginous-fuscous, narrowly banded transversely with white; spurs long, equal; posterior tibiæ with small clusters of short dark fuscous spines near base and on origin of spurs. Fore wing cleft from $\frac{3}{5}$; elongated, narrow at base, broadly expanded outwardly; first segment rather narrow, apex acute, termen concave, oblique, anal angle distinct; second segment posteriorly dilated, apex produced (not extending beyond anal angle of first segment), termen concave, oblique; deep chestnut-brown, thickly irrorated with ferruginous and thinly sprinkled throughout with minute patches of lilacine-whitish scales; costal edge dark fuscous; a small whitish dot on costa at $\frac{1}{2}$, a small whitish transverse costal spot at $\frac{1}{2}$ of first segment, and a small white sub-apical spot; second segment with a small whitish dot on anterior margin at $\frac{3}{4}$; cilia ochreous-white, with blackish patches at angles of both segments suffused with blackish within cleft, with black bars on dorsum at $\frac{3}{4}$ and $\frac{7}{8}$ and a black dorsal scale-tooth at $\frac{1}{2}$. Hind wing cleft firstly from $\frac{2}{5}$, secondly from near base, segments very narrow and linear; dark ferruginous fuscous, third segment with a white bar at $\frac{1}{2}$ and a minute apical dorsal scale-tooth just beyond it; cilia ochreous-white, fuscous on first segment and towards apex of second, those of third segment very long and delicate.

Type ♂ (No. 6,459) in Coll. Bainbrigge Fletcher.

Locality.—Ceylon, Province of Uva, Maḍulsíma, Cocogalla estate (4,000 feet); February, 1907, at light (W. Vaughan).

I have much pleasure in naming this species after Mr. Wm. Vaughan, to whom I am indebted for this and many other "plumes."

Oxyptilus vaughani seems closely related to *O. peltastes*, Meyr. (T. E. S., 1907, 479), but differs in the distinct band on the abdomen and in the white-banded legs. Both these species seem to approach very nearly to the members of the lately-described genus *Xyroptila*, Meyr., and will probably have to be removed from the genus *Oxyptilus*; but until the exotic Oxyptilids are better known it seems to me that no good purpose will be served by separating up the group.

Since writing the above I have examined a specimen collected by Dr. A. Willey at Trincomalee on October 4, 1908, and have also received an example taken by Mr. W. Ormiston at Haldummulla in November.

On September 10 Mr. W. Vaughan obtained a second specimen at Aráwa, and a few days later bred a third from a pupa found suspended from the upper surface of a leaf of *Dimorphocalyx glabellus* in the same locality. Furnished with this information, and thanks to Mr. Vaughan's kind assistance, I was able to visit Aráwa on several occasions during December and found the moths quite common. They were at first obtained rather sparingly by beating *D. glabellus*, but later on I found them in abundance flying in the bright morning sunshine (about 10 to 11 A.M.) around the flowers of *Leea sambucina* (Sinh. " Bouroula "). In several cases I noted that the moths were actually feeding on the flowers, their tongues unrolled and thrust violently into the flower in search of food. In other cases they were settled on the leaves, when they hung down freely suspended by the first two pairs of legs, the wings folded and held out at right angles, the tip of the abdomen strongly curved upwards, and the posterior legs with the tibiæ extended at an angle between the wings and the abdomen, and the tarsi curved inwards until the distal tarsal joint nearly touched the apex of the abdomen.

An examination of a long series shows that *O. vaughani* may differ from the type, as described above, in the following points :— (1) The white spots on the first segment of the fore wing are sometimes developed into distinct, though narrow, transverse bands. (2) The white bands on the hind legs are sometimes very indistinct. (3) The fifth abdominal segment is usually less suffused with white scales. The narrow white bar on the fourth abdominal segment, however, is always very distinct and characteristic.

The larva will probably be found to feed inside the fruit of *Dimorphocalyx glabellus* (Sinh. " Wẹliwẹnna "), from which I also beat an example of *O. vaughani* at Alutnuwara on December 16, 1908.

OXYPTILUS CAUSODES, *Meyr.*

(Plate A., figure 4.)

B. J., XVI., 582.

Distribution.—Péràdeniya. Not known outside of Ceylon, and at present only recorded from a single tree of *Dillenia retusa* in the Royal Botanic Gardens.

Early Stages.—The egg and young larva are unknown.

Larva.—The larva feeds inside the fleshy fruits of *Dillenia retusa* (Sinh. " Goḍapara "), emerging from the fallen fruit when full-fed to suspend itself for pupation on any neighbouring object.

The full-grown larva (suspended for pupation) is about 13 mm. long by about 1·2 mm. broad, being cylindrical, slender, shining, and appearing quite smooth and naked. There are two principal colour varieties :—(i.) Wholly pale green without any noticeable markings except a narrow darker medio-dorsal stripe, and this is perhaps due to the vessels beneath showing through the skin rather than to any dermal pigmented area. Towards the anal extremity a pinkish suffusion is seen along the segmental interstices. (ii.) Very pale, semi-transparent, pinkish flesh-colour; interstices of segments very pale, semi-transparent green, as are also some patches along the sub-median area of most of the segments, but the pale green and pink so merge into one another that no definite areas can be described. Head very pale green. A pale red medio-dorsal line. But some larvæ have no green markings, being wholly pink. The prolegs are very small and stumpy; hooks dark reddish. The hooks on the fourth pair of prolegs are attached into the silken pupation-pad. The arrangement of the tubercles is shown in the figure. (Plate E., figure 9.)

Pupation.—The larva pupates very rapidly; twelve hours is sufficient for it to emerge from the fruit, select a suitable place for pupation, suspend itself, and complete its metamorphosis.

Pupa.—The newly-formed pupa is of a bright light green colour, the capital extremity tinged with yellowish-brown about the base of the antenna-sheath; but it soon becomes of an almost uniform reddish gray-brown.

Imago.—The moth, which usually seems to emerge early in the morning, appears after six days.

Oxyptilus regulus, *Meyr.*

B. J., XVII., 135.

Distribution.—Maskeliya. Only recorded from Ceylon.

Early Stages.—The life-history is unknown.

Observation.—This is apparently a very rare species. I have seen no specimens.

Oxyptilus regalis, *n. s.*

♂ Exp. 14–16 mm. Head and thorax fuscous with a few intermixed whitish scales, vertex with a loose tuft of erected elongate scales which do not form a regular cone. Palpi whitish, mixed with blackish, second joint reaching middle of face, terminal joint slightly shorter than second. Antennæ anteriorly whitish striated with blackish, posteriorly pale fuscous. Abdomen fuscous with a dorsal series of light-edged blackish /\-shaped markings. Legs very pale fuscous, longitudinally striated with blackish.

Fore wing cleft from before ½, first segment parallel-sided, subfalcate, without anal angle, second narrow, posteriorly slightly dilated, apex abruptly produced; fuscous, irrorated with dark fuscous and blackish; an undefined spot of dark suffusion towards dorsum at about ⅕, and another at base of cleft, the two sometimes tending to be connected by a longitudinal area of dark suffusion; first segment with a small triangular costal patch of pale suffusion a little before ½, a whitish transverse line at about ¾ and a minute pale sub-apical patch on costa; second segment with an inwardly oblique whitish line opposite that on first segment; cilia light fuscous, within cleft ochreous-white mixed with black scales especially evident posteriorly and near base, on termen with a small black scale-tuft near apex, on dorsum with a black scale-tuft opposite base of cleft and three scale tufts beyond this, last at tornal angle, the third tuft preceded and the fourth followed by a narrow patch of ochreous-white. Hind wing cleft firstly from ⅓, secondly from near base, segments linear; dark fuscous: cilia fuscous; third segment on upper margin with a moderate ante-apical patch of black scales and a few scattered black scales between this and base, on dorsum with a fairly large triangular black scale-tooth at ¾ (opposite patch on upper margin but not reaching apex), a small apical scale-tuft, and a few scattered black scales between scale-tooth and base.

Five specimens, Colombo (July to September, 1908), collected by Mr. F. M. Mackwood.

This species seems very close to *O. regulus*, Meyr., by the description of the latter, but the black triangular scale-tooth on dorsum of hind wing does not reach the apex, nor are the two almost basal scale-teeth present in *O. regalis*.

In certain lights the "black" scale-tooth of the hind wing shows a most beautiful purplish-red iridescence.

Oxyptilus epidectes, *Meyr.*

(Plate A., figure 5.)

T. E. S., 1907, 476.

Distribution.—Kandy, Maskeliya, Madulsíma.

Probably widely distributed in the Island, but very inconspicuous and easily overlooked.

Outside of Ceylon it has been recorded from Burma, Coorg, the Nilgiri Hills, and Mauritius.

Early Stages.—Unknown at present, but I have bred the moths from *Biophytum sensitivum*, which is evidently the food plant.

TRICHOPTILUS, *Wlsm.*

Synopsis of the Species.

1	Dorsum of third segment of h.w. with a scale-tooth at about ⅔.. ..	2
	Dorsum of third segment of h.w. with no scale-tooth	4
2	Dorsum of third segment of h.w. with an additional minute subapical scale-tooth	pelias
	Dorsum of third segment of h.w. without such	3
3	Ground-colour of f.w. pale ochreous ..	congrualis
	Ground-colour of f.w. warm ferruginous-brown..	wahlbergi
4	Hinder part of thorax white; ♂ with single anal tuft	xerodes
	Hinder part of thorax not white; ♂ with double anal tuft	paludicola

TRICHOPTILUS PELIAS, *Meyr.*

T. E. S., 1907, 472.

Distribution.—Originally described from Coorg and Assam.

Not previously recorded from Ceylon, but my collection contains four examples which agree with the diagnosis of the type. They were taken :—

(*a*) Nalanda; October 30, 1906. Amongst grass, &c., by the roadside.

(*b*) Trincomalee; November 11, 1906. Oopah estate (*E. E. Green*), at light.

(*c*) Trincomalee; November 15, 1906. Powder Island.

(*d*) Colombo; December 17, 1906. Mutwal.

It is noteworthy that all the above specimens were taken in the low-country, whilst Mr. Meyrick's Indian examples were found at a considerable elevation.

Early Stages.—Unknown.

TRICHOPTILUS WAHLBERGI, *Zell.*

(Plate A., figure 10.)

Wahlbergi.—Zell., Linn. Ent., VI., 346; Z., Mic. Caff., 117; Wlsm., T. E. S., 1881, 280; Meyr., B. J., XVII., 134.

Rutilalis.—Wlk., Cat. XXX., 943.

Rutilans.—Wlk. (*sic !*).—Wollaston, A. M. N. H. (5), III., 441.

Pyrrhodes.—Meyr., Proc. Linn. Soc., N. S. Wales (2), IV., 1113.

Distribution.—Pérádeniya, Kandy, Mátalé, Maskeliya, Bandárawela, Badulla, Madulsíma.

Common in the hill districts between about 1,000 and 4,000 feet elevation. At Madulsima I found it common about half an hour before sunset on a bank covered with rough herbage. This moth seems especially attached to *Ageratum conyzoides* ("White Weed") from which I have often disturbed it, but a search on this plant has failed to reveal the larva.

Outside of Ceylon, *T. wahlbergi* has been recorded from South Africa, St. Helena (? introduced), and Queensland.

Early Stages.—The early stages and food plant are as yet unknown (unless the larva described under *T. xerodes* belongs to this species).

Eggs laid by captured moths, however, are of a smooth elongate-oval shape and of a very pale shining greenish-white colour. In size they are about ·47 mm. long by about ·32 mm. broad and ·28 mm. high, a transverse section thus being oval. The newly-hatched larva is whitish, with a black head and long black dorsal hairs.

TRICHOPTILUS CONGRUALIS, *Wlk.*

(Plate A., figure 8.)

Congrualis.—Wlk., Cat. XXX., 943; Wlsm., P. Z. S., 1885, 885; Swinhoe, Cat. Moths, India, No. 4,545; Meyr., T. E. S., 1907, 473.

Oxydactylus.—Wlk., Cat. XXX., 944; Wlsm., P. Z. S., 1885, 885; Swinhoe, Cat. Moths, India, No. 4,549; Moore, Lep. Ceylon, III., 529, t. 209, f. 16.

Ochrodactylus.—Fish, Canad. Entom., XIII., 142; Fernald, Pter. North America, 1898, 2nd edit., p. 15.

Centetes.—Meyr., T. E. S., 1886, 16; l c., 1887, 266; Wlsm., P. Z. S., 1891, 494; l c., 1897, 56.

Compsochares.—Meyr., T. E. S., 1886, 16.

Ralumensis.—Pag., Zoolog., XXIX., 239.

Distribution.—Jaffna, Mánkuḷam, Anurádhapura, Kẹgalla, Colombo, Barberyn Island, Ambalangoḍa, Galle, Hambantota, Batticaloa, Trincomalee, Habarane, Undugoḍa, Maskeliya.*

Abundant in all the sandy waste places of the low-country where the food plant grows.

Outside of Ceylon this species has been recorded from Florida and the West Indies, from South and East Africa, from India to New Guinea and N. E. Australia, and from China, and I have found it abundantly in the Chagos Islands, Farquhar Island, the Amirantes, and Coëtivy. It probably occurs in the Maldives also, though not yet recorded thence.

* A single specimen taken by Mr. J. Pole on December 5, 1908, at Deeside Trigonometrical Station (4,900 feet); doubtles a straggler or casual immigrant in the Maskeliya district, as I have never seen its food plant (*Boerhavia repens*) at any height greater than about 1,300 feet, and at this elevation only along the road between Taldena and Badulla, whither it seemed to have been carried from the low-country by cart traffic. Mr. Pole, however, has since informed me that he has met with this plant "once or twice on the cart road side near a factory in Maskeliya."

Early Stages.—Larva.—The earlier larval stadia are as yet unknown, but the older larvæ and pupæ are to be found commonly on *Boerhavia repens*.

The following description was made from a larva found at Galle on May 10, 1907 :—" The larva has just cast its skin (which remains alongside it, uneaten), and is probably just commencing its final instar. Length 5·5 mm. Breadth in thickest part (about middle) 1·5 mm. Hairs about 1 mm. long. In shape it is cylindrical, moderately stout, tapering at either extremity. When crawling the thoracic segments, especially the prothoracic, are greatly extended and appear very slender and flattened. The head appears to be uniformly jetty-black, but under a high-power lens the central portion and jaws are seen to be yellowish with a few short yellowish hairs. The ground-colour along the side is a pale yellowish shade of dirty gray with a tinge of red (this last colour is more pronounced in some specimens). There is a narrow medio-dorsal stripe of a shade rather darker than the ground-colour and a little redder. On the metathoracic segment the two warts edging the medio-dorsal line are faintly marked with dark reddish-fuscous ; the four succeeding segments have these warts distinctly marked with the same dark reddish-fuscous, and therefore show up like spots. (In other larvæ all these dorsal warts are more or less marked with dark fuscous, shading off at either extremity of the larva.) A broad but indistinct fuscous subspiracular line. A rather broad ventral pale-greenish stripe. The prolegs are very long and slender and are of a pale grayish greenish-yellow, the hooks dark ; the legs are similarly coloured. The long hairs appear dark, but there are numerous minute white knobbed glandular secondary hairs scattered over the segments, and these appear to secrete a viscous fluid."

The following is a description of two full-fed larvæ found at Colombo on October 18, 1907 :—" Stout, stoutest about fourth somite, decreasing thence rapidly towards the head, anally gradually. Colour a pale yellow with a faint tinge of fuscous green. There is a broad dull reddish longitudinal spiracular stripe, on which the spiracles stand out as pale longitudinal blotches. The medio-dorsal stripe has a faint tinge of red in it, making it a little darker than the ground-colour. On either side of this, bordering the darker brown latero-dorsal tubercles, is a series of whitish longitudinal dashes, forming two interrupted dorsal lines—these markings absent in one larva. Head dark brown. The long hairs are black and obviously sticky.

" A younger larva, about half-grown, is dark brown without any obvious markings, the hairs very distinctly clubbed at the apex."

The figure (Plate F, figure 2) will show the disposition of the setigerous tubercles better than any verbal description.

The larva is generally rather sluggish but can be quite active, *e.g.*, if searching for food. If it loses its foothold, it drops by a silken thread. It feeds on the unripe seeds of *Boerhavia repens*, commencing by eating the viscid exudation on the outside of the perianth tube, through which it then gnaws a hole and excavates the contents. Small insects, especially ants, are often seen to be caught by this gummy secretion, but the gum does not seem to incommode the larvæ at all; probably their extremely long prolegs are specially modified to carry them over it without touching it as they walk, and the long larval hairs prevent contact of the body with neighbouring drops of gum.

Pupation.—The larva seems to pupate almost invariably on the slender stem just below a seed-head, although I have once found an empty pupa-case attached to the midrib on the under-surface of a small leaf. The pupa hangs freely suspended, the discarded larval skin not being shrivelled up but stretched out at full length along the stem just above it. The rain soon destroys the empty pupa cases and one finds only the anal portion with the discarded larval skin. The colour of the pupa is very variable; sometimes it is a light apple-green, sometimes a brownish-gray. (Plate F., figure 3.)

TRICHOPTILUS XERODES, *Meyr.*

(Plate A., figure 9.)

Meyr., T. E. S., 1886, 14; l. c., 1885, 422; l. c., 1887, 267; B. J., XVII., 134.

Distribution.—Colombo, Trincomalee, Péradeniya, Maḍulsíma.

Widely distributed, but by no means a common species in Ceylon.

This species is widely distributed throughout Australia, but does not seem to have been recorded from elsewhere outside of Ceylon.

Early Stages.—Unknown.*

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* A larva (*supposed* to be that of *T. xerodes*) was found at Péradeniya on *Gynandropsis sp.* (Capparid) on December 26, 1907. A description of this larva reads as follows:—" About 12 mm. long, cylindrical, moderately stout. Head yellowish with an orange tinge. Colour of other segments a uniform pale yellow. A large brown latero-dorsal wart emits a long white hair and about five short ones. Below this is a small black supra-spiracular tubercle emitting a single short white hair and bearing a short secondary hair. Spiracle small, black. A small black subspiracular tubercle emits (i.) a short white hair directed forwards and downwards, (ii.) a longer white hair directed backwards and downwards. Below this and a little behind it is a small black wart emitting a single hair. Towards the ventral surface are two (? three) small black-warts emitting white hairs. There are numerous small knobbed white secondary hairs. All warts are well raised above the surface of the skin, and the divisions of the segments are well marked." (Plate F., figure 4.)

Although the exact identity of this larva is doubtful, its general appearance led me to consider it that of a *Trichoptilus*, and in this connection it is noteworthy that the *Gynandropsis* has well-developed sticky glands, as in the case of the other known food plants (*Drosera*, *Boerhavia*) of the plumes of this genus. It is possible that the larva may have been that of *T. wahlbergi*, or even that of an *Oxyptilus*, but an examination of plants of *Gynandropsis* and of *Cleomo viscosa* will probably settle this question.

TRICHOPTILUS PALUDICOLA, *Fletcher*.

(Plate A., figure 7.)

Spol. Zeylan., V., 20 (figs.).

Distribution.—Diyataláwa, Maḍulsíma, Assam.

Since my original description of this species I have found it commonly in three distinct localities along the Maḍulsíma range of hills; larvæ, pupæ, and imagines being found together during May and August. It will probably be found to be widely distributed at an elevation of about 4,000 feet, but is of course confined to damp places where *Drosera* grows.

Early Stages.—These are described in the reference quoted.

DIACROTRICHA, *Zell.*

(COSMOCLOSTIS, *Meyr.*)

These little moths seem to approach the *Alucitinæ* very closely in some respects; the single nervure in third segment of hind wing and the single spina of the ♀ frenulum, however, will serve to show their real affinities with the *Platyptilinæ*. It appears to me doubtful whether *D. fasciola* is really congeneric with *aglaodesma* and its allies (*auxileuca*, *pesseuta*, and *quadriquadra*), for which latter group the name *Cosmoclostis* may be retained, but in considering a small local fauna it seems inexpedient to multiply genera more than absolutely necessary.

Synopsis of the Species.

1	Abdomen uniformly coloured; a strong scale-tooth on dorsal margin of f.w. just beyond cleft	fasciola
	Abdomen variegated; no scale-teeth on margins of f.w.	2
2	Expanse 15–18 mm; f.w. white with ferruginous markings	aglaodesma
	Expanse 10–13 mm; f.w. white with fuscous markings	pesseuta

DIACROTRICHA FASCIOLA, *Zell.*

(Plate A., figure 6.)

Fasciola.—Zeller, Linn. Ent., VI., 399; Meyr., T. E. S., 1907, 471.

Callimeres.—Meyr., M. S. (*ined.*).

Distribution.—Galle, Kandy, Badulla, Aráwa.

Probably widely distributed in the wetter districts where bilimbi trees are cultivated.

Outside of Ceylon this species has been recorded from India, Java, and the Kei Islands.

Early Stages.—*Larva.*—The short, stout, uniformly-coloured larva feeds on the flowers of the "bilimbi" tree (*Averrhoa bilimbi*). The larvæ vary much in colour, hardly two being alike. Uniform yellowish-gray, pale yellow, pale greenish-yellow, pale green, pale pink, and red are all common colours. (Plate F., figures 5 and 6.)

Pupa.—The pupa is a very pretty object, being usually a bright light green (sometimes with black markings) with numerous fasciculated tufts of yellow spiny hairs. The sketch (Plate F., figure 8), for which I am indebted to Mr. E. Ernest Green, gives a good idea of its general appearance. It is generally attached to a flower-stalk, but sometimes to a flower-petal or fruit, or more rarely a leaf, of the food plant. I noticed that those pupæ which were formed in my paper-lined boxes were all of a light-gray colour, sometimes with indications of rosy-red markings; it is possible therefore that this species possesses some degree of colour-adaptability in its pupa.

Imago.—The transformations of this species are unusually rapid, the larva suspending itself and pupating in a few hours, the imago emerging after a pupal period of only four or five days.

Habits of Imago.—Contrary to the usual habit of plume moths, this species appresses itself closely to the surface on which it is resting; also it frequently settles on the *under* surface of leaves. It may readily be beaten in the day time from bilimbi trees or from bushes in their vicinity.

Diacrotricha aglaodesma, *Meyr.*

T. E. S., 1886, 12; B. J., XVII., 134.

Distribution.—Puttalam, Anurádhapura, Kurunégala, Kégalla, Colombo, Trincomalee, Mátalé, Aráwa.

Rather scarce; may be looked for in dry low-country districts. My specimens were taken at light at Trincomalee in November, 1906, and on June 8, 1907.

Occurs also in Eastern Australia and in some of the South Pacific and Malayan Islands.

Diacrotricha pesseuta, *Meyr.*

B. J., XVII., 134.

Distribution.—Puttalam (in February and April—*Pole*); Hambantota (January 12, 1908).

This species has not yet been recorded from any locality outside of Ceylon and is evidently an inhabitant of the very dry low-country districts. My single specimen was beaten from a tangled growth of *Euphorbia*, *Capparis*, and *Vitis quadrangularis*.

EXELASTIS, *Meyr.*

This genus has lately been founded (B. J., XVII., 730) to include *atomosa* and *liophanes*. I give a figure of the neuration (Plate C., figure F), but would call attention to an apparent discrepancy between my figure and Mr. Meyrick's diagnosis. The original description reads, "Forewings .... 8 and 10 stalked, 9 absent, 11 from near angle," but I have considered the formula better expressed by taking 11 as the missing vein and numbering the others accordingly. In the hind wings also 5 and 6 are stated to be absent, but are sometimes faintly traceable.

Synopsis of the Species.

Expanse usually under 13 mm.; metathorax usually pale yellow; colour of f.w. a reddish-gray, black scales on subapical portion of dorsum of f.w. form four compact equidistant groups	liophanes
Expanse usually over 15 mm.; metathorax usually grayish; colour of f.w. pale yellowish-gray; black scales on dorsum of f.w. are often absent and, when present, are scattered and irregularly grouped ..	atomosa

Note.—Both these species seem to be very variable in size, coloration, and development of the cilial scales.

Exelastis atomosa, *Wlsm.*

(Plate A., figure 11.)

Atomosa.—Wlsm., P. Z. S., 1885, 885; Meyr., B. J., XVII., 730; Lefroy, Mem. Agric. Ind., Ent. I., 219, (figs.).

Parasita.—Meyr.; Lefroy, Ind. Ins. Pests, p. 140 (figs.).

Distribution.—Anurádhapura, Galle,. Wẹligama, Trincomalee, Undugoḍa, Maḍulsíma.

The Ceylon form of this moth is smaller and lighter-coloured than the Indian type, from which it may ultimately prove to be specifically distinct, and seems to be decidedly scarce and mostly confined to the low-country. The case is very different, however, in India, where *E. atomosa* is generally distributed throughout the plains and often becomes a serious local pest on crops of *Cajanus indicus* and *Dolichos lablab.*

Early Stages.—The early stages have not yet been found in Ceylon, but I rather expect that the larva may be found on the flowers of *Anacardium occidentale* (kádju-nut).

Exelastis liophanes, *Meyr.*

(Plate A., figure 12.)

T. E. S., 1886, 19; B. J., XVII, 136.

Distribution.—Jaffna, Mánkuḷam, Anurádhapura, Kurunẹgala. Kẹgalla, Puttalam, Colombo, Labugama, Ambalangoḍa, Galle, Wẹligama, Hambantota, Trincomalee, Mátalé, Kandy, Pérádeniya, Maskeliya, Diyataláwa, Baṇḍárawela, Maḍulsíma, Lunugala, Badulla, Alutnuwara, Aráwa.

Abundant in grassy places throughout the low-country and in the hills up to an elevation of about 2,000 feet, above which height it becomes decidedly scarce.

E. liophanes was originally described from Réunion, and I found it abundantly in Mahé (Seychelles). It is probably widely distributed.

Early Stages.—In spite of the abundance of the imago, I have never yet been able to find the larva. At Wẹligama the moths were very common around plants of *Sida humilis*, but a search on these yielded nothing.

It is a curious fact that in the original drawings* by W. de Alvis for Moore's "Lepidoptera of Ceylon," an unpublished plate apparently represents this little moth together with its larva and pupa. They are drawn of the natural size; the larva is coloured yellowish-brown, lighter below, with three small black spots on each segment, and moderately hairy; the pupa very slender, nearly black.

The moths are often to be found paired during the forenoon, so that local entomologists who reside on shore should have little difficulty in working out the life-history.

SUB-FAMILY.—*ALUCITINÆ.*

PTEROPHORUS, *Geoffroy.*

Synopsis of the Species.

1	Ground-colour of f.w. whitish or gray ..	lienigianus
	Ground-colour of f.w. ochreous-white ..	sematias

PTEROPHORUS LIENIGIANUS, *Zell.*

Lienigianus.—Zeller, Linn. Ent., VI., 380; South, Entom., XV., 105, t. 2, f. 3; Leech, Brit. Pyral., p. 63., t. 17, f. 10; Hofmann, Deutscher Pteroph., p. 171; Meyr., Handbook, p. 439; Meyr., T. E. S., 1907, 497.

Serindibanus.—Moore. Lep. Ceylon, III., 527, t. 209, f. 14.

Distribution.—Anurádhapura, Galle, Trincomalee, Maskeliya, Pundalu-oya, Paṭṭipola, Nuwara Eliya, Maḍulsíma.

Widely distributed in the island, but appears to be more common in the hill districts. Outside Ceylon it is found in Central Europe and extends to the South of England; it has also been recorded from India.

Early Stages.—The early stages have not yet been found in Ceylon. In Europe the larva feeds on the terminal leaves of *Artemisia*

* These original drawings are now preserved in the Colombo Museum Library.

vulgaris, and is described as "pale bluish-green; dorsal linebroad, darker; subdorsal yellow-whitish; head brown, blackish-marked."

Observation 1.—There is a great deal of variation in this species:—

(1) *In Colour.*—A specimen from Galle in my collection is almost pure white and another from Trincomalee has the ground-colour almost white; examples from Maḍulsíma and Maskeliya are coloured a pale yellowish-gray of a tint identical with that seen in a specimen from Silesia; whilst two individuals from Paṭṭipola and Nuwara Eliya are decidedly a dark gray, the second segment of the fore wing much suffused with fuscous.

(2) *In Size.*—Also similar differences exist. The specimens from Galle and Trincomalee expand only 13 and 15 mm. respectively; Maḍulsíma examples range from 15 to 17 mm.; five from Maskeliya are 16, 17, 17, 18, and 22 mm.; two from Paṭṭipola are 18 and 21 mm.; and one from Nuwara Eliya attains 22 mm.: Meyrick and Zeller give 18–19 mm. as the expanse of European examples, and my Silesian specimen expands 21 mm.

It will be noted that there is a marked increase in the depth of colour and in the size of the specimens as their localities vary from the coast region to the montane district. As regards the latter point it is paralleled in other species, and I have especially drawn attention to it in the case of *Steganodactyla concursa.*

Observation 2.—Some authors have lately identified this species with Treitschke's *Septodactyla*, which name they then give priority; but, as this moth has been known all over Europe for the last fifty years under the name of *Lienigianus*, I fail to see the utility of altering Zeller's name for another, whose accuracy is at least doubtful.

PTEROPHORUS SEMATIAS, *Meyr.*

T. E. S., 1907, 496.

Distribution.—Maskeliya. The unique type-specimen was taken in October.

Observation.—Except for the ochreous-white ground-colour of the fore wings, the description of the type of this species seems to apply exactly to up-country specimens of *P. lienigianus*, of which I am inclined to think that *sematias* will prove to be only a form.

ALUCITA, *Linn.*

Synopsis of the Species.

1	Hind wing with a conspicuous black dot in centre of second segment	..	melanopoda
	Hind wing unspotted	..	2
2	Ground-colour pure white	..	niveodactyla
	Ground-colour pale yellowish-white	..	candidalis

ALUCITA CANDIDALIS, *Wlk.*

Candidalis.—Wlk., Cat. XXX., 948 ; Meyr., T. E. S., 1907, 490 ; Wlsm., T. E. S., 1881, 282 ; l. c., 1897, 36.

Leucadactyla.—Wlk., Cat. XXX., 949 ; Moore, Lep. Ceylon, III., 528, t. 209, f. 15.

Distribution.—Kęgalla, Labugama, Węligama, Kandy, Maskeliya, Haldummulla, Lunugala.

In Ceylon this is apparently rather a low-country species and is not common. Outside of Ceylon its distribution extends from Sierra Leone and South Africa through India to the Philippines, New Guinea, and Queensland.

The larva is unknown, but may be looked for on some species of *Ipomœa.*

ALUCITA NIVEODACTYLA, *Pag.*

Niveodactyla.—Pag., Zoologica, XXIX. 240 ; Meyr., T. E. S., 1907, 490.

Nivea.—Snellen, Tijd. Ent. XLVI., 56, t. 5, f. 17.

Distribution.—Maskeliya (Coll. de Mowbray), Mađulsíma, Lunugala, Diyataláwa, Haputalé.

In Ceylon it is a scarce species, principally confined to the hill districts of Úva.

Outside of Ceylon it has been recorded from Java, the Philippines, and the Bismarck Archipelago.

Early Stages—Larva.—The larva feeds on the young leaves of an *Ipomœa*, eating the leaves from the outside and not entering within the unexpanded leaf in the manner of *Steganodactyla concursa.* In colour it is of a uniform pale yellowish-green thickly studded with long fasciculated tufts of whitish hairs, of which those of the dorsal row are the longest and sometimes tipped with brown. These hair-tufts are extremely complicated, and their appearance will be best understood from the rough sketch of a larval segment (Plate F., figure 9) ; under the microscope these tufts of long hairs recall the armature of spines exhibited by an Echinid, which is very common on rocks along the coast.

Parasites.—An extremely large proportion of the larvæ appears to be infested by a parasitic ichneumonid fly.

Pupa.—The pupa is green, thickly covered with pale green spinous hairs and with an interrupted dorsal and sub-dorsal row of black spots. The moth emerges after about a week.

ALUCITA MELANOPODA, *Fletcher.*

(Plate A., figure 13.)

Entom., 1907, 284.

Distribution.—Kandy, Háragama, Mađulsíma.

Apparently a scarce species in Ceylon ; it has also been found in Assam.

Early Stages.—Unknown.

EXPLANATION OF PLATES A, B, C, E, AND F.*

All the figures in plate A have been drawn by Messrs. West, Newman direct from specimens of the various species.(all previously unfigured), and the artist certainly deserves a word of praise for the manner in which he has carried out his work. I am indebted to Mr. E. Ernest Green for the pencil sketch, of which figure 8 in Plate F. is a reproduction. The remaining figures are from sketches by the author.

It must be borne in mind that all the figures in Plates E and F are diagrammatic, only being intended to give a general idea of the objects represented, so that, for example, in the case of larvæ, the secondary hairs have as a rule been omitted.

It is hardly necessary to add that the figures in all the Plates are considerably magnified ; in the case of Plate A the natural size is shown by the scale against each principal figure.

PLATE A.

(In all cases the figures lettered 1*a*, 2*a*, &c., represent a profile view of the head of the species figured under the corresponding number.)

Fig. 1.—*Platyptilia molopias*, Meyr.

Fig. 2.—*Platyptilia pusillidactyla*, Wlk.

The abdomen usually shows a characteristic broad chocolate-coloured band a little beyond its middle, not sufficiently represented in the figure.

Fig. 3.—*Platyptilia brachymorpha*, Meyr.

Fig. 4.—*Oxyptilus causodes*, Meyr.

Fig. 5.—*Oxyptilus epidectes*, Meyr.

The first segment of the fore wing is represented as much too blunt at the apex, which really tapers to a fine point as in figure 6.

Fig. 6.—*Diacrotricha fasciola*, Z.

This figure is tinted a little too dark.

Fig. 7.—*Trichoptilus paludicola*, Fletcher.

This figure scarcely shows the white markings on the fore wing.

Fig. 8.—*Trichoptilus congrualis*, Wlk.

Fig. 9.—*Trichoptilus xerodes*, Meyr.

Fig. 10.—*Trichoptilus wahlbergi*, Z.

Fig. 11.—*Exelastis atomosa*, Wlsm.

Fig. 12.—*Exelastis liophanes*, Meyr.

Fig. 13.—*Alucita melanopoda*, Fletcher.

PLATE B.

(Neurational Details.)

Fig. A.—*Platyptilia pusillidactyla*, Wlk.

Fore and hind wing.

Fig. B.—*Heptaloba argyriodactyla*, Wlk.

Fore wing only ; for neuration of hind wing see text.

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* There is no Plate D, the letter D having been passed over by mistake.

Fig. C.—*Deuterocopus rubrodactylus*, Pag.

Fore and hind wing of ♀. It will be noted that the spina of the frenulum, which is very long and strong, is single, but is divided by a deep groove running from the base nearly to the apex so that it is practically composed of two spinulæ soldered together.

PLATE C.

(Neurational Details.)

Fig. D.—*Trichoptilus congrualis*, Wlk.

Fig. E.—*Diacrotricha fasciola*, Z.

Fig. F.—*Exelastis atomosa*, Wlsm.

The neuration of *E. liophanes*, Meyr., is similar.

PLATE E.

Fig. 1.—Three segments of larva of *Steganodactyla concursa*, Wlsm., showing arrangement of tubercles and primary hairs.

Fig. 2.—Outline sketch of pupa of *Steganodactyla concursa*, Wlsm.

Fig. 3.—Sixth and seventh segments of larva of *Stenoptilia zophodactyla*, Dup., showing arrangements of tubercles.

Fig. 4.—Sixth and seventh segments of larva of *Platyptilia molopias*, Meyr., showing arrangement of tubercles and primary hairs.

Fig. 5.—Two segments of larva of *Platyptilia pusillidactyla*, Wlk.

Fig. 6.—Outline sketch (latero-ventral aspect) of pupa of *Platyptilia pusillidactyla*, Wlk.

Fig. 7.—Three segments of larva of *Deuterocopus rubrodactylus*, Pag.

Fig. 8.—The two conjoined latero-dorsal tubercles of larva of *Sphenarches caffer*, Z., showing a more detailed view of the peculiar palmate hairs seen in figure 10.

Fig. 9.—Abdominal segment (rather a latero-ventral view) of larva of *Oxyptilus causodes*, Meyr. The crescentic object at the bottom of the figure represents the proleg with its semi-circle of darker hooks.

Fig. 10.—Sixth and seventh segments of larva of *Sphenarches caffer*, Z.

PLATE F.

Fig. 1.—Outline sketch (lateral view) of pupa of *Sphenarches caffer*, Z.

Fig. 2.—Sixth and seventh segments of larva of *Trichoptilus congrualis*, Wlk. A few of the club-shaped secondary hairs are indicated.

Fig. 3.—Terminal portion of pupa of *Trichoptilus congrualis*, Wlk., showing armature of spines and double cremaster.

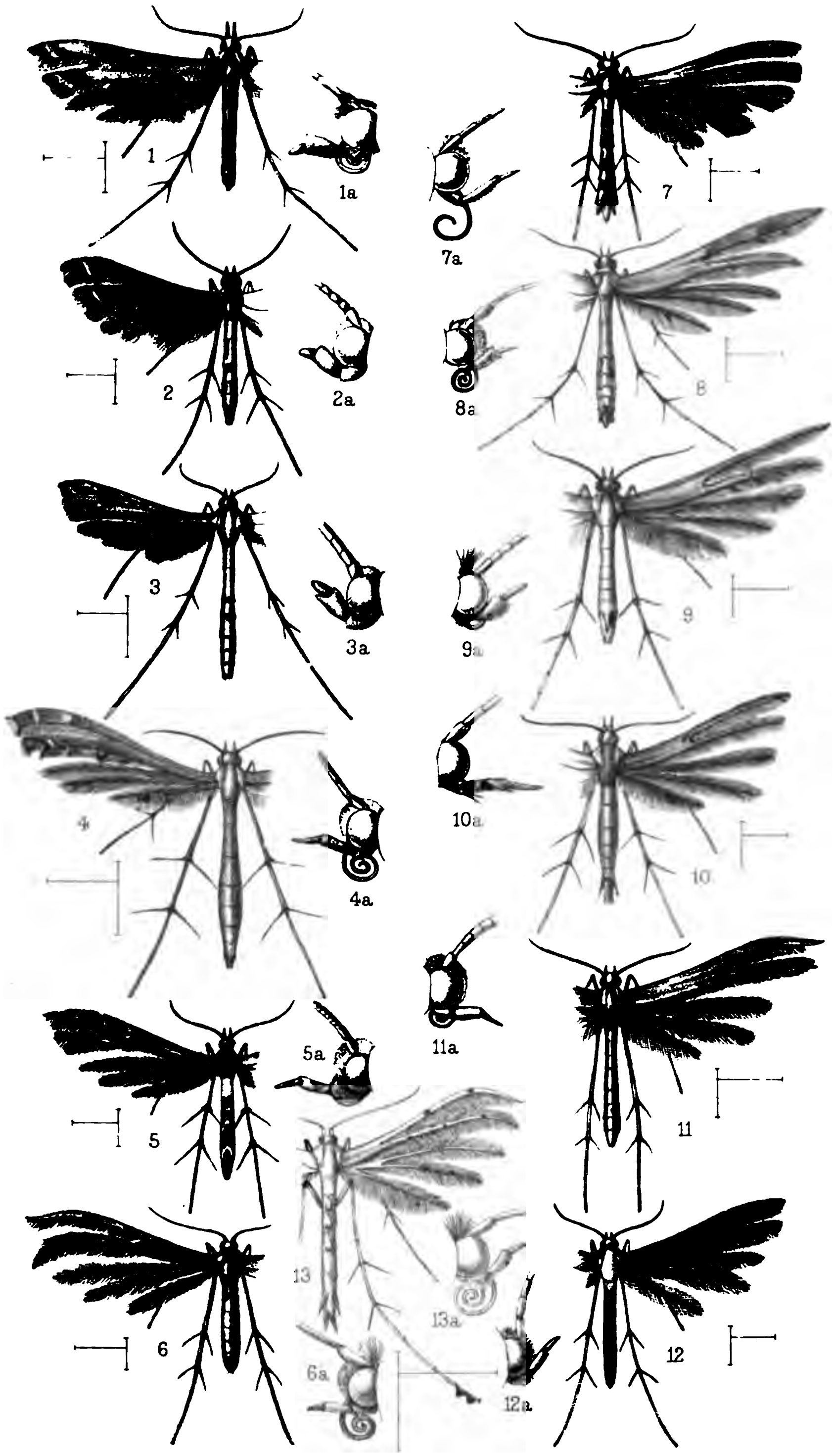
Fig. 4.—Sixth and seventh segments of larva of *Trichoptilus* sp. (? *xerodes*, Meyr).

Fig. 5.—Sixth and seventh segments of larva of *Diacrotricha fasciola*, Z.

Fig. 6.—Profile sketch of a tubercle of larva of *Diacrotricha fasciola*, Z.

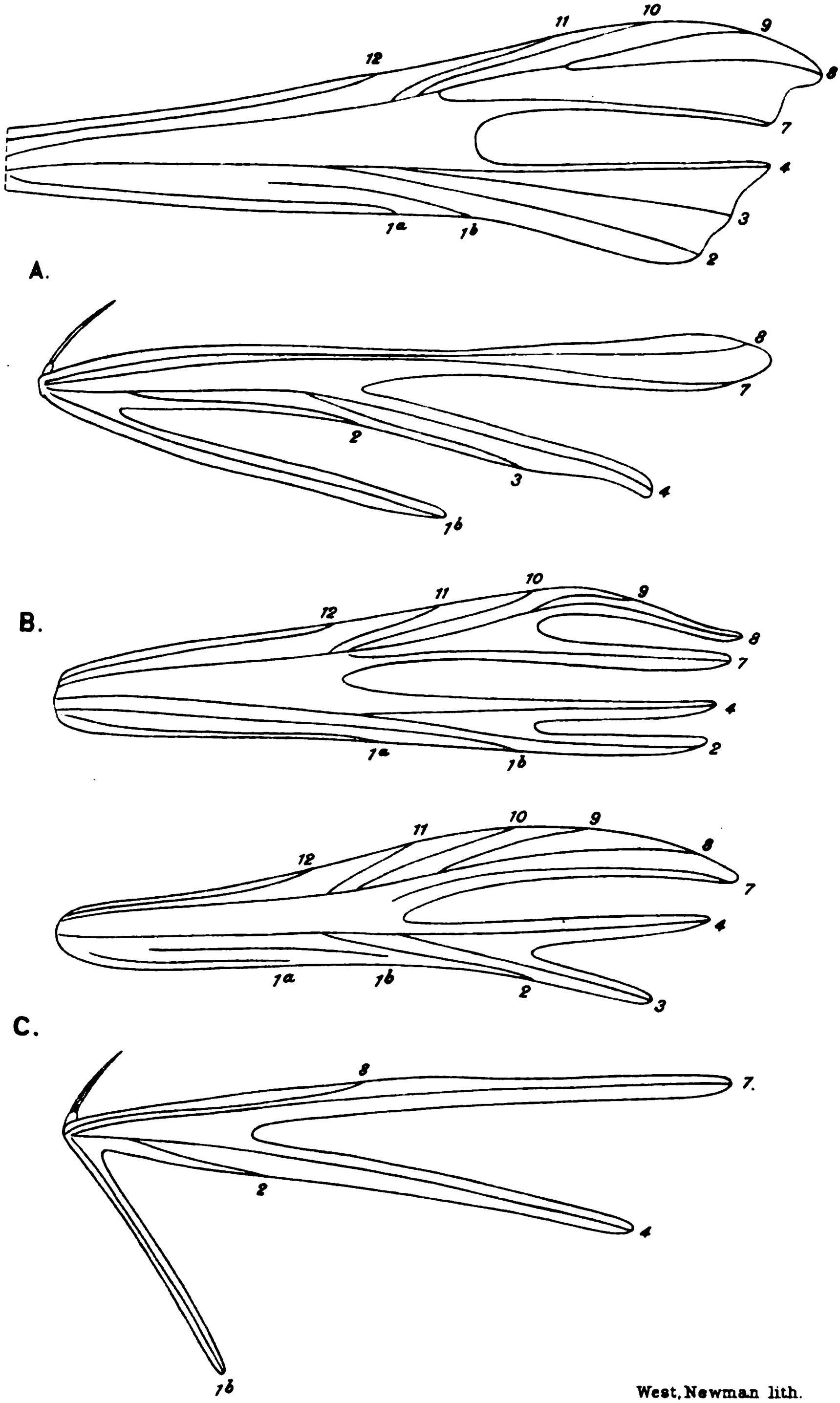
Fig. 8.—Diagrammatic sketch of pupa of *Diacrotricha fasciola*, Z. From a pencil drawing kindly made by Mr. E. Ernest Green; this drawing does not purport to be accurate as regards exact details, but gives a capital idea of the general appearance of this pupa.

Fig. 9.—Segment of larva of *Alucita niveodactyla*, Pag.



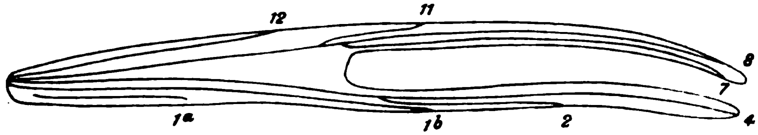
West, Newman del. et lith.

PTEROPHORIDÆ.

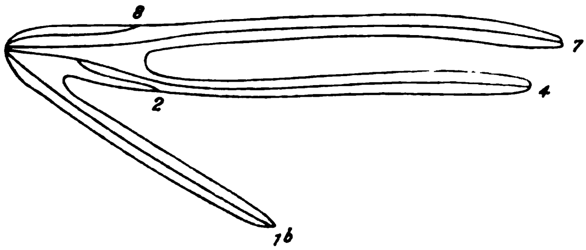


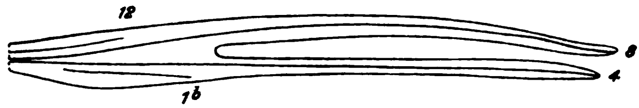
West, Newman lith.

A. Platyptilia pusillidactyla, *Wlk.*
B. Heptaloba argyriodactyla, *Wlk.*
C. Deuterocopus rubrodactylus, *Pag.*

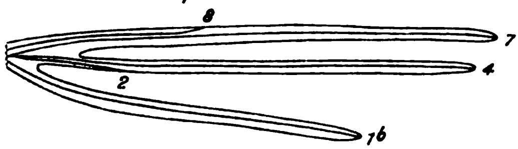


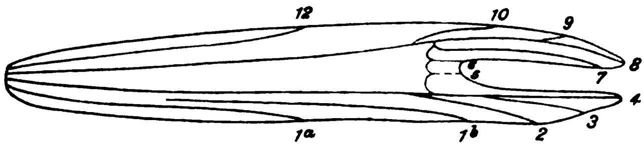
D.



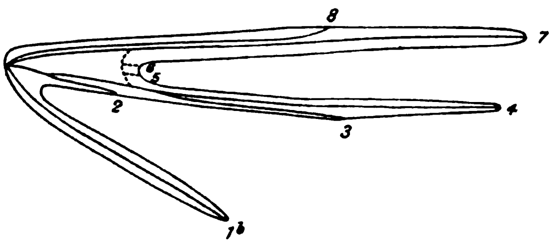


E.



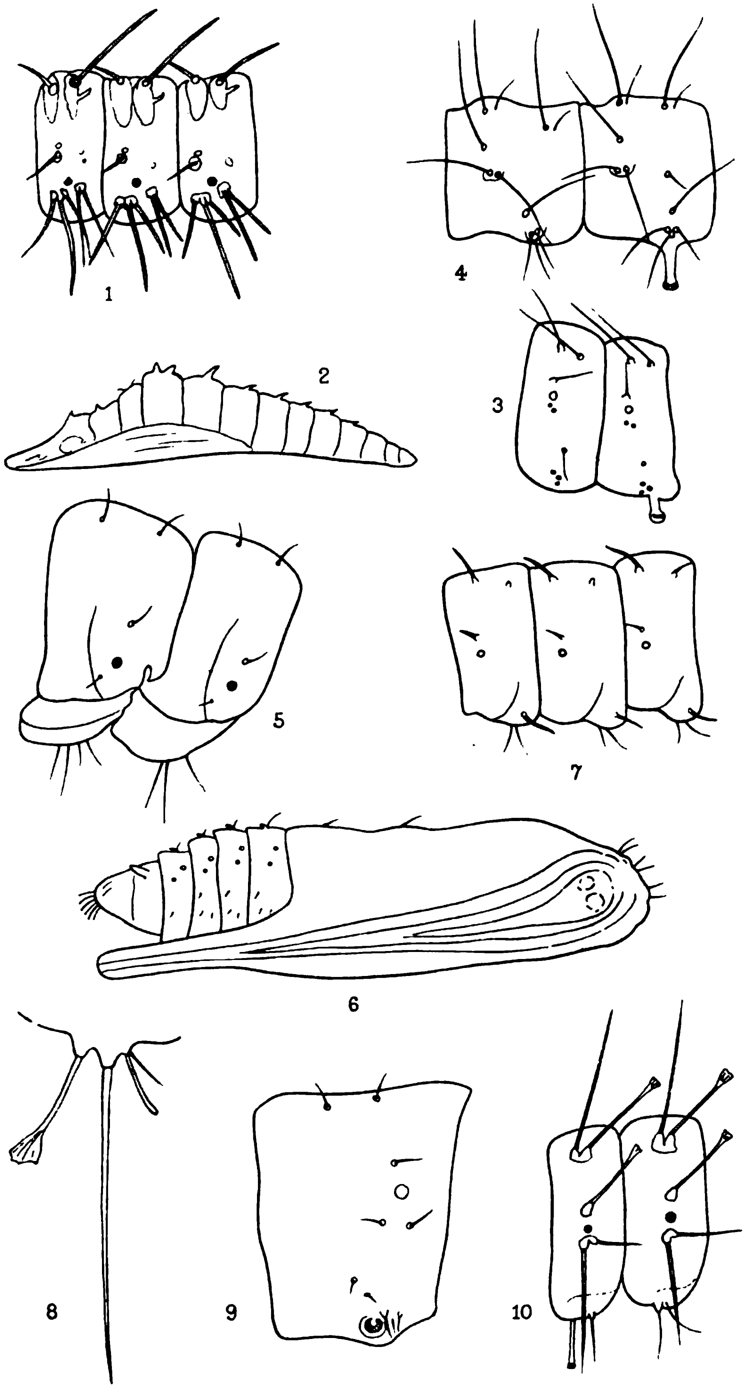


F.



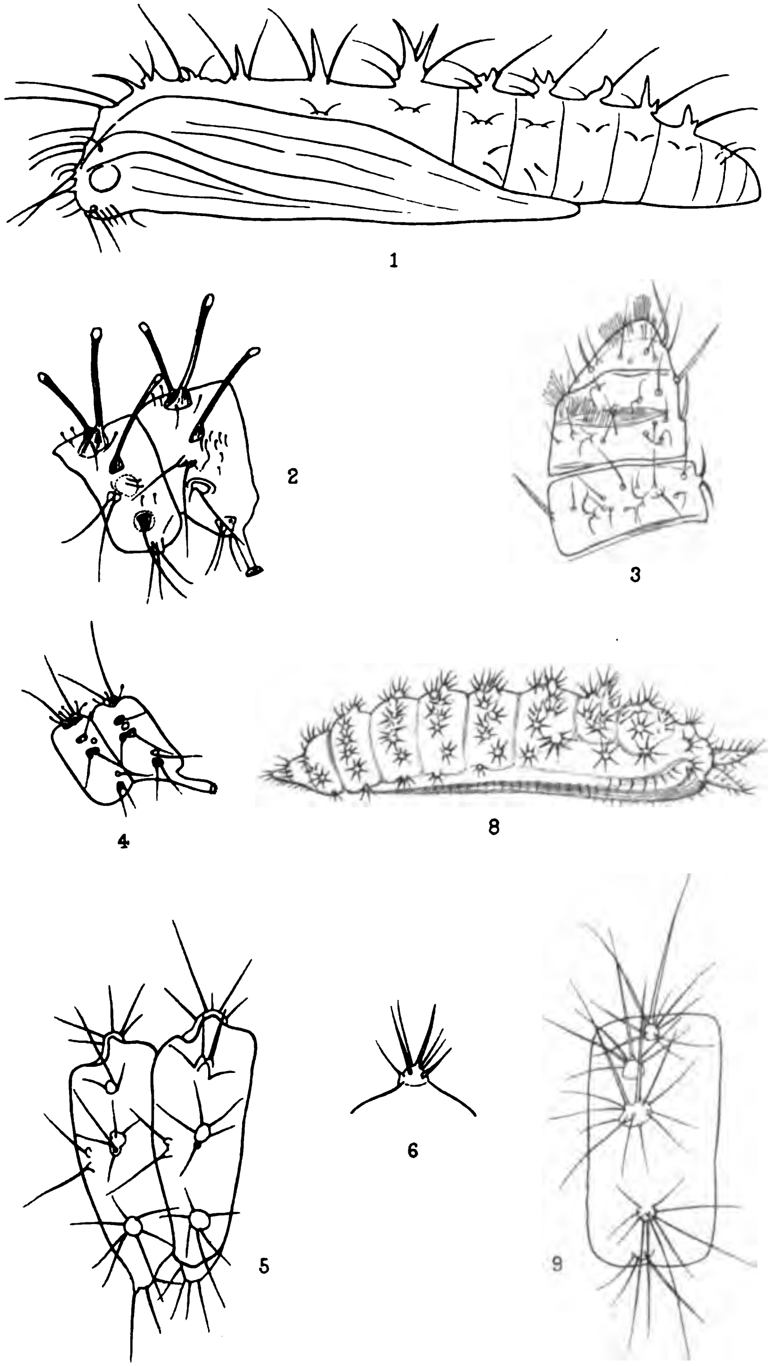
West, Newman lith.

D. Trichoptilus congrualis, *Wlk.*
E. Diacrotricha fasciola, *Zell.*
F. Exelastis atomosa, *Wlsm.*



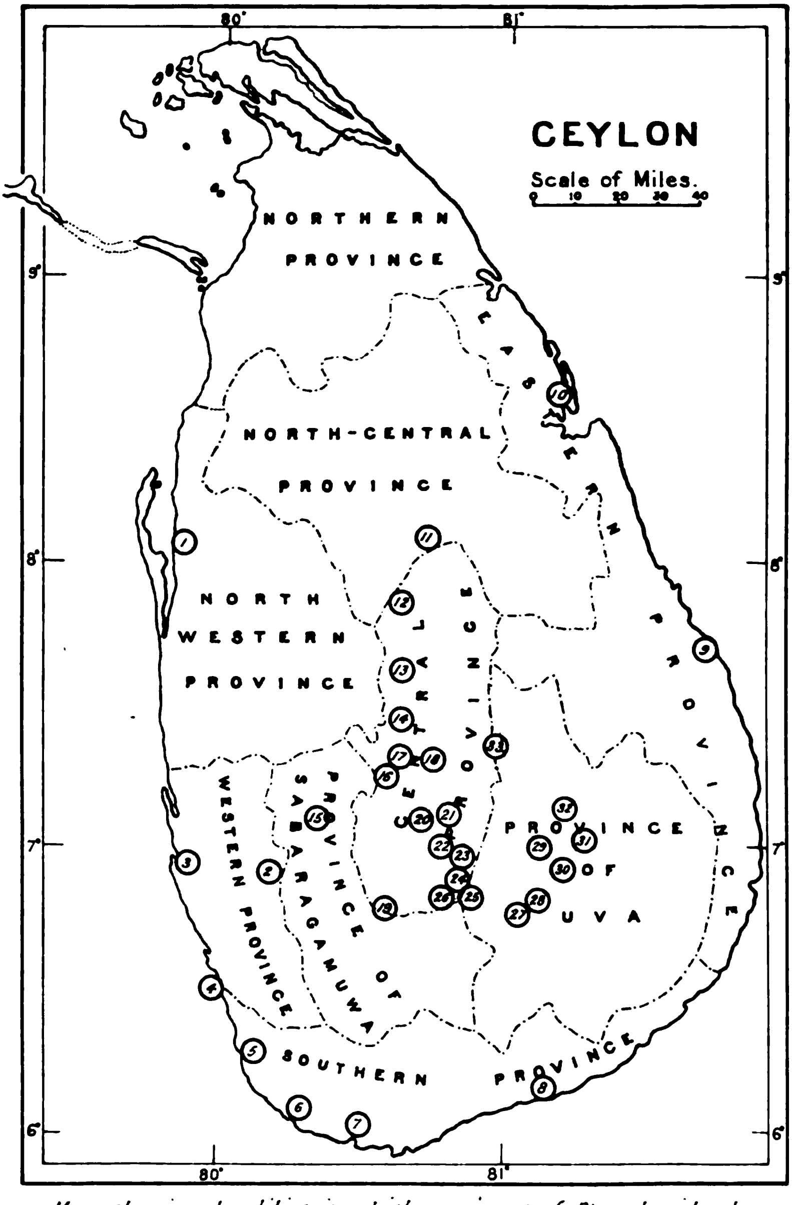
T.B.F. del. ad nat. West, Newman lith.

PLUME MOTHS OF CEYLON.



T. B. F. del. ad. nat. West, Newman lith.

PLUME MOTHS OF CEYLON.



Map showing localities in which specimens of Pterophoridae have been collected.

Lith., S.G.O. N° 5/09.

Explanation of the Map.

Number of Place on Map.	Name of Place.	Approximate Height above Sea. Ft.
1	Puttalam	Sea-level
2	Labugama	200
3	Colombo	Sea-level
4	Barberyn Island	Sea-level
5	Ambalangoḍa	Sea-level
6	Galle	Sea-level
7	Wẹligama	Sea-level
8	Hambantota	Sea-level
9	Batticaloa	Sea-level
10	Trincomalee	Sea-level
11	Habarane	100
12	Dambulla	200
13	Nálanda	600
14	Mátalé	1,200
15	Undugoḍa	1,000
16	Pérádeniya	1,700
17	Kandy	1,700
18	Háragama	1,250
19	Maskeliya	4,000
20	Pundalu-oya	4,200
21	Maturaṭa	4,000
22	Nuwara Eliya	6,200
23	Hakgala	5,700
24	Paṭṭipola	6,200
25	Ohiya	6,000
26	Horton Plains	7,000
27	Diyataláwa	4,000
28	Banḍárawela	4,000
29	Badulla	2,200
30	Passara	2,000
31	Lunugala	2,500
32	Maḍulsíma	3,500–4,000
33	Alutnuwara	600

Speaking very roughly, Nos. 1, 8–12, 33 are dry low-country ; Nos. 2–7, 13–15 are wet low-country ; Nos. 16–18 wet, 29–31 rather dry, intermediate zone ; Nos. 19–26 are wet hill-country ; Nos. 27, 28, 32 are dry hill-country.

ON SOME UNDESCRIBED ICHNEUMONIDÆ AND BRACONIDÆ, REARED BY MR. T. BAINBRIGGE FLETCHER, R.N., FROM CEYLONESE LEPIDOPTERA (PTEROPHORIDÆ).

By P. CAMERON.

IN this paper I have described one species of Ichneumonidæ and five of Braconidæ, reared by Mr. T. Bainbrigge Fletcher R.N., F.E.S., from the larvæ of moths collected and reared by him in Ceylon, while stationed on board H. M. S. " Sealark." The Braconid genus *Apanteles* appears to be well represented in Ceylon. Several species of *Microgaster* have been described by Walker and by the Russian Entomologist Motschulsky, none of which I have been able to identify. Whether the species described by these authors belong to *Microgaster*, *sensu stricto* or, as is most likely, to *Apanteles*, is a point which can only be settled by an examination of the types, if these be still in existence.

At the request of Mr. Fletcher I send the descriptions for publication in *Spolia Zeylanica.*

ICHNEUMONIDÆ.

Hymenobosmina trichoptilus, sp. n.

Black, the antennal scape and the legs fulvo-testaceous, the scape and the four front coxæ and trochanters paler, more yellowish in tint ; the hind coxæ, except narrowly at the apex, the apex of the hind tibiæ, and the hinder tarsi black ; the apex of the first abdominal segment, the apical third of the second, and the sides of the third to sixth, testaceous ; the second ventral segment pale yellow, the others testaceous, more or less infuscated. Wings hyaline ; the stigma dark fuscous, the costa and nervures blackish. Basal five or seven joints of flagellum of antennæ dark rufo-testaceous. Male.

Length 4 mm.

Galle, Ceylon. Bred from *Trichoptilus oxydactylus*. December.

Head with the face, clypeus and cheeks densely covered with silvery pubescence, as are also the pleuræ and, more particularly, the metapleuræ and metanotum. The pile on front and vertex sparse and short. Mandibles yellow, their teeth blackish ; the palpi of a paler yellow. Base of metanotum with two areas, widened distinctly on the outer side ; their keels uuite at the base, forming almost an area, widened towards the base ; there is a distinct areola, longer than wide, narrowed to a sharp point at the base, the apex transverse; there are three areæ on the apical slope, the outer becoming wider towards the apex, the central strongly closely transversely striated; there is a keel outside the spiracles and a less distinct, curved one over and between the two hinder coxæ. Pleuræ finely, closely punctured; the depression on the propleuræ with some stout striæ; the mesopleuræ above finely, closely longitudinally striated, the lower half of the apex with a few short striæ. Metapleuræ more strongly punctured than the rest.

Head, mesonotum, and scutellum finely, closely punctured; the metanotum has the punctures more distinctly separated. Abdominal petiole smooth and shining, the post-petiole dilated. The recurrent nervure is received almost the length of the transverse cubital nervure beyond it; the transverse median nervure is interstitial; the recurrent nervure is largely bullated, as is also (but more narrowly) the disco-cubital nervure; the apical nervures in the hind wings are obsolete. Antennæ 27-jointed, almost as long as the body, the flagellum densely covered with short, stiff pubescence.

Braconidæ.

Apanteles paludicolæ, sp. n.

Black, the apical two-thirds of the fore femora, the apical third of the middle and all the tibiæ and tarsi, rufo-testaceous, the ventral surface of the abdomen at the base more or less rufous, the sides of the first abdominal segment narrowly dark rufous; wings clear hyaline, the stigma and costa pale fuscous. Palpi testaceous. Metanotum finely, closely rugose, furrowed down the middle; the base and apex with a transverse furrow. First abdominal segment almost square; the basal two-thirds raised, the apex of the raised part bordered by a wide deep, curved furrow, the sides bordered by a distinct furrow; it and the second segment are closely rugosely punctured; at the apex of the second is a distinct transverse furrow; the third and following segments are smooth, shining, and covered with a microscopic down. Hypopygium large, wide, projecting, cultriform. Female.

Length 2 mm. Diyatalawa, 4,000 feet. August and September. Bred from *Trichoptilus paludicola*, Fletcher.

The amount of black on the legs varies; in the male the femora may be testaceous below, and the apex of the hind tibiæ and the hind tarsi may be black. Probably a common species.

Apanteles platyptiliæ, sp. n.

Black, the legs red, the base of the coxæ black, the apex of the hind tibiæ and the hind tarsi slightly infuscated; wings hyaline, the costa and stigma fuscous; centre of metanotum keeled, the keel running at the apex into a smooth round fovea; the apex on either side of this and the sides keeled. First abdominal segment longer than wide, strongly aciculated; second with a smooth raised line in the centre, the sides with a narrow oblique furrow; the segment is as strongly aciculated as the first and appears to be also finely striated; the base of the third is more finely, less strongly aciculated. Basal half of the ventral surface rufous. Hypopygium cultriform, the ovipositor only very slightly projecting. Female.

Length 2 mm.

The keels on the metanotum may be somewhat indistinct. Pubescence sparse in parts, short and white. The amount of rufous colour on the base of the ventral surface of the abdomen seems to vary; and the basal segment above may be narrowly lined with rufous. Metanotum aciculated finely, shining.

Madulsima, Ceylon; *ex*-larva of *Platyptilia molopias;* May; nine examples. Allied to *A. taprobanæ*, Cam.

Apanteles stegenodactylæ, sp. n.

Black, densely covered with a white microscopic pile, the apex of the fore femora broadly, the base of the four hinder tibiæ and of the tarsal joints narrowly, pale yellow; wings clear hyaline, the nervures almost white; first abdominal segment wider than long, the centre raised, wider than long, the sides bordered by two keels, strongly aciculated, the sides at the apex with a smooth triangular space. Palpi testaceous. Male.

Length 2 mm.

Galle, Ceylon. Bred from *Stegenodactyla concursa.*

The abdomen becomes gradually obliquely narrowed from the base of the second abdominal segment, the second segment minutely aciculated, raised slightly in the centre, the others smooth and shining, their apices fringed with white pubescence. Head and thorax alutaceous, the scutellum smooth, shining, its sides below bordered by a furrow. Post-scutellum depressed, the edges bordered by a broad keel, the apex rounded. Apical part of the radius straight, the posterior sloped towards the base of the wing, forming an acute angle with the apex of cubitus, which is thinner and shorter than it.

Apanteles bisulcata, sp. n.

Black, the apical half of the two front femora, the apex of the middle below, the fore tibiæ entirely, the greater part of the basal two-thirds of the middle, slightly more than the basal half of the posterior, the four anterior tarsi, except narrowly at the extreme apex, and the base of the four basal joints of the hinder (the basal more broadly than the others) pale yellow, the tarsi paler than the tibiæ or femora; wings clear hyaline, the nervures pallid testaceous.

Female. Length 1·5 mm. Terebra fully half the length of the abdomen.

Ceylon, S. P., Weligama. Bred from *Stegenodactyla concursa*, Wlsm.

Head and thorax opaque, shagreened, covered with a microscopic white pile; the scutellum smooth and shining, the sides bordered below the top by a distinct furrow. Metanotum with a gradually rounded slope, a distinct, clearly defined furrow down its centre. First abdominal segment almost square, aciculated, furrowed down the middle; it is raised and clearly separated from the second segment. Sheath of ovipositor more fuscous than black, narrowed at the base. Apical abscissa of radius straight in front, the posterior (and smaller) obliquely bent towards the base of the wing.

Cocoon snow white, longish oval, spun solitarily on the leaf of food plant.

Apanteles leptoura, sp. n.

Black, the anterior femora, tibiæ and tarsi, the apex of the four hinder femora, the middle tibiæ and tarsi, the hinder, except the apex of the tibiæ, the apical half of the hinder metatarsus and the apex of the last joint, which are black, rufo-testaceous; wings very clear hyaline, the stigma and nervures very pale testaceous. Sheath of ovipositor broad, narrowed at the base; it is as long as the abdomen. Female.

Length 3 mm.

Madulsima, June 3.

Antennæ as long as the body, covered with a white pile, the head and thorax finely, closely, distinctly punctured, the metanotum closely, transversely striated; in its centre is an area, wide at the base, longer than wide, roundly narrowed towards the apex, the keels rounding it weaker towards the base; the area, except at the base, is more strongly transversely, and widely striated than the rest; the outer edge of the metanotum is margined by a keel. First abdominal segment wider than long, closely rugosely punctured, the sides margined by a curved keel; its apex is margined by a smooth curved narrow furrow; it is clearly separated. The other segments smooth, shining. Bred from Tortrix larva burying in stems of "dadap."

TWO FRAGMENTS.

By James Parsons, B.Sc., F.G.S.

With an Introductory Note.

[Nearly twenty years ago it was my fortune to spend some months in the little fishing village of Peloro Faro near Messina, studying the development of an archaic type of fish of very small size, called the lancelet. On December 28 last this place, so I am told, shared the ruin wrought by the Messina earthquake. On the following day, December 29, my friend Mr. J. Parsons went out for a short walk in the open country at Nuwara Eliya, in order to examine an exposure of country rock on a tea estate. Such exposures can, as a rule, only be observed satisfactorily in the open; and the jungle which surrounds a clearing has little or no attraction for a geologist. From my personal acquaintance with him, extending over five years, I can well believe that he was cool, methodical, and cautious.

He left his hotel at 10 o'clock in the morning intending to return for luncheon. On such a trifling excursion he did not require an attendant. About noon he was seen walking through the tea on the Oliphant estate, and the spot is pointed out where he was last seen, "durai kanda veddam." From that hour and place every trace vanishes, and no effort of the imagination can pierce the darkness which swallowed him up. It is even impossible to make reasonable suggestions. Almost any suggestion which can be made has to be rejected. But there is one sinister circumstance attending the disappearance. Night and day following the rain fell incessantly, five inches on the first day, four inches on the second. During this distressing time all the available forces of the countryside, headed by Brigadier-General R. C. B. Lawrence, scoured the hills, ravines, forests, and streams of the neighbourhood in vain.

The search was continued for weeks subsequently; experienced trackers were employed and rewards offered, but so far not a shred of evidence has been obtained. There are formidable stretches of jungle between the Great Western mountain and Pidurutalagala affording plenty of opportunity for getting lost; but this was not his destination.

I have elsewhere compared the jungle with the desert and the high sea, and it is on an occasion such as this that the aptness of the comparison becomes apparent. In the jungle beyond Oliphant there is a habitable cave with traces of comparatively recent occupation. Round about it the trees are draped with luxuriant festoons of mosses and scattered orchids, the kind of wild place which an orchid collector might visit with prospects of success. So hidden is this cave in the heart of the jungle that, although it is not far from the tea, it was unknown to the Superintendent of the adjoining estate.

Parsons came out to Ceylon in 1902 as Assistant to his college friend Dr. A. K. Coomaraswamy to undertake a Mineralogical

BLOCK OF FLUORSPAR (DARK) INTERGROWN WITH QUARTZ (PALE), FROM MATALE [PARSONS].
Slightly less than one-half natural size.

Survey of Ceylon. When Dr. Coomaraswamy's engagement came to an end in 1906, the work was continued by Mr. Parsons, who became Principal Mineral Surveyor.

During the Vedda expedition at the beginning of 1908 Mr. and Mrs. Parsons rendered essential service to Dr. C. G. Seligmann and Mrs. Seligmann.

His work in the field kept him during most of the year away from the towns, so that he was a stranger to those places where men most do congregate. But to his colleagues and friends the news of his disappearance spelt consternation, and it remains to this day unaccountable and still incredible.

The short papers presented below were intended by Mr. Parsons for publication in this Journal, and were found without any difficulty arranged in due order amongst his papers. He has done excellent work in the Mineral Gallery at the Colombo Museum.

Colombo, March 2, 1909. A. WILLEY.

I.—Fluor-spar in Ceylon.

A FINE specimen of fluorite (fluor-spar) was found at Crystal Hill estate near Matale, the same locality as that mentioned in the paper on "The Modes of Occurrence of Quartz in Ceylon" in the last issue of *Spolia Zeylanica*. The fluorite is intergrown with transparent quartz, and the two minerals must have crystallized simultaneously, though the quartz shows crystal outlines, while the fluorite does not show its characteristic cubic form. An inclusion of fluorite in the quartz will be noticed in the illustration. The octahedral cleavage is, however, well developed, and renders the specimen very frangible.

Fluorite is found of many colours, that of the blue or violet "Blue John" in Derbyshire being best known. The Matale fluorite is colourless, though on account of iron-staining along the cleavage cracks the general appearance of the mineral is reddish.

The block was not found actually *in situ*, and the mode of origin is not known. It is, as a rule, a vein mineral.

Traces of a blue mineral, which was probably fluorite, were found in 1903 in charnockite near the Officers' Bathing Place, Colombo, and Dr. Gygax in 1847 recorded it from "Galle Back."

The specimen here described and figured is the first example of any size that has been noted in Ceylon.

II.—Votive Offerings of Weapons.*

Offerings *ex voto* are commonly made at Buddhist shrines in Ceylon and at the dewales or temples devoted to Sinhalese naturalized Hindu worship, as well, probably, as to that of more primitive indigenous cults. Indeed, at dewales such offerings form an integral portion of the ceremonies so far as the public participates in them.

* This paper was left in a somewhat unfinished state, and has had to be pieced together from notes.—Ed.

In viharas these offerings for the most part take the form of flags, often with a human head and an inscription with symbolical device roughly embroidered on the calico. Other gifts of jewels, images, clothes, &c., do not, as a rule, appear to be votive. The ceremonial act of carrying fire on the head for lighting purposes is, at least sometimes, votive in character. I have seen it performed at Wesak in the compound of a vihara in the Morawak korale.

While in viharas only the images or *rupas* of the Buddha and Buddhist saints are seen with wall paintings or plaster reliefs of Vishnu and the more prominent gods, in the dewales the actual god or gods to whom the temple is dedicated are believed to be present at all events at certain times; consequently, great sanctity attaches to the shrine, to which Europeans especially are seldom admitted.

Such sanctity even may extend to the surroundings of the temple, as in the case of a small dewale on the seacoast north of Ambalangoda, where I was requested not to rest on a rock adjacent to the building for fear of desecrating it. It is, however, known that votive offerings of articles of value are made in the larger dewalas, *e.g.*, those of Alutnuwara and Kataragam. At the latter place, it is stated that silver models of limbs are offered *ex voto* by individuals who have been cured of maladies in the parts represented.

The restrictions with which the larger dewalas are guarded are, either from indifference or security from intrusion in remote districts, relaxed in the case of the small village shrines or *kovilas*, and admission to them can be occasionally obtained with little difficulty. A small dewale, which I once visited in the Wanni, had not even a door.

These buildings are, as a rule, of the rudest character, with mud walls and a small outer court or verandah. Following the Buddhist tradition arising from the early use of caves as temples, they are often built against or under overhanging rocks.

The worship in these village shrines is, however, of peculiar interest, not only on account of their being devoted to the cult of minor deities, local in character and probably pre-Buddhistic in origin, but because the worship consists very largely in votive offerings of ceremonial forms of weapons, tools, and elephant and cattle goads.

With reference to the temples of Ceylon, Knox (Historical Relation of the Island Ceylon, 1681, p. 73) writes: "In them are idols and images most monstrous to behold, some of silver, some of brass and other metals; and also painted sticks and targets, and most strange kind of arms, as bills, arrows, spears, and swords. But these arms are not in the Bouddou's temples, he being for peace;" and, again, with special reference to the small dewales: "The temples called *kovels* are inferior to the other temples, and have no revenues belonging to them. A man piously disposed builds a small house at his own charge, which is the temple, and himself becomes priest thereof.

Therein are bills and swords and arrows and shields and images painted upon the walls like fierce men." Knox goes on to state that when they are sick they dedicate a red cock to the devils. This is held with an arrow by the priest, who thus dedicates it to the god, and on the recovery of the sick man the cock is sacrificed.

The priest is able to become possessed by the god or devil and make oracular statements by holding the weapons on his shoulders. According to this account, the weapons do not however, appear to be votive offerings.

Last September I climbed up the hill scarps above Padiyapelella to a small dewale built under a rock high on the hillside. There are two dewalas, an upper and a lower, in the village of Idampitiya near Maturata, Central Province. These dewalas are on the north side of the valley of the Belihul-oya, one near the cart road, and the other more difficult of access some 500 feet higher. The upper one was the first visited. It is called the Galapita kovila *alias* Okanda-gala dewale. It was built of mud on a small rock platform under a partially excavated rock, a fallen block from the cliff scarp above. The entrance was by a small double door of Kandyan type, only fastened by a stick thrust through the handle. The lintel of the door was roughly carved with simple lotus and diaper pattern.

On entering, the side of the small room opposite the door and the greater part of the two adjacent walls were seen to be crowded with weapons and various implements in extraordinary variety. These were standing in small compartments or bins raised about four feet from the ground, built of masonry. There were seventeen of these bins, the centre one of which, beneath the image of the god rudely painted on a wood panel covered with folding doors, was about twice the size of the others. It contained upwards of 150 of the weapons. There were arrows of various shapes, many like the broad ceremonial arrow of the Veddas; some of bo-leaf shape, among which many had dangling bo-leaves attached. There were also some "katties," a small new brass one, with bo-leaf dangling from point, also tiny elephant goads. They were set upright in their shafts. Some of the latter were lacquered, but most of them were plain. Many of the objects were only toy things, and all, I think, had been made specially for the purpose. A round wooden shield was over the door; and in one of the other bins there was a small bronze shield.

The lower dewale was situated down the hill above the vihara, and was similarly built. It contained a similar assortment of votive weapons, about 200 in number, arranged in seventeen divisions on high stools called "putuwa," with roughly carved scrolls on the sides. The centre one under the main god (roughly painted on an oval fan-shaped piece of wood), had comparatively few weapons, but large and fine, including an arrow with a piece of money tied to it. The other sixteen chairs were for the attendant deities, and contained the greater number of the offerings. Among these there was a fine bronze shield with a device upon it, also an old painted cloth with bo-leaf corners. The centre chair was reserved for human diseases, the two to the extreme right for cattle.

I took out three typical weapons to the outer court and photographed them. The men said they would not touch them, but I could if I wished, nevertheless they were nervous. I presented twenty-five cents to the main " chair " and ten cents to each of the others where I had moved a weapon, which seemed to be right and received grunts of approbation. They showed great anxiety that I should put the weapons back in the correct chair. The lower dewale is the Nikahetiya dewale.

Following is a list of the seventeen *putuwas* or seats of the gods, together with the purposes for which they are severally invoked :—

(1) Kintibandara-deyiya. For cattle.
(2) Abimana-deyiya. For infants.
(3) Kaḍora-deyiya. Diseases of women.
(4) Kalubandara-deyiya. For everyone.
(5) Irugalbandara-deyiya. For everyone.
(6) Pitiya-deyiya. For cattle.
(7) Pallebadda-deyiya. For cattle.
(8) Hantane-deyiya. Not ascertained
(9) Kalukumara-deyiya. Smallpox.
and
Dewatabandara-deyiya. Chickenpox.
(10) Kiyulagedera-alut-deyiya. Cattle.
(11) Wannibandara-deyiya. Cattle.
(12) Kumara-deyiya. Cattle.
(13) Hadunkumara-deyiya. Crying of infants not taking milk.
(14) Diwa-deyiya. Crying of children not taking milk.
(15) Monerawela-deyiya. Cattle.
(16) Kohomba-deyiya. Barrenness in women.
(17) Kaludewata-deyiya. Everyone.

[Here ends the manuscript on the votive offerings in the cave-dewales of Ceylon.]

NOTES.

1. *Ambalantota to Hambegamuwa.*—Some incidents which befel in the course of a museum collecting trip to Hambegamuwa in the south-west corner of Uva last November may be put down in narrative form. I may remark that the observations cannot be correctly described as casual, since it was one of the objects of the journey to collect them. The bulk of the material collected is not referred to in this account.

By previous arrangement our party was met at the Ambalantota resthouse on November 19, 1908, by three Hambantota carts, which are specially constructed for travelling along minor roads. Two of them were drawn by four bulls apiece, the third by a pair of bulls, and, in addition, there was a spare bull. The bulls wore wooden bells, the constant liquid-sounding clangour of which proclaimed their whereabouts, for it is not the custom to carry fodder in this part of the country, but to turn the bulls loose to graze at every halting place, a proceeding sometimes entailing vexatious delay which cannot be helped.

Leaving Ambalantota in the early morning the first few miles of road skirt the eastern bank of the Walawe-ganga. Shortly before reaching Koggala (7 miles) we passed the spoor of a leopard which had evidently just crossed that way. As usual, the dung was matted together with monkey hair. In Ceylon the occurrence of monkeys in abundance implies the presence of leopards in the neighbourhood, and the latter are then only a source of danger to the simian community, not to the human family.

The schoolmaster of Koggala gave us some information about the route to be followed. There was a scarcity of water, the village tank being dry, and we engaged a man to guide us to a rock-pool, where I decided to camp for the night. This was at a spot named Kandantibu-gala, about 3½ miles from Koggala. Incidentally, I inspected the principal sights of the countryside, namely, the Karambe-gala (commanding a view of Kataragam), and the hot springs. On the rock were large rock-pools containing frog-larvæ, and adhering by one side to the rock with the lower side bathed in the water was a spherical foamy spawn-mass of *Rhacophorus*, looking like a snowball. The exposed portion of the ball was slightly hardened as a delicate membrane. There are also extensive rock-shelters, or gal-geval sometimes doubtless occupied by bears. In the vertical face of a great escarpment are some curious holes or pockets like pot-holes, but passing inward at right angles to the surface.

On the way to the hot springs we passed the fresh footprint of an elephant and the dung of a crocodile in the jungle far from water. We also flushed a large talagoya (*Varanus bengalensis*), about 2½ feet long, which forthwith scampered up the trunk of a tree, finally stopping on the lower side of a slightly overhanging main branch some 25 feet from the ground. I watched it in this unusual position for a minute, or so, when it suddenly made a flying leap to the ground with limbs outspread, breaking its fall somewhat by a bush below, and then ran off rapidly. It is rather remarkable to see one of these unwieldy fat reptiles running up a tree after the manner of a tree-lizard. In this instance it was obviously a flight manœuvre, not a regular mode of progression. The talagoya, or edible monitor, is essentially a ground-dwelling lizard, and I have often seen the young, when alarmed, take refuge in termite nests. In the North-Central Province I have seen termite nests which had been dug open by men for the alleged purpose of taking talagoya eggs. In some places, but not in all, not, for instance, in the Hambegamuwa division, the large lizards are much sought after on account of their edible and strengthening properties, and in fact talagoya curry is a native delicacy. The stomach of a specimen, which I dissected at Horana some years ago, contained 12 entire cockroaches, a fact in harmony with their terrestrial habits. Last June I saw one which had been shot high up on a tree on the Dambulla-Trincomalee road and had not fallen down. It seems justifiable to conclude that the young individuals take to holes and that older ones frequently ascend trees, as a flight manœuvre.

It is appropriate to add here a few remarks upon the water monitor or kabaragoya (*Varanus salvator*), the flesh and fat of which are reputed to be poisonous. Large specimens are sluggish creatures on land, but active enough in water, and I have no record of their ascending trees when full-grown or half-grown, but once beside a tank in the Vanni country (at Erupotana) I saw a little bevy of young kabaragoyas peeping out of a hole in the high branch of a tree. They had probably climbed up for safety, rather than for food, so that, so far as the observations go, they seem to point to the conclusion that old talagoyas and young kabaragoyas ascend trees only under exceptional circumstances. The stomach of a kabaragoya was found to contain the skeleton of a large frog, a slug, and insect remains.

The hot springs of Mahapelessa bubble up with slight rhythmic convulsions like a miniature geyser; the water is not too hot for the hand to be immersed. A fuller account of the hot springs of Ceylon, their temperature, periodicity, and distribution, is to be found in the Administration Report (Mineral Survey, 1907) by Mr. James Parsons, who told me that the springs at Mahapelessa will be described in detail in the forthcoming report for 1908.

On the way back to our camp, beside the roadside rock-pool, I turned aside to examine one of those "gal-geval" with drip-ledges which are so characteristic of old Ceylon. The roof was nearly covered with mason-wasps' nests.

Early the next day (21st) we started for Suriyawewa, distant two "gaw," *i.e.*, eight miles. Along this part of the road the leading cart was twice upset, the track usually becoming very difficult at the approach to a village. At Beddewewa I was told that the villagers had no water, and were compelled to travel 1½ mile to Suriyawewa, where I saw them straining the muddy remnant of the nearly exhausted tank-water through cloths into their chatties to keep out the larger foreign particles and also the water leeches which abound here. We were conducted to a dry spot under a "palu" tree in the bed of the tank, where we outspanned in fine weather. Whilst standing under the tree a red-headed, black and white streaked hairy caterpillar fell upon the back of my neck, producing a disagreeable numbing effect, rather like a stiff neck. At a subsequent stage of the journey I came upon what looked, in profile, exactly like a patch of fur upon a dead tree trunk. Closer inspection revealed an assembly of gregarious hairy caterpillars packed together in a single layer, touching each other at all points like the pieces of a mosaic. The size of the patch would be about 15 inches long and 9 inches wide (estimated). Near the same place I came upon an analogous assemblage of immature dark gray tree-bugs. This diurnal assembling of immature forms protected by their nauseous properties is evidently a biological fact of some significance.

Alas, for our camp in the bed of the tank under the palu tree! In the afternoon clouds gathered and a downpour of rain commenced, which continued far into the night, converting the thirsty tank into a well-filled reservoir, the water rising to the axle-trees of the carts, out of which one stepped in the morning into an unsought leech-ridden bath knee-deep. If a bare foot were placed upon the grass at the edge, it was instantly and severely stung by black ants. It seems that this was the first great shower of the season, and we found afterwards that it was quite local. As soon as the bulls could be found next day we left for Weliwewa (3 miles), the track being partly under water, and after making inquiries at the school-house there, went on two miles to Mihigahajandura, where we were accommodated for the night at a disused dispensary.

At Kumbukwewa, a mile further on, the tank contained the usual muddy residue thickened by a green scum and undrinkable. The drinking water was obtained from a hole in the centre. This drought at the end of November is unusual; by this time the village tanks should be full of water. The next village, three miles on, is called Auriyapelessa, with (at this time) a nearly dry tank and a noble gal-kanda towering at one end of it. Another half mile brought us to the Kudawewa junction, where the road branches off to the right to Nikawewa and Tanamalwila, to the left to Hambegamuwa. Half a mile beyond the junction is the village of Suriya-ar, where we stopped for breakfast and were fortunate in securing a fine example of the remarkable locust *Teratodes monticollis* (see this Journal, vol. II., p. 200); its prevailing colour was grass green, with a yellow border along the dorsal crest.

Near Suriya-ar I encountered a small gecko* resting in the usual attitude, head downwards on the trunk of a tree. Even at some little distance I noticed that it presented two pairs of delicate prominences in the middle of the back, about half an inch apart. These proved to be the upstanding wings of two small yellow-bodied flies, and I believe this is the first time that flies have actually been seen upon these geckos, a fact of some interest in connection with the transmission of their blood-parasites. I secured the gecko, but missed the flies; later on I saw two more of the geckos in a like position, but without flies.

That night we camped in a pretty dingle, where the country rock flanks the road about a quarter of a mile beyond the village of Kalawelgala. Here were several rock-pools, one of which yielded drinking water, another contained tadpoles and Ephemerid larvæ. The next day found us at our destination, where we took up our quarters under the galvanized iron roof of a new irrigation bungalow. From here the road continues as a bridle track or footpath, 24 miles northwards to Haldummulla. The Hambegamuwa people, in their simple piety, wend their way along a leafy lane, at the end of which there is a modest shrine with steps leading up to it and backed by a green tumulus, the crumbling remains of an ancient dagoba. In its perfect seclusion and old-world rusticity I have seen nothing to equal it in Ceylon.

Among the more interesting species of birds obtained here were the Indian cuckoo, Sonnerat's cuckoo, green-billed malkoha, the black and white fan-tailed flycatcher, several warblers, and a kestrel. The Ceylonese hornbill was very abundant; a large stork-billed kingfisher was collected; among the tank birds, the taxidermist reported that he had seen only one shell ibis. The illustration shows the superficial resemblance, in general physiognomy and colour-markings, of the Indian cuckoo to the smaller birds of prey. Sonnerat's cuckoo (*Penthoceryx sonnerati*, see Blanford, Fauna Brit. Ind., III., p. 219) is now more appropriately referred to as the banded bay cuckoo in allusion to its rich bay or chestnut-coloured plumage with dark cross-bands; the colour appears sombre in jungle light, into which the specimen obtained flew about an hour before sundown, alighting noiselessly upon a low branch.

At this time the water in the great tank at Hambegamuwa was very low, a large part of the bed being dry. The fallen logs, which

* Hemidactylus frenatus.

PLUMAGE RESEMBLANCES:
Crested Goshawk; Indian Cuckoo: Kestrel.
H. F. Fernando, Taxidermist.

were scattered about the bed, covered a varied cryptozoic fauna, including, besides millipedes, insects, and numerous very young tank shells (*Ampullaridæ*), a great many frogs (*Rana limnocharis*) and some Indian field mice (*Mus buduga*). The mice were nesting in shallow burrows, into which the females brought grass to form a couch for the young. Mice and frogs were associated together under the same logs. The former made no attempt to escape from the vicinity of their burrows when exposed to the light, but simply hid their heads ; it was their breeding season. There were also some skinks, including the red-tailed lizard (*Lygosoma punctatum*) and the black-tailed lizard, the oviparous keel-back skink, *Mabuia carinata*, with its eggs.

It was interesting to see an earwig tending a clutch of small round eggs which she had laid in a little saucer-shaped depression under a log. The flash of daylight alarmed it, and it commenced sweeping round the surface of the eggs with a lateral flexure of the abdomen, and actually caught a small intruding ant between its forceps. Then unwillingly she began to pick up the eggs one by one with her jaws, after the manner of ants, and removed them to a safer place.

February 8, 1909. A. WILLEY.

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2. *Random Notes.*—On December 26 last, near the Vessagiri caves at Anuradhapura, I saw about thirty kites, eight crows, four blue rollers, and a number of swallows all mixed up together and engaged in hawking white ants, while the perfect insects were on flight. The kites used their talons for the capture, and the other birds their bills.

While I observed the crowd of birds hawking the termites, the light was good (8 A.M.), and, although I sat close by for perhaps half an hour, the birds paid me little or no attention. The swallows swooped in and out among the trees ; and, so far as they go, my assumption that they caught the insects is based only on deduction. The crows and rollers caught the insects in their bills, and not only could the snapping be distinctly heard, but the falling wings of the captured termites were each time apparent as they fluttered down.

The kites used their talons ; after each swoop they put down their beaks and took the insect from the grip of their feet, at the same time dropping the discarded wings.

At the drinking pokuna in Anuradhapura I recently saw a red paradise flycatcher plunge from its station on a tree and capture something in the water. The bird went almost straight down and in with a splash, just like a kingfisher.

In the crevices of the stones which line the channel just below the Tissawewa sluice at Anuradhapura snakes are very often to be seen. The other day I saw one (about 4 feet long) which had, head foremost in its jaws, a fish some three or four ounces in weight, and perhaps six inches long. I watched the snake for about two minutes while it swallowed the fish on or very near the surface of the water. He then tried to pass between the stones into a hole in the bank; but the bulge of the fish blocked the way. After several attempts he succeeded.

In the North-Western Province, near Ganewatta Station, I noticed in a paddy field a most ingenious method of capturing flying foxes. Great strings of cane are hung across the narrow fields, and from them depend at intervals of 3 or 4 feet long streamers made by tying together several of the whip-like thorny shoots of the common jungle cane. These whips are so thin as to be almost invisible in the dusk, and their thorns are sufficiently tenacious to hold captive any unfortunate flying fox who gets into their grip.

November 29, 1908. JOHN STILL.

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3. *Some rare Aculeate Hymenoptera in Ceylon.*—Whilst looking over some recent captures in the Colombo Museum, I was interested to find a fine specimen of *Montezumia indica* (Sauss.). This is a species belonging to the same family, Eumenidæ, as our common "mason-wasp." The specimen in question is new to Ceylon, and evidently a rare species, being previously recorded from Java and rare from Sikhim (Fauna, Brit. Ind., Hymenoptera, vol. I., p. 350, pl. II., fig. 10). Thus it is widely distributed; and it seems strange that, although it is a large and conspicuous insect, it has not, so far as I can ascertain, been recorded from any of the intermediate countries. This specimen was caught at Niroddumunai, Eastern Province, in September, 1908.

The other species of the same genus recorded from Ceylon and represented by specimens in the Colombo Museum are *M. impavida* (Bing.) and *M. rufipetiolata* (Wick.). The former was taken at Nedunkeni, Northern Province, in April 1904, and is also recorded from the Pegu Hills and Tenasserim (Fauna, Brit. Ind., p. 351). The latter was described and figured by me as a new species in *Spolia Zeylanica*, vol. V., 1908, p. 120, figs. 14 and 15; taken at Mamadu, Northern Province, April, 1904.

Colombo, February 5, 1909. O. S. WICKWAR.

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4. *Snakes of Badulla.*—As requested I now send you a list of the snakes which I have either caught or had sent me from round about here during the last year. The elevation of Badulla is 2,222 feet; and this bungalow about 2,500 feet, four miles out of Badulla. The

numbers after the names show the totals received. Probably, I could have got a good many more rat-snakes (*Zamenis mucosus*), green whip-snakes (*Dryophis mycterizans*), and brown pit-vipers (*Ancistrodon hypnale*) had I wanted them. One specimen of the green polonga (*Lachesis trigonocephalus*) measured rather over 32 inches as he lay after having been killed by a cooly pruning tea. In Haly's report on the collections of Reptilia and Batrachia in the Colombo Museum, 1891, only one specimen of *Ablabes calamaria*, without statement of locality, is recorded as having been presented by Mr. W. Ferguson.

1. Python molurus (1). Strayed from low-country probably.
2. Aspidura brachyorrhos (2).
3. Lycodon aulicus (2).
4. Ablabes calamaria (1).
5. Oligodon sublineatus (2). Common on the patanas.
6. Oligodon subgriseus (2). Common on the patanas.
7. Zamenis mucosus (12). Very common.
8. Coluber helena (2).
9. Tropidonotus stolatus (4). Very common.
10. Tropidonotus asperrimus (2).
11. Tropidonotus plumbicolor (6).
12. Dipsadomorphus ceylonensis (2).
13. Dipsadomorphus Forstenii (5). The Sinhalese call this the "roofsnake" in the vernacular.
14. Dryophis mycterizans (9). Common.
15. Bungarus ceylonicus (2).
16. Naia tripudians (8).
17. Vipera Russellii (2).
18. Ancistrodon hypnale (9). Common.
19. Lachesis trigonocephalus (2).

I have known of two cases of bites from No. 18 and one from No. 19 during the last year, but in all cases the patients recovered in about three days. There was a lot of swelling and pain locally. In other cases it has been impossible to identify the snake. Since making the list as above, I have received a specimen of *Dendrelaphis tristis*.*

Moragalla, Badulla, S. H. PEARLESS.
August 27, 1908.

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* This is the tree-snake commonly known in Ceylon under the name *Dendrophis pictus*, another species which had been confused with it.—*Ed.*

ANCIENT BRONZES IN THE COLOMBO MUSEUM.

INTRODUCTION.

IN the edition of the "Guide to the Collections in the Colombo Museum," which was issued in 1905, and also published in Vol. III. of this magazine, the bronzes were referred to in a short paragraph on page 22. Since that time considerable accessions have been received at intervals from the Archæological Commissioner, Mr. H. C. P. Bell, C.C.S., culminating in great discoveries of bronzes in the Siva Devale and adjoining sites at Polonnaruwa in 1907 and 1908. A provisional list of the 1907 series of Polonnaruwa bronzes was published in the Administration Report of the Colombo Museum for 1908. The principal objects in this series were photographed at the Museum by a local amateur, Dr. Andreas Nell, and from his photographs the copper blocks illustrating this part have been prepared by Messrs. Bemrose, Ltd., of Derby, England. Brief explanatory descriptions of these illustrations have been kindly furnished to the Museum by the Hon. Mr. P. Arunachalam, M.A., C.C.S., M.L.C., and will be found below. Mr. Arunachalam intends to publish a fuller account of the Polonnaruwa (1907) bronzes in the Journal of the Ceylon Branch of the Royal Asiatic Society.

A. WILLEY,
Director, Colombo Museum.

Age and Classification of the Bronzes.

Oriental scholars will have their own ideas concerning the age and classification of our bronzes, but as they are not in a hurry to impart them, it is necessary to look about for a working basis of classification for local and immediate service. The readiest method seems to be afforded by the localities of the treasure trove, and will be adopted here.

A catalogue of the "finds" made from time to time over a period of about sixteen years up to the year 1906 by the Archæological Survey Department, and deposited at the end of 1906 and beginning of 1907 in the Colombo Museum, was prepared by Mr. John Still, formerly Assistant to the Archæological Commissioner, and was printed for private circulation only. This catalogue includes a number of notable bronzes. Unfortunately it was not found possible to classify the objects in chronological order, and there is no direct indication whether those from Anuradhapura belong to the first or second periods of its prosperity.

The king called Sigiri Kasyapa rendered a lasting service to the chronological history of Ceylon by murdering his father in the fifth century A.D.; but for this signal act of parricide Ceylon dates would be in a greater state of confusion than they are. This central fact in the history of Ceylon broadly marks an epoch separating the Mahawansa Period from the so-called Suluwansa Period, which terminated in the year 1815 A.D.

It would appear that the antiquity of the bronzes is not very great, and that we have no examples belonging to the Mahawansa Period. Consequently it may be assumed that all the ancient bronzes of Ceylon belong to the period known in Europe as the Middle Ages. In his "Report on Archæological Discoveries at Tissamaharama" in the Journal of the Ceylon Branch of the Royal Asiatic Society, Vol. VIII., 1883–1884, Mr. Henry Parker, who estimated the date of the remains at about 100 B.C., noted that "working in copper had arrived at considerable perfection," but he discovered no bronzes.

Professor Albert Grünwedel ("Buddhist Art in India," translated by A. C. Gibson, revised and enlarged by James Burgess, C.I.E., London, Quaritch, 1901), states that "Indian Art is the most modern of all Oriental artistic efforts. No important monument goes further back than the third century B.C."* Until the Middle Ages "the sculptures are executed in stone, and frequently on a large scale, but gradually the Buddhist sculpture becomes a miniature manufacture in different materials—wood and clay in place of stone, and later, in metal casts—carried on as a trade."

Sigiriya Bronzes.

The Sigiriya bronzes appear to be the earliest that have been discovered in Ceylon, and they are few in number and of miniature proportions. The following contains the descriptions of those sent to the Museum in 1906, the numbers prefixed to the names of the objects being those which have been painted upon them. When we consider the magnitude of the stone work at Sigiriya, and remember also the celebrated Sigiriya frescoes or rock-paintings, the insignificance of the bronzes is particularly noticeable.

The occupation of Sigiriya by King Kasyapa happened during the years 479–497 A.D. References to literature dealing with this romantic history are given in Mr. H. C. P. Bell's Annual Report for

* Marco Polo, the Venetian, who touched at Ceylon near the end of the thirteenth century, refers to the Saracen belief that Adam's Peak is "the sepulchre of Adam, our first parent; but the idolaters say that it is the sepulchre of [Gautama Buddha], before whose time there were no idols. They hold him to have been the best of men, a great saint in fact, according to their fashion, and the first in whose name idols were made." (The Book of Ser Marco Polo, the Venetian, translated and edited by Col. Henry Yule, 1871.)

1895 (Sessional Paper XL., 1904, page 10). In his Annual Report for 1896 (Sessional Paper XLI., 1904) Mr. Bell notes that among the "finds" made during the season's excavations pottery predominated: "half a dozen flowerpots, lamps, fragments innumerable of chatties, dishes, &c., with iron and copper nails, bolts, &c., *ad libitum*." In the Annual Report for 1897 (Sessional Paper XLII., 1904) Mr. Bell records the digging up of a few more "finds" of special interest: "A handsome Greek-pattern vase or cruse, blue enamelled, was the chief.* A quantity of heavy iron nails, bolts, clamps, &c., proves that the woodwork was massy and strongly bound." There is still no mention of bronzes, for the apparent reason that there was none sufficiently striking to be deemed worthy of special notice.

That the age of the bronzes does not necessarily coincide with the historical dates is shown by the fact that from the *maluwa*, or terrace, upon which the colossal brick-built lion of Sigiriya was discovered, a copper *massa* of Queen Lilavati was dug out of the *débris*, and this, Mr. Bell says, "may prove that the *maluwa* was occupied as late as the thirteenth century" (Annual Report, Archæological Survey, 1898, Sessional Paper XLIII., 1904).

1. Miniature bronze horn, seven-sided, shaped like a cornucopia, open at both ends, 2¼ in. long.

2. Bronze cylinder with funnel-shaped ends, resembling a double lotus-calyx, showing traces of gilding, 2½ in. long.

3. Bronze bell, 2 in. high. "The clapper was not attached to the crown of the bell, but seems to have hung in two holes pierced near the rim" (Still).

5. Miniature bronze **Bodhi-tree,** 5 in. long, broken in two.

6. Toes of left human foot, 1¾ in. long, 1¼ in. wide across the toes. This is not a fragment, but an object complete in itself, the edge being rounded behind.

7. Miniature bronze *makara* head.

8. Heavy bronze ring, 2 in. in diameter.

12. Two pieces of thin bronze, engraved and inlaid with copper and silver. "The larger piece (3 in. long by nearly 1 in. wide) shows men on horseback. The men are dressed in trousers, and have long sashes on; their headdress seems to be a turban; one seems to be armed with a quoit; they ride on saddles. The horses are hog-maned" (Still).

13. Oval bronze plate, nearly 4½ in. long, inlaid with silver; "probably a door-plate" (Still).

14. Bronze instrument shaped like an ingot, 3½ in. long; "apparently a two-headed chisel."

* Now in the Museum.

17. Small bronze bell. This is a *gejja*, or tinkling bell, worn by bulls and dancers.

23. Broken instrument of bronze.

39. Nameless fragments.

Anuradhapura Bronzes.

The tenth century A.D. may be accepted as a crucial date for the bronzes which have been unearthed at Anuradhapura. Some of them attain to a high degree of artistic excellence, others to an equally high degree of technical finish.

Nos. 57 to 63 are from Pankuliya :—

57. Bronze basin, 11 in. across, 3¼ in. deep.

58. Bronze basin, 9¼ by 3¼ in.

59. Octagonal bronze dish, about 4⅛ by 1¼ in.

60. Bronze ring, 3⅛ in. diameter.

61. Bronze tripod, 2¼ in. high, 2⅝ in. across, one leg broken off.

62 and 63. Pair of **bronze feet,** 3 in. long, broken off at the ankle, where an iron core shows ; excellently modelled.*

Nos. 69 to 76 are from Vijayarama :—" Below the floor of each of the four porches [of the Vijayarama Monastery] was found a brick-built *cella*, a cube 1 ft. 6 in., containing a bronze figure of a double-faced god, an animal, and three small clay saucer lamps. The east porch held an elephant, the south a horse, the north a lion, the west a bull. The figures probably represent the Sataravaran-deviyo, or **Four Guardian Gods** " (H. C. P. Bell, Annual Report, 1891, Sessional Paper XXXVI., 1904, page 4). These remarkable bronzes are illustrated on Plates XXII to XXVI of Mr. Bell's Sixth Progress Report (Sessional Paper XII., 1896), where the names of the respective demi-gods are given in the above order as Dhritarashtra, Virudha, Vaisrawana, and Virupaksha, who, according to Buddhist legend, were appointed by Indra to watch, on the Yugandhra rocks, the four quarters of Maha Meru, against the Asuras. The attendant animals are from 3 to 3½ in. high, the gods about 6⅝ in.

Nos. 77 to 80 are from the summit of Mirisvetiya Dagoba. They represent guardian demi-gods, about 3 in. high, all broken ; one of them, with head missing, carries a fish, another has the hands clasped to the breast.

* These well-formed bronze feet from Pankuliya Vihare were found in 1891, and figured on Plate XVII. of Mr. Bell's Seventh Progress Report, Sessional Paper XIII., 1896. " In each the great toe is turned upward, and the others bent down a little. The feet are broken off at the ankle, on which are shown anklets of tinkling bells." (Bell, *loc. cit.*, p. 7.)

Nos. 81 to 84 are four-armed guardian demi-gods, 10½ in. high, from Puliyankulam. Beneath the four cardinal portico entrances or *doratu* at this monastery cellas like those at Vijayarama were opened. Each contained a bronze figure of its proper guardian god, but not double-bodied, and unaccompanied by the animals. (Bell, Annual Report, 1896, Sessional Paper XLI., 1904, page 3.)

Nos. 85, a wheel-shaped object, the **Dharmachakra,** mounted on a stand, 8 in. high, with a thin plate of silver on each side; 86, an object shaped like a parasol, 6½ in. high; 88, a small bronze label with Sinhalese inscription, were also found at Puliyankulam.*

92. Miniature **Sri Patula,**† sacred footprints in relief, like a seal, 1½ in. long, from the "Tamil ruins *walawa*"; this is quite unique, and offers a capital example of the rendering in miniature of a sacred symbol, which was usually executed in stone on a large scale. The Museum possesses a number of such stones, formerly used as offering slabs.

93. Bronze bell, 6¼ in. high, found below Basawakkulam bund, south of the cross road.

95. Sedent bronze image, over 3 in. high, from the alms-hall near the former resthouse.

96. Large **bronze panel,** thick and heavy, 20 in. by 7 in., beautifully embossed, with traces of gilding. This is one of the gems of the collection, and will probably be illustrated in a forthcoming work on Indian Art to be written for the Clarendon Press by Mr. Vincent A. Smith.

97. Bronze **statuette** of a demi-god or king, 20¼ in. high. This was dug up in 1898 to the south of Thuparama Dagoba, near Basawakkulam. Before the discovery of the 1907 Polonnaruwa bronzes, this statuette was considered to be the highest artistic achievement in bronze in Ceylon. There is the usual wealth of *parure* without the usual stiffness; on the contrary, the pose is elegant and the proportions just. It is probable that it will afford another illustration for the work to which allusion has been made.

98. Thirty-nine flat sheets of bronze (only one of which is exhibited), each 5 in. square, with a round hole in the centre, found south of the south pavilion near Basawakkulam.

99–101. Two sedent images of **Buddha** and the shaft of a parasol fitting into the back of one of them. The smaller image is 3¼ in.

* The Dharmachakra (No. 85) was found in 1896 in a brick-built *cella* under the pavement in Vihare No. 2 of the Puliyankulam monastery.

A similar cella in the middle of Vihare No. 3, belonging to the same monastery, contained a metal *patra*, or begging-bowl. This is probably the bowl numbered 173 below on page 71 (Archæological Survey, Annual Report for 1896, Sessional Paper XLI., 1904).

† Called also Sri Pada. Adam's Peak is the Sri Pada kanda

high, the larger seated on a lotus is 9 in. high and a work of great distinction. They were found in the Toluvila *pilima-ge*, or image-house.

107. This is a small broken bronze plate from the south-east corner of Pirivena near Thuparama.

110. Flower-shaped bronze *gejja*, or tinkling bell, from the Thuparama area.

126. Bronze bell upwards of 1½ in. high, from the site of the Buddhist railing at Abhayagiriya.

130–132. Bronze bowls, 4¾–5 in. in diameter, from the kovil west of the Y road.

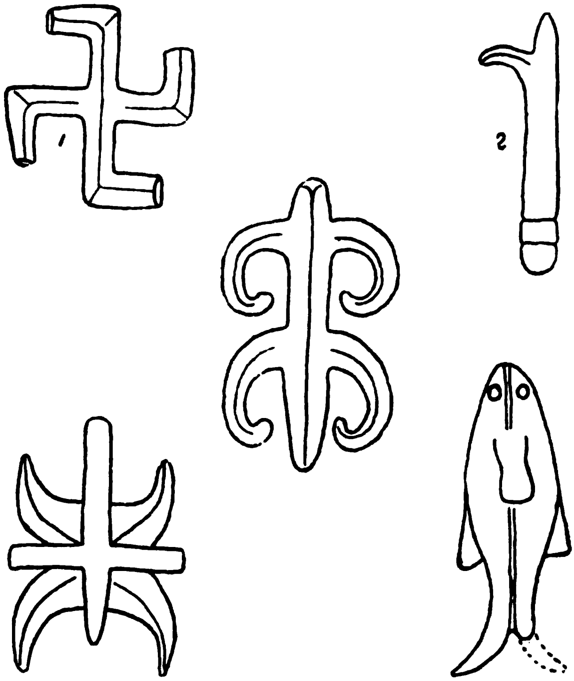
133. Four-armed bronze image, 3¾ in. high, from the Sangili Kanadara tank.

134–135. Portions of large bronze lamp stands, with iron core, from Etakada, Kadawat korale. One of the pieces is about 2½ ft. in length.

138. Colossal bronze **cauldron,** diameter 3 ft. 7 in., depth 8½ in. It was used for one of those purposes for which cauldrons generally are employed, but nobody knows whether it was for dyeing priests' robes or for cooking their food. It was found when digging the foundations of the resthouse. Two handle-rings, 7 in. across, are linked at the sides. It is exceedingly heavy, three-quarters to 1 in. thick bronze.

140. Reliquary over 2 in., shaped like a dagoba, from inside the Aralagam Vila Dagoba.

For many years the Museum has possessed a number of miniature bronzes from Anuradhapura, which have been labelled "Hindu Emblems." These include four small engraved rectangular plaques from Ruwanweli Dagoba, a cobra, trisul, vajra, sceptre, fishes, crabs, tortoises, a shell, a perforated ring, and above all a **swastika.** The sign of the swastika is not common in Ceylon, though it does occur incised upon stone and pottery. It is a symbol of pre-Buddhist origin and worldwide distribution, but it must be very rare as a separate portable charm. In this condition it appears to represent the limitless immensity of space reduced to the dimensions of a pocket amulet. Its typical shape is that of a Greek cross with the ends of the beams bent at a right angle in one direction either to right or to left. In the preface to the second reprint of the "Report on the Old Records of the India Office" (London, 1891), Sir George Birdwood gives an explanation of the ritualistic significance of the swastika in Hindu symbolism. He says that the "right hand swastika is, among modern Hindus, a symbol of Ganeesa, and is commonly placed by them, instead of the image of Ganeesa at the head of invoices and other papers. It is also the symbol of the sun in his diurnal course" from East to West, and it is coloured red, the proper colour of the East. The left hand swastika is the symbol of Kali, the mother of Ganeesa, and of the sun in his nocturnal course from West to East, and is coloured blue. The right and left hand forms are spoken of as "reversely revolving swastikas," and, indeed, the idea of rotation seems to be clearly indicated, and may very likely be the most fundamental attribute of the symbol. (Text Figs 1-5).



Text-figures 1-5. "Hindu Emblems."
1, Swastika ; 2, Goad or Sceptre ; 3, A double trisul (the middle figure) ; 4, Vajra or thunderbolt ; 5, Twinned fishes.

The deities who preside over the four quarters of the universe, according to Oriental cosmogony, are called in the vernacular the "Hataravaran-deviyo."* In a spirited wood-carving they are represented in a realistic manner, revolving round the sun in the direction of the hands of a watch. The right hand of each figure is raised over the head to grasp the extended right foot of the succeeding one. Each right forearm is bent approximately at a right angle upon the upper arm, and the whole device suggests the idea of the swastika. The wood-carving (08, 79–231) is about 18 in. in diameter ; the bronze swastika about 2½ in.

* Or Sataravaran-deviyo.

The Chaturmaharajika-chakra (symbol of the four gods) also appears as a decorative design upon Sinhalese tobacco or betel brass boxes. An example of this is figured on page 91 in Dr. A. K. Coomaraswamy's recent monograph on Mediæval Sinhalese Art; and in the description of the figure the name of the swastika appears with a mark of interrogation.*

The word Swastika is an anglicized form of svastika which is derived from the Sanskrit *su*, well, *asti*, it is, (Latin est) and *ka*, an attributive suffix.

Polonnaruwa Bronzes (First Series).

The general date assigned to the Polonnaruwa bronzes as a whole is the 12th–13th century A.D. The first series comprises those which were brought to the Museum at the end of 1906.

40. Finial from the top of Wata-da-ge Dagoba, nearly 4 ft. high, entire, on broad circular base.

41. **Temple bell,** 11½ in. high, with the figure of a bull in relief on one side. This and the following are from the Siva Devale, unless otherwise stated. (See Text-fig. 6 on next page).

42. **Double-ended spoon,** 13½ in. long.

43. Pair of bronze **cymbals,** 5½ in. in diameter.

44–45. Bowls, 5–6 in. in diameter, much broken.

46. Six small fragments of sheet bronze.

50. Four fragments of bronze dishes, one of which is gold plated.

51. Two small lumps of bronze.

52. Four scraps of a bronze finger ring. All these (Nos. 50-52) are from Vishnu Dewale.

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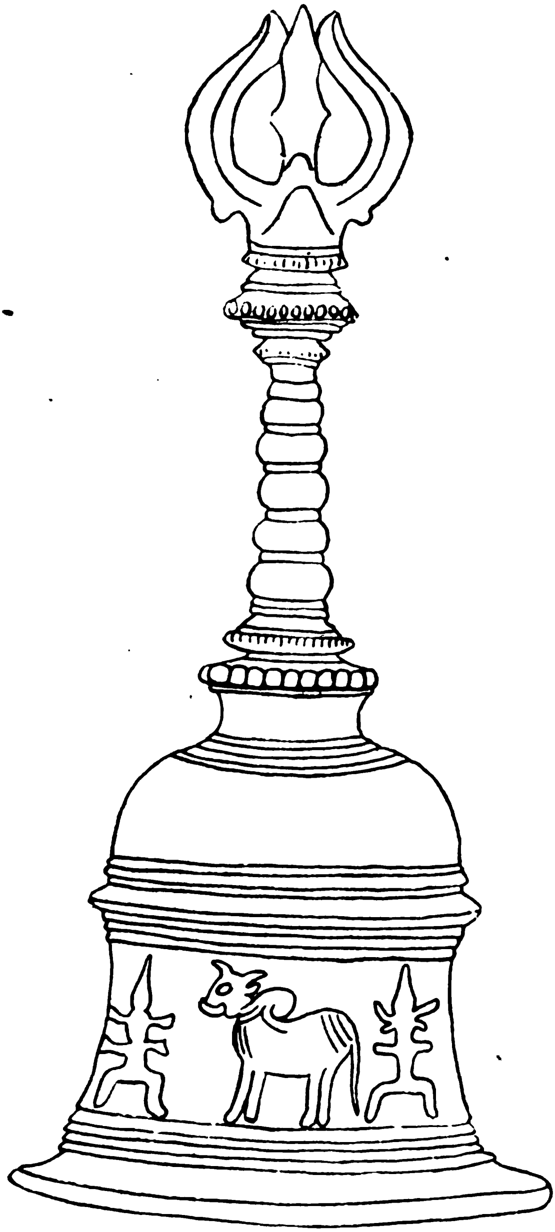
* The example referred to is not quite analogous, inasmuch as the revolving figures represent females, and on page 106 of Dr. Coomaraswamy's work the decorative design is described as "four women arranged swastika-wise."



Text-figure 6. Temple bell with trisul ornament above and figures on the barrel (No. 41, Polonnaruwa).

Polonnaruwa Bronzes (Second Series).

Description of the Bronzes found in the Siva Dewale at Polonnaruwa by the Archæological Commissioner in 1907.

By the Hon. Mr. P. Arunachalam, M.A., Registrar-General.

Plates I. and II.—Siva as Nata-raja, or Lord of Dancers. The dance represents the operations of the universe carried on by forces of which Siva is the director or ruler, hence he is called Nata-raja, or Lord of Dancers.

The hair of the head is braided, forming a crown at the top and, at the back (Plate II.), a circular knot, the lower braids whirling in the dance. On these, on the right is a mermaid or Matsyanari representing the river Ganges; on the left a crescent moon and a serpent. At the base of the crown is a skull, symbol of destruction. He wears a necklace of skulls of Brahmas, Vishnus, and Rudras, symbolizing the successive evolution and involution of the universe through the æons. He has three eyes (one on the forehead), representing the sun, moon, and fire; and wears on the right ear a round earring such as is worn by women, and on the left a man's earring, for Siva is both male and female.

He is represented with four arms :—

(*a*) The hand of the right upper arm holds a small drum shaped like an hour-glass and symbolizing vibration, the first stage in evolution.

(*b*) The left upper hand holds fire, symbol of destruction or involution, and of Siva's purifying grace.

(*c*) The right lower hand is raised in token of dispelling fear and assurance of protection.

(*d*) The left lower hand points to his raised foot, the refuge of the soul. The other foot rests upon a prone Asura or Titan holding a snake, symbolizing the cosmic illusion which is trampled under foot and crushed by Siva for the emancipation of the soul.

The figure stands in a halo or circle of flame, and the whole rests on a lotus, the lotus-throne, or *padmasana*. The serpents coiled in various parts of the body may be relics of the old serpent-worship, and are deemed symbols of Siva's destructive energy and of his obscuring energy (the cosmic illusion).

The total height of this fine image is 3 ft. A fuller account is reserved for the Journal of the Ceylon Branch of the Royal Asiatic Society.*

Plate III.—Two figures of Siva as Nata-raja (Nos. 15 and 24†); one is 2 ft. high, the other half an inch lower. Both bronzes are incomplete, without the halo, and one of them without the whirling braids; the missing parts no doubt broken off, or perhaps never added, as there is no sign of fracture. The figure on the right side of the plate is the best finished of all the bronzes.

Plates IV. and V.—Front and back views. Siva seated at ease (*sukhasana*) with his consort Parvati or Siva-Kami, his cosmic energy, "Mother of millions of world-clusters, yet Virgin by the Vedas called." On Siva's crown are the sun, moon, and the Ganges. In one of his hands he holds a deer, in another a battle-axe; in other respects the ornaments are mostly as in I. and II. Parvati holds a lotus bud in hand.

The two heights of the figures from the base of the pediment are 2 ft. and 1 ft. 8 in. Both figures are seated upon the lotus throne, or *padmasana*. This bronze is No. 2 in the original list.

Plate VI.—Siva standing with his consort Parvati and embracing her (*alinga*), surrounded by a halo. The halo (No. 22), height 1 ft. 3½ in., breadth 1 ft. 1 in., was found separately, but fitted upon the supports on the main bronze (No. 5), the heights of which are 1 ft. 3 in. and 1 ft. 1 in. respectively.

Plates VII. and VIII.—These contain representations of three bronzes in different views. The middle figure (No. 12, height 1 ft. 10½ in.) is Siva in one of his dances called *Sandyanirtta* with his consort Parvati (the shortest figure, No. 23,‡ height 1 ft. 4½ in.) looking on. The bull in Plate XIV. would naturally form part of

* [Perhaps it may be thought that the admirable reproductions accompanying this description render unnecessary any further appreciation here of this bronze, the first of its class to be recorded from Ceylon. It is desirable, however, to be clear upon one point. There are some experts who will declare that these bronzes are not so good as South Indian bronzes. Such a statement rests upon the conscious or more likely unconscious assumption that Ceylon is a paradise of mediocrities, and that whilst it produces many good things, it never has produced one really excellent thing. The assumption may be correct, but it should be stated explicitly if it is so.

Other experts will beg the question in an equally grotesque manner by claiming that these are in fact South Indian bronzes. Let it be asserted once for all that they are Polonnaruwa bronzes for better or for worse.—*Ed.*]

† Colombo Museum Administration Report, 1908.

‡ No. 23 is distinguished by the form of the armlet, a scroll design, not clearly shown in the figure.

this group. The tallest figure (No. 3, height 2 ft. 9 in.) does not properly belong to this group.

Plates IX. and X.—Both bronzes are representations of Siva's consort Parvati or Siva-Kami. The shorter figure with the chest-cord branching to right and left (No. 7, height 1 ft. 8 in.) would belong to Siva in I. and II. The other figure (No. 19, height 2 ft. 3½ in.) has the right arm broken. The richly flowered armlets of delicate workmanship merit particular attention.

Plate XI.—The first figure from left to right is a statuette of Tiru-gnana-sambandha Swami (*circa* 500 A.D.), one of the chief saints and apostles of Siva, and his psalms are in daily use in the temples. He is said to have been called to be an apostle while still a child (at Shikali in Tanjore District), and to have died a child. Hence he is represented as a child nude, save for a child's waist string of beads and anklets, and with a child's tuft of hair on the front of the head, and holds in his hands the Golden Cymbals which he received from Siva, and with which he went about singing Siva's praise. No. 13; height 1 ft. 4 in.

The second figure is that of Suriya, the Sun God, with halo round the head and a lotus bud in either hand. This is a noteworthy and uncommon type. No. 18; height 1 ft. 5½ in.

The third figure represents Appar Swami, or Tiru-na-vukkarasu Swami, apostle and psalmist of Siva, contemporary and friend of Tiru-gnana-sambandha Swami (*circa* 500 A.D.), a Buddhist converted to the religion of Siva. He holds in his hand a gran-cutter, with which he went about weeding the gran in the courtyards of the temples. No. 4; height 1 ft. 9 in.

The last figure again represents Appar Swami on a taller scale, although the total height of the bronze is somewhat lower. He is here shown with shaven head, clad only in a breech-clout, and the end of the gran-cutter has been broken off. No. 10; height 1 ft. 7 in.

Plates XII. and XIII.—Figure 1 in XII., of which figure 1 in XIII. is a side view, and figure 2 in XII., of which figure 3 in XIII. is a side view, represent Sundara-murti Swami, an apostle and psalmist of Siva about 700 A.D. He was a native of Tiruvarur, near Negapatam, in the Madras Presidency; called to be an apostle on his wedding day, hence dressed in the clothes and ornaments of a bridegroom. Nos. 16 and 17; heights 1 ft. 8 in. and 1 ft. 4½ in.

Figure 3 in XII., of which figure 2 in XIII. is a back view, represents Manikka-vachaka Swami, the greatest of Siva's apostles and psalmists, about 100 A.D. He was prime minister of the Pandyan King of Madura in Madras Presidency before he was called to be an apostle. He holds in his hand a palm leaf manuscript of his psalms,

PLATE I.

Nata-raja; front view.

PLATE II.
Nata-raja; back view.

PLATE III.

Two Nata-rajas, one without the braids, both without the halo.

PLATE III.
Two Nata-rajas, one without the braids, both without the halo.

PLATE IV.
Siva and Parvati; front view.

PLATE V.
Siva and Parvati; back view.

PLATE VI.
Siva and Parvati standing.

PLATE VII.
Two figures of Parvati and one of Siva.

PLATE VIII.
The same figures as in VII., seen from different aspects.

PLATE IX.

Two figures of Parvati.

PLATE X.
The same two figures of Parvati in different aspects.

PLATE XI.

Tiru-gnana-sambandha Swami ; Suriya the Sun-god ; and two figures of Appar Swami.

PLATE XII.

Sundara-murti Swami (2) and Manikka-vachaka Swami.

PLATE XIII.
The same three sages as in XII., in different aspects.

PLATE XIV.

Bull, Bell, and Braid. Chandesvara or a Demigod or King.

Tiruvachakam, the holy word, with the initial words of the first psalm "Namassivaya" inscribed. No. 8; height 1 ft. 9 in.

Plate XIV.—The bull (No. 25, height 1 ft. 5 in., length 1 ft. 2 in.) is Siva's charger, representing the soul (*pasu*), of which he is the lord (*pati*), hence he is called *pasu-pati*. The pedestal upon which the bull was placed to be photographed is an ancient curry-stone having no connection with the bronze. Below the bull is a temple bell (No. 6, 5 in. high), and part of the crown of a Nata-raja (No. 11, 1 ft. 11 in. long).

The standing figure in XIV. is believed to be Chandesvara,* an apotheosized devotee of Siva. He is holding a garland of flowers. On the base there is an inscription which has been read by D. M. de Z. Wickremasinghe, who has kindly furnished the subjoined note (*vide* Appendix).

Of the few remaining bronzes of this series which have not been illustrated, special mention should be made of a nude figure of Krishna, originally dancing upon one foot, but now the head and foot are severed from the rest of the body, though no part is missing (No. 14, height 1 ft. 5½ in.); and a figure of Parvati in sitting attitude, but without the seat (No. 21).

It should be added that all of the bronzes are massive and very heavy.

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* No. 9; height 1 ft. 10 in.

Polonnaruwa Bronzes (Third Series).

These are the bronzes which were found at Polonnaruwa in 1908 and forwarded to the Museum by the Archæological Commissioner in 1909.*

1. A *Nata-raja*, like that of Plates I. and II. of the second series, but on a much smaller scale; height 18 in.

2. A *Parvati*, of similar type and dimensions to those of the first series; height 2 ft. 5 in.

3. A small *Parvati*, 12 in. high.

4. Round dish or *tampalam*, 10½ in. across.

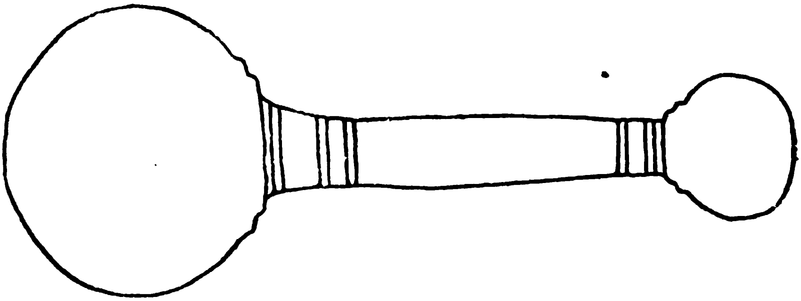
5. Tripod with ornate feet, 6 in. high, 6¼ in. across the top.

6. A *patra*, 5¼ in. across, with good lustrous *patina*.

7. Bell, 13 in. high, with an inscription round the barrel.

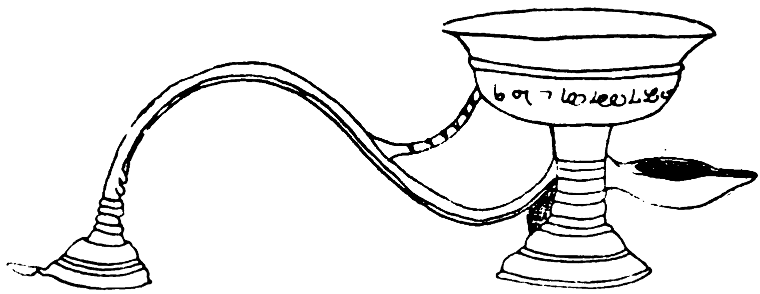
8. Bell, 11 in. high, without inscription.

9 and 10. Double-ended spoons, or *tadappe*, 14–15 in. long, with flat bowls; like No. 42 in the first series. (Fig. 7.)



Text-figure 7.* Double-ended Spoon. The larger end is 4¾ in. across, the smaller 2⅔ in. (No. 9—08, Polonnaruwa)

11. Incense vessel, or *tuvakkal*, with an inscription on the bowl; length 9½ in., height 3 in. (Fig. 8.)



Text-figure 8. Incense vessel with inscription. (No. 11—08, Polonnaruwa).

12. Similar incense burner without inscription.

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* The objects are marked 1·08, 2·08, &c.

Other Bronzes from the North-Central Province.

In some instances no exact locality was attached to the pieces, and these form a miscellaneous assortment from the North-Central Province. Only a few of them need be mentioned here. Chief amongst them are a bronze **ampulla** (No. 146) of graceful design, over 1 ft. high, the bottom detached, a narrow straight rectangular spout, and a lid supported by a chain; and, secondly, a plain bronze begging-bowl, or *patra*, 5½ in. in diameter, 4 in. deep (No. 173; this is clearly the *patra* from Puliyankulam referred to above in a footnote on p. 61).

147. Incense burner or cresset 8½ in. long.

149. Pear-shaped tinkling bell (*gejja*) 1½ in. long.

152–153. Pediments over a foot in diameter.

154–156. Thin bronze dishes, much broken.

157–158. Probably gongs.

159–161. Small bells, 2–2½ in. high.

162. Bronze box for lime (chunam box), 2 in. high.

163. Seven-headed cobra, 6¼ in. high, roughly cast and unfinished.

164–165. Bronze finials, 6–7¾ in. high.

167. Ornamental bronze shaft, 14¼ in. long, broken at both ends.

168–170. Three pieces of a bronze tripod which stood 1 ft. 6 in. high.

171. Single cymbal (like No. 43 in the first series) with the smith's mark inscribed upon it.

172–173. Bowls (see note above on No. 173).

174–175. Lids, 4½–6½ in. across.

176–177. Bronze bangles.

181. Bronze pin, 1¾ in. long.

Dondra Bronzes.

The history of Dondra (near Matara) is summarized in Tennent's "Ceylon" 1860, Vol. II., pp. 113 and 114.

"The most important temple was a shrine which in very early times had been erected by the Hindus in honour of Vishnu. It was in the height of its splendour, when in 1587 the place was devastated in the course of the marauding expedition by which De Souza d' Arronches sought to create a diversion during the siege of Colombo by Raja Sinha II."

Sir Emerson Tennent may have been somewhat in error in attributing the foundation of the temple to the Hindus, inasmuch as the cult of Vishnu is closely connected with that of Buddha in Ceylon. In most Buddhist Vihares in Ceylon there is a black statue of Vishnu either in the same room with the Buddha-rupa, or in a separate *camere*.

The bronzes which have been rescued from the disaster of Dondra are all miniatures, and should be associated with the so-called Hindu emblems which have been described above. They include seven bronze elephants of three sizes, well executed, the largest barely 2 in. high (X 109/115-181); three lions; three horses, the largest 1¼ in. high.; one bull, 1¼ in.; six homunculi; a bronze bottle, 1¼ in. high; a conch shell, 2¼ in. long; miniature chatties; and a few other articles. Some of these things may have partaken of the nature of toys without being divested of a religious significance. A great annual religious fair is still held at Dondra, at which forms of animals crudely modelled in pottery are sold for the delectation of the young. The age of bronze and copper has given way to that of brass and unglazed pottery.

The miniature bronzes of Dondra, Sigiriya, and Anuradhapura are no less interesting in their way than the massive and ornate productions of Polonnaruwa. By this it is not intended to touch the question as to where any of these bronzes were actually cast. All that concerns us here is the places where they have been found, and where they have lain buried for centuries.

Kurunegala Bronzes.

These appear to have been sent to the Museum about the year 1887 by Sir Frederick Saunders.

1. Large bronze tripod, two legs broken, nearly 8 in. high, 10¼ in. across the top. It bears a general resemblance to the tripod (No. 5) contained in the third collection from Polonnaruwa (A.B. 1–83).

2. The top of a similar tripod (marked A.B. 4–83), 10 in. across, with the ornate terminals of the feet remaining, may also have come from Kurunegala, but the record is lost.

3. Drinking vessel, or *kothali*, somewhat broken, 5¼ in. high, about 4 in. across the bowl, with a greenish lustre (A.B. 13–84).

4–10. Seven bronze stirrups, one of which has a rectangular base, the others are round. Unluckily there is nothing further recorded about them (X 60/66–169).

11. Figure of Krishna in kneeling attitude, holding a toy in right hand, 3 in. high (X 108–181).

For further information about the history of Kurunegala, reference may be made to Simon Casie Chitty's "Ceylon Gazetteer," 1834, pp. 145–148.

Muniseram Bronzes.

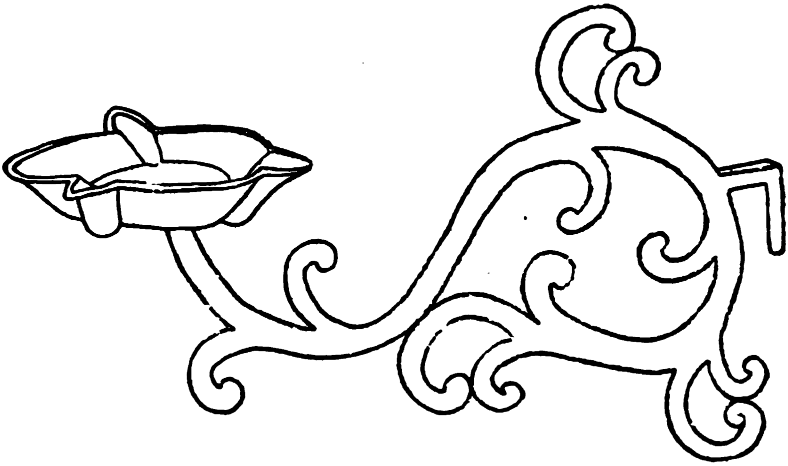
Muniseram is not mentioned by Sir Emerson Tennent. Some notable bronzes have been found there, for which the Museum was again indebted to Sir Frederick Saunders.

A three-branched **candelabra,** 18 in. high, and a **cresset** in the Grecian style, with handle, bowl, and spout, in all 14¾ in. long

Bronze elephant-spouted kothali from Ratnapura.
Lent to the Museum by Mr. P. E. Pieris.

(A.B. 15–84), are the principal pieces. There are also two large lamp covers having a modern appearance.

A number of bracket lamps with scroll work and prong for fixing into a socket, hand lamps shaped like the incense-burners from Polonnaruwa (third series), but without a spout below the bowl, and *hansas*, or sacred geese, complete the collection, which deserves more consideration than can be given to it on this occasion.



Text-figure 9. Bracket lamp from Muniseram.

Up to the year 1906 the Muniseram and Kurunegala bronzes were the principal bronzes in the Museum,* apart from the unique bronze Buddha† from Badulla District, the elephant-spouted kothali from Ratnapura,‡ and the bronze elephant bell with bo-leaf and triangle ornament, which was figured by Dr. A. K. Coomaraswamy in "Mediæval Sinhalese Art," Plate XLIV., fig. 3.

There are more bronze Buddhist images and ornaments which have been sent to the Museum from time to time from different places or have been acquired by purchase. Their enumeration must be deferred to a supplementary list later.

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* See *Spolia Zeylanica*, Vol. III., p. 22. † *Ibid.*, p. 17.

‡ *Ibid.*, p. 22, and illustration herewith.

APPENDIX.

Remarks on Metal Inscriptions.

BY DON M. DE Z. WICKREMASINGHE, EPIGRAPHIST (OXFORD).

THE inscription at the base of the statuette of Chandeswara (see Plate XIV.) is in a dialect composed of mixed Grantha and Sinhalese. The first character is a compound letter, which gives the proper name of the person the figure is supposed to represent. The first letter of the compound is unreadable, but the last looks like a cerebral N or a long U. The word cannot be *Ganapati* to judge from the figure. The next word is *Pati*, meaning chief or lord; the next is *Usaba*, a Sinhalese word found in inscriptions, meaning excellent, best derived from Sanskrit *Risabha*, meaning ox. The final word is *Vamse* (Sinhalese Vahanse), an honorific title given to lay or clerical personages.

From the above, and looking at the figure which is in an attitude of worship, it seems to be that of a lord or chief or a king, and not a deity.

No. 25 is a copper strip with inscription from Sigiriya, the letters of which are undecipherable.

No. 87, a copper plate from Anuradhapura, contains Sanskrit characters dating from about the second half of the 10th century A.D. I have taken a rubbing of this for future reading.

No. 88, a bronze label with inscription from Anuradhapura. The phrase is " Daham-da-depatek " in Sinhalese characters of the 12th century, the word *depatek* being repeated in Sanskrit characters of 11th–12th century.

Translation : " Two leaves of the Dharma Jataka." This label was most probably attached to two leaves of the Dharma Jataka written on copper.

No. 115, copper plate inscription from Anuradhapura. This is figured and described in "Epigraphia Zeylanica," Part I., pages 39–40.

NOTES.

1. *Prehistoric Fortifications.*—Around the foot of Mapagala hill, close to Sigiri fort, is a wall of huge unshaped boulders, in some places 20 ft. high, with occasionally a slight parapet. There are some traces of similar work on Sigiri hill itself. Some of the stones are about 10 ft. long by 4 ft. broad and thick. They are just such walls as are numerous in Provence and elsewhere in Southern Europe; there is one, for example, at Puy Ricard, above the Cap de la Veille, near Monaco. These have been ascertained to be pre-Roman; they are sometimes called Ligurian; the material is not always equally massive. They date from the Stone Age down to about the time of the Roman occupation, a few centuries before the Christian era.

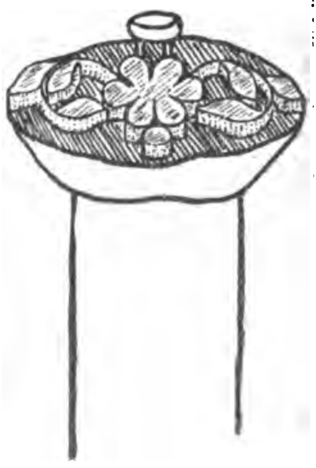
It is fair to suppose that those of Mapagala are equally old, probably built at a time before metal tools were in use, or the stones would have been broken to avoid the herculean labour necessary for moving them in their present size. This, of course, would date them before the building of Anuradhapura, or the legendary invasions of Vijayo and Rama. As the use of metal is believed to be earlier here than in Europe, it is not rash to suppose that these walls were built 5,000 years ago. Probably others similar will be discovered one day. Of what nature, for example, were the forts in Ceylon described in the Ramayana and the Mahawansa?

Before visiting this monument I had made an excursion into Coorg. Close to Mercara the capital, is seen an example of the dykes, *kadangas*, great trenches many miles long, often described. This one near the "Rajai Seat" has the peculiarity of interrupting the usual rather straight line by descending to make a loop around a neighbouring hill somewhat lower down converting it into a fortified enclosure, so to speak, somewhat like the so-called "rings" common in England. Dr. Richter in his book on Coorg noticed the resemblance. These dykes may be very ancient; the native chronicle of Coorg speaks of repairs having been made several centuries ago; the natives talk of thousands of years. The trench is some 15 ft. deep; the earth thrown up on one side gives to that part some 30 ft. in height.

Returning to Mapagala, the wall adjoins the cooly lines at the base of the hill, only a short distance from the resthouse. At one point on that side it recedes sharply as if to form an entrance passage. The wall is continuous, except where it is rendered unnecessary by the steep natural rock formation. During my visit Mr. A. R. Siriwardena, Assistant to Mr. H. C. P. Bell, the Government Archæologist, kindly gave me the great advantage of his company.

April 5 1909. J. B. ANDREWS.

2. "*Gold Embedding.*"—In my "Mediæval Sinhalese Art," p. 210, I have referred to the characteristic South Indian and Sinhalese jewellery called in Sinhalese *tahadu kola bemma* (gold-leaf application), and have figured examples of it on Pl. XLVIII., 5–7; XLIX., 11.; LI., 1, 8, 18, &c. I am now able to give a short description of this very interesting process, which is, I think, peculiar to South India and Ceylon. The notes are taken from observation of a South Indian *kammalan* (a Tamil goldsmith) working in Colombo. The process is called in Tamil *idu tarigam*, gold-embedding. Having prepared a design, thin strips of gold, rather less than ⅛ in. in width, are bent into the shape of the various parts of the designs, and soldered on to a thin gold plate, forming a series of vertical sided cells. The thin strips are previously roughened with prick-marks to make the subsequently added gold hold more firmly. The prepared framework (called *umisam*) is then imbedded in melted wax and fastened on to a short piece of cane for convenient working; the framework is then partially excavated from the hard wax, until it stands out clearly on a plane surface just above the level of the gold plate foundation. The separate cells are left about two-thirds filled. This stage is illustrated in the accompanying figure.



Gold embedding framework
prepared for stones (natural size).

The stones, usually thin cabochon rubies, are laid in their cells, generally with a backing of foil to heighten the colour, and a glowing charcoal is held to each to melt them in firmly. When all the stones have been thus inlaid, very thin gold leaf strip (not to be confused with the relatively much stouter strips of which the framework is made) is taken and applied around and between the stones and worked in with much force, applied with a progressive rocking movement of a small double ended chisel-shaped tool (*sitakku*), fixed in an ingenious wooden holder. Finally, the gold thus firmly applied is smoothed and polished. The final result is an ornament showing gold on both sides (the back generally engraved in outline, corresponding to the whole design), and having a foundation of wax remaining between back and front.

Only the very simplest tools are used throughout: two or three of the chisel-shaped gravers, a pair of pincers, the wax, and the short stick on which the wax and contained framework are mounted.

The effect is one of great richness of colour. This is now, however, generally spoilt by the use of facetted stones, which reflect white light, and so largely spoil the colour effect.

A. K. COOMARASWAMY.

Colombo Museum Libr.
8-1-1926

NOTES ON A COLLECTION OF NUDIBRANCHS FROM CEYLON.

By Sir Charles Eliot, K.C.M.G.,
Vice-Chancellor, University of Sheffield.

IN two Papers published in the Proceedings of the Zoological Society of London (1906, pp. 636–691, and 1906, pp. 999–1008) I discussed the nudibranchs already recorded from Southern India and Ceylon, with special reference to the drawings left by Kelaart, some of which were published with the first Paper. Subsequent authors have, in many cases, allowed Kelaart's names to stand in their lists as if they were valid, but have duplicated species by re-describing the same animals under new names. Kelaart's species are mostly recognizable if his figures are compared with living animals, but if they are compared with preserved specimens identification is often difficult. I therefore asked Dr. Willey to let me have any specimens of nudibranchs he could find in Trincomalee (where Kelaart collected) or elsewhere in Ceylon, with notes on the living animals, and any suggestions which he could make as to their identification with Kelaart's figures. He has very kindly sent me examples of fourteen species, with most useful notes. As a result, I am able to give further details about the animals which Kelaart called *Eolis tristis*, *Doris fidelis*, *D. preciosa*, and *Trevelyana ceylonica*; also about the *Scyllæa marmorata* and *Doris areolata* of Alder and Hancock. It is further, I think, clear that *Trippa ornata*, Bergh = *Doris intecta*, Kelaart, and *Discodoris morphæa*, Bergh = *D. fragilis*, A. & H. The second specific name of each pair must stand.

The following abbreviated references are used:—

Kelaart 1 .. Ann. & Mag., Nat. Hist., 1859, Vol. III., pp. 291–304.

Kelaart 2 .. Ann. & Mag., Nat. Hist., 1859, Vol. III., pp. 388–496.

Kelaart 3 .. Ann. & Mag., Nat. Hist., 1859, Vol. IV., pp. 267–70.

Alder & Hancock 1 .. Notes on a collection of Nudibranchiate mollusca made in India—in Proc. Zool. Society, 1864, pp. 113–47.

Eliot 1 .. On the Nudibranchs of Southern India and Ceylon—in Proc. Zool. Society, 1906, pp. 636–91.

Eliot 2 .. On the Nudibranchs of Southern India and Ceylon—in Proc. Zool. Society, 1906, pp. 999–1008.

The list of species is as follows. They all of them belong to genera already recorded from the Indo-Pacific, but the variations in the anatomy of *Trevelyana* as illustrated by *T. ceylonica* are interesting.

I have examined the original specimens described by Alder and Hancock and by Bergh in all cases where they affected the identifications here suggested. They are preserved in the Museums of Newcastle-on-Tyne and Copenhagen respectively.

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1. Cuthona tristis (Kelaart).
   ? = *Cratena cucullata*, Bergh.
2. Scyllæa marmorata (A. & H.).
   ? = *Sc. pelagica var. orientalis*, Bergh.
3. Hexabranchus marmoratus (Q. & G.).
   = *Doris gloriosa*, Kelaart.
4. Trippa intecta (Kelaart).
   = *T. ornata*, Bergh.
5. T. areolata (A. & H.).
   = *T. (Phlegmodoris) mephitica*, Bergh.
6. Discodoris fragilis (A. & H.).
   = *D. morphæa*, Bergh.
7. D. concinna (A. & H.).
   = *D. concinniformis*, Bergh.
8. Diaulula sp., juven.
9. Hallaxa decorata (Bergh). [*Hallaxa n. n.*]
10. Chromodoris fidelis (Kelaart).
    = *Chr. flammulata*, Bergh.
11. Chr. preciosa (Kelaart).
12. Trevelyana ceylonica (Kelaart).
13. Doridopsis nigra (Stimpson).
14. D. rubra (Kelaart).

Cuthona (*Cratena*) *tristis* (Kelaart).

= *Eolis tristis*, Kelaart 2, p. 491. See Eliot I., p. 686, Pl. XLIII., fig. 5.

One specimen from Trincomalee, which, when alive, probably agreed with Kelaart's plate of *Eolis tristis*, since Dr. Willey has labelled it with that name. Its appearance as preserved supports this supposition. The colour is yellowish white, with grayish pigment, formed of minute dots, distributed in bands over the body and cerata.

The animal is elongate and narrow, about 14 mm. long and 3–4 mm. broad at different points. The right oral tentacle and right rhinophore are very large, more than 5 mm. long, whereas the corresponding organs on the left are not half the size. It is not clear whether this conformation is a monstrosity or due to distortion by the preserving fluid. The corners of the foot are rounded. The rhinophores are quite smooth and show no trace of perfoliations. The genital orifices lie below the dorsal margin, about 2 mm. from the head, and the anal papilla about 2 mm. further back in the line of the margin. Most of the cerata are detached. They were set on seven low oblique ridges. The anterior ridges seem to have borne 8–9 cerata, the others fewer. The largest cerata are about 4 mm. long. The margin of the foot is expanded, and posteriorly the foot is prolonged behind the body in a tail.

The jaws bear a single row of very distinct denticles with squarish tips. The radula consists of a single row of 22 teeth of the horse-shoe type. The posterior limbs are long. The central cusp is large and long: on either side of it are four or five (generally five) long, thin, lateral denticles.

No armature was found in the genitalia.

This animal seems referable to *Cratena*, Bergh, but as I have indicated elsewhere (Journ. Mar. Brit. Assn., 1906, pp. 363–6) the genera *Cuthona*, *Cuthonella*, and *Cratena* seem to me not distinguishable by any valid generic characters. Species should therefore be described under the oldest generic name, viz., *Cuthona*.

The present species is nearly allied to, and possibly identical with, the later (1905) *Cratena cucullata*, Bergh, from Gisser island in the Malay Archipelago, near Timor.

Cr. cavancæ, B., *Cr. pusilla*, B., and *Cr. bylgia*, B., all seem to be allied species.

Scyllæa marmorata (A. & H.).

See A. & H. I., p. 136, and Eliot I., pp. 675–6.

? = *Sc. pelagica var. orientalis*, Bergh, Mal. Unt. in Semper's Reisen., pp. 339–41.

One specimen from Trincomalee. It is 15 mm. long and of a pale brown. The epidermis detaches itself very easily, and has mostly disappeared from the sides of the body, but on the back and inside the cerata it can be seen that the pale brown ground was elegantly marked with darker marblings. Traces of a light margin still remain on the rhinophore sheaths, cerata, and caudal crest. There is a row of 4–5 white tubercles on either side of the body.

The animal is much like Alder and Hancock's figure, except that the tail is shorter. The cerata are rounded, not jagged or indented. The rhinophore sheaths and caudal crest are not large. The branchial tufts are ample and luxuriant, pellucid, but marked with fine brown lines. They are found on the inner side of the cerata, on the back, and caudal crest. There is a small accessory lobe on the left side between the two cerata, arising from the base of the anterior one. It looks as if it were a monstrosity, but it is remarkable that in A. & H.'s figure there is also a small additional excrescence on the left side.

The internal organs are much as described by Bergh for *Sc. pelagica var. orientalis*. The buccal parts, both jaws and teeth, are not materially different from those of the typical species. The formula of the radula is $20 \times 23 \cdot 1 \cdot 23$ in the longest rows. The median teeth have 4 or 5 denticles on either side, the laterals 4–6. After receiving the ducts of two branched salivary glands, the œsophagus dilates into the somewhat wider but elongate and tube-like first stomach. This is followed by the more globular second stomach, which bears a band of twenty horny plates. They are not very strong, white with yellow edges, and triangular in shape. Large and small plates alternate regularly. The whole alimentary tract is profusely but not uniformly spotted with little brown dots. The liver appears to be divided into three parts, one anterior and two posterior. The posterior portion, if not actually double, is at any rate deeply divided. The hepatic branches are few, colourless, and small. I was unable to trace them beyond the immediate neighbourhood of the liver.

The central nervous system, like the alimentary canal, is profusely spotted with brown. In the ganglia the cerebral and pleural portions are distinct. The pedal ganglia are large and rather elongate; the buccal round and close together. In the anterior portion of the genitalia the twisted vas deferens and the spermatotheca are both bright brown, and contrast vividly with the white albumen gland on which they lie.

This species appears to be both the *Scyllæa marmorata* of Alder and Hancock and the *Sc. pelagica var. orientalis* of Bergh. It is hard to say whether it should be given specific rank or not. But it has a characteristic appearance and does not resemble any *Sc. pelagica* that I have ever seen, so I think A. & H.'s specific name may be employed, at least provisionally.

Hexabranchus marginatus (Q. & G.).
= *Doris gloriosa*, Kelaart I., p. 291.

See Quoy and Gaimard on *Doris marginata*. Voy. de l'Astrolabe Zool. II., 1832, p. 255, Pl. 17, figs. 1–5, and Bergh, Siboga Exped. Opisthob., 1905, p. 90 and Pl. I., fig. 2.

One specimen of this fine species from Colombo Breakwater. When alive it was 6 inches long and from 3½ to 5 inches broad, according to its state of expansion.

A diagram of the colours shows that it was a typical specimen of *H. marginatus*, of which there is a beautiful drawing in Bergh's account of the Siboga collection (l. c.).

The form is common in the Indo-Pacific, at any rate on the East African coast. It may be doubted whether the species of *Hexabranchus* are for the most part more than colour varieties.

Trippa, Bergh.

The genera *Trippa* and *Phlegmodoris* were created by Bergh as separate in 1877 and 1878 respectively, but subsequently united (see Bergh in Semper's Reisen Heft. XVII., p. 904; *id.* Siboga Exp. Opisthob, p. 129). This amalgamation is undoubtedly correct, for though the two types *T. ornata* and *Ph. mephitica* are not much alike in appearance, they agree in their anatomy, and the external structure is fundamentally the same in both, as the back is soft but spiculous and covered with compound tubercles. In the internal organs there is no armature on the labial cuticle or genitalia; the radula is rather small, and consists of hamate laterals without a central tooth; and the only special feature is the presence of ptyaline glands at the extremity of the oral tube. It may be doubted if these glands should be considered a necessary character of the genus.

I think that I have shown in the descriptions which follow that the two animals named above are identical with *Doris intecta*, Kelaart, and *D. areolata*, A. & H., and should therefore be called *Trippa intecta* and *Trippa areolata* respectively. *T. monsoni* from East Africa* (? = *Doris leoparda*, Kelaart) also seems to have the full characters of the genus, but is small and perhaps immature. The other species are more doubtful. *T. affinis*, B., is probably a variety of *T. intecta*, and *T. spongiosa* (Kel.) of *T. areolata*. Though the characters of *T.* ? *hispida*, B., and *T.* ? *anceps*, B., are clear, Bergh himself expresses some doubt whether the animals are really referable to *Trippa*. *T. luteola* (= *Thordisa* ? *caudata*, Farran) is perhaps referable to this genus, for it has flat tubercles bearing secondary spiculous projections, and also smooth patches among the tubercles which perhaps correspond to the pits of other species. Also it has ptyaline glands. But it must be admitted that in general appearance it is not like the typical species.

Trippa intecta (Kelaart).
= *T. ornata*, Bergh.

See Kelaart I., p. 302; Eliot I., p. 658; Bergh in Semper's Reisen Heft. XII., p. 543; and Heft. XVII., p. 905; *id.* Siboga Expeditie, p. 129–33.

Nine specimens from Trincomalee. The largest is 55 mm. long and 37 broad, the smallest 18 mm. long and 12 broad. The colour varies from bottle green to black, with white markings, and the smaller specimens are the darkest. The white markings are absent

* See Eliot. in Proc. Z. Soc., 1903, p. 371, and *id.* I., p. 660.

altogether in one, in another they form a continuous and regular line from the branchiæ forwards. In the rest they consist of patches, generally arranged so as to form a more or less interrupted medio-dorsal line, but occasionally are scattered over the sides as well. They look as if the animal had been sprinkled with sand, but are due to the entire absence of pigment in certain areas of the dorsal surface, both in the depressions and in all the tubercles, large and small.

The animals present the general appearance of a heap of tufted seaweed. This is due to the back being thickly covered with compound tubercles of very irregular shape, the largest about 5 mm. high, but often greater in breadth than height. In shape they are roundish and somewhat flattened at the tops. They bear a variable number (5–25) of flat knobs, and on each of these knobs is set a group of very small cylindrical papillæ, from which sometimes, but not always, a few spicules project a little. But the shape of the tubercles shows infinite variety, and is not even constant in one specimen. Sometimes the raised patches which bear the papillæ are set on the flattest parts of the dorsal surface, sometimes the tubercles are flat, and sometimes they are conical. When large, they may often be described as four-fold, that is to say, a roughly conical tubercle develops bulges at the side; on these bulges are set flat prominences, and on the flat prominences are set the papillæ. All the tubercles and integuments are very soft and flabby. The margin of the foot has a shallow groove in front, and the upper lamina is divided in the middle; the two lappets thus formed run up to the mouth on either side. In many specimens no tentacles are visible. In others it is plain that there is a long tapering well-formed tentacle near the point where the lappet joins the lips. As may be imagined from the luxuriantly tuberculate character of the back, the rhinophores and branchiæ are not conspicuous. The sheaths of the rhinophores are raised, and sometimes as much as 5 mm. high; the surface is tuberculate and the margin very irregular. In some specimens it is edged with a row of small white papillæ. The branchial pocket is also raised, tuberculate, and irregularly lobed. The rhinophores are dark, with white tips. The branchiæ are 5, tripinnate, and dark, with a variable amount of white colour on their inner sides. They are united at the base. The general impression produced by the animals, particularly by those which have the white line on the back most perfect, is that there is a median dorsal ridge or keel. But this impression depends largely on the white line. The dorsal keel is irregularly and sometimes very slightly developed, and in one specimen is entirely absent. The foot is broad and pellucid, with little colour of its own, but often covered with minute brown dots.

Immediately behind the lips on the outer wall of the mouth tube—that is, on the surface turned towards the body cavity and viscera—

are set a circle (or two half circles divided by an interval) of small glands, each consisting of a roundish mass bearing small tuberculate processes. They appear to be ptyaline glands, and are additional to the ordinary band-like salivary glands, which also are present in the usual place behind the buccal bulb..

The buccal mass is small. The radula does not exceed 30 rows, even in large specimens, and the number of teeth in each half row is only 40–45. They are hamate and rather slender. The inner and outer teeth are smaller than the rest, but not denticulate or materially different in shape. There is no trace of buccal armature. The œsophagus is broad and dilates into a sort of bag. The stomach is not very large, and has thin walls.

The liver is of a deep brown. It is covered with a thick layer of the whitish hermaphrodite gland which sends branches into its substance, some of which are 5 mm. long. The branches of the gland, though thick, allow the dark mass of the liver to be seen between them. The liver is deeply cleft in front to receive the stomach, and pointed at the posterior end.

In the central nervous system the cerebro-pleural ganglia are fused into an egg-shaped mass, a little broader in front than behind. The pedal ganglia are round. The eyes large, with red lenses. The blood gland is brown, rather large and thick, and appears to consist of several lobes compressed together.

The outer of the two large genital glands (the mucus gland) is bright brown, and still soft and sticky. The inner portion (the albumen gland) is hard, and yellowish white. The vas deferens is long and much coiled. There is no prostate gland, but the upper portion of the vas deferens is thicker and softer than the lower. The two receptacula seminis are close together, both spherical, and both of much the same size. One is pink, the other yellow.

I have compared these specimens with the type specimen of *Trippa ornata* in the Copenhagen Museum, and consider that they belong to the same species, although the type specimen is much lighter, being brownish green. It may represent a light variety, but has also lost its original colour in all probability.

It is also I think certain that these specimens are the *Doris intecta* of Kelaart, as was suspected by Bergh himself (l. c. Heft XVII.). As pointed out in a previous paper (Eliot, l. c.), the objection to identifying this form with *T. ornata* was Kelaart's statement that it had long oral tentacles, but the present series of specimens shows that though the tentacles often contract under the influence of alcohol, they are sometimes elongate as preserved, and probably are always elongate in life. I doubt if Bergh's *Trippa affinis* is more than a variety of this species. The white band and the dorsal keel are not constant features.

Trippa areolata (A. & H.).

A. & H. I., p. 119, cf. *Doris spongiosa*, Kelaart I., p. 302. *Phlegmodoris mephitica*, Bergh, in Semper's Reisen Heft 13, p. 594.

One specimen, which must have been about 90 mm. long when perfect. The whole mantle margin has been detached, apparently by autotomy, as often happens in *Discodoris fragilis*, but has been preserved with the rest of the animal. The colour is now a yellowish green of various shades, diversified by circles or pits of a deep black. Dr. Willey has kindly given me some notes and a diagram illustrating the appearance of the living animal. It was of a "brownish bath sponge ground colour," with a peaked median ridge. At the sides were rows of "black areolæ with yellowish borders, increasing the appearance of depth." The row next to the ridge consists of ten relatively small areolæ. In the next row are nine, of which six are large, twice the size of any of the others. Nearer the margin are three rows of small areolæ. "The whole dorsum [is beset] with upstanding peaks between the areolæ."

The general structure of the dorsal surface is as in *T. intecta* (Kel.) already described, the chief difference being that the tubercles are united into ridges arranged in a more regular pattern, and divided in places by the black depressed areas mentioned above. There is a medio-dorsal ridge, composed of compound tubercles fused together, which gives off lateral ridges. These again send off other ridges and thus connect with one another. Near both the head and tail the ridges become so numerous and complicated that no pattern can be distinguished. The appearance of the preserved specimen does not quite agree with the diagram, evidently because the tubercles contract in alcohol and hide the smaller areolæ between them. There are four black areolæ symmetrically arranged at the sides of the median ridge, and other less distinct areolæ of the same kind nearer the mantle margin. These spaces are smooth, but the tuberculate part of the back is thickly covered with little spiculous cylindrical processes. Hence the animal, though flabby, is yet rather harsh and rough to the touch.

The rhinophore sheaths are high, tuberculate, and with jagged margins. The branchiæ are 5: three are much larger than the others and have a very wide main rhachis. The inner side is whitish. The edge of the pocket shows five very irregular undulations. The front of the foot is split, and the upper lamina runs up to the mouth on either side. At the point of junction is a fairly large oral tentacle.

As in *T. intecta*, there is a ring of ptyaline glands round the mouth tube.

There is no trace of jaws. The radula is conspicuous and composed of large teeth, but its dimensions as a whole are not large. The formula is about 25 × 40·0·40 as a maximum. The teeth are simply hamate, rather stout, and blunt. Those near the rhachis are small and low, the full size being attained only about the tenth tooth. The outermost are thin, but not degraded.

The stomach is large and external to the liver. It has thick walls and a copiously laminated interior. The intestine also is large, and runs far forward before turning backward. The liver is greenish brown, but covered by a thick layer of the whitish hermaphrodite gland. It is very deeply cleft in front, and the glandular layer covers both sides of this cleft, and also penetrates into a smaller cleft running to the right. Thus the anterior right-hand corner of the liver almost forms a separate mass, but the two portions are connected below.

The central nervous system shows a number of distinct coarse granulations, but the different ganglia are not at all distinct. It is enclosed in a very tough spotted membrane.

The blood gland is large, greenish grey, and, though compressed together, seems to be divided into several lobes.

The genitalia are as described by Bergh. The ampulla of the hermaphrodite gland lies on the anterior genital mass in a few short coils. There is no prostate. The vas deferens is thin and coiled. The round spermatotheca has a very short duct, and is nearly sessile. The spermatocyst is unusually large, sausage-shaped, and bent on itself. The vestibulum genitale is black.

I have no doubt that this specimen is Bergh's *Phlegmodoris* (*Trippa*) *mephitica*. It agrees in structure and general appearance with the original specimens with which I have compared it, and also offers many coincidences in detail, such as the granulate nervous system and the deep cleft in the liver. I have also no doubt that it is the *Doris areolata* of Alder and Hancock, and should bear that specific name. It is possible that this and the *D. spongiosa* of Kelaart are both varieties of one species, for *D. spongiosa* appears to be similar, but without the black pits. But until a specimen with the external characters described by Kelaart has been examined, no conclusion is possible.

Discodoris fragilis (A. & H.).

=*Disc. morphæa*, Bergh, Mal. Unters. in Semper's Reisen Heft. XII., pp. 536–40, *id.* Challenger Report, 1884, pp. 93–8.

See A. & H. 1., pp. 118–9; Eliot 2, p. 1004.

Two specimens from Colombo. They are somewhat bent, but about 75 mm. long. In one the autotomy of the mantle which is characteristic of the species is commencing, but the flap has not yet been thrown off. The texture is soft, though the tubercles on the dorsal surface are hard.

The colouration of both specimens is extremely complicated, but not quite the same, though similar, since in one the predominant tint is green, in the other dull pink. In both there is a yellowish ground profusely marbled with light and dark shades of greenish or pinkish brown, and also with white. Besides this, yellow freckles are irregularly scattered here and there, and the whole dorsal surface is profusely sprinkled with white flattish tubercles of various sizes the largest being as much as 1 mm. in width. The sole of the foot and under-surface of the mantle are pinkish in one specimen, yellowish in the other, and in both bear numerous blotches of gray or olive.

The foot is broad. Its anterior margin is deeply grooved and the upper lamina is notched in the middle, but the sides overlap so that the notch is hidden. Hence, probably, it was not noticed by Alder and Hancock. The tentacles are large, and have a hard core composed of spicules and granules, visible even externally through the transparent integuments.

The pockets of the rhinophores are moderately raised and tuberculate like the rest of the back. The branchial pocket is also a little raised, and has an undulated but not stellate margin. The branchiæ are six, quadripinnate, and with stout stems. They are grayish, with darker speckles. The integuments are full of small spicules of various shapes, mostly bent in the middle, and with swollen ends.

The inside of the body cavity is pinkish, and the same tint prevails in the intestines. The labial armature is very distinct, and consists of two triangular or hatchet-shaped plates composed of minute rods. The formula of the radula is about $45 \times 75 \cdot 0 \cdot 75$. The teeth are hamate and rather erect, especially the outermost, which are thinner than the others. The stomach lies outside the liver and near the exit of the intestine ; its interior bears numerous folds of a mossy appearance. The liver is pinkish in one specimen, yellowish in the other. In both specimens the intestine makes a bend under the liver mass on the right-hand side and comes up again.

The blood glands are olive coloured, of moderate size, and entirely separated from one another by the central nervous system which lies between them. This latter is flat and coarsely granulate ; the separate ganglia are not distinguishable as preserved.

The ampulla of the hermaphrodite gland is thick and coiled several times. The large distinct prostate shows two portions, one pink and one greenish. The vas deferens is not very long or much coiled. The lower part, where it passes into the præputium and the præputium itself, bear folds and knots, but no hard armature. The spermatotheca is large and green ; the spermatocyst small.

I have compared these specimens with A. & H.'s text and figures, and also with the fragments of their original specimens of *Disc. fragilis* preserved at Newcastle, and find that they belong to the same species, the only point of difference being that Alder and Hancock say that the upper lamina of the anterior pedal margin is not notched, whereas here it is divided in the middle. But, as explained above, this notch, though distinct when seen, may be hidden and easily escape notice.

Also, after comparison with Bergh's original specimens in the British Museum and Copenhagen Museum, I think that *Disc. fragilis* is the same animal as his *Disc. morphæa*. His specimens have lost their colour, but what remains of it and the texture support the identification. The only difference to be noted is that the original specimen from the Philippine Islands had thickenings on the rhachis resembling teeth. But these were not found in the *Challenger* specimens, and they are probably often absent, perhaps only occasionally present. Against this difference may be set not only the general resemblance of *Disc. fragilis* to *Disc. morphæa*, but the following coincidences in details:—(1) The central nervous system is granulated and the divisions are not distinct; (2) the two blood glands are separate and divided by the central nervous system; (3) the stomach is laminated internally; (4) the intestine dips down under the right side of the liver and comes up again; (5) the præputium is laminated; and (6) the oral tentacles have a spiculous core.

Discodoris concinna (A. & H.).

= *D. concinniformis*, B.

See A. & H. I., p. 118; Eliot I., pp. 251–2; and Eliot II., p. 1005.

One specimen from Trincomalee, which is probably immature, being only 26 mm. long and 16 broad. According to the notes it was brownish gray when alive, with darker patches. Down the centre of the back ran a line of not very clear whitish areas; on either side of this was a line of dark patches more deeply coloured than the rest. There were numerous other patches, smaller and fainter.

The grayish tint of the animal (which is well reproduced in Alder and Hancock's plate) is due to the papillæ with which the back is densely covered being gray, irrespective of the ground colour on which they stand. The branchial pocket is raised, but not stellate.

The buccal parts are as usual in the species. The formula of the radula is about $27 \times 60 \cdot 0 \cdot 60$. The teeth at the end of the rows are long and thin, but not denticulate or degraded.

This species is common in the Indo-Pacific, and extends northwards to Japan. It attains a length of 6–7 centimètres, and the general colour is sometimes bluish rather than brown, as in this specimen. But the curious gray effect produced by whitish papillæ on a darker ground is always noticeable. It appears to be nearly related to *D. notha* from the West Indies.

Diaulula sp., juven.

One specimen from Trincomalee. When alive it measured 14 mm. in length and 9 mm. in breadth. The colour was translucent white, but the viscera showed dark through the body wall, and on the white ground were a small number of scattered white spots. With the aid of the microscope it could be seen that the whole upper surface is peppered with minute black spots.

The back is hispid, being covered with minute white papillæ, from which project tufts of spicules. The foot is deeply grooved in front and notched. The oral tentacles are long and thin. The rims of the rhinophorial and branchial pockets are slightly and evenly raised. The branchiæ appear to be 5.

The buccal parts are protruded. On the labial cuticle are dark patches, but nothing that can be called an armature was found under the highest power.

Only 11 rows (? all) were found in the radula, with a formula of about 31·0·31. All the teeth are simply hamate, but whereas the first 15 or so are small and low, the rest are tall and stout. The outermost tooth is slender, but not much degraded.

The penis appears to be armed with scales, but no spines were found.

The specimen does not fit conveniently into any recognized genus, and belongs to a group of Dorids which are difficult to classify, namely, those with papillate back, and no very decided peculiarities in the internal organs. As the present specimen is almost certainly immature, it does not seem desirable to make it the type of a new genus. Among existing genera it comes as near to *Diaulula* as any other.

Hallaxa decorata (Bergh).

See Bergh, in Semper's Reisen Heft. XIII., pp. 572–4.

The name *Halla*, given by Bergh to a genus of nudibranchs in 1878, was already in use for a Polychæt worm, *Halla parthenopeia*, A. Costa, 1844,* and must therefore be altered. It is suggested that it should be replaced by *Hallaxa*.

Three specimens without notes, but in a bottle, whose contents come from Trincomalee. The largest is 14 mm. long and 9 broad; all are flat and soft, with an ample mantle margin.

The colour produces an impression of dark bluish gray or indigo, but under a lens is seen to be due to a complicated system of markings: (1) the ground colour is formed by mottlings of grayish purple, varying in intensity; (2) over these mottlings are scattered numerous dark brown or black dots; (3) there are also round spots

* See A. Costa in Ann. Accad. d. Aspiranti Naturalisti Napoli, II., p. 63, 1844.

of the same purplish colour but darker. They are not numerous, and are set in a ring round the mantle margin and in fairly symmetrical rows on the back. They look as if they were tubercles, but in reality are very little raised, if at all, and the dorsal surface is practically smooth. The foot is yellowish, especially towards the margin.

The lips are ample, and the buccal parts seem slightly protruded, but not enough to show the labial armature. There are no tentacles but the lips are connected with the mouth parts by two lappets. The rhinophores are dark purple. The branchiæ are 12 and simply pinnate; their colour is much like the dorsal surface, but the axes are beautifully lined with white on the inner side.

The labial armature is a narrow band, composed of rods. The formula of the radula is $25 \times 14 + 1 \cdot 0 \cdot 1 + 14$, and the teeth have the remarkable shape described by Bergh. The innermost on either side of the rhachis are large, broad, and divided into two portions at the top. The outer of the two portions bears six or more denticles. The remaining teeth are thin and erect, and bear about twelve denticles.

This is apparently a dark variety of Bergh's *Halla decorata*. It will be observed that the composition of the colouration is as described by him, though the general effect is different. Information as to the colour of the living animal is desirable, for these complicated patterns are often much altered by alcohol.

The affinities of this remarkable form are doubtful, but it shows some resemblance to *Sphærodoris* (especially *Sph. levis*) in both the external and internal structure of the mouth parts and in having simply pinnate branchiæ.

The radula also shows some resemblance to that of *Thorunna furtiva*, and both recall the dentition of the *Polyceridæ*, inasmuch as they are narrow and have one tooth sharply differentiated from the rest.

Chromodoris fidelis (Kelaart).

Kelaart I., p. 295; Eliot I., p. 642.

One specimen from Trincomalee. There are no notes on the living animal, but as Dr. Willey labelled the specimen *Chr. fidelis* it presumably resembled Kelaart's drawing, which has a very distinct colour pattern, viz., a white dorsal surface, with which contrast vividly a broad red border of irregular outline on the inner side, and black rhinophores and branchiæ. In the preserved specimen the dorsal integuments are of a uniform white, but the rhinophores and branchiæ are coal-black. The black liver mass can be seen through the integuments.

The length is 8 mm. and the breadth 4 mm. The skin is smooth. The rhinophore sheaths are slightly raised. The mantle margin forms ample expansions over the head and tail.

The labial armature is dark purple and of unusual appearance, being arranged in regular rows like a radula. It is formed of short, bent, bifid rods, which stand up exactly like the teeth of many Chromodorids. It really forms a complete circular band, but there is an apparent interruption, as at one point the rods, though present, are colourless. This armature must have much the same action as a radula, and this is perhaps the reason why the real radula is minute. It is composed of 40 rows, which contain about 35 extremely small yellowish teeth on either side of the rhachis. There are traces of triangular thickenings on this latter. The first laterals are broad and denticulate on both sides. The second and third are also broad but denticulate only on the outside. The rest are erect with hamate tips, and bear under the principal hook 5–8 denticles. Near the end of the rows the denticles are fewer and situated chiefly on the apex of the teeth.

The central nervous system is very large. All the ganglia (including the olfactory and buccal ganglia) are large, round, and distinct.

Chr. flammulata, Bergh, and *Chr. lactea*, Bergh, are perhaps both colour varieties of this species. In the former the red border of the back deepens to black or brown at its inner edge, and in the latter the border is altogether absent.

Chromodoris preciosa (Kelaart).

Kelaart I., p. 295; Eliot I., pp. 642–3; for *Chr. flammulata* and *Chr. lactea* see Bergh, Siboga Expeditie, 1905, pp. 151–2, 159–60.

Three specimens from Trincomalee. Dr. Willey's notes on the living animals say "Small white Chromodorids. Foot extended behind mantle in crawling. Crimson border, followed by a yellow sub-marginal border. A few obscure spots on dorsum. Red rhinophores and red gills. In one specimen the rhinophores and gills are black."

As preserved, the integuments, rhinophores, and branchiæ are all white. The largest specimen is 10 mm. long and 5·5 broad. The mantle is ample, and expanded over the head and tail.

The labial armature is very regularly arranged as in *Chr. fidelis*, but still conforms to the normal type, and the elements which are bifid rods do not stand erect. It must be remembered, however, that this organ in *Chr. fidelis* is described from a single specimen, and that an examination of others might show the existence of variation. It forms in *Chr. preciosa* an incomplete circle, and the interruption appears to be real, not an appearance produced by change of colour. The teeth are much as in *Chr. fidelis*, but the denticles are coarser and more distinct.

Kelaart appears to have thought that *Chr. fidelis* and *Chr. preciosa* resembled one another, though the similarity is not very apparent from either the descriptions or figures. But the idea that the two forms are related is borne out by their structure, and they may prove to be merely colour varieties.

Trevelyana (Kelaart).

According to Bergh's definition of this genus (Siboga Exp. Opisthob. 1905, p. 188, and elsewhere) the hermaphrodite gland is separate from the liver.

"*Glandula hermaphrodisiaca a hepate discreta.*"

Though this can be said of many of the species already examined anatomically, it is not strictly true of all, *e.g.*, *T. crocea*. But of the present species it is not true at all, and the generic definition must be modified. Still, even in this form the structure of the hermaphrodite gland is appreciably different from that usual in the *Dorididæ* and less diffuse. It forms not a larger spread over the liver, but two thick coils of varying shape and length attached to the anterior and under surface of the liver. We should, I think, say that *Trevelyana* is characterized by having a more or less concentrated hermaphrodite gland, which sometimes takes the form of coils or flat lumps on the surface of the liver and sometimes of one or more masses (generally globular) separate from it.

Trevelyana ceylonica (Kelaart).

See Kelaart, Ann. and Mag. of Nat. Hist., 3rd Ser., Vol. I., pp. 257–8, 1858; *cf.* Bergh on *T. rubromaculata* in Siboga Expeditie, 1905, Opisthob. p. 189–91.

Four specimens from Trincomalee of much the same size: length about 30 mm., height 15 mm., breadth 12 mm. With them is preserved some spawn, resembling a piece of string 3 mm. thick and loosely coiled. It has a coarsely granulated appearance, owing to the yellowish egg packets arranged within it, so that three or four lie in a transverse section. They each contain several eggs.

The skin is soft and smooth, but here and there, especially near the tail, there are raised tubercular spots. The general shape is as in other *Trevelyanas*. As preserved the colour is dirty yellow, but Kelaart describes the animal as being white in life, with red spots on the back and red lines marking the axes of the branchiæ and the margin of the foot. The rhinophore pockets are not much raised; no oral tentacles are visible.

The most conspicuous feature in all the specimens is the branchial tuft, which is very large, most of the plumes being 8 mm. high, whereas in other species of *Trevelyana* these are generally not more than 4 mm. high in animals 40–50 mm. long. In all the specimens there are 10 large plumes set in a circle, open behind, though the interruption is not visible. At this point there are two smaller plumes set a little inside and nearer the anal papilla, and there are generally one or two quite small plumes set irregularly between the large ones. Thus the total number is 13–14.

The labial cuticle is unarmed. The formula for the largest radula is $22 \times 27 + 1 \cdot 0 \cdot 1 + 27$; but most of the rows are considerably shorter. The first tooth on either side of the rachis is much larger than the others, but all have the same form, awl-shaped and erect.

In the central nervous system the ganglia are very distinct. The cerebral and pleural portions are arranged so as to appear like the figure 8.

The stomach extends unusually far back and is free on the upper surface (except in one specimen), but its under surface and extreme posterior end are covered by the liver. This latter is purplish and so loose in consistency that it hardly answers to the definition that the liver of the *Holohepatica* forms a compact mass. It opens into the central cavity or stomach by such numerous ducts that the walls look as if they were basket work. The hermaphrodite glands are not separate from the liver, but in all four specimens adhere to it so closely that the two organs are separable only with difficulty. The details of the arrangement are not the same in all the animals, though in all there seems to be two more or less coiled glands. In one they form two short simple coils on the anterior part of the liver about 6 mm. long. In another the liver has spread above the stomach more than in the others, and bears on its anterior portion a triangular mass of glandular coils, clearly divided into two halves down the middle. In the remaining two specimens the hermaphrodite glands are invisible from above, but are disposed on the lower surface of the liver in two thick, rather complicated coils about 9 mm. long.

On the male branch of the genitalia is a very large prostate, the interior of which is composed of numerous leaves or laminations. Bergh also found this organ in *T. alba var. pallida* to be provided "*mit starken blattartigen Falten der Innenseite*." The vas deferens is not very long, and forms only one or two coils. The penis is thin, cylindrical, and covered with bent spines.

I regard this animal as undoubtedly the genuine *T. ceylonica* of Kelaart. It is characterized externally by its large branchiæ, and internally by the structure of the hermaphrodite gland, which, though variable, does not in any specimen form globules separate from the liver. I think that Bergh's *T. rubromaculata* is the same as this species. Of the hermaphrodite gland he says, "zwei .... Zwitter-drüsen die von Meniscus—Form waren .... am Hinterende der Leber, an dieselbe angehaftet." This does not quite describe the conformation in the present specimen, but indicates that the gland is not separate.

Doridopsis nigra (Stimpson).

Three specimens from Trincomalee. One, about 22 mm. long, of a uniform jet black when alive, belongs to the variety *aterrima*.

The other two were black with white spots, tending to aggregate in larger spots, and white tips to the rhinophores. No coloured borders are mentioned or visible in the preserved specimens.

Dr. Willey thought these specimens belonged to two species, but *D'psis nigra* is one of the most variable of nudibranchs, and I can find no differences except in colour.

Doridopsis rubra (Kelaart).

For the branchiæ see Eliot, in Journ. Linnæan Soc. Zool., Vol. XXXI., 1908, pp. 118–9.

Three specimens from Trincomalee. Length of largest 35 mm. According to the notes on the living animal, confirmed by the appearance of the preserved specimens, two were uniformly carmine coloured and the third blotched crimson, this effect being produced by the diffusion of red pigment in varying intensity over a neutral ground. In all the tips of the tentacles and the anal papilla were whitish.

In two of the specimens the branchiæ are normal. In one they seem hardly retractile.

In the living animal the branchiæ were infested by an ectoparasitic copepod, numerous specimens of which are preserved, some still hanging on the branchiæ. When perfect it bears two or more egg sacks at the posterior end, but one or both have been knocked off in many specimens.

ON A NEW MEGASCOLEX FROM CEYLON.

By Dr. W. MICHAELSEN (Hamburg).

(With figures in the text.)

SOME time ago Dr. Willey, Director of the Colombo Museum, sent me a small lot of earthworms of small size "characterized by abundant milk-white cœlomic fluid which shows through the body-wall during life, and when the worms are placed in spirit issues from the dorsal pores as a flocculent precipitate."

As the earthworm fauna of Ceylon belongs to the best known of the tropics, I was surprised at seeing that these worms represented a new species. This circumstance gives a new indication of the richness of the Oligochæt fauna of Ceylon, and of our being far from a complete knowledge of the latter.

The new species belongs to the most interesting group of *Megascolex*, which forms a transition to the nearly allied genus *Notoscolex*.

MEGASCOLEX WILLEYI, *n. sp.*

Habitat.—Ceylon; found in damp situations in low-country forests near Galle (Buonavista Hill) and in the Ratnapura District (Labugama), &c.

External Characters.—Dimensions of mature specimens:—Length 40–55 mm. Greatest thickness (behind the clitellum) 2 mm. Number of segments about 140, both in smaller and in larger specimens. Colour of spirit specimens yellowish gray; clitellum brownish gray; the colour of the living animals is chiefly white; it is the white earthworm of Ceylon, and one of the few species which is instantly recognizable and can never be mistaken for any other in the same country.

Systematic Description.—Head epilobous ($\frac{1}{2}$). Hinder appendix of prostomium nearly square, open behind, separated from the prostomium by a slight transverse furrow.

The setæ are slightly enlarged at the ends of the body, the ventral setæ to a somewhat greater extent than the dorsal setæ; their number is 8 at each segment of the anterior part of the body, beginning with the second; in the other parts of the body, nearly without exception, there are 12 setæ at each segment. Only once I found 8 setæ on one side of a segment and 6, as is usual, on the other side, making 14 in all.

At the anterior part of the body the setæ are placed in regular longitudinal rows, forming four rather wide pairs in each segment, those of the dorsal pairs (*cd*) being somewhat, but only a little, further apart from one another than those of the ventral pairs (*ab*), and the latter somewhat farther apart from one another than the neighbouring setæ of both pairs (*b* and *c*). The median ventral interspace is about twice as wide as the distance between the setæ of the ventral pair. The median dorsal interspace is about five times as wide as the distance between the setæ of the dorsal pair. The different interspaces between the setæ of the eighth segment may be indicated by the following proportional measurement :—*aa* : *ab* : *bc* : *cd* : *dd* = 24 : 12 : 14 : 13 : 64. The setæ of the *a* series are regularly placed in two straight rows throughout the whole body. In most of the specimens the other setæ also form regular longitudinal rows throughout the middle and posterior parts of the body, after having increased to 12 per segment.

The somewhat varying arrangement of them may be indicated by the following proportional measurements taken at the twelfth segment from the hinder end of the body :—*aa* : *ab* : *bc* : *cd* : *de* : *ef* : *ff* = 24 : 12 : 12 : 11 : 12 : 11 : 45 ; and again at the third segment from the hinder end :—*aa* : *ab* : *bc* : *cd* : *de* : *ef* : *ff* = 24 : 12 : 12 : 10 : 13 : 13 : 26. In some of the specimens examined the arrangement of the setæ *b*, *c*, *d*, *e*, and *f* becomes irregular in the hinder half of the body, the irregularity beginning with the dorsal rows *e* and *f* about the middle of the body, whilst the ventral and lateral rows *b*, *c*, and *d* are still regular ; these become irregular further back. Once only I found this irregular arrangement of the setæ associated with an increase of their number as mentioned above, eight on one side and six on the other in one segment.

The **dorsal pores** are very conspicuous ; the first pore lies in the intersegmental furrow IX./X.

The **clitellum** is distinguished by its darker colour. It is ring-shaped, and occupies the four segments XIV.–XVII. The fore margin of the fourteenth and the hinder margin of the seventeenth segment are often less modified than the intervening tract.

The **male pores** are placed in segment XVIII. in the line of setæ of the series *b*, if not a little lateral of this row, on each side. They are borne at the summits of a pair of penial protuberances, which appear to be non-retractile. These protuberances arise by a broad basis from the posterior half of the eighteenth segment, and have a rather sharply pointed, nearly equilateral triangular shape, flattened antero-posteriorly, and bent over forwards. Sometimes the protuberances are connected with one another by a median transverse ridge, which is also inclined forwards, and partly covers a transverse depression occupying the fore part of the segment medio-ventrally.

In most cases there is a pair of small transversely oval, rather flat, **copulatory papillæ** at the anterior part of the eighteenth segment in the lines of the ventral pairs of setæ, *i.e.*, somewhat medial from the lines of the male pores. In one case there was an unpaired median ventral papilla instead of this pair. A pair of more circular copulatory papillæ may also be detected sometimes at the nineteenth segment in front of the ventral pairs of setæ; and in one specimen two pairs of such papillæ at the ninth and tenth segments in the corresponding situation.

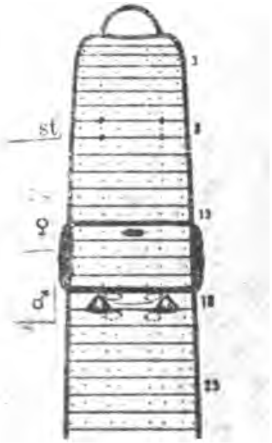

Fig. 1.—Diagram of the anterior part of the body of *Megascolex willeyi*, from the ventral side. *st* marks the position of the spermathecal pores.

The **female pores** lie medial from the setæ *a* of the fourteenth segment; they may be paired or unpaired; in the latter case median.

Two pairs of **spermathecal pores** occur in the intersegmental furrows VII./VIII. and VIII./IX. in the lines of setæ *b*.

Internal Anatomy.—The **septa** in the region of the anterior male organs are somewhat thickened. No septum is wanting in the region of the gizzard.

Alimentary Tract.—A large gizzard is apparently lying in the sixth segment, but perhaps it may be in the fifth segment. No calciferous glands could be discovered in connection with the œsophagus.

The nephridial system is micronephric.

Anterior Male Organs.—Two pairs of glittering sperm-duct **funnels** lie ventrally in the tenth and eleventh segments; they are free, not enclosed in testicular vesicles. Two pairs of racemose sperm sacs depend from the septa X./XI. and XI./XII. into the eleventh and twelfth segments respectively. The single "berries" or lobules of the sperm sac clusters are rather small and globular.

The **prostates** are small, the glandular part racemose or rather villose, with small and densely crowded glandular knobs at the

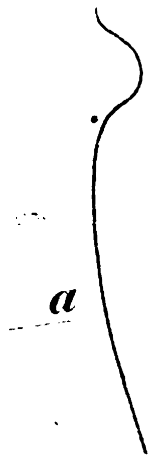

Fig. 2*a*.—Penial seta of *M. willeyi*, slightly enlarged.

surface. The muscular duct is straight, about as long as the glandular part, rather thick, somewhat tapering towards the ends, nearly spindle-shaped.

Penial setæ slender, about 1 mm. long, proximally 13μ thick, in the middle about 10μ thick, distally tapering gradually, somewhat before the distal extremity still 5μ thick. They are bent in a very characteristic manner, arcuate below the tip. The latter is simple, but the convexity of the arc (occupying the distal sixth part of the seta) is beset with densely crowded transverse rows of rather long spine-like hairs, which are nearly as long as the thickness of the seta at this point. These rows of hairs form transverse semicircles and are restricted to the convexity of the distal curvature; they diverge distalwards from the stem of the seta. (Figs. 2*a* and 2*b*.)

Spermathecæ.—Ampulla long-stalked, pear-shaped; muscular duct short, hardly longer than thick, just as wide as the distal end of the stalk of the ampulla. In a superficial inspection the character of the muscular duct can hardly be seen, the long narrow distal end of the ampulla seeming to be part of the duct. Not until the preparation has been made transparent by acetic acid can the rea short muscular duct be detected. A small, shortly-stalked, sausage-shaped diverticulum enters the main pouch at the proximal end of the short muscular duct. The diverticulum is about one-fourth as long as the main pouch (ampulla plus muscular duct), and about one-

Fig. 2*b*.—Distal extremity of the same seta, much enlarged.

third as thick as the muscular duct; it is plain externally, but its internal structure is somewhat complicated, as may be seen in preparations made pellucid by acetic acid. There seems to be no central lumen, but a very great number of minute seminal chambers filled with equally minute elliptical sperm-balls. These chambers form a simple layer in the thick wall of the diverticulum, their fine ducts probably uniting to form an axial duct. (Fig. 3.)

Remarks.—As said before, *Megascolex willeyi* is one of those species which form a transition from the genus *Notoscolex* to the genus *Megascolex*. The anteclitellar and clitellar parts of the body which present a regular lumbricine arrangement of the setæ, if cut off, might be determined as belonging to a species of *Notoscolex*. In this character *M. willeyi* resembles some Australian species, *e.g.*, *M. enormis*, Fletcher, and *M. attenuatus*, Fletcher. The middle and hinder parts of the body represent, almost without any exception, the first step on the way to a complete perichætine arrangement of the setæ: six pairs of setæ on each segment, being that state for which W. B. Spencer created the genus *Trichæta* (with six pairs of setæ per segment throughout the whole body). The next step in the sequence from *Notoscolex* to the proper *Megascolex* is represented

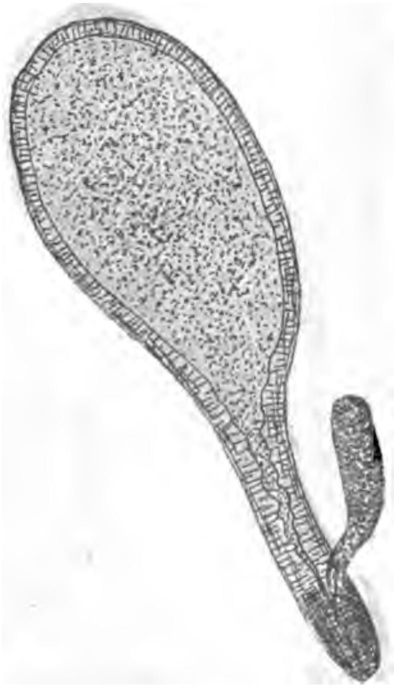

Fig. 3.—Spermatheca of *M. willeyi*.
From an acetic acid preparation; enlarged.

by the Ceylonese species *Megascolex zygochætus*, Michaelsen, which has six pairs of setæ at the second and third segments, and a greater number further back.

Thus *M. willeyi* resembles *Notoscolex* at the head end, *Trichæta* at the tail end; on the other hand *M. zygochætus* resembles *Trichæta* at the head end, the proper *Megascolex* at the tail end. Regarding these relations, it must be admitted that I was justified in abolishing the genus *Trichæta*, which represents only an insignificant stage in the continuous series from *Notoscolex* to *Megascolex*.

THE OCCURRENCE OF SOLENOSTOMA OFF THE COAST OF CEYLON.

By A. Willey.

(With one Plate.)

THE single specimen upon which this record is based was obtained during the cruise of the steam trawler, ss. "Violet," belonging to the Ceylon Company of Pearl Fishers, accompanied by their inspection barque, to the paars south of Dutch Bay, in March, 1909. Arrangements were made for me to take part in this cruise, the narrative of which has been written by Mr. T. Southwell, Scientific Adviser to the Company and Inspector of Pearl Banks, and Captain J. C. Kerkham, R.N.R., Superintendent of Fisheries.*

On March 10, whilst dredging over the Nagal Paar, about five miles north by west of Chilaw, in 9½ fathoms, the dredge brought up a quantity of brown rockweed, and in turning this over on deck, the specimen in question was found. It is equally remarkable for its colour, bright orange, crimson, and white, and for its form. The markings, difficult to describe when fresh, and impossible to depict after preservation, consisted of an orange-coloured zigzag pattern on the head, body, and fins (except the pectorals, second dorsal, and anal, which are colourless), bordered by crimson on a white ground. The gill-covers were quite hyaline and the pulsating gills showed clearly through them, the gill-arches being marked by paired white tufts. The ventral fins were juxtaposed so as to form a brood-pouch, which contained eggs and fry at all stages of development.

Solenostoma laciniatum.†

The head, body, and fins of the specimen are beset with simple or branched, cylindrical or subulate papillæ. These are especially numerous over the crown of the head from before the eyes to the base of the first dorsal fin ; they also occur, singly and in pairs, along the crest of the snout and along the ventral side of the snout and fore body, continuing along the edge and on the surface of the ventral fins. They are present about the extreme end of the snout, but not on the sides of the snout. Four pairs of long (up to 3·5 mm.), subulate papillæ are found along the hinder border of the first dorsal;

* T. Southwell and J. C. Kerkham. Report on an inspection of those Ceylon Pearl Banks under Government control, situated between Dutch Bay Point and Negombo : conducted by the Ceylon Company of Pearl Fishers, Limited, from March 4 to 17, 1909. Ceylon Marine Biological Reports, Part III., June, 1909. Colombo, 1909.

† It may be a phase or form of a previously described species.

others occur on the anterior border of the fin, near the ends of the rays, at the base of the fin, and on the surface of the fin along the lines of the rays. Similar soft dermal papillæ occur on the elevated basal portions of the second dorsal and anal fins, but not on the free portions of these fins nor on the pectoral fin. Finally a few small papillæ are found on the caudal fin, the free border of which, like the first dorsal and the ventrals, is laciniate. Some of the papillæ are compound, bifid, or trifid. Sometimes they are visibly constricted at the base, indicating that they are deciduous; some were found loose in the tube which contained the specimen.

The general surface of the body is spinose, with three longitudinal rows of small recurved spines segmentally arranged on each side. The spines are larger, and the three parallel rows are closer together on the caudal peduncle. In the region comprised between the hinder angle of the first dorsal and the front edge of the second dorsal there

Fig. 1.—*S. laciniatum*. Diagram showing arrangement of lateral dermal spines and papillæ between the first dorsal (I D) and the second dorsal (II D) fins.

are twelve spines in the dorsal row, seven in the central row, and twelve in the ventro-lateral row. Following close upon four of the spines in the central row are to be found, on each side of the body, four large dermal papillæ (see diagram).

The colour markings, after preservation, appear as an irregular labyrinthine network formed by anastomosing tracts of dark contracted pigment cells, both on the snout and on the body. When alive, as stated above, the predominant colour was brilliant scarlet with orange marbling. The pectoral, second dorsal, and anal fins are absolutely hyaline—a condition which conspires with the general scheme of colouration and laciniation to produce harmonious relations with the environment. This fact is not brought out in published figures.* It renders the essential organs of locomotion chromatically non-existent, and comparable in this respect with the condition met with in the "Leaf Fish," the yearling stage of the

* *Cf.* Playfair and Guenther. The fishes of Zanzibar. London, 1866, p. 137, Pl. XX., figs. 2 and 3 (*S. cyanopterum*).

so-called "Sea Bat," *Platax vespertilio*, whose chromatic reactions differ materially from those of the adult stage of the same species.*

The vivid colours of *Solenostoma*, which contrasted strongly with the brown seaweed amidst which the specimen was living, belong to the category of warning colours, and combine with its other characters to make the animal look like anything except a fish. Kaup pronounced it to be "one of the strangest forms to be found in the whole class of fishes." Perhaps it resembles a brightly-coloured sponge when at rest in its natural surroundings.

Next to the colour and the form, the most salient characteristic of the specimen is afforded by the presence of the numerous dermal appendages which I have described. These are not mentioned in Dr. Guenther's Catalogue,† but they are referred to in Kaup's earlier Catalogue,‡ where a solitary tassel is shown on the lower side of the snout in the figure which he gives; and in the text he states that "some of the specimens have little skinny tags round the mouth and rostral tube, as represented in Pallas's figure." Pallas's species was *S. paradoxum* from Amboyna; Bleeker's first species was *S. cyanopterum* from Zanzibar and East Indies. The catalogue descriptions seem to convey no differences between these species which are outside the range of normal variation; on the contrary they agree in the striking characters of the ocellation of the first dorsal fin and the abbreviation of the caudal peduncle. There is a very distinct named species, *S. brachyurum*, Bleeker, but Dr. Guenther doubts its validity. It is for the sake of the local interest that I present the first member of the Solenostomidæ from Ceylon waters § under the name *S. laciniatum*.

The first dorsal fin is 5-rayed, and is marked by two long black ocelli between the first three rays, as in other species of the genus. In the second dorsal I count 21 rays, in the anal 20, and in the ventrals 7, the three uppermost ventral rays bifurcated. The ventrals are concrescent with the body-wall along the whole length of their upper border, and they are connected together below by a membrane extending for about one-fifth the length of the lowest rays. The two fins are thus held together like apposed hands, and the pouch so formed contains embryos in all stages of development, both before and after hatching. The eggs are supported upon stalked discs, which are borne at the ends of a ramifying system of dermal processes arising from the inner surface of the pouch. (Pl. I., fig. 1.)

The eyes are surrounded by a circlet of small subulate papillæ, and a row of spines occurs at the base of the rostrum below and in

* See *Spol. Zeyl.*, II., 1905, pp. 51–5, and *Nature*, Vol. 80, 1909, p. 247.

† A. C. L. G. Günther. Catalogue of Fishes in Brit. Mus., VIII., 1870, p. 150.

‡ J. J. Kaup. Catalogue of Lophobranchiate Fish in Brit. Mus., 1856, p. 2.

§ *S. cyanopterum* from Cargados Carajos in 20–30 fathoms, and *S. paradoxum* from the Maldives, Mulaku, 27 fathoms, are recorded by C. Tate Regan in Rep. on Marine Fishes collected by Mr. J. Stanley Gardiner in Indian Ocean. Trans. Linn. Soc. Zool. XII., 1908, p. 221.

front of the eyes. A triradiate osseous flange occurs on the basis of the pectoral fin, consisting of the sector of a circle and three radii meeting at a point; there is a spine with a papilla at the end of each radius and at the point of intersection of the radii. (Fig. 2.)

The total length from the tip of the snout to the end of the middle caudal rays is 81 mm.; to the base of the caudal fin, 65 mm.; length of snout (from anterior border of eye), 20 mm.; height of snout in the middle of its length, 3 mm.; length of base of second dorsal, about 6·5 mm.; length of caudal peduncle from the end of the second dorsal to the base of the middle caudal ray, about 7 mm.

Fig. 2.—Surface view of the basis of a pectoral fin, showing the appearance of the dermal scute and papillæ.

The drawings of eggs and larvæ on Plate I. bring out the fact, mentioned above, that the brood-pouch contains eggs and young at very different stages of development. This is unusual amongst brood-nursing fishes, and is obviously connected with the circumstance, first ascertained by Dr. Guenther,* that in the case of the Solenostomidæ it is the female which carries the eggs during the period of incubation, whereas in the allied family of the Syngnathidæ the male performs this office;† but the pouch of the female Solenostomid is not homologous with that of the male Syngnathid.

The clear eggs in the pouch measure about half a millimètre in diameter; the developed eggs 1 mm. The embryo grows to such a length that its body becomes twice wound round the amber-coloured yolk; and the eyes become darkly pigmented while still within the egg-membrane. The hatchling (Fig. 3) possesses a pair of small pectoral fins, but no ventrals; the head is bent at right angles to the body, its lower surface being attached to the front wall of the yolk-

* *Op. cit.* (Fishes of Zanzibar).

† Dr. G. Duncker (Syngnathiden-Studien. Jahrb. Hamburg. Wissensch. Anstalten, XXV., Beiheft 2, 1908, p. 63) states that in several species of *Syngnathus* and *Hippocampus* a rudimentary brood-pouch appears as a rather frequent abnormality in female individuals. This work should be consulted for data relating to variation in number of rays in the dorsal fin, in the proportion of height to length of the snout, and in other characters of the genus *Siphonostoma*.

sac. In the next stage (Fig. 4) the head is released from the yolk-sac, and is beginning to bend forwards. In the following stage the head has nearly attained its definitive horizontal position and the elongation of the snout has commenced; at the same time there is a characteristic gular projection below (Fig. 5). In the latest stage seen by me (Fig. 6) there are still no ventral fins, and the embryonic median fin-fold retains its normal proportions. The segmental papillæ, already present in the hatchling, are now very distinct. I observed two rows on each side, a dorso-lateral and a ventro-lateral row; in the example figured there were 31 dorso-lateral papillæ; between the vent and the caudal expansion of the embryonic fin there were 13 dorso-lateral and 13 ventro-lateral papillæ. The first dorso-lateral papilla lies behind the humeral arch, the first ventro-lateral over the pyloric complex. These segmental papillæ are present in other larval or post-larval Lophobranchiate fishes, and do not correspond with the laciniations of the adult fish,* of which there is no trace at this stage; their position near the dorsal and ventral ends of the myotomes may correspond with the distribution of the *rami cutanei dorsales* and *ventrales* respectively, and if this is so they could be regarded as segmental receptors.

The cartilages of the head can be seen with great clearness through the transparent integument (Fig. 6). Their disposition accords in general with that of larval pipe-fishes.† A marked feature of the larvæ of *Solenostoma* is the apparent occlusion of the branchial apparatus so far as the external view is concerned. The pigment on the body and fin-fold is confined to small groups of cells as shown in the figures. There is a special pigment-group at the base of the pectoral fin, and another on the pyloric complex (Fig. 6). There is still no sign of the definitive median fins, although the yolk-sac has been used up.

In conclusion it may be pointed out that *S. laciniatum* seems to afford an instance of the combination of warning colouration and protective laciniation such as is rarely met with amongst fishes.

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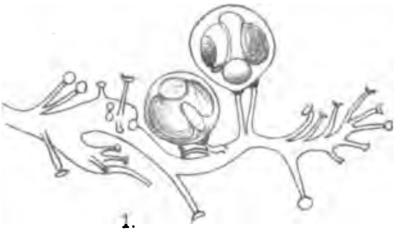
* They correspond with the spines of the adult, at least in part.

† *Cf.* H. H. Swinnerton. Morphology of Teleostean Head Skeleton. Quart. Journ. Micro. Soc., Vol. 45, 1901, see pp. 537 and 554 and Pl. 31, fig. 48 (*Siphonostoma*).



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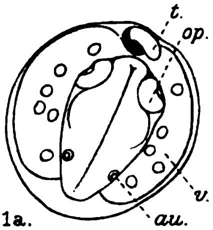

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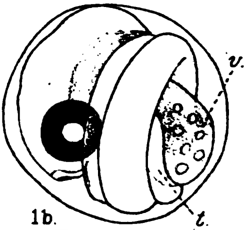

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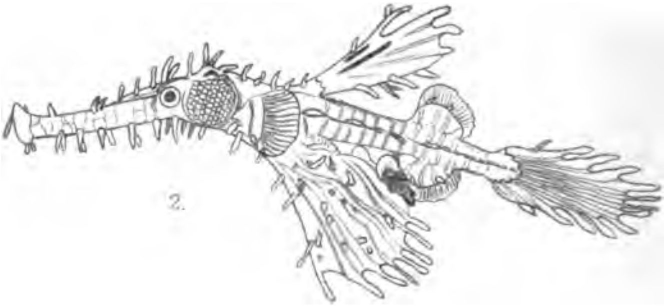

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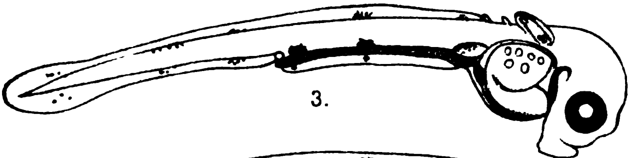

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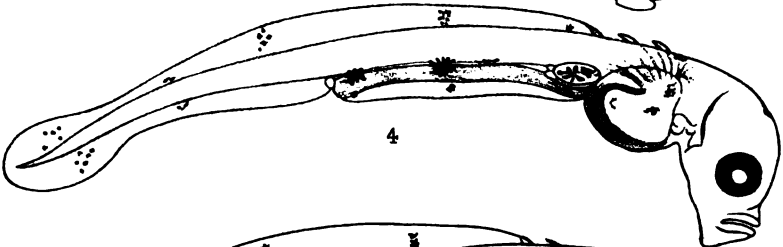

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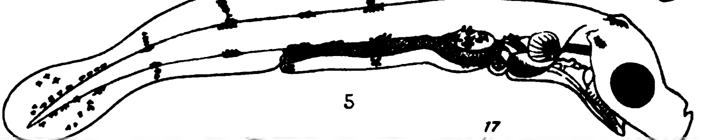

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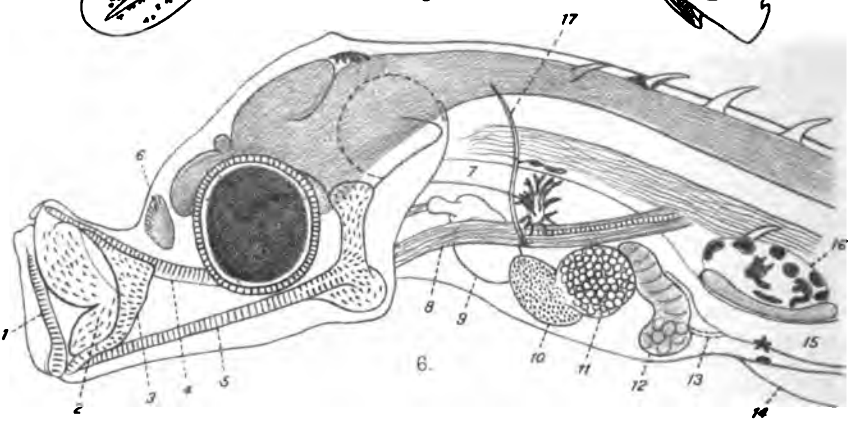


6.

A.W. del. ad nat.
Fig. 2. C.W. del.

West, Newman lith.

SOLENOSTOMA.

Explanation of Plate I.

Solenostoma laciniatum.

Fig. 1.—Branched dermal process from the brood-pouch, showing stalked ovigerous discs.

Fig. 1*a*.—An egg containing an unpigmented embryo coiled once round the yolk; diameter, 0·7 mm.; *t*, tail; *op*, optic vesicle; *v*, vitellus or yolk with oil globules; *au*, auditory sac.

Fig. 1*b*.—Egg containing an advanced embryo twice coiled round the yolk, with pigmented eyes.

Fig. 2.—Sketch of the adult fish, showing the laciniæ. Nat. size.

Fig. 3.—Hatchling showing pigment tracts on the body and oil-globules in the yolk-sac; the pectoral fin is seen above the latter. Length 3·75 mm.

Fig. 4.—Larva at the second stage; the head is released from the yolk-sac. The pectoral fin was obscure in the preparation. Length, 4 mm.

Fig. 5.—Larva at the third stage. The œsophagus shows by transparency in front of the pectoral fin, and the heart below the œsophagus. The projection of the basibranchial apparatus in the gular region is normal. Length, about 4·5 mm.

Fig. 6.—Anterior end of brood-pouch larva at the fourth stage. The outline was drawn under Zeiss 2A, cam. luc. The pectoral fin is omitted, but its basal pigment is seen in front of the humeral arch.

1. Meckel's cartilage.
2. Palato-pterygoid arcade.
3. Quadrate.
4. Ethmoid.
5. Symplectic.
6. Nasal sac.
7. Œsophagus.
8. Basibranchial muscle.
9. Heart.

10 to 12. Liver.

13. Bile-duct (obscure).
14. Front end of embryonic fin.
15. Intestine.
16. Pyloric complex.
17. Humeral arch.

The basibranchial muscle is seen to be accompanied at its origin by a transverse cartilaginous process.

OBSERVATIONS ON THE NESTS, EGGS, AND LARVÆ OF OPHIOCEPHALUS STRIATUS.

By A. WILLEY.

(With two Plates.)

NOTWITHSTANDING the fact that the "lula" or "murral" is one of the celebrated freshwater fishes of the East, and, at least in the low-country of Ceylon, easily the first in importance as a native source of food-supply, affording good sport and a capital meal into the bargain, there has been no scientific record concerning the nature and appearance of the spawn after oviposition. Such published information as is available may be summed up in the following quotation from Dr. Day, which has already been cited by Dr. Theodore Gill in his article on "Parental care among Freshwater Fishes" (Ann. Rep. Smithsonian Inst., 1905, Washington, 1906, p. 492):—"The *O. striatus* of Mysore is said to construct a nest with its tail among the vegetation near the edges of the tanks, whilst it bites off the ends of the weeds which grow in the water." The first portion of this vaguely stated assertion is likely enough to be true; it is almost as much as to say that a human habitation is built by hands. The second portion relating to the cutting of the surrounding weeds does not go without saying, but it is none the less correct, and it is a habit in which it resembles the North American Bowfin (*Amia calva*), according to the observation of Drs. Jacob Reighard and Bashford Dean. There are other similarities of habits in regard to the position and guarding of the nests. In both cases the small roundish clearings occur in the reedy shallows near the margins of lakes and tanks; and in both cases the male parent tends the nest. Here, however, the analogy ends in essential points, inasmuch as the eggs of *Amia* are scattered over the bottom of the nest, whereas the eggs of "lula" float at the surface.

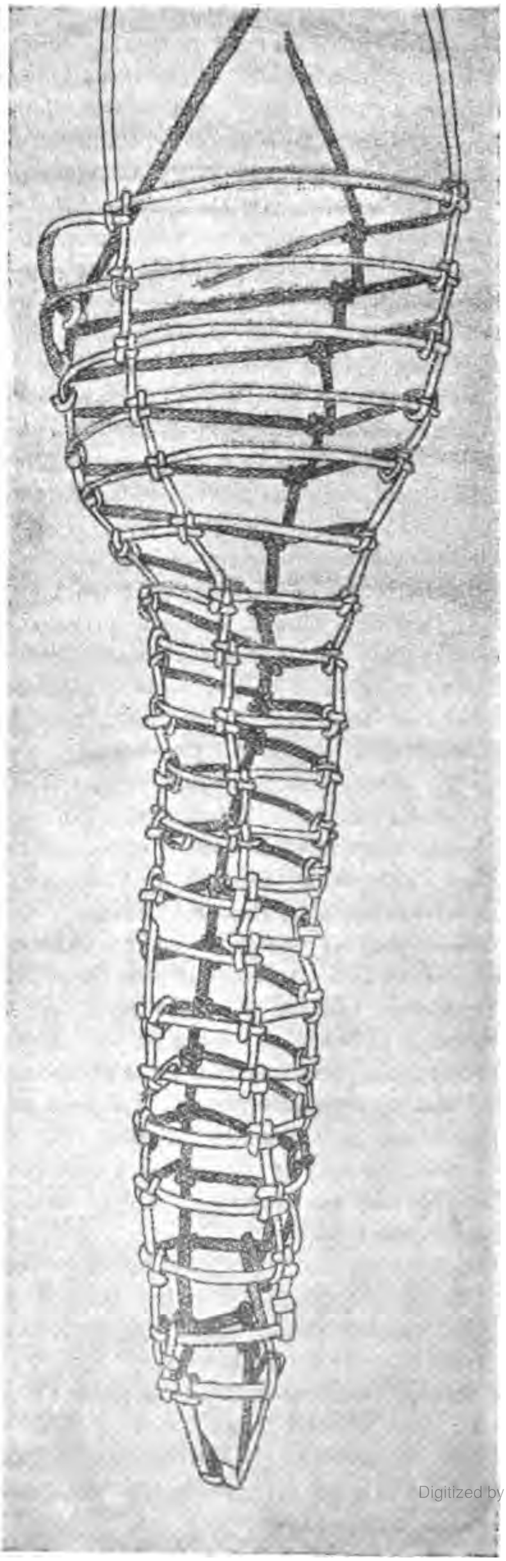
Before leaving this comparison, the following extract from Dr. Dean's paper on the habits and breeding of *Amia*, published in the Fourth Annual Report of the Commissioners of Fisheries, &c., of the State of New York, dated 1898, will be useful:—"The eggs are scattered over the nests thickly, in number varying from a few hundreds to possibly a hundred thousand. A single male tends the nest, keeps away intruders, and by vigorous breathing produces a current of water which probably retards the growth of fish fungus. The fish stands guard, sometimes for hours motionless, save for its movements in balancing and breathing: at other times it appears restive, turning about in the nest, making short detours, and returning by the runway which it provides. A favourite position is for the fish to lie in the runway with its head projecting over the nest. It usually remains in the shaded side of the nest, but appears occasionally in bright sunlight, so that it can be seen quite a distance away."

The similar habits of "lula" and the existence of runways to and from the nests are known to some of the natives of this country, who utilize the knowledge for the purpose of capturing the fish during the breeding seasons. They say that whilst watching over its eggs and fry, "lula" will not take the bait and can only be caught by the *kuda*. This is a small basket of deep conical form and wide mesh, about 20 inches long, ending blindly at the narrow end, opening like a funnel at the wide end, just large enough to receive the body of the fish, which, once inside, cannot withdraw. At Minneriya these *lula-kudu* are made by a cunning old descendant of the Veddas, named Sirataweli, and they are also used at Topawewa. (Text figure.)

On February 21 last Sirataweli accompanied me, wading through part of Minneri tank, in search of nests of "lula." Five nests were found, of which two were empty, two others contained a swarm of fry in each, while one contained floating eggs and very young fry intermingled with *Lemna* and with fragments of vegetation detached from the neighbouring plants and likewise floating on the top. One of the nests containing a swarm of fry, situated behind a tussock of grass under the shade of some bushes, apparently belonged to "madaru" or "mada-karaya" (*O. punctatus*), and not to "lula."

On May 28 a man brought some "lula" eggs to me, which he had taken from a nest amongst the rushes in the Hunupitiya arm of the Colombo Lake. I waded out to this nest and again saw the characteristic translucent golden yellow or amber-coloured eggs, some newly hatched, spread like a sheet, flush with the surface in a subcircular area behind a tussock of rushes which partly served to filter the direct rays of the sun. Amongst and around the eggs were scattered the usual detached fragments of herbage, consisting chiefly of small leaves of aquatic plants. I did not see the adults, but the man said that both parents had been near the nest, the smaller of the two aggressively protecting it; he called this one the female, possibly not knowing that amongst fishes the male is smaller than the female.

At a little distance from the "lula" nest just described there was a swarm of "mada-karaya" fry. A few days later (June 3) another batch of the same kind of eggs was brought to me from Hunupitiya, but the finder said that they were "mada-karaya" eggs, and he brought a dead fish of this species along with him to prove his point. They had the same diameter, about 1·25 mm., as the "lula" eggs, and the subsequent stages were those of the development of "lula." I conclude therefore that I have not yet seen the spawn of "mada-karaya,"



Vedda trap for nesting lula, in use at Minneriya. About one-third natural size.

and do not know for certain whether the eggs of this species float at the surface like those of "lula," or whether they lie at the bottom like those of most other freshwater fishes. I hope to clear up this point at an early date.

On June 1 still another lot of "lula" eggs was brought in from Welikada, near the toll-bar on the road to Kotta near Colombo. The material upon which this paper is based has thus been derived from four broods, namely, one from Minneriya, two from Hunupitiya, and one from Welikada.

The floating eggs of "lula" owe their buoyancy to the presence of a single large oil-globule which occupies the greater part of the ovum and is immersed in the golden yellow yolk (Pl. II., Fig. 1). It is adjacent to the upper pole of the egg, and in surface view under a low power of the microscope is seen to be surrounded by a narrow zone of the yolk, the whole being contained within a space bounded by the vitelline membrane (Fig. 2). As the eggs lie immediately below the surface film of water exposed to the quickening influence of air and sun, the intravitelline or embryonic development goes forward rapidly; although I have not been able to time this period accurately it would appear that hatching takes place within three days after oviposition, and perhaps within twenty-four hours. From the condition represented in Fig. 1, as seen with a simple lens at 5.30 P.M., we reach overnight the stage shown in Figs. 3 and 4, where the body of the embryo encircles about two-thirds of the yolk like a belt. The surface view (Fig. 4) shows that while the head is still appressed to the yolk, the tip of the tail is becoming folded off; the eye and auditory vesicle are also present.

A few hours later the heart begins to beat and the tail to twitch. The orientation of the embryo is constant, the left side being uppermost when viewed from the upper pole of the egg (Figs. 4 and 5). The movements of the tail soon lead to the rupture of the vitelline membrane and the liberation of the embryo; and now commences the larval period of development The eggs retain their glistening oily golden yellow lustre up to the moment of hatching, but before this event the outlines of the future pigment cells can be seen upon the surface of the yolk under the microscope. The pigment does not become obvious until some hours after hatching.

The general appearance of a young first day "lula" hatchling is shown in Fig. 6. It measures 3·5 mm. in length; the microscope only reveals very faint pigmentation, and the eyes are destitute of pigment. There is a wonderful yolk-sac circulation; the anterior cardinal vein is seen issuing from the head behind the auditory vesicle and passing across the front part of the yolk-sac to join the sinus venosus. The caudal vein pours its blood into the subintestinal system, which is joined by the posterior cardinal vein at the level of the angle contained between the projecting yolk-sac and the hind-body. The blood in at least the hinder moiety of the posterior cardinal vein flows backwards into the subintestinal vein in conjunction with the caudal circulation—a fact which I have repeatedly observed in other fish larvæ as well as in "lula."

For three days after hatching the larvæ remain at the surface of the water, resting on one side with the yolk-sac up. When they swim they sway and rotate irregularly, sometimes apparently spinning round. The network of stellate cells over the yolk-sac soon darkens and forms a pigment reticulum, and pigment begins to appear in the eyes on the first day, but, as I have already mentioned, at the time of hatching the eyes are clear and devoid of pigment. In fact, throughout a great part of the first day after hatching, the spawn presents the same appearance as it did before hatching, and only closer inspection reveals that the yolk-laden larvæ have escaped from the egg-membranes. First day hatchlings are thus distinguished as unpigmented or clear "lula" surface hatchlings.

Second and third day hatchlings are called pigmented "lula" surface hatchlings. They measure 4·5 mm. in length. Whereas in the very young hatchling the caudal vein passes *in toto* alongside the hind-gut into the subintestinal system (Fig. 6), it is now seen to give rise to a capillary system which is joined by the posterior cardinal vein and discharges into the subintestinal vein behind and below the yolk-sac (Fig. 7). Connected with this and with the anterior vessel shown in Fig. 6 there is a marvellous yolk-sac circulation, forming a perfect system of capillary irrigation. During the early days of larval life, neither the aorta nor the caudal vein extends backwards as far as the end of the notochord, but the former opens directly into the latter behind the free end of the septum, which otherwise separates the two vessels at this stage; and the point of confluence lies some distance in front of the end of the notochord. About the twelfth day after hatching the vessels are carried farther backwards, and a capillary network forms in the caudal fin beyond and below the tip of the notochord (Pl. III., Fig. 11). Larvæ of the second day no longer have the clear eyes of the first day, for the eyes now contain black pigment. Another striking new character of this stage is the first appearance of the pectoral fins as rudimentary buds *in situ* above the yolk-sac.

By the third day the length is slightly increased, about 5 mm., the pigmentation is intensified, and the mouth is open. Besides the uniform layer of pigment over the yolk-sac, stellate cells are distributed over the myotomes, especially along their upper and lower borders, and a thin line of cells occurs along the centre of the dorsal and ventral embryonic fins, which at this stage show an equal amount of pigment. On this day indications of the air-sac appear, the pectoral fins begin to flap, and respiratory movements commence. The larvæ still rest at the surface when not swimming, and are capable of resting at the bottom.

On the fourth day the larvæ have attained a length of 6·75 mm. They are now leaving the surface and swimming freely at all levels; bright yellow spots appear over the eyes. The hinder extremity of the notochord is still straight, but the embryonic fin has exchanged the vacuolated structure of the preceding days for a fine radiate striation. The sides of the body are free from pigment, and are consequently traversed by a pale longitudinal band parallel with the notochord. There is also a more or less interrupted pale band in the middle dorsal line of the fore-body, in front of the embryonic fin. There is a faint massing of embryonic tissue below the hinder end of the notochord, a little before its extremity. This is the primordium of the caudal fin-ray system.

The fifth day shows no increase of length. The caudal pigment is increasing, though still diffuse, and the caudal primordium is becoming denser. On the sixth day the length is found to exceed 7 mm., and there is a further slight concentration of pigment and embryonic tissue.

On the seventh day, still with a length of about 7 mm., we find the first traces of the basal cartilages of the caudal rays, situated below the free straight end of the notochord at the point where the myotomes or muscular segments cease. The rudiments of three cartilages can be made out, but the caudal pigment, which has a peculiar relation to the formation of the fin-rays, is still diffuse. The pigment in the ventral portion of the embryonic fin is now beginning to predominate over that in the dorsal portion of the fin.

In the next three days I observed no increase in length, but the caudal pigment below the end of the notochord is tending to lie in radial streaks, marking the position of the future caudal rays; and the caudal capillary system makes its appearance.

On the twelfth day (Fig. 11) the end of the notochord begins to bend up, and the caudal rays begin to show; there is still no further increase in length; on the contrary, as the tissues and cavities of the body begin to expand, there is a very slight decrease in length to be noted, from about 7 mm. to about 6·75 mm., this length being maintained to the end of the fifteenth day. Incidentally I noted the fact that the twelfth day larvæ were not rising to the surface of the water to take the air. Up to this time the body of the larva has been colourless, except for the black pigment. On the fifteenth day some of the more advanced larvæ display a pronounced yellow ground colour associated with a further condensation of the black cells. The contour of the caudal fin at this period is shown in Fig. 11.

There is now a gap in my observations until the twenty-fifth day, the fry having been kept meanwhile within a small enclosure in a glass tank. The embryonic median fins are still continuous (Fig. 12); the ventral portion of the embryonic fin, from which the anal fin arises, is much more highly pigmented than the dorsal portion; neither of them shows any trace of secondary rays. The fasciculation of the primary caudal rays (*i.e.*, the striations), which was foreshadowed on the fifteenth day in some individuals, has made further progress, but I noted that the developing secondary caudal rays were not yet provided with the basal prongs by which they subsequently become articulated with the cartilages, nor had they become transversely jointed.

Larvæ preserved on the twenty-eighth day after hatching varied in length from 8·5 to 10 mm., with ten to twelve caudal rays, of which the larger are jointed and provided with a pair of basal prongs astride of the basal cartilages (Fig. 13). The caudal fin-rays all lie below the upturned end of the notochord; they consist of two groups, upper and lower, separated by a special notch in the basal cartilage, through which the blood is transmitted to the caudal capillary system (Fig. 13). The fin-rays are controlled by special divaricator muscles (not shown in the figure), which arise from the skeletogenous tissue below the notochord at its point of flexure, and can be traced to the ends of the radial prongs, the fibres which supply the upper group passing obliquely upwards parallel to the notochord.

Larvæ thirty-seven to forty days old vary in length from 10 to 13 mm. The length bears no direct proportion to the bulk, since a larva of 13 mm. has at least twice the bulk of one of 10 mm. This is the transition period from the larval to the postlarval phase of growth. At 10 mm. there are still no external rudiments of the ventral fins, but these appear when the larva has attained the length of 10·25 mm. They arise *in situ* a short distance behind the plane of the pectoral fins and far in front of the vent, as minute buds close to the middle line of the abdominal surface. The embryonic fins are still continuous, but a shallow constriction, both above and below, separates the future definitive dorsal and anal fins from the caudal fin, the intervening portions of the embryonic fin in the region of the caudal peduncle undergoing reduction and degeneration, accompanied by the appearance of vacuoles in their substance (Fig. 14). The primordial formative tissue of the dorsal and anal rays has now invaded the corresponding parts of the embryonic fin, obscuring the striations, leaving a peripheral rim free, where the primary striations are clearly visible. The anal rays appear in the middle of the substance of the fin, separated by an interval from the basal line and surrounded by dense pigment. The dorsal rays arise from the basal line (Fig. 14), and the pigment is sparse.

The larvæ are now swimming near the bottom of the shallow aquarium in which they have been reared and come to the surface to take in air. On the twenty-eighth day a larva gulped the air once a minute, eight times in eight minutes, each time leaving a small air-bubble at the surface.

As already indicated, the fortieth day after hatching may be taken to mark approximately the end of the larval development, in so far as this is denoted by the condition of the fins (Figs. 15 and 16). As soon as the fin-rays are properly laid down and their outlines darkened by pigment, the amount of pigment in the dorsal and anal fins becomes equalized. The other characters at this stage are the broad yellow lateral stripe, a short yellow band in front of the dorsal fin culminating in a shining golden occipital spot, and a golden yellow mark over each eye.

The subjoined table gives a summary of the chronological data which I have been able to ascertain regarding the external features of the development of *Ophiocephalus striatus* :—

Days after Hatching.	Total Length.	Principal Events.
1	3·5 mm.	Yolk-sac circulation established; pigment cells develop their black colouration; pigment begins to appear in eyes.
2 & 3	4·5 to 5 mm.	Pectoral fins arise; mouth opens, and respiratory movements commence.
4	6·75 mm.	Larvæ leaving the surface and swimming freely at all levels. Bright yellow spots over eyes.
7	7 mm.	Larvæ swarming and turning in unison at the slightest concussion. Caudal cartilages appear.
12–15	6·75 mm.	Posterior end of notochord bends up.
28	8–10 mm.	Caudal rays jointed and articulated with the basal cartilages. Larvæ rise to surface to take air.
37	10 m.m.	Primordia of dorsal and anal rays.
40	10·25–13 mm.	Rudiments of ventral fins appear. Dorsal and anal fins separating from caudal.
63	17 mm.	The fry now hide in the mud.
73	25 mm.	

With reference to the above it is to be noted that after the absorption of the yolk about the fifth day after hatching, when the larvæ begin to feed independently, the daily growth begins to vary; and the variation is probably the greater on account of the larvæ having been reared in captivity. It has been similarly noticed that in the case of the trout, larvæ of equal ages occur in very different stages of development.* Only one larva was examined on the thirty-seventh day. The striking increase in length to the extent of a

* Compare E. Goeppert. Die Entwicklung des Pankreas der Teleostier, Morph. Jahrb., XXI., 1893, p. 90.

millimètre between the first and second days is normal and noteworthy.

On July 28 a swarm of "lula" fry was found close to the bank in a part of the Colpetty arm of the Colombo Lake. They were incessantly streaming to and from the surface, and their presence in the thick water was made manifest by this action. They were coloured a soft reddish brown or brown and pink, quite different from the black and yellow of "madaya" fry (*O. punctatus*) of the same size. Their total length (including the caudal fin) varied from about 15 to about 17 mm.—a size which corresponds with the dimensions of larvæ which I have reared in an aquarium for sixty-three days after hatching. The general colour-effect is dominated by a broad lateral reddish orange band occupying almost the entire height of the myotomes, commencing from the eye on each side, and ending behind with a rounded edge at the base of the caudal fin concentric with the terminal contour of the latter. The iris is golden with a red flush; there is a bright golden occipital point; and the basis of the anal fin is dense black along its whole length. The colour of the fry is essentially that which it had acquired at half the size; and it retains this colour until it has doubled the size, after which the definitive markings begin to appear.*

On the same occasion (July 28) I obtained a sample of "madaya" fry of the same general dimensions as the "lula" fry from a neighbouring muddy swamp. Instead of the reddish brown subtranslucent ground colour of the "lula" fry, the "madaya" fry are characterized by a blackish ground colour, upon which the bright golden yellow bands stand out clear, namely, a pair of lateral bands about half the width of the "lula" bands, occupying the central third of the height of the myotomes and ending behind in a point extending about one-third of the length of the caudal fin into the substance of the fin. Along the length of the back is a golden yellow line running along the basis of the dorsal fin, and presenting a more or less distinct interruption in the occipital region in front of the fin at the spot where there is a minute golden speculum in "lula." Besides all this, the "madaya" fry present a clear yellow spot on the snout and do not possess the black basis of the anal fin. The postlarval stage of "lula" is thus easily distinguishable from the postlarval "madaya." Moreover, at this stage the median fins have completed their differentiation from the embryonic matrix. "Lula" and "madaya" fry of 17 mm. exhibit the following differences in respect of their median fin-rays and lateral bands :—

"Lula" .. D 47, A 30, Lat. band 1·20 mm. wide.
"Madaya" .. D 30, A 20, Lat. band ·60 mm. wide.

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* A. Willey. Fishery observations. *Spol. Zeyl.*, V., 1908, p. 145 *et seq.* I take this opportunity of correcting the name of a protozoon referred to in this note as *Blepharisma*. It should have been *Loxodes*.

General Considerations.

So far as I am aware no other instances of eggs of freshwater fishes floating at the surface of the water by their own buoyancy have been described hitherto. The same advantages, namely, direct proximity to atmospheric air and to sunlight, are partly secured in other ways, as by attachment to aquatic plants or by deposition in very shallow water. The floating eggs of *Ophiocephalus striatus*, with their accompaniment of small fragments detached from the surrounding plants, such as cut pieces of tank weed, leaves, and lengths of cut stem, rather invite comparison with the floating nests of *Gymnarchus* which were described by the late J. S. Budgett.* He found these nests amidst the dense grasses of a West African swamp floating at the surface in three to four feet of water; the deepest part of a nest was only about six inches below the surface; in it " were deposited about a thousand large spherical amber-like eggs 10 mm. in diameter. The eggs hatched five days after being laid, and in eighteen days a thousand young fry of *Gymnarchus niloticus* left the nest," having in this short time attained a length of three inches.

In the same flooded grass-lands Budgett frequently found " masses of white foam floating on the surface of the water." These proved to be the foam-nests of another fish, *Sarcodaces*, a member of a family, the Characinidæ, which is not represented in Ceylon. They were filled with numerous transparent ova, 2½ mm. in diameter; on hatching, the larvæ " make their way through the foam in which they are laid, down to the surface of the water, and there the young larvæ hang, holding to the surface of the water by a large adhesive organ situated on the front of the head." There is no adhesive organ in the young larvæ of *Ophiocephalus striatus*, but all the same they are kept at the surface by the extraordinary buoyancy of the yolk-sac, and in due time they strike out from the surface to the bottom; whereas the hatchlings of most freshwater fishes strike out from the bottom towards the surface.

Thus the larva of *Ophiocephalus* differs from that of *Sarcodaces* in the absence of a frontal cement organ, and from that of *Gymnarchus* in the absence of external gills. Like the Mormyridæ, the family to which *Gymnarchus* belongs, and the Characinidæ, the Ophiocephalidæ is a characteristic family of tropical freshwater fishes whose morphology is better known than their bionomics; and the present contribution, with others which are to follow, will show how much remains to be done upon the subject which was so successfully and tragically inaugurated by Budgett.

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* J. S. Budgett. On the breeding habits of some West African fishes. Trans. Zool. Soc. London, XVI., 1901. Reprinted in the Budgett Memorial Volume, edited by J. Graham Kerr, Cambridge Univ. Press, 1907, pp. 119–36, plates and text-figures.

There are several other points with regard to which comparisons with other forms may be both instructive and interesting. The simple ventral flexure of the embryo of *Ophiocephalus*, the absence of retinal pigment within the egg, and the formation of the pectoral fins after hatching, are facts to be noted as contrasting with what occurs in the development of many other Teleostean fishes. The later appearance of the ventral fins is the rule amongst bony fishes.* In the two Dipnoan fishes, *Lepidosiren* and *Protopterus*, the paired limbs arise simultaneously; in the former thirteen days after hatching; † in the latter, according to Budgett, the rudiments of the limbs begin to show about the third day after hatching, and by the tenth day after hatching the larva is provided with well-developed limbs.‡ On the other hand, in the Australian Dipnoan genus *Ceratodus*, according to Semon's observations,§ the ventral fins appear about a month later than the fore-limbs, approximating in this respect to what I have described above for *Ophiocephalus*. In this connection it is interesting to note that in the genus *Channa*, which also belongs to the Ophiocephalidæ and occurs in Ceylon, the ventral fins fail to put in an appearance throughout life.

As described above, the development of the definitive caudal rays of *Ophiocephalus* is marked by a succession of phases: firstly, the proliferation of primordial or formative tissue below the posterior end of the notochord; then the formation of a capillary plexus; the development of basal cartilages and the fasciculation of the primary striations; lastly, the appearance of the basal prongs. The actual rays thus arise peripherally or centripetally; and this relation appears to be more pronounced in the case of the anal rays (Fig. 14). An analogous peripheral origin of fin-rays has been described by J. Schmidt in the pelagic larvæ of the marine salmonoid fish, *Argentina silus*, where at a stage of 28–32 mm. in length, the primordia of the dorsal and anal interspinous rays appear nearly half-way between the contour of the body and the outer border of the embryonic fin, without direct connection with the body. At a length of 39 mm. the fin-rudiments touch the margin of the body.|| The general ontogeny of the median fins of *Ophiocephalus* resembles that described and figured by Assheton for *Heterotis niloticus*.¶

The rhythmical darts to the surface for the gulping of air by the 28-day larvæ of *Ophiocephalus* is paralleled by the larvæ of *Gymnarchus*, although the latter are burdened by an enormous pendent or

* F. M. Balfour. Comparative Embryology, 2nd edit., 1885, Vol. II., p. 80.

† J. G. Kerr. Development of *Lepidosiren paradoxa*. Phil. Trans. R. Soc., London, Vol. 192, 1900, p. 316.

‡ J. S. Budgett. *Op. cit.* Pl. VIII., figs. 12-13, p. 127.

§ R. Semon. Forschungsreise; quoted from Kerr, *loc. cit.*

|| J. Schmidt. Development of the Argentines. Medd. fra Komm. Fiskeri II., No. 4, Copenhagen, 1906.

¶ R. Assheton. Teleostean Larvæ from the Gambia River. Budgett Memorial Vol., Cambridge, 1907, p. 439.

external yolk-sac which persists much longer than the yolk-sac of *Ophiocephalus*. "By the tenth day after hatching the larvæ are able to drag their yolk-sac to the surface of the water, when they take a gulp of air into their lung-like swim-bladder and fall again to the bottom, on reaching which they again start for the surface with unceasing regularity, so that when looked at from above, the nest of *Gymnarchus*, with its swarm of scarlet-bearded [referring to the external gills], yolk-hampered larvæ, presents a most amazing spectacle." (Budgett, *op. cit.* pp. 131–32.)

The circulation of the blood in the larvæ of *Ophiocephalus* conforms to the larval Teleostean type of circulation and presents several interesting characteristics, chief among which are the direct junction, during the early days of larval life, between the aorta and the caudal vein; the yolk-sac circulation which is intercalated in the subintestinal system in a manner analogous to the relations of the hepatic cœcum in Amphioxus; the subintestinal vein itself, which, as was pointed out long ago by Balfour (*op. cit.* p. 651), recapitulates an ancient pre-piscine organization; lastly, the reversed current of the posterior cardinal blood, which, instead of flowing forward towards the heart, flows backwards to join the subintestinal system, so that the aortic blood and the cardinal blood is seen to be flowing in the same direction.

Lastly, it may be noted that although, as I believe, the floating eggs of "lula" are unique amongst freshwater fishes, so far as the available records go, yet they present some analogy with the eggs of some species of marine fishes. Thus the transparent eggs of the greater weever (*Trachinus draco*), with a diameter varying from a little less to something over one millimètre, have a single large oil-globule and float at the surface of the sea. Four or five days after oviposition the embryos are hatched; and four or five days after hatching the yolk has become absorbed. The buoyancy of the yolk-sac causes the larvæ to float helplessly in the water for some time after hatching, with the yolk-sac uppermost.*

PRACTICAL CONSIDERATIONS.

The usefulness of "lula" as a source of food-supply for the low-country of Ceylon, together with the fact that attention is now being drawn to the maintenance and replenishment of the stock of fishes in the rivers and tanks of this country, makes it incumbent upon us to examine the practical bearing of the foregoing observations and

* J. Boeke. On the early development of the Weever Fishes. Tijdschr. Nederland. Dierk. Ver. (2) VIII., 1903, pp. 148–57, Pl. VII. I have not seen the original paper, but it is quoted by Dr. Theodore Gill in "Life histories of Toadfishes compared with those of Weevers and Stargazers," Smithsonian Miscellaneous Collections, Quarterly Issue, Vol. III., Part 4, Washington, 1907, p. 421. A subsequent paper by Boeke on "The later larval development of Trachinidæ" appeared in the above-named journal, Vol. X., 1907, pp. 245–54.

others like them. In other places it is recognized that methods of culture should be based upon a knowledge of the breeding habits of fishes under natural conditions,* and if this point of view is accepted locally the utility of these notes on "lula" may be taken for granted. The necessity of differentiating between the successive ages and stages of the growing fish, and between fry of the same age belonging to species which may be closely allied zoologically though far apart economically, and the study of the conditions under which fry can be reared best under an artificial system, are points which must always guide cultural operations whenever they are undertaken.

The feeding of "lula" during its earlier stages is not an insuperable difficulty, and under suitable conditions it even goes forward to a large extent automatically. It is known that the growth of fishes is governed directly by the food-supply. "Lula" is one of those fishes whose size-limit is practically indefinite. The more food it receives of the right kind, the quicker and the larger it grows. Some young "lula" which I kept in an aquarium at my bungalow in Colombo had an average total length of about 35 mm. in February, 1908; 45 mm. in July, 1908; 96 mm. in April, 1909. The series last measured consisted of six individuals ranging from 85 mm. to 115 mm. The latter measurement may be taken as representing approximately the usual growth of a yearling "lula," although under more favourable conditions it might reach six inches in total length from the tip of the snout to the end of the tail fin. It will be observed that in the nine months from July to April the young "lula" more than doubled their length. A sample of "kavaiya" fry, *Anabas scandens*, six in number, kept in the same tank at the same time, behaved in a similar manner; when first measured in June, 1908, their average length was 33·5 mm.; a month later the average had increased to 41 mm.; and in April, 1909, it had reached 83 mm. Another tropical freshwater food-fish, which may be introduced into Ceylon some day, namely, the Gourami (*Osphromenus olfax*), is known to attain a length of about four inches in the first year, seven or eight in the second, and ten or eleven in the third, after which it begins to breed.†

From what has been said above, and also from what has long been known respecting the powers of endurance possessed by the Ophiocephalidæ, it is obvious that, as soon as required, yearling "lulu" could be reared with comparative ease in protected ponds, and could be distributed subsequently as required.

The extent to which the fry of freshwater fishes depend for their sustenance upon the aquatic larvæ of mosquitoes or Culicidæ is a matter of practical moment and also of special interest at the present

* Compare Dwight Lydell. The habits and culture of the Black Bass. U. S. Fish Comm. Bull., 1902 (Washington, 1903), pp. 39–44, Pl. 8.

† See A. Willey. Ceylon Admin. Rep., 1908. Marine Biology (including first part of Report on Inland Fisheries).

time, for although the little fishes called "millions" in the West Indies, top-minnows elsewhere, are not such a universal panacea for malaria as it has been suggested they would prove to be, yet it is useful that renewed attention should be given to the part played by fishes in general, by the fry of the larger fishes, and by top-minnows in particular, in checking the natural increase of mosquitoes by feeding upon their larvæ.

Mosquito larvæ too often thrive best in places to which fishes can never have access, as in the small accumulations of chocolate-coloured water in the crevices of jungle trees; and even in the tanks they favour the scum-covered water at the edge, where the vegetation is rotting, though this of course will vary with the water-level in the tank at a given time. An analogous case is afforded by the Colombo Lake fly, an undetermined species of *Chironomus*, whose numbers have not appreciably diminished in spite of all the precautionary steps which have been taken during the past five or six years, due, it must be supposed, to the fact that although their larvæ are naturally useful as fish-fodder, yet they thrive best in places which are not otherwise attractive to insectivorous fishes. In such a case as this the normal balance cannot be restored without the application of herculean methods.

Next to the microscopic crustacea which compose the most important source of food-supply for the young of freshwater fishes, the larvæ of mosquitoes are looked upon as the best friends of the fish-culturist, although the mature insects are amongst our worst enemies.* We are thus placed, often at one and the same time, in perplexity as to how we may procure the larvæ and how to avoid the flies. In any case, it is expedient to recognize as beneficial those species of fishes which prey upon mosquito larvæ.

Wishing to test the selectivity of mosquitoes for different waters, I placed two chatties side by side, one (referred to as A) containing water rendered turbid by decaying animal matter, the other (B) containing clear water. Two days later I took 20 culicine egg-rafts from A, as against 1 from B. On the following day 11 more egg-rafts appeared on A; none on B. On the day after this, again 14 rafts were found on A, only 2 on B, the water not having been changed in the meantime. At the same time another species was observed to lay single eggs which adhered to the surface of chatty A below the surface of the water close to the water's edge. Water containing decaying vegetable matter is equally attractive to egg-laden mosquitoes. Such a pronounced preference for a putrescent nidus for the eggs on the part of insects whose feeding habits are so highly specialized, amounts to a biochemical reaction to which the term saprotaxis might be applied.

* Compare Dr. Emil Walter. Die Fisherei als Nebenbetrieb des Landwirtes und Forstmannes. Neudamm, 1903, see pp. 57–62.

Young *Anabas* not only consume the larvæ, but will swallow the entire egg-rafts, each comprising about 160 eggs. On June 4, "lula" fry of the seventh day after hatching were observed to ingest a quantity of separate white mosquito eggs floating on the surface of the water in a glass dish. Here it may be mentioned that on the same day about 30 "lula" surface hatchlings from another brood were eaten up by older "madaya" fry. Later on it was found that the "lula" fry would approach the culicine rafts, but would not eat them; as soon however as the minute larvæ hatched out from the eggs, the fry devoured them. Since then I have fed my "lula" fry with abundant mosquito larvæ, without always observing the actual process of ingestion.

Top-minnows (Cyprinodontidæ) are represented in Ceylon by one or two species of *Haplochilus*, of which the commonest is *H. lineatus*, called "diya pita hendeva" in Sinhalese. They lay eggs which become attached by glutinous threads to water plants, about as large as "lula" eggs, with pale amber-coloured yolk containing a number of oil-globules. I have not found them so attached, but have seen them freshly extruded in July. The vitelline membrane shows a reticulated sculpturing, and the long adhesive threads radiate from a centre placed near the oil-pole. The mature fish attains a length of about 1½ inch; the snout is flattened and shovel-shaped, adapted for surface feeding; the male is larger than the female, exhibiting at the breeding season a bright golden green lustre on the scales of the hind-body; ventral and anal fins greenish, the latter with backwardly prolonged orange-coloured rays and three black basal flecks; dorsal and caudal fins and lower lip orange; hind-body without the 6–8 vertical black bars which are present on the spawning female.

Maimed mosquitoes dropped upon the surface of the water are seized and swallowed by the top-minnows. These fishes (*H. lineatus*) possess a flashing white occipital triangular spot, which can be alternately darkened and rendered invisible by the expansion of black pigment cells, and can again flash out resplendently when these contract. It is not phosphorescent; I think that it acts as a lure, but have not been able to prove that it does.

Explanation of Plates II. and III.

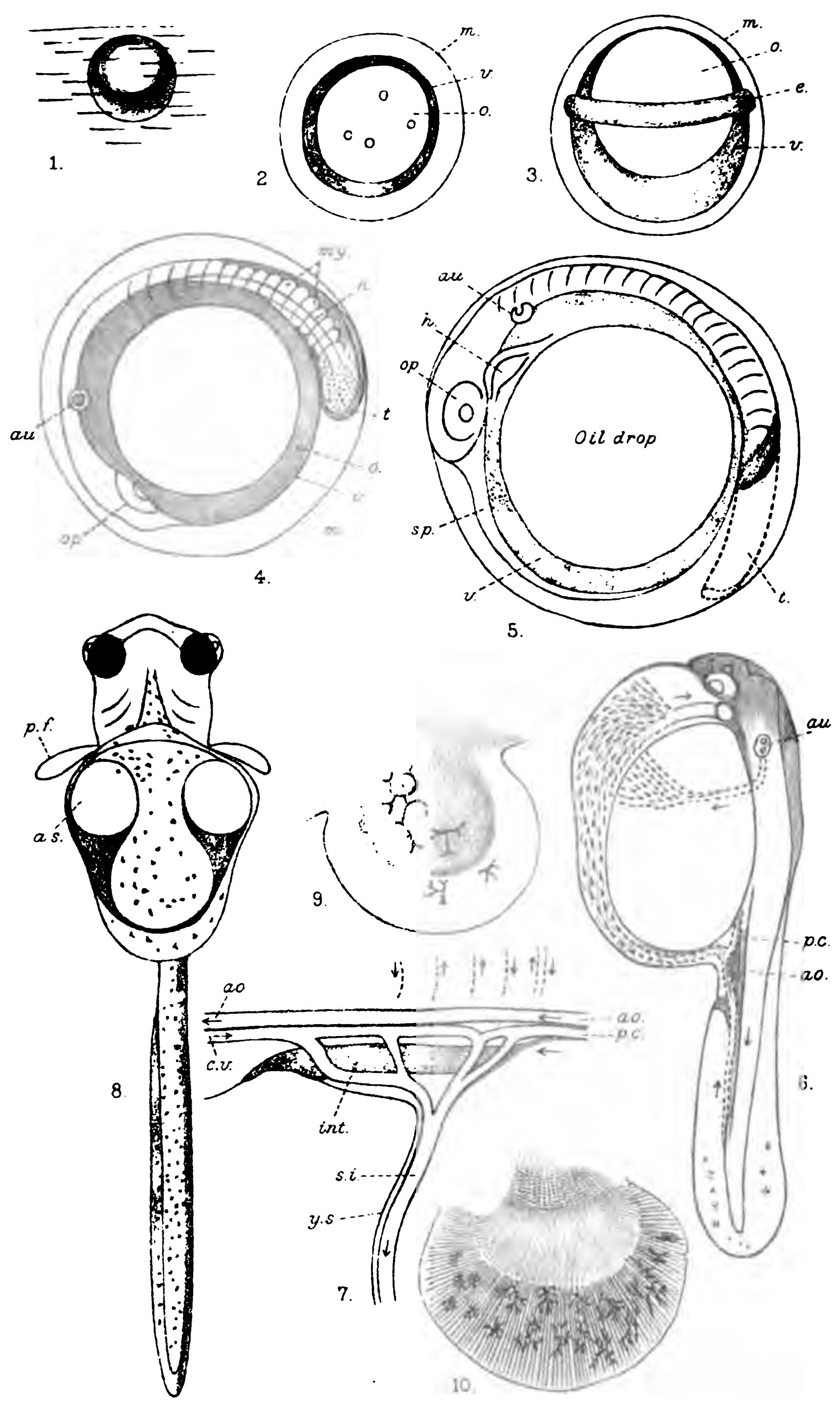
Ophiocephalus striatus.

Fig. 1.—Egg with single large oil-globule, floating below the surface film of water, as seen with a simple lens.

Fig. 2.—The same seen from the upper pole under a low power. The small spherules inside the large globule appeared with a deep focus. *m*, vitelline membrane; *v*, yolk; *o*, oil-droplet.

Fig. 3.—Egg seen in suspension about fifteen hours later; *e*, embryo.

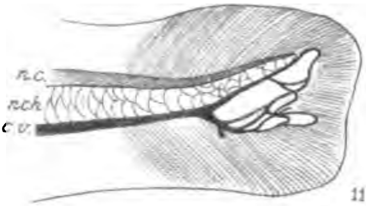
SPOLIA ZEYLANICA. Plate II.



A.W. del. ad nat. West, Newman lith.

OPHIOCEPHALUS.

Plate III.



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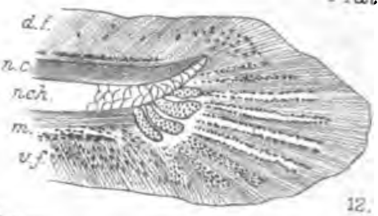

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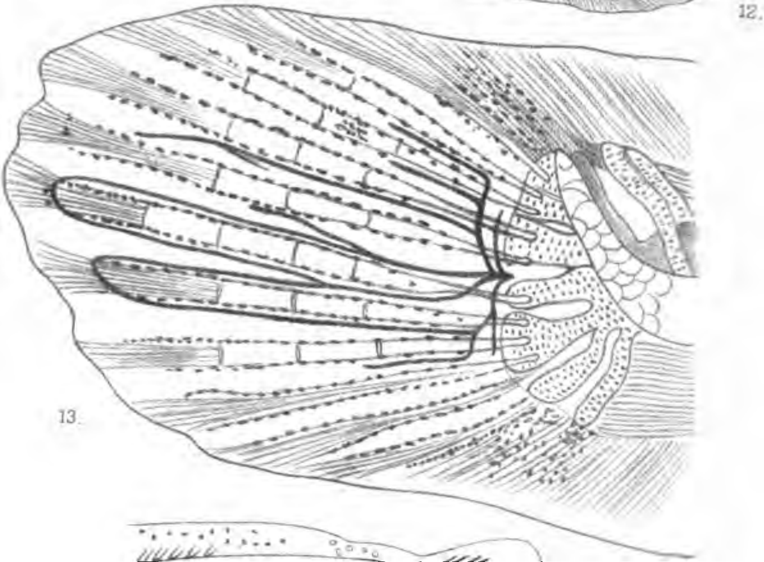

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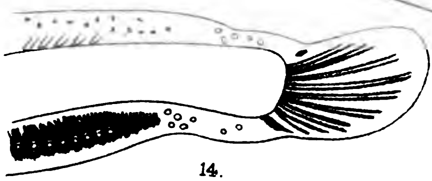

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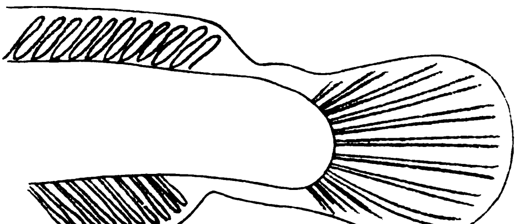

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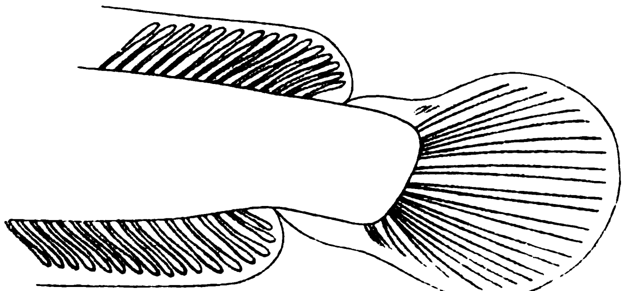


A.W. del. ad nat.

16.

OPHIOCEPHALUS.

West, Newman lith.

Fig. 4.—The same seen from above; *op*, eye; *au*, auditory sac; *my*, myotomes; *n*, notochord; *t*, free end of tail.

Fig. 5.—Egg five hours later, from above. The shaded portion of the tail (*t*) shows it bent down, the dotted portion shows it in extension. *h*, heart; *sp*, body-cavity (splanchnocœl); *v*, yolk; other letters as before.

Fig. 6.—Newly hatched larva; length 3·5 mm.; eyes colourless. *pc*, posterior cardinal vein joining the caudal vein to form the subintestinal vein; *ao*, aorta; *au*, auditory sac containing two otoliths.

Fig. 7.—Second day larva. Sketch of the capillary network at the confluence of the caudal, posterior cardinal, and subintestinal veins. The arrows above the aorta indicate the direction of the flow of blood in the segmental parietal vessels. *ao*, aorta; *cv*, caudal vein; *pc*, posterior cardinal vein; *int*, intestine; *ys*, posterior surface of yolk-sac; *si*, subintestinal vein running round the yolk.

Fig. 8.—Third day larva; length 5·5 mm.; seen from below. *pf*, pectoral fin; *as*, dorsal air bladder seen in optical section.

Fig. 9.—Pectoral fin of third day larva. It is attached to the body dorso-ventrally; diameter 0·42 mm.

Fig. 10.—Pectoral fin of seventh day larva, showing primary striations; no fin rays; striated basal muscles; diameter nearly 1 mm.

Fig. 11.—Twelfth day larva. View of the tail end from the left side, showing notochord bending up and a capillary formation below it, the finely radiate structure of the embryonic fin, and its truncate extremity; *nc*, medullary tube; *nch*, notochord; *cv*, caudal vascular system, diagrammatic, without distinction of artery and vein.

Fig. 12.—Twenty-fifth day larva. Tail end from the left side. The total length of the larva was 7·5 mm. The figure illustrates the commencing fasciculation of the caudal striations, and the basal cartilages below the subterminal convexity of the notochord. *df*, dorsal embryonic fin; *m*, muscle fibres below the notochord; *vf*, ventral embryonic fin, more highly pigmented than the dorsal.

Fig. 13.—Twenty-eighth day larva; length 8·5 mm. End of tail from the right side; shows basal prongs and joints of caudal rays and the caudal capillaries.

Fig. 14.—Thirty-seventh day larva; length 10 mm. Posterior end of the body to show the commencing constriction of the caudal fin and the primordia of the dorsal and anal rays, the latter accompanied by dense pigment.

Fig. 15.—Fortieth day; length 10·75 mm. Constriction of caudal fin progressing.

Fig. 16.—Hinder end of another larva of the fortieth day; length 12·5 mm. Constriction of caudal fin complete.

NOTES.

1. *Review: Indian Insect Life, a Manual of the Insects of the Plains (Tropical India), by* **H. Maxwell-Lefroy,** *assisted by* **F. M. Howlett.**—Published under the authority of the Government of India for the Agricultural Research Institute, Pusa, by Thacker, Spink & Co., Calcutta and Simla, 1909, pp. 786, with 536 text-figures and 84 plates.

This richly illustrated volume will be welcomed by those who take a general interest in Indian entomology. The majority of the plates have been executed in three colour process by the Calcutta Phototype Co., and are particularly successful, as indeed are most of the text-figures.

It may be useful for a future edition of this attractive work to point out that the figures of the Cetoniid beetle, *Thaumastopœus pullus*, on pp. 252 and 257, do not bear much resemblance to each other; and some of the diagrams are not so good, often imperfectly explained. The differences of neuration of the wings in the dipterous families, Trypetidæ (Fruit Flies) and Ortalidæ, are figured and described on pp. 632 and 635, but as the figures are without index letters the description is useless, except to the specialist, for whom the book is not intended. The opposite treatment is meted out to the diagrams of the lepidopterous wing on p. 400, where the figures are provided with abundant index letters and numbers without an explanatory description. The diagram of the Gryllid on Plate I. is very poor, and that of the Mantid on the same plate is confusing. All these are minor defects, easily remedied, which do not impair the value of the work.

Special prominence is given to the habits of insects in their bearing upon agriculture, and numerous references to other sources of information are scattered through the text. Such a work as this is badly wanted in Ceylon; but since many of the species, or closely allied forms, are found in Ceylon, Mr. Lefroy's book should satisfy the demand here meanwhile.

On p. 431 brief mention is made of the common Hesperid butterfly, *Suastus gremius*, Fabr., the caterpillar of which feeds upon palm leaves. It is equally the commonest skipper in Lucknow and in Colombo. In "Indian Museum Notes," Vol. I., 1889–1891, p. 10, L. de Nicéville published the first record of its earliest stages. He bred it repeatedly (often from the egg) in Calcutta, where it feeds on the date palm. After describing the egg and larva, he goes on to say that "the pupa is enclosed in a rolled-up leaf, the inside of which is lined with soft silk, out of which flies when opened a quantity of fine white waxy powder with which the pupa is thickly covered."

In their "Notes on the Larvæ and Pupæ of some of the Butterflies of the Bombay Presidency" (Journ. Bombay Nat. Hist. Soc., Vol. V., 1890, p. 370), J. Davidson and E. H. Aitken found the same species on the coconut palm. Their account differs in some details from that of De Nicéville. According to them, "the larva forms a tube-cell by joining the edges of a leaf, and never leaves it. The pupa is formed in the same shelter, which is first lined with silk and closed at the ends."

It seems clear that the above-named authors found nothing very much out of the common in the larval habits of *Suastus gremius*; and it is probable that they reared the larvæ in boxes on detached pieces of leaves, not observing them when left to themselves in the open; while Davidson and Aitken only concerned themselves with the latest stages.

The following notes upon the leaf-cutting caterpillar of *S. gremius* were collected on the verandah of my bungalow in Colombo, from July to September, 1908. For some time previously the eggs, larvæ, and pupæ of the clicker, *Elymnias fraterna*, had been kept under observation on pot-palms. This butterfly, when alighting upon the sprays of the fan-shaped leaves in search of a likely spot upon which to deposit a solitary egg, has the peculiarity of emitting a loud clicking sound, like that of certain grasshoppers (*Tryxalidæ*). The caterpillars were prevented from becoming a pest by the common babblers, who often broke the chain of observation.

On July 25 a new caterpillar appeared upon the same palms, not feeding openly as does the larva of *Elymnias*, but making a shelter for itself by folding over a portion of leaf and fastening it down with a web. In this way it lives, coming out half-way to eat. As it grows it makes larger shelters, sometimes on the same spray, sometimes on a different one. A single caterpillar will construct six successive shelters, the last one becoming the puparium.

When the young caterpillar has consumed the leaf-blade within reach of its shelter, leaving the latter with the caterpillar still inside suspended from the leaf by the midrib alone, it then forsakes its cover, crawls along the pendulous midrib to the main leaf, and, on reaching the latter, it turns round deliberately and bites through the midrib at the point where it joins the body of the leaf, whereupon the old shelter, or, as Davidson and Aitken call it, the tube-cell, falls to the ground.

The caterpillar next sets about testing the upper surface of the leaf, moving its head from side to side, and laying down a mat of webbing. It then commences the construction of a new house, biting through the leaf at a suitable distance from the apical end of the leaf-spray. Each biological moment is sharply expressed, the folding of the leaf-cover, the subsequent feeding and growth, the departure, the ascent of the midrib, the turning round, and the cutting of the cable. But although the chief events, which were repeatedly observed, are remarkably constant, there is considerable variation in detail, both as regards the order of procedure in the construction of a shelter and in the manner of feeding. Occasionally a caterpillar comes quite outside its house in order to feed upon a neighbouring spray for a short time, after which it returns home.

Fig. 1 is a composite outline showing a young caterpillar, 10 mm. long, with pale green body and orange-coloured head, engaged in the operation of discarding its second tube-shelter. It is seen beginning to leave the tube below, and again above, biting across the midrib. That this was its second shelter was inferred from other observations, the earliest tube not being noted in this instance. When first

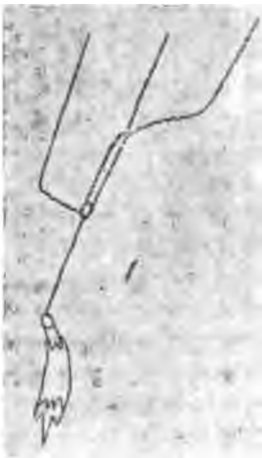
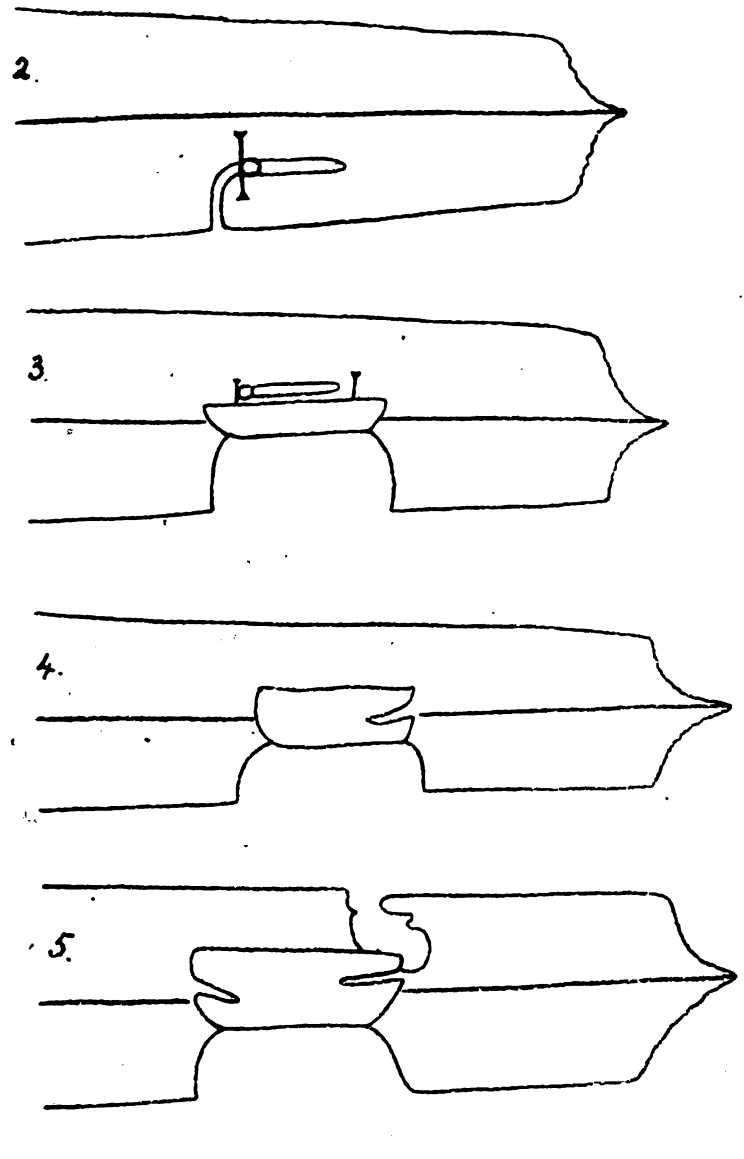


Fig. 1.—Diagram showing a caterpillar about to leave its tube-cell and ascend the bare midrib; and again on the leaf-blade, biting across the midrib.

hatched the larvæ are dark red in colour, retaining a red colour until leaving the first tube-shelter, which is very small and easily overlooked. A few minutes after ridding itself of its now useless shelter, the larva shown in Fig. 1 moved along the leaf-blade and began to lay the foundation of a new tube-cell by cutting across one-half of the blade of the spray at a distance of about 2½ inches from the original cut end.

The usual method of forming a shelter is shown in Figs. 2–5. In these figures the projection at the free end of the leaf-spray is not the true apex, but it is the point where the pedicle of the previous house was bitten off. At a distance of 2½ inches from this point a larva was seen making a curved incision across one-half of the spray, not quite reaching the midrib. It then spun a silken strand by repeated transverse movements of the head across the head of the bight, preparatory to curling the leaf. An hour later a second incision, one inch removed from the first, had been completed, a similar strand had been spun, and the portion of the leaf between the two cuts had been bent partially over. Each strand, fore and



Figs. 2–5.—Four stages in the formation of a tube-cell or shelter.

aft, is thickened by continual mouth-weaving; and at the same time each in its turn visibly shortens, so that the gradual folding of the roof of the shelter can be watched. After another hour the hinder angle of the roof was in contact with the opposed blade of the leaf, and the larva then cut out a notch at the front end (Fig. 4). This is the commencement of the fringing of the openings of the tube which usually takes place. Three hours later the folding was complete, the edge of the roof was sealed down upon the blade, a notch had been cut at the hinder border, and the larva had begun to feed from the front opening (Fig. 5). This was the third house in the life-cycle of this individual. On the same day another larva built a house also 1 inch long and 1½ inch from the cut end of the leaf. After bending over the cover, it began feeding from the opposite edge of the leaf before fringing the openings. After having fed, it resumed the work of shortening the trabeculæ to close down the edge of the roof. There is thus both method and variety in their manner of working.

The larva, to which figures 2–5 refer, remained in that shelter, feeding at intervals from both openings, for four days. Then, having exhausted the feeding-area within reach of its domicile, it left the latter and cut it off as described above. It then moved to another spray and commenced its fourth house, in which it remained for another period of four days; at the end of this time the tube-shelter, about 1¼ inch long, was suspended by a midrib-stalk 2 inches in length. The stalk had been partly broken, the two parts held together by webbing only. The caterpillar had to pass over this portion in order to get to the base of the stalk for the purpose of cutting it off. It then moved to another spray, where it made the usual floor of webbing, and began to draw the leaf-halves together without cutting, by weaving two strands, 1¼ inch apart, from one side to the other. The larva at the time of making its fifth house is nine-tenths of an inch long, colour a milky green with dark green dorsal line, dull whitish head and white-rimmed pygidium. A larger feeding-area is provided for, the front strand or silken beam of the house being laid down at a distance of 5½ inches from the leaf-end. It occupied the fifth house for twenty-four hours only, when it quitted the shelter and cut it off as before. It then made the sixth and last house, this time binding two sprays together. Two days later it had disappeared, but was subsequently found on the ground inside its tube; it was placed in a chatty with moist earth and leaves, and the butterfly emerged a fortnight later.

When the caterpillar has finished feeding and has achieved its full growth and is ready to pupate, it remains in the tube which is hanging suspended from the leaf by the bare midrib (Fig. 6). Eventually it bites through the fibre more or less flush with the basal end of the tube, the latter, with the larva inside, falling to the ground, leaving the suspending fibre attached to the leaf. The distal or hinder end of the last nest is fringed as usual, and the tassels are held together by webbing. The proximal or anterior end is plain, and it is from this end that the larva projects the forepart of its body, dragging its case along the ground after the manner of a caddis worm. When it has found a suitable hiding place under moss or leaves or loose earth, it seals up the front door and enters upon the resting stage. On opening one of these pupal cases at the split end, a dense white flocculent web, the strands of which crossed from one

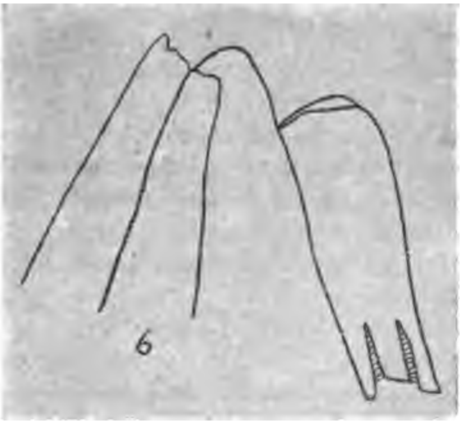


Fig. 6.—The last tube-cell, in which the larva will pupate, still suspended by bare midrib to the leaf-blade.

side to the other so as to conceal the animal, was exposed. Continuing the opening up of the puparium, the pupa was displayed with the head turned towards the split end and the body covered with a dusting of white powder, which also coated the inner surface of the puparium. The larval exuvia was lying at the bottom of the puparium covered with a dense white deposit.

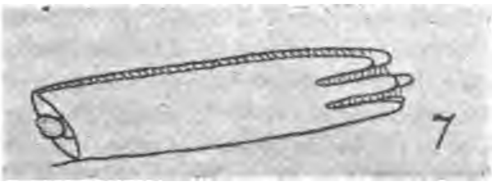


Fig. 7.—The last tube-cell has been bitten free and has fallen to the ground. The head of the larva is seen emerging from the open end to the left of the figure.

More free pupa cases were observed on the ground in November. In the following January a case was noticed where the larva pupated while still hanging on the frond of the palm. Both ends of the tube were sealed up, and everything was complete except for the biting off and liberation of the nest. This observation seems to point to a greater degree of variation of instinctive habits than is usually admitted. In all previous instances the final house was bitten off as described (Fig. 7). In the example figured a small tag of the fibre by which it was suspended to the leaf is seen at the mouth of the tube. The butterflies emerged fourteen or fifteen days after commencement of pupation and proved to be *S. gremius.*

A. WILLEY.

Colombo, 1909.

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2. *The Colombo Crow* (*Corvus splendens*)—*a case of the Survival of the Fittest.*—I have had occasion during six or seven years to study the habits of this bird in the immediate neighbourhood of my house, the Artillery Mess, and Military Hospital on the Galle Face. The birds here are somewhat isolated from their fellows, and live in a small community of their own, and I have no doubt, judging by one which has a tin ticket round its neck, live their lives in this small area and seldom or never venture out of it. The consequence is there is a struggle for existence, the food-supply which is limited being constant, but the bird population having a natural tendency to increase. It would seem that the birds themselves recognize this, and make some attempts to regulate matters in the following way. The normal number of eggs in a clutch is four, but I have never seen as many as three young crows off the nest, and very rarely two; the almost invariable number is one. So far I never found four youngsters in a nest, but only two, and of these two, one is invariably larger than the other to the extent of two-thirds, when they are quite blind and without the vestige of a feather. When the chick is half-fledged its dead brother or sister may be found in a mummified condition underneath it. This shows that it does not act like the young cuckoo by ejecting its fellows, but, either by being stronger at birth it manages to obtain the greater portion of the food brought to the nest, or else the parent birds deliberately feed the stronger at the expense of the weaker, in consequence of their difficulty in obtaining food. Whether this be the case I cannot satisfactorily determine, and further observations are needed. I am, however, inclined to the latter view, as we find in the case of other birds that the young are fed in rotation, and are, generally speaking, equally robust.

N. MANDERS,
Lieut.-Col., R.A.M.C.

Colombo, August 10, 1909.

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3. *Pugnacity of the Drongo.*—The drongos have earned for themselves the name of "King Crow" from their habit of pertinaciously attacking and driving off crows and other birds many times larger and more powerful than themselves. This habit is of very common observation; but I have to-day witnessed, for the first time, the

mobbing of a dog by these birds. My white fox-terrier was running about beneath a mango tree when a pair of drongos (the "Ceylonese white-bellied drongo," *Buchanga leucopygialis*, Blyth) dashed out and repeatedly swooped down upon the dog. They appeared to actually flick its head at each swoop. The dog seemed to think it a fine game, and tried to turn the tables by springing at the birds as they passed. The pugnacious little creatures followed their enemy for at least fifty yards beyond the tree, in which perhaps they have their nest.

E. ERNEST GREEN.

Peradeniya, April 13, 1909.

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4. *Arboreal Habit of the "Kabaragoya"* (*Varanus salvator*, Laur.).—In a recent number of *Spolia Zeylanica* a doubt is thrown upon the tree-climbing propensities of any but very young examples of this lizard. But some three years ago, a specimen measuring at least three feet long was captured in a jak tree outside my laboratory in the Peradeniya Gardens. It was seen to run up the tree, and was finally noosed by a string at the end of a long bamboo at a height of about twenty feet from the ground. This specimen was kept in captivity for a few weeks, during which time it fed upon frogs and young rats.

E. ERNEST GREEN.

Peradeniya, April 13, 1909.

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5. *Habits of Babblers.*—Some years ago on coming down to early tea one morning my appoo told me he had caught some young birds. They were in a crate in the verandah just outside the dining room, and I found them to be three common babblers (*Crateropus striatus*), and told the appoo to let them go. Whilst having early tea I noticed that three or four old birds were hopping about the verandah with food for the young ones.

About a fortnight ago I found two young babblers in a cinnamon bush close to my house; they were beginning to fly, and one was caught and killed by a cooly as I came up. I caught the other and had it placed in a cage at an open window and watched all day. Four grown birds were in attendance and fed it at intervals throughout the day. In the evening, after the crows had gone home, I put the bird back in its nest, but it had gone the next day.

I shall be interested to know if any of your readers have observed young babblers being fed by more than the actual parent birds.

In Legge's "Birds of Ceylon" you will find "Layard writes as follows of this bird: 'They are always seen in small parties, varying from three to seven according to the number of young ones in a nest, which seem to remain with their parents until the period of incubation again commences, when they separate to form families of their own.' "

This does not account for the feeding of the young by more than the parents.

In Hume's "Nests and Eggs of Indian Birds," in treating of *Malacocercus canorus* (Jungle Babbler), a bird presumably of similar habits to *Malacocercus striatus*,* and usually laying three eggs though four are frequently found, he writes :—

"The late Mr. A. Anderson remarked : 'Although one of the most common birds in the North-West Provinces, its nidification is interesting, inasmuch as its nest (in common with that of *Argya Malcolmii*) is used as a nursery for the young of *Hierococcyx varius* (hawk cuckoo) and *Coccystes melanoleucus* (crested cuckoo).

'On June 21 last a boy brought me a nest of this species containing eight eggs. Two, if not three, of this clutch are easily separable from the others and are unquestionably parasitical eggs.

'Again on July 9 I took a nest in person, which also contained eight eggs. Seven of these are all alike and are well incubated, while the eighth is quite fresh, and doubtless owes its parentage to one of the above-mentioned cuckoos.

'Strange to say, I have now another nest marked down, which in like manner contains the same number of callow young. It is just possible that the foster parents may have to perform double duty in this case.

'From the foregoing it may be inferred that *Malacocercus canorus* does occasionally lay more than four eggs, or, as the birds are gregarious even during the breeding season, it is possible that two birds may occasionally deposit eggs in the same nest.' "

The latter explanation may be the right one, as unfortunately in neither of the above cases mentioned by me can I say how many eggs there were originally in the nests, though at the time of their discovery there were three and two young ones respectively only.

March 29, 1909. V. A. JULIUS.

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6. *Figure of Kapila at Isurumuniya Vihara, Anuradhapura.*—On the right hand side of the Isurumuniya Vihara at Anuradhapura there is found on the face of the rock, cut in rather high relief, the figure of a man, seated in the *mahárája líla* posture (attitude of "kingly ease") and holding in one hand the halter of a horse, of which

* The Common Babbler of Ceylon was known for many years as *Malacocercus striatus* and the Jungle Babbler of Bengal was *Malacocercus canorus*. The British Museum Catalogue and the "Fauna of British India" now refer these species to the genus *Crateropus*, Swainson, 1831.

the head only is shown. The figure represents a man of grave and noble aspect, absorbed in thought, and apparently unconscious of the presence of the horse; the figures are so cut as to appear as if occupying the mouth of a cave or recess in the rock.

The sculpture belongs to the finest period of Indian art, being characterized by the abstraction of form, suppression of anatomical detail, and dignified grace which belong to the classic period of Indian art. It may be compared in these respects with the bronze figure of Avalokitesvara from Ceylon, figured by Mr. Havell in his "Indian Sculpture and Painting" (Pl. XI.), and by myself in an article on "Art and Yoga" in "Orpheus" for June, 1909, and in the J. R. A. S. for April of the same year. The date of the stone sculpture, like that of the small bronze, may be about the seventh century A.D. The object of the present note is to suggest an identification of the Isurumuniya sculpture. No satisfactory identification has I think been proposed.

There can, I think, be little doubt that the figure represents the sage Kapila. The story is given in the Balakanda of the Rámáyana. Briefly, it runs as follows :—

King Sagara of Ayodha had sons by his wives, one son by one and sixty thousand by the other. The gods were angered by their violent and unruly behaviour. Sagara engaged in a horse-sacrifice (Asva-medha). On the horse being stolen, he commanded his sixty thousand sons to search for it. Digging at last deep into the earth, they found it grazing beside the sage Kapila in Patála. Recognizing him to be the thief and destroyer of the sacrifice [acting as a matter of fact on behalf of the gods, with the object of destroying the sixty thousand], they rushed upon him with clubs and weapons, but are destroyed by his glance.

The necessity of water for their funeral rites afterwards led to the calling down of Gangá from heaven, by means of the penance of Bhagíratha, but with this part of the story we are not now concerned.

It is I think evident that the sculpture represents the sage Kapila, with the horse, in Patála (the nether regions of the earth).

A. K. COOMARASWAMY.

September 18, 1909.

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7. *A Sinhalese Game.*—There is a game in Ceylon identical with what Mr. Crooke in his "Natives of Northern India" (page 189) describes as the "Dom Crow" played by the Punjabi boys. "Each boy in turn," says Mr. Crooke, "is abused as the 'Dom' (scavenger), and he rushes away and mounts a pile of sticks or cow-dung fuel cakes, shouting out 'Raja above and Doms below,'

while the others try to drag him down. Whoever succeeds in maintaining his position wins." The Sinhalese boy similarly cries out—

Rajjuruvó uḍayi uḍayi.
Gúkolló bimayi bimayi.

ARTHUR A. PERERA.

Kandy, October, 1909.

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8. *Birth of a Loris.*—On August 16 I bought a Ceylon loris in Colombo, and she has been in a cage by herself ever since. On November 19 she gave birth to a young one. The young was born without hair, and holds tightly on to its mother's abdomen. When the mother is going about her cage, which is a big one and has branches in it, it is marvellous to see how she avoids touching the young one against anything, although she goes quite fast in the evening after insects.

S. H. PEARLESS.

Badulla, November 23, 1909.

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9. *Rambling Notes* :—

(*a*) **Sting of the Carpenter Bee.**—The common carpenter bee (*Xylocopa tenuiscapa*) is not an aggressive insect, though it is possessed of a very powerful sting for defensive purposes. I have experienced its stinging powers on two occasions. The first time, I was stung on the inside of the thumb. The point apparently penetrated a small vein, for a jet of blood followed the withdrawal of the sting. The pain was severe for a short time, but it soon became dull, and passed off altogether in a few minutes' time. On the second occasion, the sting took effect on the back of a middle finger, and there was no effusion of blood. The pain, as before, was severe at first, but lasted for a short time only.

(*b*) **Action of Cobra Venom on its own Body.**—While a large cobra was being caged, and the removal of a noose (that had been tied round its neck) was being attempted, the snake became so enraged that it lashed out wildly in every direction, and finally buried its fangs in a coil of its own body. The wounds of the fangs were plainly visible and exuded two minute drops of blood. The snake soon became very subdued and lay quietly in its cage, refusing to respond to any attempts to rouse it. But on the following morning it had completely recovered and was as lively as ever.

(*c*) **Habits of Grasshoppers of the Genus Gryllacris.**—The weird-looking long-horned grasshoppers of the genus *Gryllacris* construct temporary shelters for themselves by biting a long curved slit in a leaf and folding back the included area, the edges being fastened down by mucus secreted from the mouth of the insect. The insect rests under this shelter and sallies forth in search of its prey, which consists of other insects smaller than itself. These grasshoppers often fly into bungalows, attracted by the lights, and then set to work to construct shelters of any material that comes handy. I have seen a semicircular piece cut in a lace curtain and folded back to cover the body of the insect. I have recently received a piece of office paper treated in the same way. In this case the operator was *Gryllacris æqualis*. The cut was made as neatly as if executed with a pair of scissors, and takes the form of a double curve with a backward loop at the inner extremity. The excised area measures three and a half by one and a half inches. This insect, in captivity, fed freely upon spiders, crickets, and small moths.

(*d*) **The Cockroach as a Predatory Insect.**—The list of the natural enemies of termites (in the winged stage) is already a long one; but I have now to add the cockroach to the number. Whilst watching a flight of white ants fluttering against the outside of my window, my attention was attracted by one that appeared to be in difficulties. On looking closer, I saw that it was in the grasp of a large cockroach (*Blatta australasiæ*), which had commenced to feed upon it. The cockroach was holding down the struggling termite with its front legs.

(*e*) **The Hairs of Caterpillars a protection against Ants.**—I have often wondered how any insect could exist on a bush infested by the ferocious red ant (*Œcophylla smaragdina*). Yet it is a common occurrence to find the leaves of such bushes attacked by caterpillars of various kinds. The small hairy larva of a Lithosiid moth was observed on a leaf adjacent to the nest of these red ants. To see in what manner it protected itself, the caterpillar was dropped into the middle of a horde of the ants that had emerged from their nest on the disturbance of the bush, and were drawn up ready to attack any intruder. They rushed at the apparently defenceless caterpillar, but were met by a "cheval de frise" of projecting hairs. The caterpillar, meanwhile, calmly commenced to walk through the angry crowd. One or two more intelligent ants each seized a hair; but, without interrupting the even tenour of its course, the caterpillar shed the captured hairs and finally walked out of the baffled crowd.

(*f*) **Insect Fauna of Sigiriya Rock.**—The Sigiri rock rises out of the plains to a height of about 1,150 feet. The sides of the rock are so sheer that an elaborate system of iron ladders and railings has been erected to enable the visitors to reach the summit, where are the remains of the famous native fortress. The ground at the top is more or less covered with coarse grass, which affords a home to innumerable Acridian grasshoppers. Many dragon flies were observed, and a single butterfly (*Eulepis athamas*) was circling round a small bush growing out of the stones of the trigonometrical station.

But the principal entomological interest was centred in the ancient reservoir, which was still watertight and contained a fair-sized poo surrounded by mud and sand. Hundreds of small red and black Staphylinid beetles (of a species that appears to be common all over the Island) were running over the mud. I captured two species of Tettrigid grasshoppers (*Scelimena logani* and *Euparatettix personatus*). The former is truly aquatic, having the hind legs flattened and flanged for swimming. Both the larvæ and the adult insects rest on the margin and dive into the water when disturbed. Another abundant insect on the water's edge was a small shining black cricket (*Tridactyla nigræneus*). Mr. R. C. Punnett, who visited the place a few days later, brought back specimens of a mole-cricket that were found in the mud, actually under water. The time at my disposal was too short to permit of an exhaustive investigation of the fauna of this pool. The insects captured were, none of them, rare or peculiar; but it was interesting to find this small isolated pool on the summit of a barren rock so fully populated.

E. ERNEST GREEN.

Royal Botanic Gardens,
Peradeniya, November 8, 1909.

9.3

SPOLIA ZEYLANICA.

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A DESCRIPTIVE NOTE ON THE CAPTURE OF A LARGE SAW-FISH (PRISTIS CUSPIDATUS) CONTAINING INTRA-UTERINE EMBRYOS.

By T. Southwell, A.R.C.Sc. (Lond.), F.L.S.,
Scientific Adviser to the Ceylon Company of Pearl Fishers, Ltd., and Inspector of Pearl Banks.

DURING trawling operations which were being conducted by the ss. " Violet " at the mouth of Portugal Bay (Ceylon Pearl Banks) on December 15, 1909, a large specimen of this fish (*Pristis cuspidatus*) was caught. It was a female measuring 15½ feet, extreme length. The rostrum (or saw) measured 4½ feet, and the breadth across the pectoral fins was 5¼ feet. The weight was approximately 170 lb. The interest attached to this capture lies purely in the fact that it contained 23 embryos, which will be referred to later.

A small male was also captured at the same time, having an extreme length of 6¾ feet and a breadth of 1½ feet.

Both these specimens occurred on mud in 4 fathoms. Two years ago a specimen was trawled by the " Violet " off the east coast of Ceylon, but not being present I have no details, save that it measured " just over 18 feet."

The flesh of this species is dried and salted, and is considered excellent by the Tamil fishermen, whilst the fins are a delicacy of some rarity. The Tamil name is " Veila, " and refers to the rostrum or saw.

Day ("Fauna of British India, Fishes," vol. I., 1889) refers as follows to the family :—

" Snout much produced, flattened, and having a saw-like appearance, due to the existence of large teeth on its lateral edges. Trunk passing gradually into the tail.

" The endoskeleton of a tooth of the saw of one of these fishes consists of from three to five hollow tubes tapering towards their extremity, and covered with an osseous deposit, which is perforated with fine holes. The teeth vary both in size and number in the same species, rendering them unsuitable as specific, but admissible as individual distinctions.

" Great injuries can be inflicted by these fishes, which strike sideways with their formidable snouts ; and although not personally a witness to the fact, I have been informed on native authority that large ones have been known to cut a bather completely in two.

The largest sample I saw was off the coast of Sind (*Pristis zysron*); it measured over 16 feet, the rostrum being 4 feet 2 inches in length. A *Pristis cuspidatus*, 14 feet long, captured at Calicut, was found to have a liver weighing 185 lb., which was taken to the oil factory when I was present.

"At Gawadur, on the Mekran coast, I found that the fishermen of all religions presented the saw of these fishes at a small temple, where they were hung up inside or piled round the outside. The priest was expected to pray for success for the fishermen in their takes and a safe return to shore. At the Andaman Islands the aborigines, wishing to make a suitable offering to their superintendent, attacked an enormous saw-fish, which they harpooned, and eventually secured at the risk of their lives. They presented him with the rostrum, which I now possess.

"*Geographical Distribution.*—Seas of tropical and temperate regions."

Our female specimen struggled violently on deck, at intermittent periods, for over a quarter of an hour. The exhibition clearly indicated the serious nature of the danger of which these fish are capable.

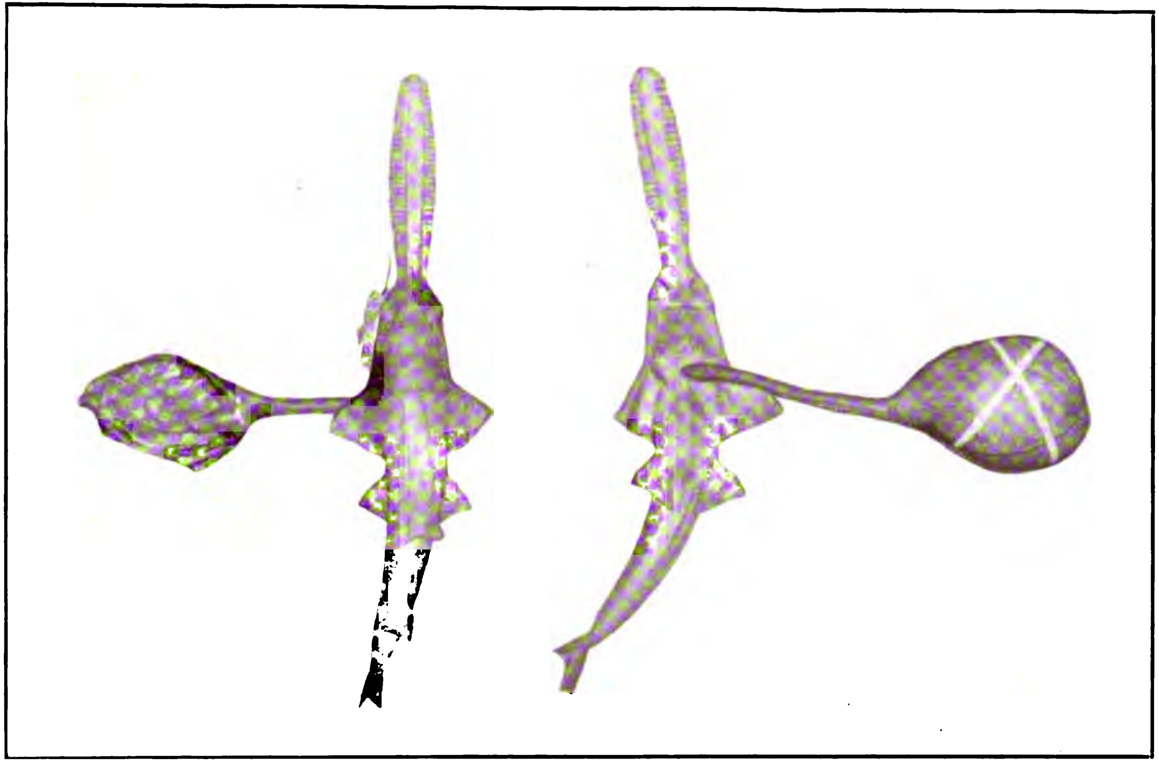
The small male presented no outstanding features. The stomach, however, contained a few small fish; the spiral valve was full of a stringy green muddy slime, and contained over 136 specimens of cestodes, all belonging to the same species, which I am describing elsewhere as a new species of *Cephalobothrium* (*C. variabile*).

Other cestodes present remain unidentified, and are possibly new. The length of the rostrum was 1¼ feet, and 1½ inches broad. The teeth numbered 22 on the right side and 25 on the left. It is curious to note that the proximal 17 teeth on each side were in pairs, whilst the distal remaining ones were irregular. Three teeth were broken, and the teeth varied greatly in size.

In the female, to which we must refer in particular, the stomach contained one rather large Sepia sp. newly ingested and three small fish measuring 5½ inches. The intestine contained green fibrous slime and fish débris, but no cestodes. Except the distal 4 pairs, the teeth on the rostrum were strikingly and accurately alternate, except a single proximal one on the left side. The teeth numbered 27 on the left and 25 on the right. Five teeth were broken, and 4 showed distinct signs of repair.

The internal wall of the stomach presented coarse longitudinal folds. The folds of the spiral valve were fairly closely approximated. Immediately on capture a discharge occurred from the cloaca, consisting of a serous fluid tinged with blood, and two embryos were noted protruding, rostrum presenting.

On internal examination the ovaries were found to be long and narrow, the left one small. Both oviducts (Müllerian ducts) were distended, equal in size, and measured 17 inches long by 15½ inches



Saw-fish embryos, seen from above and below, with the yolk-sac attached to the body by a long stalk.
(The shred near the left eye of the left figure is a flaw in the block.)

in circumference. They lay ventral in the abdominal cavity, and were connected together ventrally by a thin delicate serous membrane, which was united to the body wall dorsally. Their external walls were highly vascular, whilst the internal walls presented the appearance usual amongst viviparous Selachians.

The oviducts were united at the cloaca to form a wide infundibular opening. The left oviduct contained 12 embryos, the right one 11. Of the 23 embryos, 9 were males and 14 females. Having no information to hand as to the period of gestation, I give the following particulars.

The embryos all lay horizontally, *i.e.*, parallel to the axis of the parent. There still remained a small quantity of a serous fluid in the oviduct, the bulk of which had probably been lost prior to examination, as previously noted. Some embryos lay with the rostrum close to the cloacal opening, whilst others were exactly opposite. The embryos themselves measured in extreme length 14 inches; breadth across pectoral fins 4½ inches; length of rostrum 5 inches; length of placental stalk 5 inches; diameter of yolk-sac 2¾ inches; the stalk of the yolk-sac was whitish gray, increasing slightly in diameter as it approached the sac, the greatest diameter being ¾ inch, the average ½ inch. The sac itself was exactly similar in colour to the yolk of a hen's egg.

The blood vessels all ran parallel to the direction of the stalk. The presence of the substance of the yolk-sac was noted right up to the origin.

With reference to the rostrum, the dentition, whilst apparent, was obscured by being entirely covered by a transparent cartilaginous tissue, which of necessity must disappear later. Even in the fœtus the teeth are irregular in number, and vary between an alternate arrangement and a distribution in pairs. The number present in the 23 embryos varied from 23 to 28 on both sides, and the distribution in pairs from 5 to 26.

All apertures were open to the exterior. A line of mucoid pits were well defined on each external side of the gills, running to the eye and terminating at the origin of the pectoral fin.

The eyes were protruding. Two well-defined but minute pits, approximated, occurred dorsally, opposite to the posterior limit of the orbit, otherwise the embryos presented no outstanding features.

NOTES ON CEYLONESE TETRIGINÆ (ORTHOPTERA), WITH DESCRIPTIONS OF SOME NEW SPECIES.

By JOSEPH LANE HANCOCK, M.D., F.E.S.

(With two Figures.)

THROUGH the generosity of Mr. Thomas Bainbrigge Fletcher, R.N., I am enabled to present herewith some descriptive notes on Ceylonese Tetriginæ.* While Mr. Fletcher was in Ceylon during the years 1908–1909, he made a collection of these small insects, comprising 289 specimens, which he kindly sent to me for study. I find in this series of examples are represented ten genera and sixteen species, one of the former and two of the latter being new to science. These are described in the enumeration of species in the sequence. I have been privileged to use in this connection Mr. Fletcher's field notes, which add material value to the subject.† The life of the Tettigids‡ seems to be greatly dependent upon the climatic conditions in Ceylon. In reviewing these conditions we find "In August, 1908, everything was very dry at Madulsima, there having been practically no rain at all since April. The monsoon rains commence about October, and from this time to December is a very wet period. It is noticeable how few Tettigids are now visible (December 21, 1908), as compared with four months ago. This is probably due to the rain, which has enabled them to scatter much further afield in quest of food, whereas in August they were confined to a very few spots which still retained a little moisture, and possibly also this (December) is their breeding season, and the young individuals are still minute and inconspicuous." In August it was found that "A small pool by the pathside, fed by a pipe, made a moist spot, very attractive to small Tettigids, which appeared to have congregated here from all the more arid situations around it." In this assemblage I determined three species, namely: *Euparatettix variegatus*, *Systolederus greeni*, and *Criotettix tricarinatus*. Moreover, in August, Mr. Fletcher says: "The Tettigids seemed rather lethargic, and are perhaps in a state of partial æstivation." This supposition was based on the fact

* In a former number of *Spolia Zeylanica*, vol. II., pp. 97–157, 1904, I have given an account of the Tetriginæ of Ceylon, which is frequently referred to in the present paper.

† The localities in which Tetriginæ were observed include the following: Madulsima, Province of Uva; Haputale, 4,800 feet; Labugama, Western Province, about 150 feet; Maskeliya, Central Province, about 4,000 feet; Weligama, Southern Province; Dondra; Taldena, Province of Uva, 1,100 feet; Colombo; Galle; Polgahawela, 250 feet; and Hambantota, South-East Ceylon.

‡ [Tetriginæ and Tettigidæ are here used as alternative terms.]

that the whole country was in a state of drought, and also from the fact that he found certain Tettigids (which I determined to be *Systolederus anomalus*) burrowing under dry moss on a rock.

The behaviour of Tettigids under changing climatic conditions, such as moisture and dryness, is one of great importance from the evolution standpoint, and further data are needed. The segregation of certain species under one condition of dryness, and their dispersal under another condition of moisture, forms a theme worthy of further study, if nothing more were gained than the light it might throw on the subject of isolation and natural selection in this group.

Scelimena gavialis, Saussure.

Ann. Soc. Entom., France, p. 485, 1860. Figured by Hancock in *Spolia Zeylanica*, vol. II., Plate I., figs. 4–4c.

This is one of the most interesting aquatic species found in Ceylon. Its hind tibiæ are modified into perfect paddles for swimming. This species is often found on dark coloured rocks projecting above the water in the streams, and readily jumps into the water when disturbed. It frequently submerges its body completely, and clings to the stones on the bottom. But finally, when the supposed danger has passed, it crawls up again on to the rocks. Mr. Fletcher's first captures of this species were at Haputale (4,800 feet) in the Province of Uva on September 18, 1907, under which date he writes: "The first specimen taken was found in the net when catching Notonectids in a small stream; the second was seen swimming under water against the current with its wings closed; it settled on a stone under water, and looked not unlike a dragon fly larva. Subsequently about a dozen were taken sitting on rocks near little cascades. They seemed to be gregarious and inclined to be social, for they occurred in little groups of about half a dozen specimens in a space of a few yards, and on several occasions two specimens were seen sitting side by side on a rock; in at least two instances these proved to be male and female. In spite of the vivid red edging to the thorax, this species is not at all conspicuous on the dark rocks on which it rests." Under date December 19, 1907, Mr. Fletcher notes two examples taken along a stream on Cocogalla estate (4,000 feet) in the Madulsima district: "These two, apparently male and female, were at rest on the same rock, but two or three inches apart. They usually seem to go in pairs, male and female, but I have not seen them *in cop.*" Mr. Fletcher also says: "At Madulsima, May 13, 1908, a small rocky-bedded stream contained some immature *Metrocoris stali*, and on the rocks were numerous examples of *Scelimena gavialis*. As usual, these were generally sitting on the rocks in pairs, close to one another, near the surface of the water, but I saw none in copulation. On being disturbed they jumped into the water and clung to the stones on the bottom, crawling up again on to the rocks out of the water when the threatened danger had passed. I saw one use its wings to escape when hard pressed, but this is unusual." In viewing these insects on the rocks in a small hillside stream at Madulsima, May 16, 1908, he observes: "The coloration of *Gavialidium crocodilus* is eminently procryptic, as it is also in the case of *Scelimena*, but the latter rests on the dark rocks, and usually just above the surface of the water." On May 19 he found this species was common in the bed of a stream on the Roeberry estate (about 4,000 feet elevation). Here their behaviour was similar to that noted above. They were found sitting locally on the rocks just out of the water in little colonies. "When pressed they sometimes take to wing and fly out of reach, but more frequently dive into the water and crawl up again when the danger is presumably over." Again, under date of May 26, he says: "In the morning I followed up the rocky bed of a small stream and took a large number of *S. gavialis* and a few (mostly immature) *Gavialidium*." Later on in the season at Madulsima, August 13, this species was found common at the waterfall. They were closely grouped together just above the water's edge. A male was found clasping a female, but not in copulation. Two individuals had just completed an ecdysis and were quite soft; the cast skins remained beside them. In making comparison of the behaviour of *Gavialidium crocodilus* and *Scelimena gavialis*, Mr. Fletcher found at Madulsima, August 16, that "the former species occurs usually in little colonies, on damp rocks near water, and is very sluggish, rarely jumping and never taking to wing. *S. gavialis*, on the contrary, often takes to wing when disturbed, or very frequently dives into the water, above the edge of which it is usually found. *G. crocodilus* is not generally found in such close proximity to the running water itself. Still later in the season, on January 13, this species was found at Madulsima. "Along the banks of a small stream it was fairly common, and flew actively in the hot sunshine; one example on being disturbed deliberately flew into the water and dived to the bottom. In one case two quite immature individuals were found on a rock on either side of an adult and almost touching it." Again we are reminded of the difference in the behaviour of *G. crocodilus* and the species under consideration by the following observations. At Madulsima, January 17, 1909: "A specimen of *G. crocodilus* was taken on a rock beside a small stream; as usual, it was very sluggish, and readily allowed itself to be captured in my fingers. Very different is the behaviour of *S. gavialis*, an example of which was also on a rock close to *G. crocodilus*; when approached with the hand, the *Scelimena* jumped off smartly and took to wing." Under date of January 28, he further says: "At Labugama is a large artificial reservoir, which supplies Colombo with water; this reservoir is surrounded by low hills, which are reserved forest—that is, no buildings whatever are permitted. In one part of the reservoir a small stream trickles down over the face of a rock and makes a small waterfall. Here *S. gavialis* was common in all stages on the damp rocks, taking wing fairly readily. I had always looked on this species as a representative of the montane region, but Labugama is at an elevation of only about 150 feet." Ninety-one specimens in all were taken by Mr. Fletcher in the following localities: Madulsima, Haputale, Labugama, and Maskeliya. It has previously been reported from Dambulla, Peradeniya, Pundaluoya, and Kandy.

Scelimena logani, Hancock.

Spolia Zeylanica, vol. II., pp. 120–122, Plate I., figs. 5–5*c*, 1904.

Like the preceding, this species is also aquatic, often diving in the water, and living on rocks in streams. But one example was taken at Madulsima, May 16, 1908, by Mr. Fletcher, who says: "In the evening I went over to Roeberry estate, worked a little way down the bed of the stream there, and took a few specimens of *Scelimena gavialis*, and among them two examples which appear to be *logani*. Nothing special was noticed about the habits of these latter." I find only one specimen of *logani* in the collection forwarded to me bearing this date on the label. This species has previously been recorded from Kandy, Haragama, and Kalawewa. *S. logani* is easily distinguished from *gavialis* by the presence of an additional small tubercle situated on each side of the lateral lobes before the spines, by the several distinct spines arming the lower border of the posterior femora, and also by the yellowish colour of spines and thin edging of the same colour on the pronotum. In *gavialis* this colouring is replaced usually by vermilion red, instead of yellowish, as in *logani*.

Gavialidium crocodilus, Saussure.

Ann. Soc. Entom., France, p. 485, 1860. Figured by Hancock in *Spolia Zeylanica*, vol. II., Plate II., figs. 4–4*c*, 1904.

This is a singular species, having more sluggish habits than *Scelimena*, and often living on grayish coloured rocks. It is not aquatic, though sometimes individuals associate in small groups not far from the water. The hind tibiæ are not modified in the form of paddles in this species. At Madulsima, May 16, 1908, Mr. Fletcher found two examples along a small hillside stream; both were on dusty gray rocks, not immediately near the water, and they were very difficult to distinguish. In the previous notes under *Scelimena gavialis* is mentioned the eminently procryptic coloration of both *S. gavialis* and *G. crocodilus*, which need not be repeated in detail here. On May 20, along the lower road at the waterfall, a few specimens were taken in all stages. Again on the 26th the rocky bed of a small stream yielded a few, mostly immature, individuals. Later on in the season, at Madulsima, August 12, it is mentioned as occurring "on damp rocks near a small stream, now nearly dry, a male and female were associated, the male clasping the female, but not actually in copulation." On August 13: "At the waterfall *G. crocodilus* and *S. gavialis* were common, each in little patches on certain rocks, the former scattered and some little distance from the water, the latter closely grouped together just above the water's edge. A male *crocodilus* was found clasping a female, but not in copulation." This species is again recorded in the notes as occurring at Madulsima, August 16, "usually in little colonies, on damp rocks near water, and is very sluggish, rarely jumping, and never taking to wing." Later in the year, on January 17, 1909, it was again observed; see note of this date under *S. gavialis*. It was taken at 3,500 feet elevation at Madulsima, on December 8, 1908, "on a rock near a stream," and on the 21st "a single example was found on a dead stump near a stream. As usual, it was very sluggish, and allowed itself to be caught in the fingers." Forty specimens were taken by Mr. Fletcher at Madulsima and Haputale. This species has also been previously recorded from Pundaluoya and Kadugannawa.

Criotettix tricarinatus, Bolivar.

Ann. Soc. Entom. Belgique, XXXI., p. 224, 1887. Figured by Hancock in *Spolia Zeylanica*, vol. II., Plate III., figs. 15–15*b*, 1904.

A small graceful species having an acute spine on each side arming the lateral lobes of pronotum. It frequents the banks of streams and grassy lands.

At Madulsima, May 13, 1908, it was taken by Mr. Fletcher in a damp place along a path. On May 20, at the waterfall, a number were taken seemingly in company with *Systolederus greeni*. Later both of these species were again observed on August 12 on damp rocks near a small stream, now nearly dry. The following day it was found congregated about a small pool by the pathside, this moist spot offering an attraction to several small Tettigids. Still later, on August 16, it was found "common in damp places. It is rather sluggish as a rule, but active when disturbed. In life some of these insects showed a light patch surrounding basally the sharp lateral spine." A few individuals were taken, December 10, at rest on an old damp log lying across the path at Arawa, about 900 feet elevation, in a damp hollow amongst secondary jungle. Two days later a couple more of this species were found on the same log. One of these insects is extensively suffused with pale coloration on the dorsum of the pronotum. Sixty-four specimens are represented in the collection taken at Madulsima and Weligama, and one of these was taken at Polgahawela. It has previously been recorded from Peradeniya, Pundaluoya, Kandy, and Kadugannawa. It has also been recorded from Southern India by Bolivar.

Criotettix spinilobus, Hancock.

Spolia Zeylanica, vol. II., p. 129, Plate III, figs. 12–12*b*, 1904.

Resembling the preceding species, but slightly smaller, the vertex of head little wider and the pronotum above lightly tuberculate. It lives on swampy ground. But one specimen was taken by Mr. Fletcher at Maskeliya, March 10, 1909. It has heretofore been recorded from Pundaluoya.

Acanthalobus miliarius, Bolivar.

Ann. Soc. Entom. Belgique, XXXI., p. 226, 1887. Figured by Hancock in *Spolia Zeylanica*, Plate II., figs. 8–8*a*, 1904.

This species is larger than *Criotettix;* the spine arming the lateral lobe on each side of the body is directed obliquely backward, and the vertex is broader between the eyes. It lives in rice fields and along the banks of streams. Two examples were taken: one at Colombo, October, 1907; the other came to light at Galle, November 11, 1907. It has previously been reported from Peradeniya, Kandy, and Pundaluoya.

Loxilobus rugosus, Hancock.

Spolia Zeylanica, vol. II., p. 135, Plate III., figs. 17–17*b*, 1904.

A small short-wing species without lateral thoracic spines. It lives on grass lands and on swampy ground. One example was taken by Mr. Fletcher at Weligama, January 16, 1908. It has heretofore been recorded from Pundaluoya.

Systolederus greeni, Bolivar.

Ann. Soc. Entom., France, LXX., p. 584, 1902. Figured by Hancock in *Spolia Zeylanica*, vol. II., Plate II., figs. 9–9*b*, 1904.

A species readily recognized by the elevated closely proximated eyes, which are also strongly globose in profile view. It often frequents hot dry rocks away from the water, and is very active on the wing. At Madulsima, May 13, 1908, Mr. Fletcher writes that a small rocky-bedded stream contained a number of these insects, "which skipped nimbly over the rocks well clear of the water." Three days later, on May 16, he found on visiting a small hillside stream a number of these insects, which occurred commonly on the bare surfaces of the dark rocks in the sunshine. Again, on May 20, he mentions: "In the forenoon went along the lower road out to the waterfall and took a number of small Tettigids." I have identified these insects as *Systolederus greeni* and *Criotettix tricarinatus*. Later on in the season, August 12, this species occurred on damp rocks near a small stream, now nearly dry; here it was again found in company with the above species at a small pool by the pathside. Again, referring to this species, on August 16, he says: "In the morning went a short distance along the lower road and took a few

Tettigids. The commonest is a small dark species without any sharp lateral spine on the pronotum; it is very active, both when running over the bare rocks in the sunshine and when on the wing."

Fifty-two examples were taken by Mr. Fletcher in all. Most of these were from Madulsima, but a few of the specimens bear labels signifying they are from Maskeliya and Haputale. It has previously been recorded from Kadugannawa, Pundaluoya, and from Kodaikanal, Southern India.

Systolederus anomalus, sp. nov.

Head only very little exserted, body rugose punctate and sparingly tuberculate. Vertex narrow, nearly half the width of one of the globose eyes, tricarinate anteriorly, in profile not advanced beyond the eyes; facial frontal costa somewhat narrowly compressed, between the antennæ arcuately elevated; eyes somewhat prominent, but much less so than in other species, little elevated above the dorsum; antennæ inserted scarcely in advance of the anterior lower angle of the eyes. Pronotum anteriorly truncate and advanced nearly to the eyes but not touching them, a small portion of the occiput being left uncovered; dorsum rugose punctate, tuberculate, and deplanate; median carina irregularly undulate; humeral angles lightly carinate, posterior process cuneate, not or nearly reaching to the apices of posterior femora; lateral lobes distinctly obliquely ampliate, explanate at the inferior borders, posterior angles outwardly produced, being acute angulate but not spined, behind widely obliquely truncate; superior elytral sinus arcuately excavate and very shallow or almost wanting; elytra narrow, minute, and elliptical. Wings small, not reaching to end of pronotal process, anterior and middle femora entire, slightly compressed, elongate; posterior femora rather stout, the apical and anteapical genicular lobes small and acute; first and third articles of posterior tarsi equal in length, the three pulvilli of the first article nearly equal in length. Colour of body dark fusco-variegated.

Length of body, female (to end of ovipositor) 9·5 mm.; pronotum 9 mm.; post. fem. 5·5 mm.; male 7 mm.; pronotum 7·8 mm.; post. fem. 5 mm.

Three of these curious Tettigids, comprising one female and two males, were found by Mr. Fletcher at Madulsima, August 12, 1908. In noting their capture he says: "A short walk in the morning yielded three specimens of Tettigids, found burrowing under quite dry moss on a rock by the pathside."

Genus *Spadotettix*, nov.

Related to *Tetrix*. Face strongly oblique. Viewed from above the crown of head oblong; the vertex wider than one of the eyes, strongly produced beyond the eyes, bearing a very distinct projecting median carina, viewed in profile angulate produced forward before the eyes (in the type species a distance scarcely equal to two-thirds the length of one of the eyes). Pronotum anteriorly truncate, advanced forward coming in contact with the eyes; lateral lobes having the posterior angles slightly reflexed outwards, obtuse and obliquely truncate behind. The superior elytral sinus of lateral lobes, the elytra and wings absent.

This genus is represented by one diminutive apterous species, the type being *Spadotettix fletcheri* described herewith.

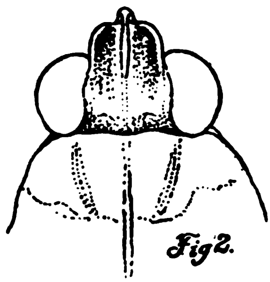


Fig. 1.—*Spadotettix fletcheri*, sp. nov. Profile view of the head and part of pronotum.

Fig. 2.—Dorsal aspect of the same.

Spadotettix fletcheri, sp. nov.

Body small, apterous, coloured dark testaceous infuscated. Head not exserted, vertex viewed from above oblong, wider than one of the eyes, widened backwards between them and strongly produced forward beyond them a distance of about half their length; the crown bearing a distinct median carina, which projects forward as a prominent tooth from the middle of the rounded-truncate border; on either side of median carina longitudinally canaliculate; the anterior marginal carinulæ flexed backward laterally running parallel to the front border of the eyes; in profile view the vertex strongly acute angulate produced a distance nearly equal to two-thirds the length of one of the eyes; face distinctly oblique, the facial frontal costa slightly excavate opposite the eyes, the rami somewhat widely sulcate, and barely compresso-elevated between the antennæ; eyes moderately small; posterior ocelli situated in advance of the middle of the eyes; antennæ slender and filiform, consisting of thirteen to fourteen articles, inserted opposite the anterior lower angle of the eyes. Pronotum granulate subscabrous, moderately widened between the shoulders; dorsum subtectiform forward depressed subfossulate behind the shoulders; median carina biundulate, distinctly compresso-elevated in front of the shoulders; humeral angles widely obtuse angulate and carinate; the front border truncate advanced to the eyes, posteriorly cuneiform and the process abbreviate, not reaching to the end of posterior femora, the lateral margins of process bicarinate; the short prozonal carinæ forward distinct and convergent backward; between the shoulders the dorsum bearing two abbreviated supernumerary carinulæ, posterior angles of the lateral lobes reflexed outwards, obtuse yet obliquely truncate behind; elytral sinus at the sides, the elytra and wings absent. Anterior and middle femora compressed, the lower margin of middle femora triundulate bearing a small median lobe; posterior tibiæ black annulate with light yellowish behind the knee, carinæ armed with spines and serrulate; first articles of posterior tarsi somewhat longer than the third, the first and second pulvilli acute, the third more flattened below.

Entire length of body, female, 8 mm.; pronotum 6·5 mm.; posterior femora 4 mm. Two examples were taken at Madulsima, December 8, 1908, "on mossy rocks about 3,500 feet elevation."

I take pleasure in dedicating this interesting species in honour of Mr. Fletcher.

Lamellitettix pluricarinatus, Hancock.

Trans. Entom. Soc., London, Dec., 1908, p. 404.

This slender species was originally described from a single female example taken at Deltota, the type being now in the Oxford University Museum. The dimensions of the present male specimen (taken at Maskeliya on the surfaces of rocks along a stream, March 10, 1909) are as follows:—

Entire length of body 12·8 mm.; pronotum 11·5 mm.; posterior femora 4·5 mm.

Euparatettix variegatus, Bolivar.

Paratettix variegatus, Bolivar. Ann. Soc. Entom., Belgique, XXXI., p. 278, 1887.

This species is represented by two female examples, which were taken at Madulsima, August 13, 1908. At the time Mr. Fletcher found this species in association with *Systolederus greeni* and *Criotettix tricarinatus* at the border of a pool.

Euparatettix personatus, Bolivar.

Paratettix personatus, Bolivar. Ann. Soc. Entom., Belgique, XXXI., p. 278, 1887. Figured by Hancock in *Spolia Zeylanica*, vol. II., Plate II., figs. 10–10*b*, and Plate III., 1904.

A series of fifteen specimens was taken at Hambantota. In referring to them (on November 28) Mr. Fletcher says: "Several Tettigids were taken along the edges of a pond, seeming to occur specially in places where there was a scanty fringe of grass. They were active and were well concealed when at rest on the brown mud. One specimen had a pure white patch on the thorax, but this has faded after death; it had rather the appearance of a splash of bird lime." The next day this species was again noted here along the margins of the pond, one specimen being very broadly suffused with white above. "This specimen is much more suffused than that one taken yesterday, and I doubt whether either is more than a colour variety." This species has previously been recorded from Colombo, Kesbewa, and Peradeniya.

Euparatettix pilosus, Hancock.

Trans. Entom. Soc., London, pp. 409–410, Part III., Dec., 1908.

Two examples were obtained along the edge of a wet ditch at Weligama, January 21, 1908. It has not heretofore been recorded from Ceylon, the type specimens being described from Indian examples taken at Mysore.

Hedotettix gracilis, de Haan.

Bijdr. Kenn. der Orthopt., p. 169, 1842. Figured by Hancock in *Spolia Zeylanica*, vol. II., Plate III., figs. 19–19*a*, 1904.

Also *H. gracilis abortus*, Hancock.

Spolia Zeylanica, vol. II., p. 151, 1904.

Thirteen specimens, two of the form *gracilis* and the remainder *abortus*, were taken at Weligama, January 2, 1908, along the edge of a wet ditch. This species has previously been recorded from Colombo, Dambulla, and Kandy. It frequents rice fields and grass lands.

THE PLUME-MOTHS OF CEYLON.

Part II.—The Orneodidæ.

By T. Bainbrigge Fletcher, R.N., F.E.S., F.Z.S.

(With 2 Plates and 8 Figures.)

Introductory.

The Orneodidæ, easily recognized and sufficiently characterized by the fact that both wings are cleft into six or more segments, each ciliated on both sides, form an isolated group of Lepidoptera, few in numbers and usually small in size, which may be considered as nearly allied to the Pyralidæ with some affinities to the Tineidæ. The point to be borne in mind is that the Orneodidæ and Pterophoridæ, although both popularly included under the name of "Plume-moths," do not appear to be at all closely allied to one another.

The normal state of affairs in this group is a fission of each wing into six segments, but in Ceylon we find the endemic genus *Triscædecia* with seven segments in the hindwing and six in the forewing, this unusual amount of fission forming a parallel to the analogous case of *Heptaloba* amongst the Pterophoridæ. It is worthy of note, however, that the fissures in *Triscædecia* do not extend more than half way into the wing, whilst in *Orneodes* they reach practically to the base itself; this appears to indicate a very early divergence from the primitive form, which we may imagine as having had shallow clefts, or more anciently mere scallopings, in the margin of each wing between the terminations of the nervures.

The Orneodid larva and pupa are extraordinarily different from those of the Pterophoridæ, and very closely resemble the forms found in the Tineidæ. The larvæ of some, but not all, of the species are peculiar in their habit of burrowing within the flower-stalks, stems, or young shoots of the food plants, in which their presence gives rise to gall-like excrescences.

Classification.

Hitherto four genera have been recognized in this group—*Orneodes* *Pælia*, *Microschismus*, and *Triscædecia*—of which the first and last only have been found in Ceylon, *Pælia* being peculiar to South America and *Microschismus* to South Africa. *Microschismus* includes two species, *Pælia* and *Triscædecia* are monotypical, but *Orneodes* at present consists of some forty species, which have been recorded from every part of the world. The constituent species of this last genus exhibit remarkable differences *inter se*, especially in the structure of the palpi, but the group is small, compact, and well characterized, so that it appears undesirable to split it up in the light of our present knowledge. In the presence of the peculiar costal scale-tufts and in the well-developed maxillary palpi, *O. trachyptera* amongst our species in Ceylon seems remote in structural characters from the other members of the genus, but, as stated above, it does not appear necessary at present to separate it generically. *O. microscopica* is also very distinct from the remaining species by the shallowness of the first cleft in the forewing and the very stout sixth segment in the hindwing.

Distribution in Space and Time.

It is especially noteworthy that nearly all the species of Orneodidæ hitherto discovered in Ceylon are peculiar to the Island, the monotypical genus *Triscædecia* being indeed unknown outside of Ceylon. With an increase of our knowledge of the Asiatic forms of this group, it is possible that our views regarding their geographical distribution may require considerable modification, but in the light of what we know at present it is perhaps permissible to deduce a very high antiquity for this little family, such deduction being based logically on the one hand upon the extremely similar but highly peculiar facies of the members of this group, and on the other hand upon their extremely wide distribution throughout all the zoögeographical regions,* whilst the occurrence of the individual species within very circumscribed areas appears to indicate very limited powers of distribution. Except in the case of *O. hexadactyla*, which occurs throughout the Holarctic realm (*i.e.*, Europe, N. Asia, and N. America), we know no single instance of an Orneodid species whose distribution extends outside of a very small portion of one of the zoögeographical regions, a state of affairs which appears to point to the fact that these localized species have been evolved within very circumscribed areas of space, although the universal distribution of the family forbids us to add the qualification "and of time also." Nothing is known of any Orneodidæ in a fossil state.

Habits and Life-Histories.

So far as Ceylon is concerned it is a matter for regret that, up to the present at least, the information under this heading is almost a perfect blank. The few specimens of imagines collected have almost invariably been attracted by light, a method of capture which gives us very little information about their habits in a natural state. I once, however, beat a specimen of *O. montigena* at Ohiya, and this was disturbed from a mossy roadside bank on which it settled again.

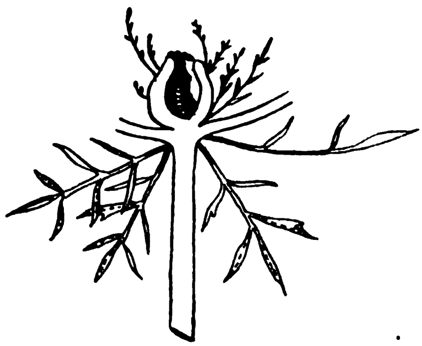
* No Orneodid has been recorded as yet from New Zealand, although it is reasonable to expect that some species will be found there. The members of this group are, however, rather inhabitants of warm climates.

Three examples of *O. pygmæa* were also beaten at Hambantota from jungle scrub; two of these pitched on the upper surface of *Capparis* leaves, and I noticed that they settled on the leaf with outspread wings, then gave a rapid upward jerk with the forewings and settled down again quite quietly with wings outspread and closely appressed to the surface of the leaf.

In Europe, however, their habits are rather better known, and the following summary is translated from Dr. Hofmann's account of the Orneodidæ of the Palæarctic region ("Iris," vol. XI., pp. 342–343) in the hope that it may assist local collectors in elucidating the life-histories of some of these little moths in Ceylon :—

"The larvæ of all the species, so far as they are known, live in the inside of parts of plants, either in the flowers whose filaments and

Figure 1.



Orneodid gall in Scabiosa columbaria.
(after Houard—"Marcellia" IV. 33.)

styles they consume, or in flower-stalks, branches, and young shoots, in which their presence forms gall-like swellings.

"Hitherto only the plant-genera *Lonicera*, *Scabiosa*, and *Stachys* are known to be food plants of Orneodid larvæ.

"The eggs, as has been directly observed in the case of *O. hexadactyla*, and highly probably in the case of other species also, are laid ...... on the particular parts of the plants, an introduction of the egg into the interior of the plant not being possible owing to the soft condition of the short and thick female ovipositor. The young larvæ must therefore first penetrate into their food plant from the outside.

"The larvæ living in flowers change their dwelling several times. In general the larvæ are slow and sluggish, and move around more smartly only before pupation. Notwithstanding their concealed mode of life, they are frequented not rarely by small Ichneumon flies and Tachinids.

"For the purpose of pupating, the larvæ forsake the portions of the plant enclosing them and prepare for themselves on the upper surface of the ground an oval cocoon, which is usually covered with grains of earth or sand, or is composed solely of a wide-meshed web.

"On emergence the empty pupa case remains behind in the cocoon ......

"The moths fly voluntarily only towards evening, shortly before and after sunset, around their food plants. In repose the hindwings are spread out as in flight, but the segments of the forewings, which cover the first two segments of the hindwings, are so approximated to one another that they occupy only about half the breadth usual in flight, whereby their pattern appears very distinct. The fore part of the body is raised up a little, the palpi are stretched out horizontally and project widely; the recurved terminal joint is erected at an acute angle. The antennal flagellum forms with the basal joint, which lies on the fore part of the eye, an obtuse angle and rests under the wing."

Ovum.

The egg of *O. hexadactyla* is described by Chapman (Trans. Ent. Soc., London, 1896, p. 138) as about ·48 mm. long and ·28 mm. wide, somewhat cylindrical and truncate, or like a short thick brick with the angles and corners rounded off; the surface is sculptured with irregular raised lines and pits. In colour it is at first white, then yellow, and finally orange. It is laid on the flower heads of honeysuckle.

Larva.

Hofmann ("Iris," vol. XI., pp. 339–341) gives the following general description of the larvæ of the European species of *Orneodes*:—

"The larvæ present nothing very characteristic, and seem very similar to many Tineid and Tortricid larvæ; they are sometimes short and thick, sometimes more elongated, usually tapering anteriorly or anteriorly and posteriorly, more or less convex dorsally, with a very small head; the interstices between the segments are well marked, less so in the short thick larvæ, more so in the elongated ones, but are always fairly distinct; an indented transverse line behind their middle shows that the segments are made up of two subsegments; above the spiracles runs longitudinally a linear mark, below the spiracles a longitudinal swelling (lateral ledge). The skin is covered with fine, pointed, scattered spicules, which arise from globular chitinous appendages. (Only visible under a magnification of about 350.)

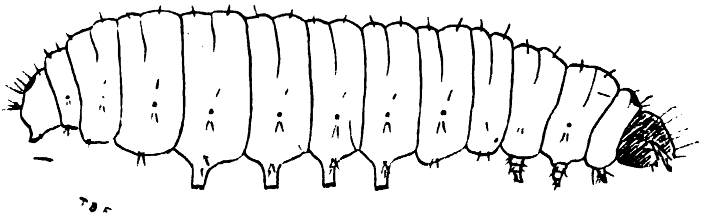
"The warts are mostly very small, inconspicuous, single-haired; their position on abdominal segments 1–8 is the same as in the Tineids. I. stands on the back of the anterior, II. on that of the posterior subsegment, III. again on the anterior over the spiracle,

IV. and V. very near together below the same, and VI. with two hairs directly under these. On the base of the prolegs stand also two warts, one exterior (VII.) and one interior (VIII.).

"On the ninth abdominal segment I could only make out four warts on each side: two dorsal ones one behind the other, and two lateral ones one above the other. On the second and third thoracic segments warts I. and II. stand one above the other, each composed of two small single-haired tubercles on a *single* somewhat large flat chitinous shield (I.*a* and I.*b*, II.*a* and II.*b*, according to Dyar); then follow more distantly below and anteriorly (in the case of *grammodactyla*), III. and IV. likewise one above the other, and still further down comes VI. Wart V. seems to be absent ...... In *Orn. hexadactyla* III. and IV. stand horizontally near one another, V. is wanting or is extremely rudimentary.

"The first thoracic and the tenth abdominal segments are provided with weak circular chitinous plates (thoracic shield and anal shield), and are furnished with numerous small-haired warts.

Figure 2.



Orneodid larva.

"The thoracic legs are of the usual pattern, generally weakly chitinized. The prolegs are completely developed circle-feet; on the anal claspers the hooks form a semicircle open posteriorly. It is very noteworthy that in very young larvæ the prolegs and anal legs are wholly without hooks.

"The larvæ are unicolorous, yellowish or reddish-white, without markings; before pupation they often assume a reddish coloration."

The accompanying sketch (Fig. 2), which must be taken to give a general idea of an Orneodid larva rather than that of any particular species, has been drawn partly from descriptions, partly from preserved larvæ received from Herr A. Bang-Haas, and partly from microscopic preparations of larvæ of *O. hexadactyla* kindly lent by Dr. T. A. Chapman.

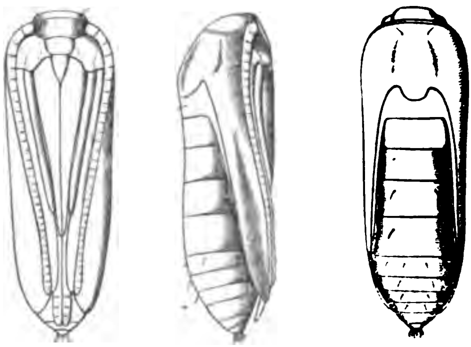
PUPA.

In their pupal state especially the Orneodidæ are seen to be strikingly distinct from the Pterophoridæ, with which group, as previously pointed out, the Orneodidæ have no real relationship, although both groups are popularly included under the same trivial name of "Plume-moths."

The pupa of *O. hexadactyla* is brown, and resembles in its external appearance the pupæ of the true Noctuids, Pyralids, and Tineids; it is short and squat, and (without regard to minute single hairs, only visible under high magnification) is smooth and glossy. In this respect alone it is strikingly different from the Pterophorid pupa.

"The head-plate (Cephalotheca) is strikingly large (as in many Pyralids and Tineids, whilst in the Pterophorids it is very small). On the lower side of the head-plate upper groove ('Oberlippe') and upper jaw ('Oberkiefer') are clearly marked, the labial palpi on the contrary only small and indistinct between the roots of the long maxillæ; no traces of maxillary palpi are present. The very slender prothorax, as well as the mesothorax and metathorax, correspond in their proportions to those of the imago.

Figure 3.



Pupa of *Orneodes hexadactyla* (after Chapman).

"The forewing-covers are broad with stumpy tips forming almost a right angle, and reach as far as the posterior margin of the fifth abdominal segment; they are free at their outermost extremity; through the covers are clearly seen the six segments of the wing as so many dark streaks, segments 1 and 2 connected at their bases, as are also 3, 4, and 5, but 6 quite free.

"The hindwings are long and slender, and first disappear under the forewing-covers at the posterior margin of the fourth abdominal segment.

"The antenna-sheaths are as long as the forewing-covers; the sheaths of the first and second pairs of legs on the contrary are shorter; of the first, the sheaths of the trochanters and femora ('Hüften') occupy a comparatively broad space between the maxillæ and second pair of legs. The third pair of legs lies under the second, and projects *freely* a little above the wings up to the posterior margin of the sixth abdominal segment.

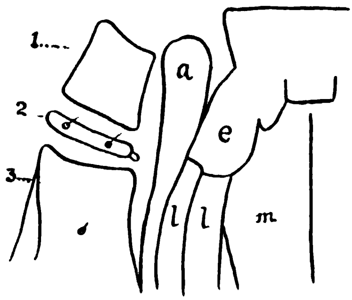
"The first four abdominal segments are very broad, and are almost concealed by the thorax on the one side and the wing- and leg-sheaths on the other.

"The much more slender segments 5 and 6 (in the male 7 also, according to Chapman) are freely movable. The likewise very slender segments 7, 8, 9. and 10 (in the male only 8, 9, and 10—Chapman) are again firmly ankylosed. and together form the blunt-rounded end of the pupa, which in many species is provided at the tip with a number of hooked unbent hairs.

"In the emerged pupa the abdominal segments 7, 8, 9, and 10 are somewhat pushed in under the free edge of the sixth abdominal segment." (Hofmann, *l.c.*, pp. 341–342.)

Chapman notes (T. E. S., 1896, pp. 137–139) that "the dehiscence is of very nearly the macro type, the antennæ separating from the head, the eye-covers remaining attached to the face-piece. It retains one, and only one, very marked micro character, viz., the

Figure 4.



Dehiscence of Orneodid pupa.
(after Chapman)
1, 2, 3 refer to segments; e = eye;
a = antenna; l = leg; m = maxilla.

possession of a dorsal head-plate; not only so, but this plate is of immense size, whilst the prothorax is correspondingly reduced. Contrarily the pupa of *Pterophorus* retains most of the characters of a micro, the one that it has almost lost is this head-plate, which is nearly evanescent, although it retains the function of carrying the eye-cover on dehiscence.

"Both have then been derived from the micro stirps, as we know, indeed, that all pupæ have been; but the routes have obviously been divided for so long a period that it is justifiable to describe them as in nowise related, less probably than any two families of macros ......

"The dehiscence (of the Orneodid pupa) is quite macro in charac-ter, the antennæ separating from the face head parts, which remain tached to the eye-covers; the lower parts of the appendage covers main *in situ*, and are only separated at the head. There is a femur case shown, and the second leg reaches the head. The maxilla and first leg fall short, and expose a portion of the third leg, between and beyond the second. The appendages project freely over the fifth and sixth segments.

"The anal armature consists of ten or twelve fine spines, little more than hairs, curved and crossing one another in lyre shape, and having a fine recurved flattened extremity. There is also a small bristle above and below each (exposed) abdominal spiracle."

Key to Genera of Sinhalese Orneodidæ.

Hindwing with six segments ..	.. Orneodes
Hindwing with seven segments ..	.. Triscædecia

ORNEODES, *Latr.*

Antennæ in male minutely ciliated. Labial palpi 3-jointed; first joint very short, second joint much longer and usually straight, third sometimes nearly as long as second, sometimes much shorter. Maxillary palpi usually quite rudimentary, concealed under the scaling (in *pygmæa* minute, acuminate; in *trachyptera* well developed). Haustellum moderate. Legs moderately long, rather stout, closely scaled; fore-tibia in male usually with (? androconial) tuft of scales; posterior tibial spurs moderately developed. Abdomen short and thick set. Fore- and hind-wing each cleft into six segments; neuration completely developed, but in forewing veins 5, 6, 9, 10 are often weakly developed or absent; no true discal cell in either wing. The sixth segment of hindwing usually provided in the male with a characteristic scent-apparatus composed of an elongated deep fold or pocket, open above, projecting below, in which lie long yellowish erectile sensory hairs, very regularly striped longitudinally, rounded at the tip, arranged distally; in the female the fold is present, but without the scent-scales. Cilia without the ramified hair-scales so characteristic of the Pterophoridæ.

Artificial Key to Species of Orneodes.

1	Expanse under 10 mm. ..	.. 2
	Expanse 10 mm. or over ..	.. 3
2	Sixth segment h.w. much stouter than other segments	.. *miscroscopica*
	Sixth segment h.w. not stouter than other segments	.. *pygmæa*
3	Costa of f.w. with large patches of rough scales	*trachyptera*
	Costa of f.w. without such ..	.. 4
4	General colour bright ochreous-orange	.. *thapsina*
	General colour not bright ochreous-orange	.. 5
5	Expanse over 20 mm. ..	.. *niphostrota*
	Expanse under 20 mm. ..	.. 6

6	Ground-colour of f.w. dark-brown or blackish	7
	Ground-colour of f.w. not dark-brown or blackish	8
7	Dorsal surface of 3rd abdominal segment wholly ochreous-white	*mesolychna*
	Dorsal surface of 3rd abdominal segment not wholly ochreous-white	*montigena*
8	Abdomen brownish-ochreous with two large white dorsal spots	*ischalea*
	Abdomen not so marked	9
9*	Third palpal joint short, clothed with rough scales, expanded at apex	*pinalea*
	Third palpal joint long, slender, without rough scales, apex not expanded	10
10	Ground-colour of wings pale ochreous-buff ..	*toxophila*
	Ground-colour of wing white	11
11	First segment of f.w. fuscous on basal half ..	*sycophanta*
	First segment of f.w. not fuscous on basal half	*postfasciata*

* See text figure 5.

Figure 5.

Second and third palpal joints
of 1. O. sycophanta ;
2. O. pinalea.

Orneodes pygmæa, *Meyr.*

(Plate G, figure 1.)

Alucita pygmæa, Meyrick, Proc. Linn. Soc., N. S. Wales, 1889, pp. 1112–1113.

As the original brief description of this species, made from Queensland examples, is not very accessible to workers in Ceylon, I have thought it best to draw up the following redescription from Sinhalese specimens :—

Male and female. Expanse 8–9 mm. Labial palpi white ; second joint expanded with scales apically, and suffused with fuscous beneath apex ; third joint cylindrical, rather rough-scaled, about half length of second. Maxillary palpi minute, acuminate. Antennæ whitish, faintly dotted beneath with pale ochreous-brown, finely ciliated. Head white, sprinkled with dark fuscous on vertex.

Thorax white, with patches of thick dark-fuscous irroration especially evident as a transverse line on prothorax and on and above patagia. Abdomen white, suffused with ochreous-fuscous, second segment with a large conspicuous dark-fuscous blotch on each side. Legs white, fore-tibia and fore-tarsus dark-fuscous, hind-tarsus banded with dark-fuscous at bases of joints.

Forewing cleft firstly from about $\frac{1}{4}$, secondly from near base, thirdly from about $\frac{1}{4}$, fourthly from within $\frac{1}{5}$, fifthly from near base, segments 2–6 perlinear, first segment very narrow, scarcely twice breadth of second : white : first segment with two small blackish costal blotches, first subbasal, second at about $\frac{1}{5}$, followed by three outwardly-oblique broad transverse ochreous-brown bars, blackish-fuscous on costa, outer edge of third bar very oblique, and continued along hinder margin of segment into apex to form an ill-defined ochreous-brown apical blotch, an ochreous-brown longitudinal blotch on hinder margin of segments 1 + 2 near base ; segments 2 — 6 with about seven broad ochreous-brown transverse bars sprinkled with blackish narrowly preceded and followed by blackish, seventh bar terminal, first two bars ill-defined and sometimes confluent ; on the third segment the fifth bar is much broader than the sixth or seventh bars, so that the penultimate and antepenultimate white patches of ground-colour are here distinctly displaced outwards as compared with the position of similar patches on segments 2 and 4. Cilia white, ochreous-brown opposite transverse bars.

Hindwing white, crossed transversely by seven broad ochreous-brown black-sprinkled bars narrowly preceded and followed by blackish, seventh bar very narrow, terminal. Cilia white, ochreous-brown opposite transverse bars.

In Ceylon this species appears to occur in scrubby jungle in the dry parts of the low-country. I took it at Hambantota on October 18 and November 8, 1908, when it appeared to be associated with a *Capparis*, which is possibly its food plant. Although not previously recorded from Ceylon, my collection also contains specimens from Matale (August 15, 1906 ; *Pole*) and from Madulsima in April, 1907 (*Vaughan*).

Outside of Ceylon *O. pygmæa* occurs in Queensland at Brisbane and Duaringa, where it is said to swarm sometimes by thousands in the scrub. Mr. Meyrick kindly informs me also that he has received it from Cuddapah, 4,000 feet, in South India (*Campbell*).

ORNEODES MONTIGENA, *n.s.*

(Plate G, figure 2.)

Expanse 10 mm. Labial palpi rather short, whitish : second joint light fuscous at apex, which is expanded exteriorly by an acuminate scale-tuft ; third joint about $\frac{3}{4}$ length of second, rather rough-scaled, expanded apically with long hair-scales. Antennæ finely ciliated, beneath whitish, above pale brownish, on basal half clearly annulated with white. Head whitish, on back of crown fuscous, on vertex rough-scaled. Thorax ochreous-brown irrorated with white. Abdomen ochreous-brown finely irrorated with blackish, posterior margins of segments narrowly edged with white. Legs whitish: fore-tibia dilated beneath with a small scale-tuft, fore-tibia and fore-tarsus suffused above with fuscous, hind-tarsus with bases of joints banded with very pale fuscous.

Forewing cleft firstly from about $\frac{1}{4}$, secondly from near base, thirdly from about $\frac{1}{4}$, fourthly from within $\frac{1}{3}$, fifthly from near base, first segment narrow, others perlinear, first segment at base twice breadth of second : pale ochreous-brown finely striated transversely with blackish : first segment with a white costal dot at about $\frac{1}{6}$ and outwardly-oblique transverse white bars at $\frac{1}{4}$, $\frac{2}{5}$, $\frac{1}{2}$, and $\frac{3}{4}$; segments 2–6 cut transversely by six narrow white bars, preceded and followed by fine black lines ; on the third segment the third and fourth white bars are displaced outwards relatively to the positions of those on segments 2 and 4. Cilia very pale ochreous-brown, white opposite white bars.

Hindwing cleft into six perlinear segments, firstly from about $\frac{1}{6}$, secondly from base, thirdly from about $\frac{1}{6}$, fourthly and fifthly from near base : pale ochreous-brown finely striated transversely with blackish, crossed by about six narrow white bars, preceded and followed by blackish. Cilia very pale ochreous-brown, white opposite white bars.

Described from a single specimen taken by myself at Ohiya (6,000 feet), on the borders of Uva and the Central Province, Ceylon, on August 25, 1906.

Observation.—This is possibly a montane form of *O. pygmæa*, Meyr., from which species it appears to me, however, to be separated by the following characters: (i.) Its larger size; (ii.) the distinctly annulated antennæ, only very faintly marked in *pygmæa ;* (iii.) the darker colour of the abdomen, and especially the absence on segment 2 of the white dorsal patch and lateral blackish blotches so conspicuous in *pygmæa ;* (iv.) the greater breadth of the first segment of the forewing in comparison with the second segment; (v.) the much narrower white bars on the first segment of forewing. A larger series will doubtless settle in the future the question of the specific distinctness of *pygmæa* and the present form.

ORNEODES ISCHALEA, *Meyr.*

(Plate G, figure 3.)

Orneodes ischalea, Meyrick, B. J., XVI., 583.

The original description reads :—" Male 13 mm. Head white, back of crown mixed with fuscous. Palpi white, externally fuscous-tinged. Antennæ whitish. Thorax whitish, mixed with fuscous. Abdomen whitish, irrorated with fuscous, with a clear white trapezoidal dorsal patch before middle, and a spot beyond middle. Legs white, anterior femora and the tibiæ infuscated above. Forewings and hindwings whitish-ochreous, crossed by six white irregular lines edged with fuscous irroration, sixth terminal; base of forewing mixed with dark fuscous, costa spotted alternately with white and dark fuscous; cilia alternately whitish-ochreous and whitish."

This species was originally described from a single specimen taken at Pundaluoya in February by Green. I have examples from Madulsima in November, 1906 (*Vaughan*), and from Haldummulla in October–November, 1908 (*Ormiston*), and Mr. Meyrick writes that he has it also from Maskeliya.

ORNEODES MESOLYCHNA, *Meyr.*

(Plate G, figure 4.)

Orneodes mesolychna, Meyrick, T. E. S., 1907, 508.

"Male and female. 9–11 mm. Head ochreous-whitish, crown suffusedly mixed with blackish-gray. Palpi moderate, curved, ascending, transverse-flattened, terminal joint somewhat shorter than second; whitish, with apical band of second joint and median band of terminal joint blackish-gray. Antennæ ochreous-white. Abdomen rather dark fuscous, third segment ochreous-white, segments 4–6 edged posteriorly towards middle with white, towards sides with black, ventral surface ochreous-white. Legs whitish, anterior femora and tibiæ suffused with dark gray externally, apex of middle femora with a dark gray dot. Forewings ochreous-yellow; basal area irrorated with blackish; a moderate fascia of blackish irroration edged with white before ¼; first segment with three, other segments crossed by two rather broad fasciæ of blackish irroration edged by white lines margined with two rows of black scales; a slender blackish subapical fascia, and tips of segments also blackish: cilia dark gray, barred with whitish on white markings. Hindwings whitish, with about ten irregular transverse bars of blackish irroration, alternate interspaces ochreous-yellowish: cilia as in forewings, but whitish bars wider."

In Ceylon this species has as yet been taken only at Maskeliya; outside of Ceylon it is known from the Khasi Hills in Assam.

I have seen no examples from Ceylon, and am indebted to Mr. Meyrick for the loan of a Khasi specimen for figuring.

ORNEODES PINALEA, *Meyr.*

(Plate G, figure 5.)

Orneodes pinalea, Meyrick, T. E. S., 1907, 506.

"Male and female. 13–18 mm. Head white, crown more or less mixed with dark fuscous. Palpi moderately long, ascending, loosely scaled anteriorly, terminal joint half second; white, second joint externally more or less sprinkled with gray, terminal joint with a dark gray median band. Antennæ pale whitish-ochreous. Thorax white. Abdomen white, second segment with small blackish subdorsal spots, anal tuft of male whitish-ochreous. Legs white, anterior tibiæ suffused with dark gray. Forewings white; first segment with about ten pale yellowish spots partially edged with dark fuscous irroration, alternate ones more strongly suffused with dark fuscous; other segments crossed by six moderately broad pale yellowish fasciæ edged with blackish irroration, fourth broadest, represented on sixth segment by a blackish spot: cilia white, on fasciæ pale yellowish. Hindwings white; fasciæ mostly reduced to single dots of blackish irroration, but postmedian fascia faintly yellowish; sixth segment with three posterior dots only."

This species, which is not as yet known from any locality outside of Ceylon, was originally described from specimens collected at Madulsima and Wellawaya in November. I have a single example taken at Mankulam in November, 1908 (*De Mowbray*).

ORNEODES POSTFASCIATA, *n. s.*

(Plate G, figure 6.)

Male. Expanse 15 mm. Labial palpi long, cylindrical, white, slightly suffused beneath with yellowish-brown; third joint about $\frac{3}{4}$ length of second. Antennæ whitish, minutely ciliated. Head and thorax white. Legs white: fore-femur suffused above on terminal half with blackish; fore-tibia suffused with blackish, and provided with a scale-tuft beneath. Abdomen white, third segment suffused with blackish-fuscous. Spina of frenulum very long and strong.

Forewing cleft from about $\frac{2}{3}$, near base, about $\frac{2}{3}$, $\frac{1}{3}$, and from near base; first segment narrow, others linear; white: a faint subbasal blackish-fuscous costal spot; first segment with outer third faintly suffused with pale brown, posterior margin of segment indistinctly edged with blackish-fuscous at about $\frac{1}{3}$ and beyond $\frac{2}{3}$ length of segment; second segment with a longitudinal blackish-fuscous spot on anterior margin at base, cut at $\frac{2}{5}$ by a broad blackish-fuscous bar and by narrow pale brown bars at $\frac{4}{5}$ and before termen; third segment with a blackish-fuscous dot on anterior margin at $\frac{3}{5}$ on a narrow indistinct anteterminal pale-brown bar; fourth segment cut by a dark-fuscous line near base, and an indistinct pale-brown bar before termen; fifth segment with pale anteterminal bar; sixth segment with a strong patch of blackish scales (? androconia) at $\frac{1}{3}$, cut at $\frac{2}{3}$ by a narrow blackish-fuscous bar and before termen by an indistinct pale-brown bar. Cilia white: on posterior margin of first segment mixed with blackish at about $\frac{1}{3}$ and beyond $\frac{2}{3}$, on fore-margin of second segment dark-fuscous at $\frac{1}{3}$ and $\frac{2}{3}$.

Hindwing cleft from about $\frac{1}{3}$, base, $\frac{1}{6}$, base, and base; segments linear: white: all segments narrowly and irregularly suffused with blackish-fuscous at base, crossed slightly before $\frac{1}{2}$ by a broad blackish bar forming a conspicuous fascia across the whole wing, beyond this bar crossed on segments 1–4 by three, on segments 5 and 6 by only two, narrower blackish-brown bars. Cilia white, pale brownish opposite dark bars.

A distinct little species, easily recognized by its pure-white colour and the conspicuous dark fascia across the centre of the hindwing.

Described from two examples (of which the former is the type) taken by myself at light on Sober Island, in Trincomalee Harbour, on November 4 and December 8, 1906. Mr. Meyrick, who has kindly examined the type, remarks that he has an apparently similar specimen collected in the Central Province by Mr. G. B. de Mowbray.

ORNEODES SYCOPHANTA, *Meyr.*

(Plate H, figure 7.)

Orneodes sycophanta, Meyrick, B. J., XVII., 133.

"Male and female. 15–18 mm. Head and thorax white. Palpi smooth-scaled, white, apex of basal and second joints and subapical ring of terminal joint dark fuscous. Antennæ stout, serrate, whitish-ochreous, basal joint white. Abdomen white, segments 2–4 partially or wholly dark fuscous above (number of dark segments variable). Forewings white; first segment fuscous, with four blackish white-edged spots, fourth apical; second segment fuscous, with three dark fuscous bands, limited by white spots edged with blackish-fuscous; segments 3–6 crossed by two anterior series of undefined dark fuscous dots, and four posterior pale grayish-ochreous fasciæ, edged with dark fuscous, but these vary much in distinctness, and are often partially obsolete; usually a distinct blackish-fuscous spot on middle of sixth segment. Hindwings white, with six transverse series of pale ochreous spots, speckled with black."

To the above I would add that the third palpal joint is about ⅔ the length of the second; that the head is white, the crown with large ill-defined blackish spots above and between bases of antennæ; that the legs are whitish, the fore-femur exteriorly blackish on terminal half, the fore-tibia blackish with a long scale-tuft on inner side; and that the first segment of the forewing is about twice the breadth of the second segment.

This species only appears to be known from Maskeliya, where it has been taken by Mr. Pole in January, April, May, and July.

I am indebted to Mr. Meyrick for the loan of the specimen from which the figure has been drawn.

ORNEODES TOXOPHILA, *Meyr.*

(Plate H, figure 8.)

Orneodes toxophila, Meyrick, B. J., XVII., 133.

"Male. 15–16 mm. Head and thorax white. Palpi with appressed scales, white, towards base sprinkled with fuscous.

Antennæ ochreous-whitish, basal joint white. Abdomen whitish-ochreous. Forewings ochreous-whitish, crossed by ill-defined light yellow-ochreous bands before and beyond middle, and a narrow curved darker central fascia, sometimes partially speckled with dark fuscous, not reaching sixth segment, separated from them by fine lines of ground colour; sometimes a few fine blackish specks on segments; sometimes a faint yellowish subterminal line. Hindwings as forewings, but central fascia fuscous, sprinkled with blackish, entire, dark specks on segments rather more numerous, subterminal line sometimes grayish towards dorsum."

This appears to be one of the most widely-distributed of our species of *Orneodes*. It was originally described from Maskeliya specimens taken by De Mowbray in April and June, and my collection contains examples from this locality in January and March (*De Mowbray*). I also have it from Madulsima in October (*Vaughan*), from Bibile in November, 1907 (*Mackwood*), and from Kegalla in October–November, 1908 (*Ormiston*), and at lamp in bungalow at Kegalla (1,000 ft.) on October 11, 1909 (*Ormiston*).

Outside of Ceylon *O. toxophila* occurs in South India. Mr. Meyrick informs me that he has received this species from N. Coorg, 3,500 feet (*Newcombe*). The British Museum collection also contains two specimens from the Nilgiri Hills (*Hampson*); Sir George Hampson kindly informs me that these were collected by him in September at Nadgani (3,000 feet), on the western slopes of the Nilgiris.

ORNEODES THAPSINA, *Meyr.*

(Plate H, figure 9.)

Orneodes thapsina, Meyrick, B. J., XVI., 583.

"Male. 21 mm. Head whitish-ochreous, crown ochreous-yellow. Palpi and antennæ ochreous-whitish. Thorax ochreous-orange, partially sprinkled with fuscous. Abdomen ochreous-orange, segmental margins white. Legs whitish, anterior femora and tibiæ dark fuscous above. Forewings orange-ochreous, towards base partially suffused with fuscous, posterior $\frac{2}{3}$ crossed by four irregular whitish lines, partially obscurely edged with a fuscous tinge; tips of segments pale or whitish, with a minute dark fuscous terminal dot: cilia alternately whitish-ochreous and whitish. Hindwings whitish; segments 1–5 with six, segment 6 with three ochreous bars irregularly edged with dark fuscous irroration; cilia as in forewings...... Only comparable in general colouring with the Australian *O. xanthodes*, from which, however, it is quite distinct."

This is another species which, so far as we know at present, is quite peculiar to the Maskeliya district, where the original specimens were taken in February. My own examples were collected in September, 1905 (*ex* Coll. Green), and in October and December (*Pole.*)

ORNEODES NIPHOSTROTA, *Meyr.*

(Plate H, figure 10.)

Orneodes niphostrota, Meyrick, T. E. S., 1907, 507.

"Male and female. 21–22 mm. Head and thorax white tinged or sprinkled with pale ochreous. Palpi moderate, ascending, loosely scaled, terminal joint $\frac{3}{4}$ of second; gray, terminal joint white towards apex. Antennæ pale whitish ochreous. Abdomen whitish, with subbasal and subapical bands and lateral stripes of fuscous irroration. Legs whitish, anterior femora and tibiæ suffused with dark fuscous externally. Forewings white; basal half tinged with ochreous and partially sprinkled with dark fuscous, especially on base of costa and towards base of lowest cleft; segments crossed by four fuscous fasciæ sprinkled with blackish, and an additional blotch on first two segments between third and fourth fasciæ, the blotch and upper half of second fascia darker than the rest, first three fasciæ moderate, angulated on fourth segment, first obsolete towards costa, third narrow on fourth and fifth segments, fourth narrow throughout, subapical, all widely separated on sixth segment: cilia ochreous-whitish, slightly tinged with fuscous on fasciæ. Hindwings white; basal third irrorated with dark fuscous, except at base; segments crossed by four rather narrow curved or angulated fuscous fasciæ sprinkled with blackish: cilia as in forewings."

This is another species which is so far known only from the Maskeliya district, where the type-specimens were taken in October and January. My two examples, for which I am indebted to Messrs. Pole and De Mowbray, were both collected at light in September.

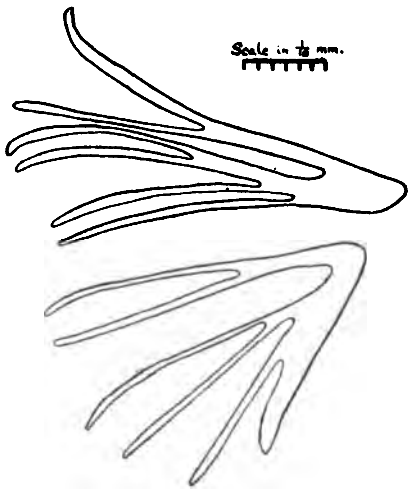
ORNEODES MICROSCOPICA, *n. s.*

Male. Expanse 7 mm. Labial palpi moderately long, porrect, third joint about half length of second; pale fuscous-gray, banded with dark fuscous at apices of joints. Antennæ fuscous, roughened with scales above. Head fuscous, a white spot on vertex between the prominent black eyes. Thorax fuscous, grayish anteriorly and laterally. Abdomen fuscous, paler on first two segments. Legs pale grayish; spurs on posterior tibia long and strong, the inner proximal spur much the longest.

Forewing cleft firstly from slightly beyond $\frac{1}{2}$, secondly from about $\frac{1}{5}$, thirdly from slightly beyond $\frac{1}{2}$, fourthly from rather beyond $\frac{1}{4}$, fifthly from slightly within $\frac{1}{4}$; first segment narrow, segments 2–6 linear: pale gray: first segment with six fuscous-brown costal spots, fourth at $\frac{1}{2}$, very broad and bar-like, nearly reaching fifth (at $\frac{3}{4}$), which is also broad but narrower than the fourth; other segments apparently crossed by several narrow transverse fuscous-brown bands only distinct towards termen; all segments with a minute blackish-fuscous terminal dot, that in first segment largest and most distinct. Cilia whitish-gray, intermixed with thick dark-fuscous hair-scales opposite darker spots and bands.

Hindwing cleft firstly from about $\frac{2}{5}$, secondly from near base, thirdly from about $\frac{2}{5}$, fourthly from about $\frac{1}{3}$, fifthly from slightly within $\frac{1}{2}$; segments 1–5 linear, sixth segment stout, apparently forming extremity of a large glandular sac contained within and along dorsal margin of wing: whitish-gray, irregularly irrorated and crossed by about six ill-defined fuscous-brown transverse bands, of which a terminal and subterminal are the darkest and most distinct; ground-colour of whole of sixth segment, to base of wing, conspicuously darker. Cilia whitish-gray irregularly intermixed with dark-fuscous hair-scales, which are well developed opposite darker markings on segments.

Figure 6.



Orneodes microscopica.

Type (No. 7,684) in Coll. Bainbrigge Fletcher.

Habitat.—Ceylon, North-Central Province, Anuradhapura. November, 1908 (*G. B. de Mowbray*).

Observation.—The unique type-specimen is unfortunately in poor condition, and I should have hesitated to describe it as a novelty, were its specific distinctness dependent on mere colour-markings. Its minute size, however, combined with the proportionate fission of the wings, and especially the extraordinarily thickened sixth segment of the hindwing, sufficiently characterize *O. microscopica* as distinct from every other species hitherto described in this family. It is still smaller than *O. pygmæa*, which has been described as "much the smallest species of the genus." *O. nannodactyla*, Rebel, also expanding only 7 mm. and described from Sokotra, is apparently very near *O. pygmæa*, Meyr., but has the third palpal joint very short and almost hidden in the scaling of the second joint.

ORNEODES TRACHYPTERA, *Meyr.*

(Plate H, figure 11.)

Orneodes trachyptera, Meyrick, B. J., XVII., 134.

"Male and female. 10–13 mm. Head, palpi, antennæ, thorax, and abdomen dark-fuscous, mixed with whitish; palpi with second joint dilated with rough scales towards apex above and beneath, terminal joint thickened with loose scales towards apex anteriorly. Forewings with costa roughened with projecting dark fuscous scales, except on the white markings; whitish, densely irrorated with dark fuscous, so as to appear dark gray; costa with six or seven small semioval ochreous-white spots, not reaching more than half across first segment; other segments crossed by about six series of ochreous-white dots, united by outwardly oblique whitish dashes in the cilia to form zigzag lines. Hindwings with ground-colour and zigzag lines as in forewings.

"Six specimens, Puttalam and Maskeliya, in March, May, November, and December (*Pole*, *De Mowbray*)."

This blackish little species, easily recognized by its roughened costa, is further remarkable in having the maxillary palpi well developed and clearly visible beyond the scaling of the head. It should probably be separated generically from *Orneodes*.

In Ceylon *O. trachyptera* usually occurs in the dry jungly districts of the low-country, where it sometimes comes into light freely. My own specimens are from Wellawaya in November, 1905 (*Green*), from Mankulam and Anuradhapura in November, 1908 (*De Mowbray*), and from Nikaweratiya (between Puttalam and Kurunegala) at light on November 11, 1909 (*Ormiston*). Mr. Meyrick tells me that he has it from Eppawela and Rambukkana.

Outside of Ceylon it is as yet known only from N. Coorg, 3,500 ft. (Meyrick Coll.).

TRISCÆDECIA, *Hmpsn.*

"Proboscis fully developed; [labial] palpi with the second joint porrect, about twice length of head and broadly fringed with hair below, the third oblique, moderate; antennæ of male ciliated; tibiæ with projecting tufts of hair at the spurs. Forewing divided into six plumes to rather more than one-third length (from within two-thirds); the costa with six tufts of scales; the scaling rough; vein 3 from well before angle of cell; 4–5 from angle; 6 from below upper angle; 7–8 stalked; 9, 10, 11 from cell. Hindwing divided into seven plumes to half length; veins 3–4 from angle of cell; 5 absent; 6–7 from upper angle; 8 free, from base."

This genus is remarkable amongst the Orneodidæ, not only in the six-cleft hindwing, but in possessing well-developed maxillary palpi—a feature which is unaccountably omitted from the original description reproduced above.

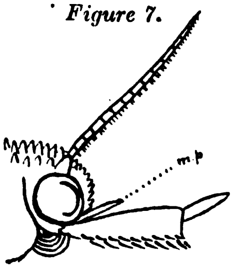
TRISCÆDECIA DACTYLOPTERA, *Hmpsn.*

Triscœdecia dactyloptera, Hampson, T. E. S., 1905, 247–248 (fig.).

"Male. Head, thorax, and abdomen clothed with whitish, pale brown, and black scales; antennæ and legs mixed with whitish; abdomen with diffused blackish bands.

Forewing clothed with grayish, pale brown, and black scales; the costa with whitish spots between the [six] black tufts of scales; the cell with small black lunules followed by whitish spots at middle and extremity; traces of a diffused oblique whitish band from lower angle of cell to inner margin; an indistinct slightly waved whitish postmedial line; the plumes with white spots at base and subterminal and terminal series of white lunules.

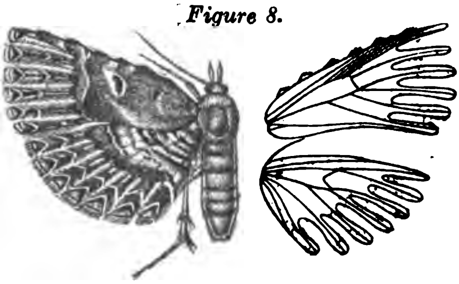
Figure 7.



Triscædecia dactyloptera.

m. p. Maxillary palp.

Figure 8.



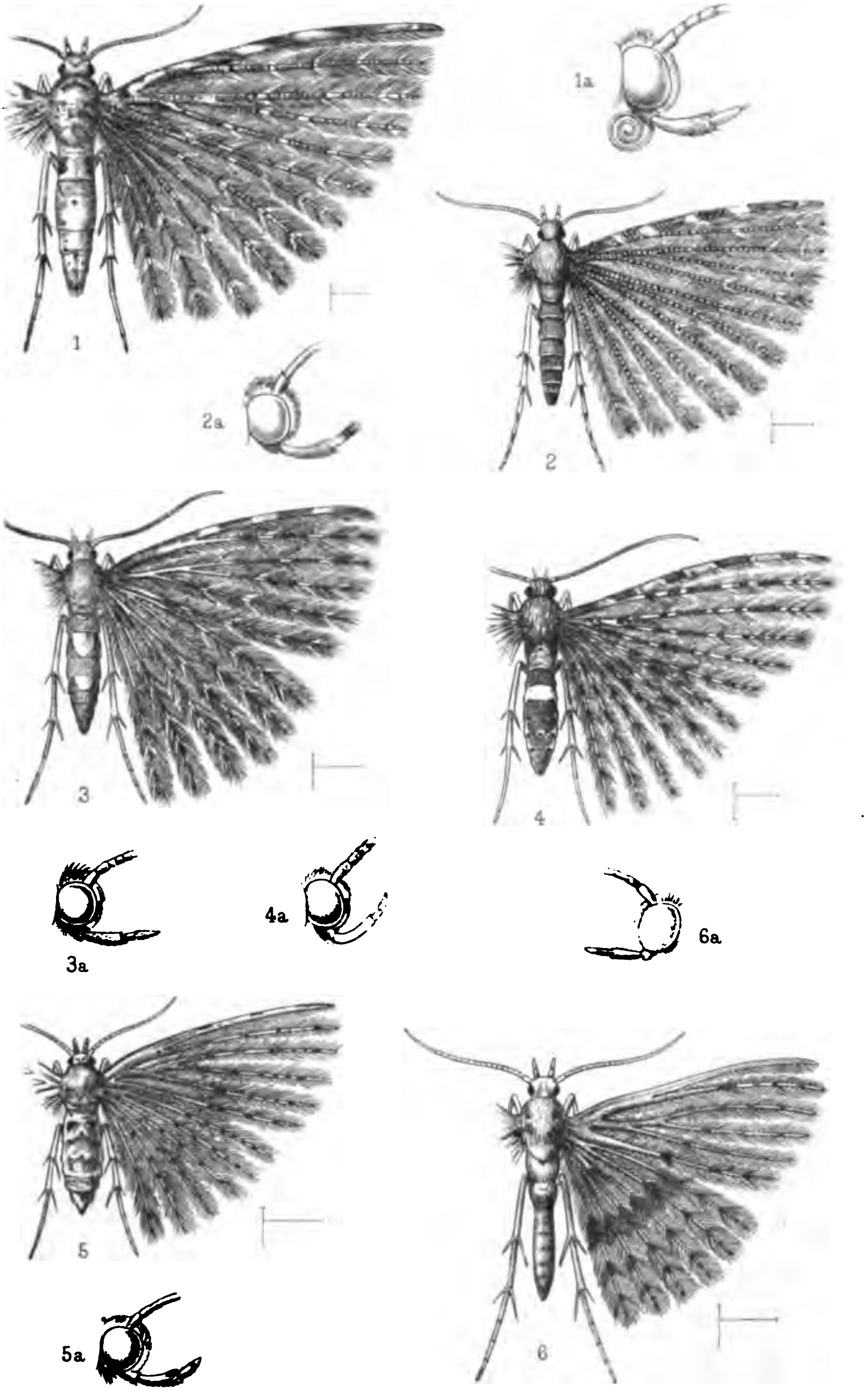
Triscœdecia dactyloptera. Hmpsn.

Hindwing with the basal half white with diffused irregular black antemedial and two medial lines on it, the first of the medial lines arising from a discoidal bar; a slightly waved whitish postmedial line; the plumes with white spots at base and subterminal and terminal series of white lunules.

Habitat.—Ceylon, Maskeliya (J. Pole), Ohiya (Gossage). Expanse 26 mm. Type in B. M."

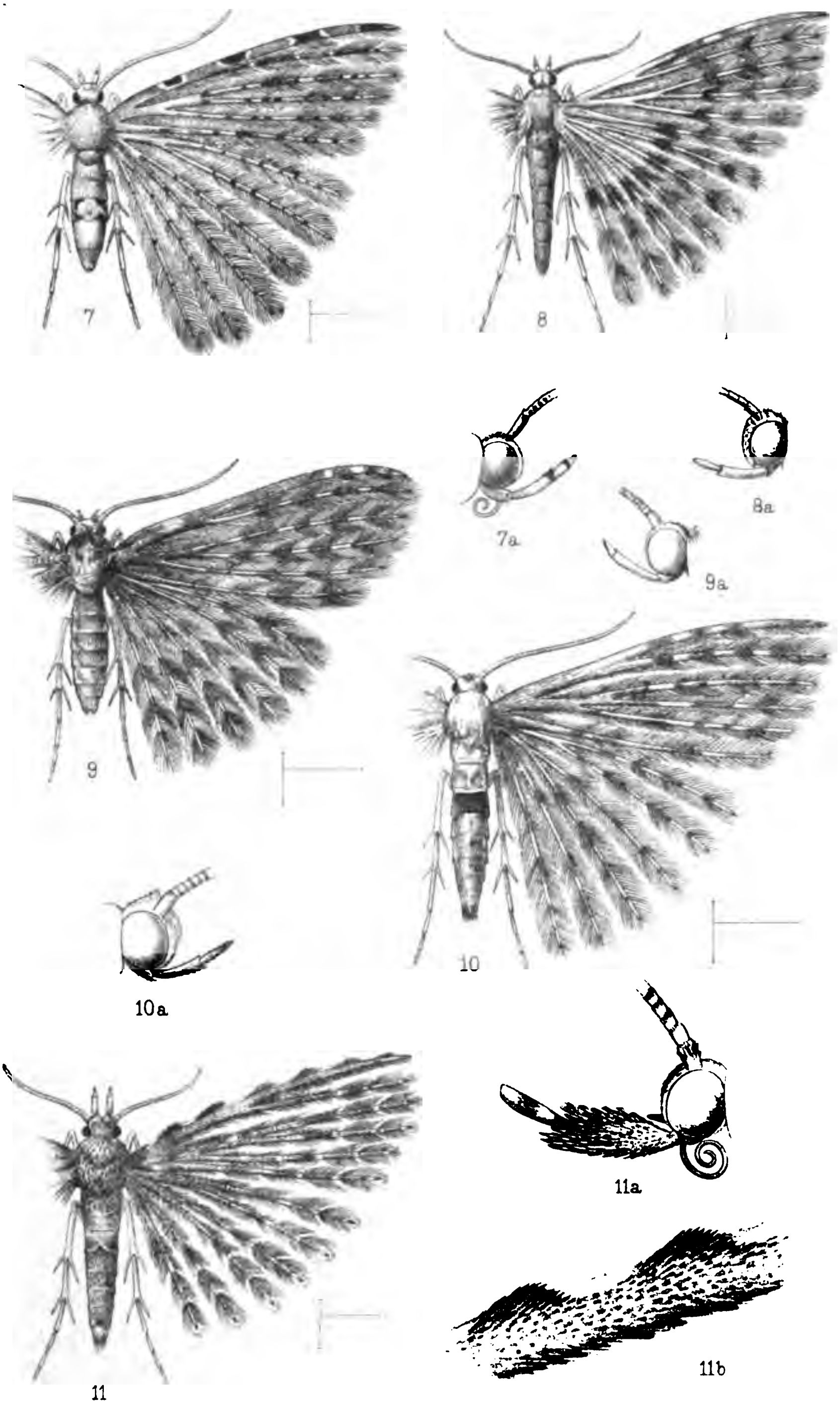
Reference to the specimens in the National Collection shows that the type of this species is the Maskeliya specimen referred to above.

My own examples are from Maskeliya (*De Mowbray*, *Pole*) and Madulsima (*Vaughan*). The only other example which I have seen is a very old one, without definite locality, which I found in the Colombo Museum figuring under the name of *Tinea* (!) *alucitana*.



West, Newman del. et lith.

ORNEODIDÆ.



West, Newman del et lith

ORNEODIDÆ.

EXPLANATION OF PLATES G AND H.

All the figures in these plates have been drawn by Messrs. West, Newman, direct from specimens of the various species (all previously unfigured). They are all considerably magnified, the natural size being shown by the scale against each principal figure. In all cases the figures lettered 1*a*, 2*a*, &c., represent a profile view of the head of the species figured under the corresponding number.

PLATE G.

Fig. 1.—*Orneodes pygmæa*, Meyr.

Fig. 2.—*Orneodes montigena*, n. s.

Fig. 3.—*Orneodes ischalea*, Meyr.

Fig. 4.—*Orneodes mesolychna*, Meyr.

Fig. 5.—*Orneodes pinalea*, Meyr.

Fig. 6.—*Orneodes postfasciata*, n. s.

PLATE H.

Fig. 7.—*Orneodes sycophanta*, Meyr.

Fig. 8.—*Orneodes toxophila*, Meyr.

Fig. 9.—*Orneodes thapsina*, Meyr.

Fig. 10.—*Orneodes niphostrota*, Meyr.

Fig. 11.—*Orneodes trachyptera*, Meyr.

Fig. 11*b*.—Portion of first segment of forewing of *O. trachyptera*, more highly magnified, to show costal tufts.

NOTES ON CEYLON DIPTERA.

By E. BRUNETTI.

THE following notes are compiled on Ceylonese specimens which have come under my notice during the last two or three years, the bulk of them having been sent me by that indefatigable collector Mr. E. E. Green, nearly all the species being preserved in my own collection. When the source of supply or the presence of the specimens referred to is otherwise, it is herein stated.

Mycetophilidæ.—Several species; including at least three or four new to science, which will be described in my forthcoming paper on this family. They include a large handsome *Platyura*, of which, however, all three examples are in bad condition.

Pselliophora taprobanes, Wlk.—Two females of this Tipulid from Peradeniya, X. and XII. 07.

Rhyphus maculipennis, V. W.—One, Peradeniya.

Plecia fulvicollis, F.—Not uncommon. X. 07 at Kandy and VI. 09 (no definite locality).

Psychoda, sp. nov.—Three specimens of a handsome new species. Maskeliya, January. To be described shortly.

Simulium, sp.—A single example, Ohiya, XI. 07.

Ptilocera fastuosa, Gerst.—Not uncommon. Two males, four females, Kandy, taken X., XI., XII., 07. Probably the commonest species in this region, of *Ptilocera*.

P. continua, Wlk.—Three males, Kandy.

Tinda indica, Wlk.—One male, Yatiyantota, III. 1902.

Sargus metallinus, F.—Generally common.

Ptecticus ferrugineus, Dol.—One, "Ceylon."

P., sp.—Two specimens of a large species (16 mm.) with all yellowish gray wings, four black abdominal bands, black hind tibiæ and metatarsi, the following tarsal joint white. Kandy, 5 IX. 09.

Microchrysa flaviventris, V. W.—Not rare, Peradeniya, VII. and VIII. 09. One specimen bred by Mr. Green from diseased cotton bolls.

Ephippium, sp. nov.—Two females, VIII. 08 and V. 09. Will be described in an early paper on "New Oriental Diptera."

Tabanus albimedius, Wlk.—Peradeniya, X. 07. One female.

T. ditæniatus, Mcg.—One female taken at light by Mr. Paiva on board ship 4 miles off Tuticorin, 25 V. 08. Received by exchange with the Indian Museum, where a series from the same source is to be found.

Atherix limbata, Big.—One male, Maskeliya, March.

Chrysopilus magnipennis, Brun.—The type of this species is from Maskeliya taken in August, since receiving which a second female has been sent me (in bad condition) from Kandy, IX. 07, and a third female in good condition from Kandy, VII. 09. Described by me in Rec. Ind. Mus., III., 213.

Hyperalonia sphinx, F.—On my way out to the East I took two females at Colombo, 1 VII. 04, both the worse for wear.

Exoprosopa collaris, W.—One female, Trincomalee, IX. 09.

E. flammea, Brun.—One female, Dambulla, VIII. 09. The species described by me in Rec. Ind. Mus., II., 466, from a single female in the Indian Museum, from Pusa, 17 IV. 07.

Argyramœba distigma, W.—One or two from Kandy.

A. ceylonica, Brun.—The type in my collection described in Rec. Ind. Mus., II., 471, from Kandy, with two other males, October and November, 1907. Also occurs at Pusa, VII. and VIII.

A. fulvula, W. (*degenera*, Wlk.).—Herr Kertesz gives this species (*degenera*, Wlk.) as synonymous with *fulvula*, W., and refers the latter species to *Argyramœba*. In my recent revised "Catalogue of Oriental Bombylidæ" it was retained under *Anthrax*, the description being insufficient to enable me to judge.

Anthrax, sp., near *afra*, F., with basal half of wing black, and silver tip to abdomen. Kandy, VII. 09.

Bombylius wulpii, Brun. (*Comastes pulchellus*, V. W.).—A pair *in cop.* of this handsome little species, Peradeniya, IV. 09; an additional male, Kandy, VIII. 09; an additional female, Kandy, VII. 09. See Rec. Ind. Mus., II., 457, for my synonymy and reasons for change of name.

B. propinquus, Brun.—One, Haragama, January, 08, a male, is the type, described in Rec. Ind. Mus., III., 226, a unique.

Syneches bicolor, Big. (*Pterospilus*, id.).—Not rare. I have seen several from Kandy, V. and IX. 09.

Baccha nubilipennis, Aust.—Four males from Kandy, X., XI. 07.

B. pulchrifrons, Aust.—Two males, Peradeniya, XI. 07.

Syrphus salviæ, W.—Generally common during summer.

S. ægrotus, F.—As above. Both species, I believe, are now relegated to *Asarcina*.

Megaspis crassus, F., and *M. zonalis*, F.—Both sexes of both species are generally common throughout the summer.

Mr. Austen informs me that *Megaspis* will have to be superseded.

Chrysotoxum citronellum, Brun.—The type (male), a unique, is from Kandy, XII. 07, described in Rec. Ind. Mus., II., 90.

Microdon auricintus, Brun.—The type male is from Kandy, X. 07, whilst I possess females from Kandy, IV., V., and IX.

M. ? flavipes, Brun.—A large female from "Nitre Cave," Ceylon, VII. 02, is apparently this species, which was described (Rec. Ind. Mus., II., 92) from specimens in the Indian Museum.

Conops erythrocephala, F.—Two males from Colombo, IV. 09, and Kandy, XII. 07, respectively.

Lucilia dux, Erichs.—Generally common, probably all the year round, being one of the most generally distributed of the "scavenger" flies in the East, a cognomen which is somewhat misleading, as it probably (in company with most, if not all, others of its genus and of all allied genera) transmits more disease than any other fly, excepting perhaps *Musca domestica* and the immediate allies of that species.

Pycnosoma flavipes, Mcg., is a probable synonym of *L. dux*, which is the species, so far as I know, which, it is alleged, caused the recent outbreak of smallpox amongst the nurses at the General Hospital, Calcutta.

The abominable contamination of food, which is absolutely inevitable, through the presence in such numbers of the commoner species of Muscinæ (*Musca*, *Lucilia*, *Calliphora*) is a subject which, in the author's opinion, is of at least as weighty importance as the crusade against mosquitoes on behalf of the extermination of malaria.

Stomoxys calcitrans, L.—Generally common everywhere in the East.

Limnophora bisetosa, Thoms.—A female from Kandy, January, 1908.

Ophyra nigra, W.—Peradeniya, IX. 07. Four males.

Senopterina eques, Sch.—One or two from Kandy.

Sepsis coprophila, Meij.—Peradeniya, XI. 07.

S. fasciculata, Brun.—Only two specimens of this species have been seen by me. The one in my own collection from Ceylon is the type, the other, now accidentally destroyed, was in the Indian Museum from Calcutta, 16 VI. 07.

Calobata splendens, W.—One female, Kandy, IX. 07.

Diopsis indica, Westw.—One from Haldummulla, VII. 09.

D. sp.—Three examples of what may be a new species from Kandy, V. and IX. 07, and from Balangoda, I. 01.

Celyphus obtectus, Dalm.—Peradeniya, V. 09.

C. sp., ? *dohrni*, Big.—Several specimens, Peradeniya, V. to IX. 07, and Kandy, IX. 07.

Olidia œnea, W.—Not uncommon. Colombo, VII. 09.

Aphiochœta, sp. nov.—This will be described in my forthcoming paper on "New Oriental Diptera."

Hippobosca variegata, Leach.—Two from Passara, XII. 07. Mr. Austen informs me of a necessary correction here to *maculata*, Leach.

Cyclopodia tykesi, V. W.—One, "Ceylon."

N.B.—The above list does not comprise more than one-third of the species received by me from Ceylonese localities, but it may be useful to workers in Oriental Diptera, and it is possible that later on I may identify some further portion of my collection from this Island.

NOTES.

1. *An Albino Wagtail.*—It may be of interest to ornithologists to know that an albino of the Gray-headed Wagtail (*Motacilla borealis*) can be reported from Colombo. I saw the bird on the Galle Face on three occasions last month. The back was slightly dusky, and there was a tinge of yellow on the breast, otherwise the plumage was quite white.

Belvedere, Colombo, W. A. CAVE.
February 6, 1910.

2. *The Call of the Flying Squirrel.*—It was only after a considerable time that I was able to determine the author of a weird nocturnal cry that has attracted my attention at intervals ever since I have lived at Peradeniya. For a long time I supposed it to be produced by a night bird of some sort. But one moonlit night the cry was repeated for hours from a large tree overshadowing my bungalow, and I was at last enabled to associate it definitely with the large brown Flying Squirrel (*Pteromys oral*, Tickell). On this occasion the animal was evidently calling for its mate. The note was so monotonous and continued for such a long time that it "got on my nerves," and I endeavoured to frighten the beast away by bombarding it with stones. But it absolutely refused to move, even after a revolver had been fired off several times in its direction, and I had to abandon the attempt. The next morning this—or another individual (possibly the desired mate)—was found entangled in a barbed wire fence at a little distance up the road and knocked on the head by a passing cooly.

The note is a difficult one to put into words. It may be described as resembling something between the cry of a duck and that of a hen. It is a single, rather sharp note, resonant and metallic, with a sort of echo or subdued grunt. I recognized the same call one afternoon in the jungle at Mihintale.

There has been a small colony, a dozen or more strong, of these squirrels located in the Royal Botanic Gardens for many years. It appears neither to increase nor to diminish to any appreciable extent. Individuals are occasionally picked up beneath the palm trees in a moribund condition, but I have never been able to discover the cause of their death. It is certainly not of old age, for the dying animals were otherwise in good condition, with clean fur and well nourished.

Their headquarters appear to be in the palm grove at the entrance gates, whence they sally out at dusk, gliding from tree to tree in the vicinity, and often wandering to a distance of at least a quarter of a mile. They are frequently to be seen in the "Ingasaman" (*Pithecolobium saman*) avenue along the Station road, and in the large Bombax trees in front of the Mycologist's and Entomologist's bungalows. They are also partial to the old *Ficus elastica* trees that used to be such a feature of the approach to the Gardens, but which are now in a state of decay. On one occasion I had the rare pleasure of watching a troop of five or six of these graceful animals parachuting to and fro between the Ficus trees and the palm grove. A few individuals may be seen almost any night, if one has the patience to wait about between the hours of 6 and 7 P.M. just outside the gates of the Gardens. The exhibition of animal-æroplaning is worth waiting for.

Peradeniya. E. ERNEST GREEN.

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3. *Cobra Reminiscences.*—In 1891 I was stationed on the Hanwella-Bope road, about 2 miles from Hanwella, and occupied a small house belonging to Mudaliyar G. Amarasekera. This house was situated on a piece of land newly cleared and planted with coconut seedlings, and was surrounded by low and thick scrub. The ground was honeycombed with white ants' nests and infested with snakes, principally cobras and polongas, of which I killed about 160 odd in two years. I had come to know the white ants' holes which contained cobras, and noticed for one thing that these snakes habitually returned to the same holes, even though they might have taken temporary refuge in some other.

I was able to satisfy myself that the partiality of snakes (at least as regards cobras) for music is nothing but a myth. The sole effect, so far as I could see, was to arouse their curiosity, as they would project their heads out of their holes equally well for any kind of noise, from the shrill piping affected by snake charmers down to the tingling noise made by dragging a surveying chain past their dwelling, or even that made by light and repeated tapping with a switch close to their hole. It would appear, however, that the tone must be high, as grave sounds, such as tom-tom beating or deep notes from a flute or ocarina, had, so far as I could see, no effect upon them.

Another delusion, which is often found in story books, and which I have never observed, is the power of fascination which they are said to exercise towards birds. On the contrary, on at least two instances I saw cobras chased by birds. The first occurred in November, 1891. Returning from work about 5 P.M. I noticed some commotion occurring in the bush about 20 yards from my door. There appeared to be a dispute going on amongst some birds; their shrill cries could be heard proceeding from the same spot, accompanied by the fluttering of wings. I approached the place cautiously, and at first made out two ordinary sparrows circling about a nest placed at the top of a thin and flexible shoot about 4 ft. high. They were evidently greatly distressed and very angry, so much so that, although I came within 3 ft. of their nest, they paid no attention to my presence, but continued circling and pecking hard at something inside their nest. I thought at first some thieving bird had taken possession of it; it seemed of large size, as its continual movement inside the nest, to avoid the pecking, made the shoot sway backwards and forwards violently. All at once a cobra about 4 ft. long, so far as I could judge, sprang from the nest to the ground and disappeared in the jungle. I was greatly surprised, as I never expected a snake of that size to have been able to climb the shoot, which seemed much too thin to support its weight, or to enter the nest at all, and above all to remain hidden in it so long. In this instance the sparrows appeared to have not the slightest fear of the cobra. There was no doubt about the species of the snake, as I could see its hood extended as it fled.

The second instance happened in 1896, near Horana. I was returning to my camp about 3 P.M. when I saw a group of people gazing at the top of a large breadfruit tree. I asked them what they were looking at, and they told me that a crow was fighting an intruder into its nest situated at the very top of the tree. The crow was circling at close quarters and pecking hard at the nest, cawing loudly all the time. The nest was at some 40 ft. above ground. Presently a snake came out of the nest and started climbing down the tree, with the crow in hot pursuit behind it, pecking at it all the time, the snake hissing hard at every blow. It took refuge about 10 ft. down in a clump of dead ferns, from which it was chased out by the crow, and it came from branch to branch until it reached a large horizontal one, which stretched out about 20 ft. Here the snake was at great disadvantage, as it could not turn upon the crow. The latter seemed to know it, and its tactics were splendid. It would peck hard near the spine close to the tail and then peck near its neck. At each peck pieces of the snake's skin were torn, and the snake would stop; but as soon as it started moving the crow would peck at it again with extraordinary surety of aim. After fully 15 minutes on the branch two large patches had been torn out of the snake, which was evidently getting exhausted. At last one of the pecks must have landed on a more sensitive portion, as the cobra tried to turn to strike, but lost its balance and fell to the ground. Before I could stop them, it was despatched by two of the spectators, and the crow flew away. It was a pity, as I should have liked to have seen the finish of the fight, which was a most determined one. What struck me as remarkable was the extraordinary endurance of the crow, which was on the wing from start to finish for at least 20 minutes.

I have certainly never seen the fascination of birds. I once tied a cobra for three hours near some birds, but whether they knew the snake could do them no harm or not, they appeared to be totally unaffected. On the other hand, I once saw a frog stand perfectly still until its capture by a common olive green snake (with yellow band); but I could not make out whether it had *seen* the snake (I understand the eyesight of frogs is by no means acute), or whether, as the latter approached, the frog was really hypnotized.

I had often been told that wherever there were wild pigs snakes disappeared, the inference being that the latter were eaten by the pigs. But only on one occasion have I seen a fight between the two. It was in 1894, early in the morning, when I was going up the slope of Panyagulakanda, near Labugama, in order to take trigonometrical observations. I had proceeded along the bed of a dry stream some 200 ft. above the valley when I became aware of a commotion in the jungle on a small ledge some 40 ft. away from where I was. So far as I could make out some animal was jumping in the most curious way while remaining in the same spot. I thought at first that it had been caught in a trap, and I crept cautiously towards it, and as I approached I found the animal was a pig, and that a fight was going on between it and a snake. I went closer still until I was about 12 ft. from the scene of the struggle, which I watched with the greatest interest. A fine cobra about 5 ft. long was endeavouring to strike at the pig, which kept jumping about from side to side to avoid its blows. Within the first five minutes the pig appeared to have been struck twice near its shoulder, but of that I could not make sure, as the movements of both were very quick. Suddenly the pig changed its tactics; every time the cobra struck at him the pig would jump right over him, when the cobra would turn right round to face the enemy. This went on for several minutes, and I thought that the jumps were made in order to tire the snake out; but I soon found that when the pig jumped it held all its four feet bunched together. I now saw that it was attempting to fall with the whole of its weight upon the snake's back. After I had been watching them for about a quarter of an hour, the snake was getting perceptibly more sluggish in turning, and the pig succeeded in descending upon him once; the cobra now attempted to escape, but the pig prevented this by jumping near its tail, when the snake had to face him again. A few minutes later the pig landed fair and square upon the middle of the back of the cobra, the blow evidently breaking its backbone, or at least paralysing him, as the upper part of its body kept close to the ground, while its tail was lashing the ground all round. The pig immediately seized the snake just behind the hood with its mouth, and placing its fore feet on either side, severed the neck of the snake in a very few seconds. It now seized the head and swallowed it first, and then coming back to the body cut it up into pieces about 5 inches long, which it devoured very quickly. After despatching a few of them it happened to look up and saw me, and immediately made off as fast as it could, leaving the tail of the snake still wriggling on the ground.

What I have said above in connection with the effect of noise on snakes reminds me of an incident connected with snake-charming, which I shall put down here, as I believe it will be found interesting.

On a Sunday morning in February, 1892, two Indian snake charmers came to my small bungalow at Hanwella. They had three snakes with them, and proceeded to make them dance as usual. I stopped them and told them that I had seen all that before, and asked them whether they could compel a wild snake to dance, and if so, whether they could catch one for the purpose. One of them expressed his willingness to do so. Ten days previously I had chased a cobra of the species called by the natives "Tom-tom beater," that is, the black cobra with a red spectacle mark on its hood. The Sinhalese I believe think that they are re-incarnations of low-caste natives; hence its name. It is certainly fiercer and more active than the common brown cobra. I had noticed at the time that it had taken refuge in an ant-hill near the edge of the paddy field which formed one boundary of the new clearing upon which my bungalow stood, and situated about 200 ft. from it. I led the charmer to this ant-hill, as the black cobras are comparatively scarce, and this was only the second specimen of the species that I had seen up to that time, in order to make certain that he had not previously hidden one of his own snakes in the ground. When I had assured him that a snake almost certainly occupied the hole, he squatted down opposite to it and started blowing into a reed pipe, which gave a sound similar to that of a bagpipe. After a long time, and when I had almost given up the idea of the snake being there still, the cobra protruded its head about an inch out of the hole in order presumably to see what was going on; the charmer pounced upon it, and seizing the head of the snake between his thumb and two fingers so that it could not open its mouth he pulled it out of the white ants' nest and brought it to the bungalow. He then tried to make it dance by holding a small piece of white root above its head. The snake tried to escape several times, but was brought back again, and ultimately was induced to dance with its hood extended; so far as I could judge it was the same snake that I had noticed before. I then asked the charmer what he would do if he happened to get bitten by a wild snake. He told me that he did not mind it, as he had a certain medicine which would prevent any ill-effects. I then, more as a joke than anything else, promised him five rupees if he would allow himself to be stung by the snake he had just caught, fully believing that he would never attempt the trial. But before I could stop him he had seized the snake by the neck and had thrust the forefinger of his right hand deep into its mouth, and when he withdrew it there were two punctures on each side of the second joint. Both punctures were bleeding slightly. He at once handed over the cobra to his companion, who immediately shut him up into the snake basket, and the charmer presently took out from his waist cloth a piece of charred bone, well known as the snake stone, which he applied at once to the two punctures. He then waited for some minutes, and I could see the veins on the back of his hand standing out like knotted strings. After a couple of minutes or so the stone dropped down, and he then told me that he had extracted all the poison; and calling for a small coconut shell full of milk he dropped the stone into it; in a moment, after a considerable amount of bubbling, there came to the surface a certain amount of an oily looking liquid, pale straw in colour.

In order to test whether the wounds on his knuckle had been produced by the fangs, or whether they were due to scratching by the back teeth, I called for a small chicken, of which I had a certain number in my fowl run, and making a small incision on its leg I dipped a feather into the oily liquid and rubbed it into the incision. The chicken died within ten minutes, with all the symptoms of snake bite. I then paid the man the amount agreed upon, and obtained in return from him a snake stone, the piece of white root which he had used to charm the snake, and a small disc of brownish material, which he said was a talisman against the action of snake poison. He asked me as a favour to be allowed to take his new capture away with him, a permission which I very gladly gave him; but I have had so far no occasion to make use of the three objects which he presented me with, and which are still in my possession.

Colombo, March 9, 1910. H. O. BARNARD.

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4. ***On the remarkable superficial resemblance of a variety of Larra fuscipennis (Cam.) to a Male Mutillid.***—Amongst other Hymenoptera collected by Dr. Willey on a recent tour through the Northern Province, he showed me a rather remarkable variety of *Larra fuscipennis*, a burrowing wasp belonging to the family Sphegidæ, which, owing to the abnormal amount of red on the abdomen, strikingly resembles the male of a Mutillid, *Mutilla dimidiata* (Lepel). The specimen was taken in November near Elephant Pass, whilst flitting about close to the ground at the edge of a shallow pool, looking, when on the wing, like a male mutillid wasp searching for its wingless female.

The families of the two species are very widely separated in point of structure. In the Mutillidæ the pronotum reaches back to the base of the wings; whilst in the Sphegidæ the pronotum does not extend to the base of the wings, but more often forms a mere collar.

The markings of the Mutillid are as follows: basal five segments of the abdomen red, the two apical segments black. The Larrid has the three basal segments red, the fourth slightly black in the centre, and the apical two black. The typical *L. fuscipennis* (Cam.) has only the two basal segments red, with the centre above black, and the rest of the segments black.

Possibly the Larrid may be a new species, although very like *L. fuscipennis* in structure. Dr. Willey tells me he caught this Larrid under the impression that it was a male Mutillid, the resemblance in general colouring and size being so deceptive.

Colombo, March 14, 1910. OSWIN S. WICKWAR.

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5. *Awkward nesting place chosen by Sceliphron violaceum* (*Fabr.*).—Wasps are very justly credited with a considerable amount of instinct and reason, and it is therefore interesting to note what appears to us to be a want of common sense in certain individuals, and to try and account for it.

In the ceiling of my room there are some horizontal rafters with a flat surface whitewashed over, and at some time or other stout nails have been driven in from below and withdrawn, leaving perpendicular holes about 1 to 1½ inch deep with the opening at the bottom. For a long time a specimen of this wasp (a common metallic blue insect with a very thin waist or petiole, which frequents houses in search of spiders or nesting holes) has been trying to store one of these holes with spiders. It comes along with a stupefied spider generally held between the intermediate legs, and in the first place has a considerable amount of difficulty in alighting, so much so that it often drops its prey in trying to do so. When at last it succeeds, it has then to ram home these spiders as "cold meat" for its young, but in doing so the spiders, or most of them, naturally fall out as soon as they are put in, with the result that the particular nest which I have watched for some weeks is not yet fully provisioned, and still this industrious little insect works away as hard as ever. Perhaps this little individual has some very good reason of its own for selecting such a difficult position.

In other instances these insects show a considerable amount of instinct or reason, for I have seen several nests built in the holes in whitewashed walls, and after lining a hole, storing it with spiders, and sealing it up with clay, they have covered over the clay with a white substance, thus covering all traces of a nest. I have not been able to ascertain what this white substance is composed of, although I suspect it is made from the white secretions of some of the common scale bugs which are found in large quantities on some plants, especially in the dry weather. I have often noticed *S. violaceum* busy amongst clusters of these bugs, but have not actually caught it in the act of collecting this white substance.

Colombo, March 16, 1910. OSWIN S. WICKWAR.

6. *Association of Barnacles with Snakes and Worms.*—The object of this note is to present to the readers of this journal a picture showing a group of barnacles belonging to two species attached by their stalks to the flattened tail of a sea-snake, *Hydrus platurus.* The attachment of barnacles to the skin of sea-snakes has long been known, and was of course mentioned repeatedly by Darwin in his "Monograph of the Cirripedes," but a conspicuous example like the one here figured is not so commonly met with in Ceylon. The specimen was brought alive to the Museum on July 23, 1909. The two species of barnacles can be recognized in the drawing; the one with complete white calcareous valves is *Lepas anserifera,* which Dr. Annandale referred to in *Spolia Zeylanica*, vol. III., p. 193, as being "the commonest pedunculate form on floating objects in this part of the Indian ocean"; the other exposing the soft brown mantle which carries the greatly reduced calcareous valves is *Conchoderma hunteri.*

The barnacles are not ectoparasites, as they do not feed upon the skin of the snake, nor do they assist the snake in any way; on the contrary, their presence must have seriously impeded the movements of the snake. Moreover, they thrive equally well when attached to floating bottles and drifting spars. So far as the snake is concerned, they are simply an incubus which cannot be shaken off, and the snake is merely their facultative vehicle. These barnacles are sedentary animals destitute of proper powers of locomotion, although capable of securing their own nourishment, but they have acquired a planozoic or passively vagrant habit, and they must be kept on the move.

Their relation to the snake is somewhat analogous to a remarkable case of association between certain Hydroid polyps (*Stylactis minoi*) and a small rock perch, *Minous inermis*, which was found by the Royal Indian Marine Survey ship "Investigator" in several places off the Indian coast, from the Mahanaddi to Calicut, in depths of 45–150 fathoms. The skin of the fish is beset with the commensal polyps, which have never been found elsewhere, and Colonel Alcock ("A Naturalist in Indian Seas," London. 1902) thinks that they help to conceal the fish from its enemies, in that they play the same part which is, in other cases, performed by frond-like cutaneous filaments.

The barnacle *Lepas anserifera* always, in my experience, occurs in pure culture when attached to bottles and logs, unaccompanied by the *Conchoderma.* But under these conditions, more particularly on logs, it is frequently accompanied by two Annelid worms, very distinct from each other, though both belonging to the same family, Amphinomidæ. In August, 1907, and December, 1909, Lepas-logs were brought to me at the Museum, upon which I found numbers of these two species, *Amphinome rostrata* and *Hipponoë gaudichaudi,* not previously recorded from Ceylon, but known from the South

Swarm of *Apis dorsata* building a comb on the roof of a verandah in the Colombo Museum.

Pacific, the Mediterranean, and the Atlantic coast of North America. The *Hipponoë* is the rarer species, and has a rich uniform pinkish coloration resembling the colour of the egg-ribbons of the *Lepas*. It sometimes penetrates within the valves of the barnacle.

Colombo, March 29, 1910. A. WILLEY.

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7. *Nest of the Bambara Bee at the Museum.*—During the building operations at the new wing of the Museum the outer verandah was appropriated by a swarm of bambara bees (*Apis dorsata*), who began building their comb on the roof of the verandah in March, 1909. They crowded together one over the other to form a dense swaying mass in the characteristic crescentic shape of the future comb, although nothing of the latter was visible. Many of them were found lying dead upon the floor from time to time. On May 19 I took a photograph of them from the top of a temporary platform. About this time the yellow basal portion of the comb began to show against the woodwork of the ceiling. Individual bees were constantly leaving the mass and returning to it laden with yellow bee-bread, round pollen-masses attached to the hind legs (femora).

On July 14 the swarm was still at work, the bees on the lower or growing part of the comb constantly leaving and returning to it as before, but now bringing two packets of white bee-bread. They had now arranged themselves in vertical columns or chains, after the fashion of the red ant (*Oecophylla smaragdina*) when drawing leaves together preparatory to the construction of a nest; one such living chain, 6 or 7 inches long, was seen to be detached from the main mass, except at the two ends.

On October 14 a Death's Head moth, which is known as a pest of beehives, was found dead on the ground below the comb; presumably it had been overpowered and stung to death, though it is hard to say why intruding moths are not always killed by the bees.

On November 27 the swarm deserted the comb in a body. The life of this particular comb thus lasted almost exactly nine months.

It is known that these bees sometimes attack horses and pedestrians, and can constitute an actual danger when disturbed, although I cannot give any references to published accounts of such attacks. The local saying is that if seven of these bees attack a man he will die.

This species is distributed over most parts of the Island to the tops of the highest mountains. In February, 1910, Mr. E. E. Green and I found them visiting the blue flowers of the "nellu" (*Strobilanthes*) on the summit of Namunukuli, near Badulla, in great numbers whenever the sun was sufficiently strong to dispel the rising mists.

Colombo, March 31, 1910. A. WILLEY.

8. *Symbols and Offerings.*—For about two years an interesting ivory object has been exhibited at the Colombo Museum. It has the form of an ivory shuttle, upwards of 10¾ inches in length, nearly 1¼ inch deep, with a decorative design lacquered red, and the story attached to it at the time of its acquisition was to the effect that it had been granted by the King of Kandy to a family of weavers as a symbol or certificate of their appointment as weavers to the royal household. Instead of giving them a sannasa, he gave them a symbol of their trade executed in precious material. On the upper side of the boat-shaped body of the shuttle there is an oblong cavity to receive the thread and a hole through one side to pass it.

This example appeared to be unique in its class, although it seems likely that an ivory *udakkiya*, or hand drum, a small spindle-shaped double-ended drum, of the same size and shape as the common lacquered wooden drums carried in perahera processions, previously lent to the Museum for exhibition by Mr. P. E. Pieris (see this journal, vol. III., p. 10), had a corresponding significance, although as is unfortunately the case with so many valuable specimens no story was attached to it.

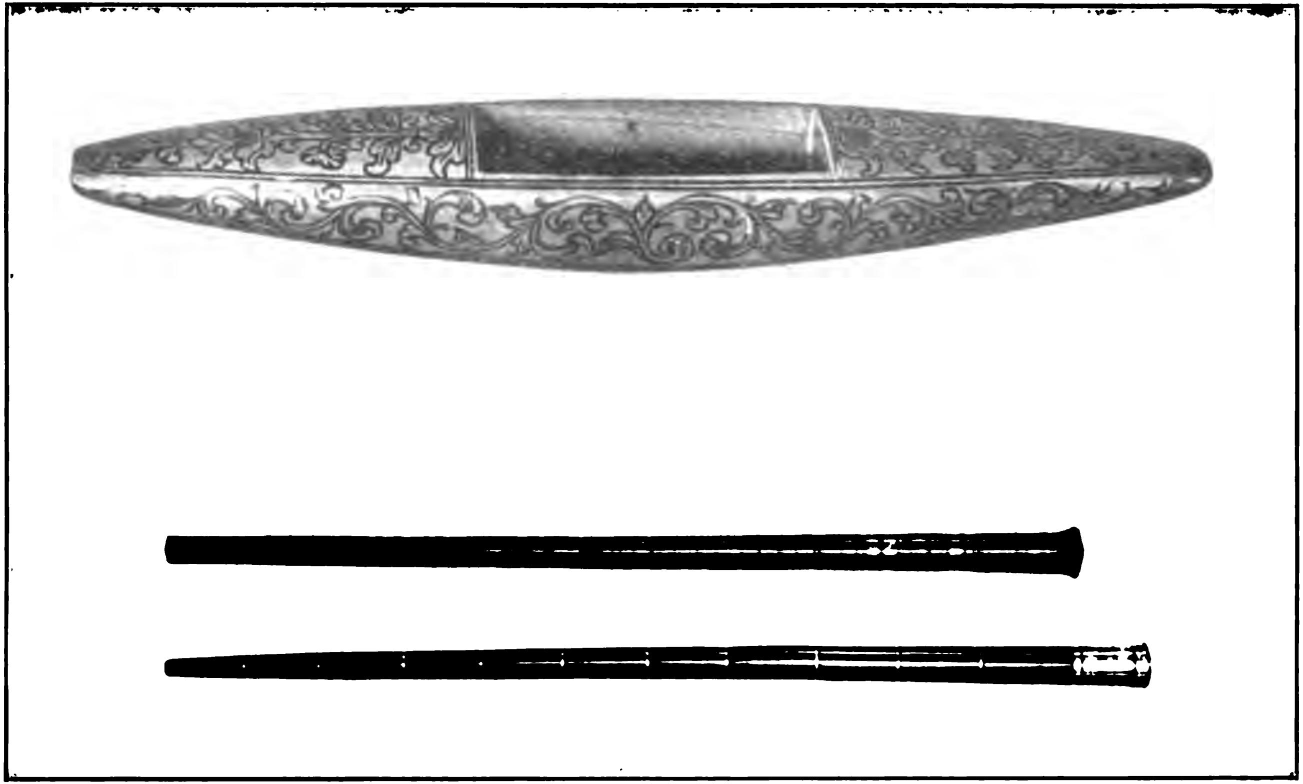
I am indebted to the writer of a letter which appeared in the *Ceylon Independent* on September 30, 1909, for some references to Mr. Justice A. C. Lawrie's "Gazetteer of the Central Province of Ceylon," Colombo, 1896, where somewhat similar instances are mentioned. The letter was entitled "Some Historical Royal Souvenirs as substitutes for Sannasas"; it is possible that the writer (who signed himself R. P.) had seen the ivory shuttle at the Museum.

The first reference is to p. 464 of Lawrie's Gazetteer, where it is recorded under the name of the village Kondadeniya, between Katugastota and Haloluwa, that one Udawattege Punchi Kankanama had stated to the Judicial Commissioner on November 28, 1828, "that he had no Talpot (*talpata*), but produced a billhook (*ketta*) given to his father by the deposed king for land, for taking care of the king's pineapple plantation in this village."

The second reference is to p. 570, where the Judicial Commissioner's diary of July 5, 1824, records that Iwedde Mudiyanse of Medagoda "gave his eldest son the rattan which his ancestor received from the king as a Sannas for land when first taken into the Katupulle Department."

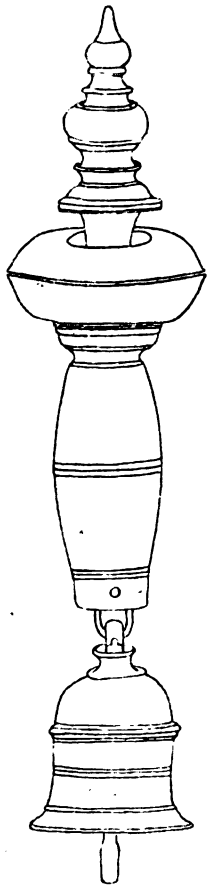
The third and last reference is to p. 761, where it is recorded that Ratwatte Disava stated to the Judicial Commissioner on October 24, 1821, "that the lands at Rambuk-oluwa were given to his father by his great-grandfather, the Dumbara Maha Disava, and that he had a firelock as a Sannas for the lands."

Another very interesting symbol of authority has recently been added to the collection at the Museum. This is a devil dancer's rattle (*halamba*) mounted upon an elegantly fashioned ivory shaft,



Ivory Shuttle.
Two jointed Medical Staffs.

to which a small bell is attached below (see figure). It was highly esteemed by the owner, a bali-karaya or itinerant devil-dancer, who goes about to houses to exorcise evil spirits and incidentally to cure diseases. The story was that it had been awarded as a Sannas to the great-great-grandfather of the present holder. The length

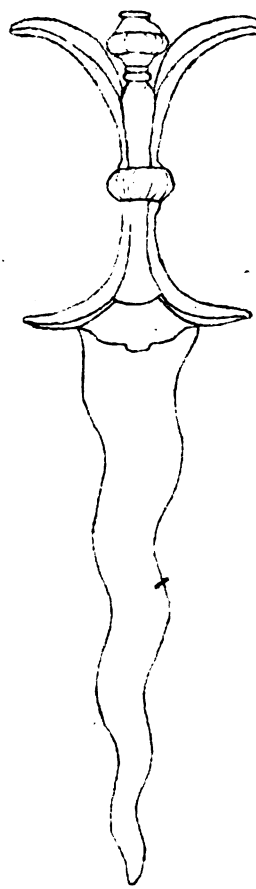


Ivory-handled Rattle and Bell.

of the ivory shaft above the rattle is about 2½ inches; the part below the rattle is upwards of 3 inches.

To the same category of *similia similibus* must be reckoned a very finely modelled silver outrigger boat said to have been vowed to Sinegama Dewale, near Hikkaduwa, about thirty-five years ago.

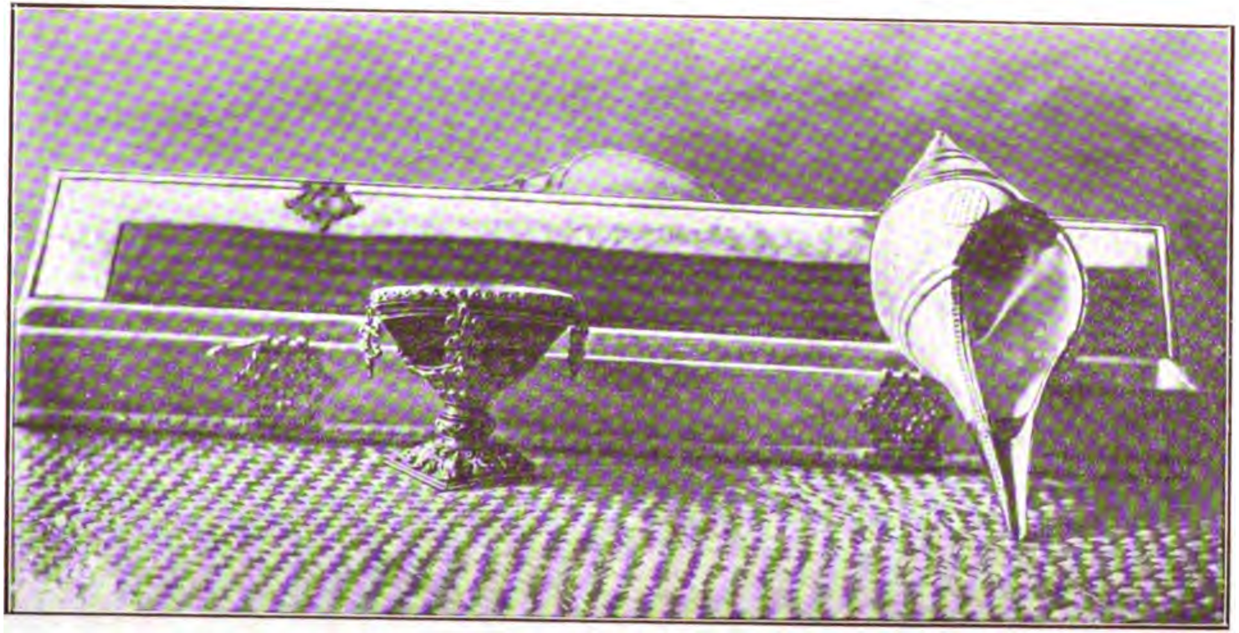
It is now exhibited at the Museum amongst a collection of *Devale abarana*, or appurtenances of dewales. It is called *Yatrawaka-ta bare*, and was offered on the occasion of the launching of one of the large coasting Sinhalese sailing vessels with outrigger, which carry salt from Hambantota to Weligama and other places. These boats are



Fire-brand Dagger.

called *Yatrawaka*, in contrast with the common fishing boats, to which the name *oruwa* is applied. The silver model has not been figured, but it is worth seeing.

The last object to which I wish to draw attention is the dagger represented in outline. It is characterized by the wavy blade



Treasures in the Maha Dévále.

resembling a flame, and on that account is called "fire-blade." It resembles a Malay kris, called in Ceylon, according to Mr. H. Parker ("Ancient Ceylon," London, 1909, p. 532), *kricciya*. He says "it is rarely seen, and does not often appear in the wihara paintings; but it is represented at the Dambulla wihara, where it is held as a dagger. The fact that a broken blade which appeared to belong to this weapon, with at least three bends, was discovered in the Tissa excavations, in the lowest pottery stratum, proves that it had been introduced into the Island in very early times." The same form of blade sometimes occurs in spear-heads. Mr. Parker (*loc. cit.*) adds that the *itiya* is the true Sinhalese form of a weapon of this type. "It is a narrow-bladed, short, stabbing spear or assegai, but it is also held like a sword. It is described as having a thin blade 18 inches long, with bends resembling those of the kris, and two cutting edges. It is found in the Dewalas, and appears in the temple paintings among the arms carried by the demons in their contest with Buddha. In a large statue of Kali at Anuradhapura, this goddess grasps it like a sword, and holds it erect."

The Sinhalese *kricciya* or hunting-knife is again mentioned by Dr. C. G. Seligmann in a "Note on the Bandar Cult of the Kandyan Sinhalese," published in "Man," vol. IX., No. 9, September, 1909, pp. 130–134.

The symbolic use of a long-bladed knife in a devil dance is also described by Mrs. Brenda Z. Seligmann in an illustrated paper entitled "A Devil Ceremony of the Peasant Sinhalese," published in the Journal of the Royal Anthropological Institute, vol. XXXVIII., 1908, pp. 368–379.

The iron handle of the dagger here figured shows remains of silver damascene-work (not drawn in the sketch); the blade is rather more than 8 inches long, and has seven bends. It was said to have been obtained in Kandy. The Sinhalese name is *gini-dalu-kricciya*.

The two objects figured below the ivory shuttle are medical staffs, the lower one made of horn and mounted with silver, the upper one of horn and ivory.* They were formerly carried about by vedaralas or native doctors. Each of them is composed of a number of hollow sections fitting together, and each section is the receptacle for a specific drug. Their length is that of an ordinary walking stick.

Colombo, March 31, 1910. A. WILLEY.

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9. *Chank and other Objects from the Maha Devale, Kandy.*—The accompanying illustration shows an ivory case and gold *sannasa*, a gold-mounted chank, and a gold-mounted cup belonging to the Maha

* This has been deposited in the Museum on loan by Mr. de Lanerolle, through Mr. P. E. Pieris, C.C.S.

Devale; these have also been figured in my "Mediæval Sinhalese Art," Pls. XL. 7, XLIII. A 4, and XLII. 5, together with a silver *kendiya* from the same temple, Pl. XLII. 4. The *sannasa* has been translated in the "Ceylon National Review," July, 1906, p. 234, and the text is given in "Jnanadarsaya" for the same year. The little *pacca kusalana*, miscalled "emerald-cup," is gold-mounted and set with rubies and sapphires, the decoration of the rim being *gal-bindu*, and of the base *pala peti*, while the pendant flowers are *sina mala*. The material of the cup itself has not been identified. The cup was no doubt used at royal inauguration ceremonies, when the sword of state was first girded on the king; and perhaps on other occasions when the king visited the temple and sandal paste was offered to him as a mark of respect, as is still done to distinguished visitors at Hindu temples. The following account of the inauguration ceremony is given by Davy ("Travels in Ceylon," p. 168): after the sword of state had been girded on to the prince by a member of the Pilima Talave family, whose privilege this was, the Kapurala "presented a pot of sandal-powder, in which the prince, who may now be called king, dipped his fingers and touched the sword; and this ceremony was performed in the Maha as well as in the Nata Devale."

The *sannasa*, cup, and chank are said to have been dedicated to the Maha Devale by Rajadhi Raja Sinha, after a victory over the Dutch at Gurubebile.

The *sannasa* itself, known as the "algam sannasa," was granted by Narendra Sinha.

Campden, Gloucester, December 13, 1909. A. K. COOMARASWAMY.

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10. *Book Notice.*—**Dermaptera (Earwigs). By Malcolm Burr, D.Sc., M.A., F.E.S., F.Z.S., Fauna of British India (London: Taylor & Francis).**—The latest number of this well-known series consists of a remarkably well-conceived and executed half volume on the Earwigs of British India. It will be a surprise to persons who have given no consideration to the subject to learn that sufficient material exists for even a half volume devoted to this order of insects alone. Earwigs are not such "common objects of the country" here, as they often are in England. I have even met otherwise well-informed persons who were unaware that earwigs of any kind occurred in Ceylon. Yet this volume describes 135 distinct species (of which 42 are recorded from Ceylon), against the three or four only that are known to occur in Great Britain.

The author in his preface defines his use of the term *type*, and pins himself to "the principle that one individual specimen, and one only, can be the type of the species." All other individuals that may have been studied during the preparation of the diagnosis are designated *syntypes*. A further term—*paratype*—" is applied to a specimen which has been identified authoritatively by comparison with a true type." I presume that to have been identified authoritatively in this sense, the comparison must have been made by the author of the specific name.

The author's claim that " no work upon this group of insects has yet enjoyed such accurate and abundant illustration " is well borne out by the ten plates (one of them in colours) containing 104 " full-length " pictures of earwigs. Ceylon is well served in this particular. Of the 42 species recorded from this Island, no fewer than 30 are fully illustrated. With such a wealth of illustration provided, it seems ungracious to ask for more; but one could wish that the distribution of favours had included some of the genera that now remain unfigured. For while every species in certain genera (*e.g.*, *Forcipula* and *Labidura*) has been honoured, others (*e.g.*, *Borellia*, *Nannisolabis*, *Metisolabis*, and others) are left out in the cold.

The figures themselves are of exceptional merit. Mr. Wilson has caught the character (one might almost say the expression) of each species in the happiest manner.

The introductory chapter deals very fully with the general structure of earwigs, and is illustrated with some really useful diagrams, indicating in the clearest manner every detail mentioned in the descriptions.

The sections on Development and general Bionomics are especially interesting and valuable. Every available grain of information has been carefully garnered and cleverly fitted into position. These sections, which occupy eleven pages, are a feature of the book that differentiates it from all other volumes of the series that have yet appeared. It is to be sincerely hoped that the authors of future volumes will emulate Dr. Burr's example in this particular.

A complete list of the literature of the subject precedes the main body of the work, of which it is sufficient to say that the descriptions are fully and admirably clear. There are practicable keys to both genera and species, which with the ample descriptions should make the identification of any species an easy task.

The appendices include a short section " On Collecting and Preserving Earwigs," and a complete glossary of terms employed in the work. The latter should be studied before making use of the descriptions, as the author gives somewhat unusual definitions to a few of the terms. Thus, the term *conical* is " applied to segments which gradually increase in thickness from base to apex " —a definition that pertains more strictly to the word *obconical*. Again, *crenate* and *crenulate* usually convey the idea of a finely scalloped edge or margin; but our author employs the term in the sense of " furnished with teeth like a comb "—a condition that would be more properly described as *pectinate*.

It is gratifying to learn that Dr. Burr is now engaged upon a monograph of the earwigs of the world. The excellence of the present work is a pleasing foretaste of what may be expected from the forthcoming *magnum opus*.

E. E. GREEN.

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11. *The Bite of Russell's Viper.*—At midnight on April 6, 1910, I was hastily summoned to see the late Mr. MacIntyre, Postmaster of Trincomalee, who had been bitten by a polonga. On arrival at his residence, thirty to forty minutes after the accident, I found him seated erect on a chair on his verandah. He was bathed in a cold, clammy sweat, and complained of feeling sick, and was vomiting continually. The ejected matter consisted of a few grains of boiled rice and water and bile-stained fluid, and later on of glairy mucus. He had been attended to, within five or ten minutes of the accident, by a constable, who applied to the wound a black "snake stone" such as I have seen in the possession of "snake charmers." Internally a remedy, prepared by dissolving part of a light green stone in water, had been administered with the object of producing vomiting.

The Postmaster stated that about ten minutes after he retired to bed he heard a noise as of heavy breathing, and imagining that it was his little boy who was asleep, he walked over to the latter's cot, about four feet away. Making him comfortable, he was returning to his own bed, when he felt a sharp sting over his heel, and jumped into bed. Simultaneously, hissing sounds were heard, and it immediately struck him that he must have been bitten by a snake. A light was brought into the room, which had been in darkness, and a search made, and a polonga was found coiled up in a corner. Three hemp ligatures were applied by his wife round the injured limb: one just above the ankle, another round the knee, and the other round the lower part of the thigh. The wound is said to have bled freely, staining all the bed linen. Careful examination, after cleansing of the limb, revealed a single, black, pin-point puncture on the inner side of the right heel, about an inch above the sole. There was then no bleeding, and but very slight pain complained of. The tissues around had a faint bluish tint, and the limb was swollen from the knee downwards. The ligatures, I found, were not too tightly applied. The patient complained of great weakness, and there was much restlessness, violent retching, and inability to sleep.

I incised the wound freely, and injected into it a saturated solution of permanganate of potash. A series of punctures were also made all round, and the same solution injected hypodermically into the tissues. Powdered crystals were then rubbed in, and the wound packed with the same. The limb was postured, and compresses also of the solution applied and frequently renewed.

Four fluid ounces of whisky and half an ounce of sal volatile were administered internally at once, and a full dose of strychnine and ether injected hypodermically into the arms an hour later. The subsequent treatment consisted of a mixture of carbonate of ammonium, citrate of caffeine, strychnine, and digitalis, and hypodermic injections of adrenalin and strychnine. The treatment adopted was that described by Dr. J. W. Watson Stephens, and in his hands proved very successful in Siam. The vomiting ceased after the first dose of whisky had been administered. I was not certain as to whether the vomiting and cold sweats were due to the snake poison or to the emetic administered by the constable, but it was evident later that these were effects of the former. The poison, therefore, had undoubtedly entered the general circulation before I first saw the patient. At dawn the patient was not so restless, but complained of great thirst and hunger. The bowels had acted once and were relaxed, the skin was warm, the tongue dry, the expression anxious, and the eyelids had now a very heavy appearance, and he was unable to open them wide. The elevators of the lids exhibited paretic symptoms. The pupils were contracted, fixed, and equal. Pulse was quick, 115 per minute, and moderately full. Finding that the ligatures were rather lax, I proceeded to remove them, following the procedure recommended by Prentiss Willson in the "Arch. of Internal Medicine," June, 1908, by intermittingly relaxing the ligature nearest to the heart, letting it become looser and looser until it was entirely removed, and the other ligatures removed in the same manner, at the same time watching the effect on the patient. At midday vomiting commenced again, but was not persistent. The tissues all round the wound were slightly tumefied and inflamed. Bleeding took place every now and again, especially if the patient exerted himself. A noteworthy feature of the blood was that it was thick, dark in colour, and did not coagulate. Restlessness was more marked. Weakness, depression, and exhaustion and pains in the small of the back were complained of, but there were no cramps, no paralysis of the limbs, and no convulsions. The skin again began to break out in cold, clammy sweat. The abdomen was distended and tympanitic, the upper part exhibiting a board-like hardness. Eructations were frequent, but did not appear to relieve the patient. He complained of suffocating pains, as if both sides of his chest were being compressed. There was great oppression. Respiration was hurried and laboured, and the pulse was becoming weak and more rapid—125 per minute. Sight was rather dimmed, but recognition of objects and persons was possible. Sinapisms were applied to the feet and over the præcordial region, and saline infusions injected per rectum, and the patient seemed to rally somewhat, the pulse falling to 118 per minute. At this stage, however, his case was taken over by a native "snake physician of known repute," and English treatment given up, but the case was watched by me with interest to the end.

Drops were instilled into the eyes by the "vedarala," and this appeared rather to aggravate the dimness of sight. Internal remedies were also administered, but with the withdrawal of stimulants there was a steady rise in the pulse, till at 5 P.M. it registered 132 beats per minute, and was soft and feeble. Respiration also became more hurried and difficult.

At 10 P.M. the pulse rose to 142 per minute, and slight signs of lividity were noticed about the face. The native physicians were now making preparations against the twenty-fourth hour, which is stated to be a critical time with cases of snake bite. At about 11 P.M. dried bile from chickens was insufflated into the nostrils, which made the patient feel very short of breath. Within a couple of minutes he called out to his wife to hurry quickly up to him, and taking leave of her dropped back on his pillow and expired instantly. Consciousness and the power of speech were retained to the very last. Death appeared to have been due to asphyxia and heart failure, and I am firmly convinced that free stimulation from the very onset is strongly indicated in cases of snake bite, if only to prevent the extreme exhaustion which marks these cases.

The external appearances noticed eight hours after death were lividity of the face, which was almost black. The lower portion of the face was swollen. Livid patches were also seen on the neck, chest, and lower extremities. The palmar aspect of the fingers was black in colour, and the nails were of a deep purple hue. A blood-stained fluid was issuing from the mouth and nostrils. The pupils were widely dilated, and the eyeballs congested. Post-mortem rigidity had disappeared, and decomposition was setting in early.

Civil Hospital, A. E. SPAAR.
Trincomalee, April 14, 1910.

H. C. COTTLE, GOVERNMENT PRINTER, COLOMBO, CEYLON.

SPOLIA ZEYLANICA.

"MIMICRY" IN CEYLON BUTTERFLIES, WITH A SUGGESTION AS TO THE NATURE OF POLYMORPHISM.

By R. C. PUNNETT, M.A.,

Fellow of Gonville and Caius College, Professor of Biology in the University of Cambridge.

(With two coloured Plates.)

BEING interested in the striking resemblances in colour and pattern which are to be found between butterflies belonging to different genera and families, I took advantage of a visit to Ceylon during the past summer (1909) to observe as many as possible of these cases in the living state. Though my stay on the Island was a short one—two months only—it was mainly devoted to the study of these phenomena, and as I have arrived at definite conclusions on some points, I have thought it worth while to place on record my observations, together with the few experiments that I was able to undertake.

Before, however, proceeding to my subject-matter, I wish to make certain acknowledgments. To my friends, Dr. Willey and Mr. R. H. Lock, I am grateful for unwearying kindness and for generously giving me all the assistance that was in their power. I owe also a debt of gratitude to Mr. E. E. Green for placing freely at my service his encyclopædic knowledge of the insects of Ceylon, and for a consignment of butterflies which arrived shortly after my return. To Col. Manders and to the Hon. Mr. F. Mackwood I am indebted for information; to the latter also for several specimens. Lastly, I wish to acknowledge the kindness of Prof. Poulton, who was good enough before my departure to give me some duplicate specimens illustrating the most conspicuous cases of mimicry in Ceylon butterflies, thereby materially lightening my task of becoming familiar with a strange fauna.

The Principal Cases of Mimicry in Ceylon Butterflies.

Though the Rhopaloceran fauna of Ceylon is not a rich one in comparison with that of most tropical countries, several cases have nevertheless made their way into the literature of mimicry. These cases I have put together in the following list :—

Mimic.	Model.*
Hypolimnas bolina, ♀	*Euplœa* (several species)
,, *misippus*, ♀	*Danais chrysippus*
Elymnias fraterna, ♀	,, *plexippus*
Argynnis hyperbius, ♀	,, —
Pareronia ceylonica, ♀	,, *vulgaris* (and allies)
Prioneris sita, ♂ and ♀	*Delias eucharis*, ♂ and ♀
Papilio clytia, ♂ and ♀	*Euplœa* (several species)
,, (var. *dissimilis*) ♂ and ♀	*Danais vulgaris* (and allies)
Papilio polytes, ♀	*Papilio aristolochiæ*
,, (var. *romulus*) ♀	,, *hector*

With the exception of *Argynnis hyperbius* and *Prioneris sita* I have had frequent opportunities of observing all these cases, and in every one it has appeared to me that the resemblance is far less striking when the insects are seen alive than when they are exhibited pinned out in the orthodox way on cork. I have found that with very little experience the eye comes to distinguish the "mimic" from the model without hesitation. As a rule, it is in mode of flight that they differ from one another. By this character the *dissimilis* variety of *P. clytia* can at once be distinguished from *Danais vulgaris* and its allies, and by it the normal form of *P. clytia* or the female of *Hypolimnas bolina* (Pl. II., fig. 6) can be readily differentiated from any of the *Euplœas*. Or again, it may be a difference in the pattern of the under surface of the wings which leads to dissimilarity in the general appearance of the living insects. The female of *Pareronia ceylonica* (Pl. II., fig. 1 B) with outspread wings is exceedingly like *Danais vulgaris* and the other closely allied species of this genus. But as soon as it flies off the difference of under surface at once becomes apparent (*cf.* Pl. II., figs. 1 C and 2 B), and in this particular instance there is also a marked difference in the manner of flight, so that these forms, although so extraordinarily similar when viewed from the upper surface and at rest, could certainly not be confused when flying. And when at rest, of course with the wings closed, they could not possibly be mistaken for one another.

One of the best known of the Ceylon models is *Danais chrysippus*, together with its ally *D. plexippus* (Pl. II., figs. 9 A and 9 B), and the three principal mimics of these two forms are the females of *Hypolimnas misippus*, *Argynnis hyperbius*, and the Satyrid, *Elymnias fraterna*. Of these three, the last-named was the one I had most opportunity of observing. It was common in Colombo during July,

* I have also seen it suggested that *Elymnias singhala* mimics *Euplœa core*, and that *Ergolis* serves as a model for the female of *Apatura parisatis*. In neither case does the resemblance seem to me sufficiently close to require further notice.

flying in places where both the models were also abundant. The colour pattern of *E. fraterna* (Pl. II., fig. 8 B) is less sharply cut than in either of the models, and this feature, combined with a somewhat different mode of flight and an entirely different scheme of colouration on the under surface (Pl. II., figs. 8 C and 9 B) is, for any but a quite unpractised eye, sufficient to identify this species at a distance of 20 feet or more away.

The case of *Hypolimnas misippus* female and *Danais chrysippus* is now so well known that it is unnecessary to dwell upon the extraordinary resemblance between these two insects as regards the upper surface of their wings. *H. misippus* I only met with occasionally, and never flying with the ubiquitous *D. chrysippus*. Its mode of flight is quite distinct, and had I seen them flying together my impression is that I should not have had much difficulty in picking it out from among the Danaids.

The relation of *Argynnis hyperbius* female to *Danais plexippus* is an interesting one. As the plate shows (Pl. II., figs. 9 A and 10 B), the two insects are quite distinct in appearance when set out in the ordinary way. But when flying, I am told by Col. Manders that they are extraordinarily alike. Now, *A. hyperbius* is a typical up-country insect, and is very rare below 4,000 feet. *D. plexippus*, on the other hand, is very rarely to be met with above 4,000 feet. The two forms only come into contact over a narrow zone on the confines of their respective territories, and for the most part their distribution is entirely separate. Under these circumstances it is difficult to believe that the presence of a distasteful species in another part of the Island, which looks like the Fritillary only during flight, can in any way benefit the latter by serving as a model.

Papilio clytia is a tailless form, dimorphic in both sexes. The brown form with orange-yellow spots on the margin of the hind wings (Pl. II., fig. 3 B) bears some resemblance to a *Euplœa* (Pl. II., fig. 11), while the other form [var. *dissimilis* (Pl. II., fig. 3 A)] is striped somewhat after the fashion of *Danais septentrionis* (Pl. II., fig. 2 A) and *D. vulgaris*. The ground-colour of the Papilio however is yellowish, while that of the Danaids is blue with a slight greenish tinge. The brown form I only met with once at close quarters, in the jungle just outside Trincomalee. *Euplœas* were very abundant at the time, but as the Papilio approached me I at once recognized that it was something different, and when caught it turned out to be *P. clytia*. Subsequently I saw several specimens in the open at Dambulla, and although I was unable to catch them there was no question of comparing them with *Euplœa*, owing to their general appearance and their stronger and bolder mode of flight. *P. clytia* var. *dissimilis* I saw first in the jungle near Sigiriya, and had no difficulty in recognizing it, though I could not get near enough to catch it among the trees. Later on I took it at Dambulla, where it was not unplentiful on the top of the rock. Danaids were also flying there, but there was no question of confusing the Papilio with them.

Putting aside for a moment the case of *Papilio polytes*, to which I shall refer later, my impression of all these so-called cases of mimicry, which I have been able to see, is that the resemblances are certainly not sufficiently close to deceive the eye of a civilized man with little experience of them. For that reason I am inclined to doubt whether they would systematically deceive an enemy brought up among them, whose means of earning a livelihood depended largely upon the readiness with which he could distinguish between mimic and model. I do not wish to deny that in some cases, and upon occasion, the resemblance may be of service. It is quite conceivable that an insectivorous animal with a distaste for Danaids would, when confronted with a choice between *Pareronia ceylonica* and a non-mimetic species, choose the latter so long as it only saw the upper surface of the former. And when the mimetic resemblance is already established, I see no difficulty in the supposition that the form which exhibits it is placed at an advantage with respect to natural selection compared with the non-mimetic form, provided that such resemblance to a distasteful model is a close one. But I feel that there are insuperable difficulties in the way of conceiving such resemblance to have *arisen* through the operation of natural selection. To this subject, however, I shall have occasion to refer later.

The Case of Papilio polytes.

Since 1865; when Wallace's well known memoir on "The Papilionidæ of the Malayan Region" appeared, this striking case has been regarded as one of the classic instances of mimicry. Excellent coloured representations of this species were given by that author, and more recently by Moore in his "Lepidoptera of Ceylon." It is also figured by Distant in his "Indo-Malayan Rhopalocera," but as these memoirs are not always readily accessible I have had prepared the coloured plate which will be found at the end of this paper. It has been made directly from the actual specimens (which were all fresh and perfect) by the four-colour process, and gives on the whole an excellent representation of the different forms shown.

P. polytes is a fly which is abundant throughout India and Ceylon, occurring both on the plains and on the hills wherever are to be found the citronaceous plants on which the larva (Pl. I., fig. 7) feeds. Throughout this region the male (Pl. I., fig. 1) is accompanied by three forms of female (Pl. I., figs. 4–6), of which two are so different from him as to have each been regarded at some former time as a distinct species, and it was not until Wallace studied them that the polymorphic nature of these females was understood. From

Wallace came also an interpretation of this peculiar case in terms of the theory of mimicry then just suggested by Bates. Briefly, that interpretation is as follows :—

P. polytes is a palatable insect. The larva feeds on citronaceous shrubs and trees and, in its later stages, is inconspicuous upon its food plant (*cf.* Pl. I., fig. 7). The chrysalis may be regarded as protectively coloured (Pl. I., figs. 8, 9).* Yet in this presumably palatable insect there exist two additional forms of female, which are characterized not only by marked divergence from the normal type, but by the conspicuous form which that divergence takes.† So far as can be seen there is no suggestion of ordinary protective colouration here. Now, living side by side with this species are two other species of Papilionid butterflies, *Papilio aristolochiæ* (Pl. I., fig. 5) and *Papilio hector* (Pl. I., fig. 6), each of which bears a strong resemblance to one of the two aberrant forms of female of *P. polytes*.‡ Both of these forms have conspicuously coloured red and black larvæ, which both feed upon the poisonous *Aristolochia* plants. Both are common species, and both consequently fulfil the conditions of abundance and distastefulness which the theory of mimicry exacts from qualified models. By their resemblance to these two unpalatable species the " mimicking " forms of *P. polytes* have been enabled to cheat their enemies and to preserve their species. And the case is the more striking in that while *P. hector* and the hector form of *P. polytes* are confined to India and Ceylon, both *P. aristolochiæ* and the aristolochiæ form of *P. polytes* have a wider range eastward.

For the upholders of the mimicry interpretation the resemblance between the model and its mimic would appear to have been brought about by the piling up of minute variations in the required direction through a process of survival of those most like the model. Upon the adequacy of this conception I do not wish to dwell, until I have offered some criticisms derived from personal experience with reference to the resemblance obtaining between the " mimics " and their " models."

* The colour is very variable, though whether this is in relation to the surfaces on which it pupates is at present unknown. The two specimens figured here were bred by me under conditions which in so far as could be seen were exactly similar, though the one became clear green and the other a darkish brown.

† In the account which follows I have used the terms " male form," " aristolochiæ form," and " hector form," respectively, for these three females, terms which indicate sufficiently which form is meant for the reader who is not familiar with this species. Technically these three forms are respectively the *pammon*, *polytes*, and *romulus* forms of the species *P. polytes* (*cf.* " Fauna of British India, Butterflies," vol. II., pp. 61, 62).

‡ Though placed in the same genus as *P. polytes* these two species differ from it in many structural points, and will doubtless eventually find their way into another genus when the classification of the family has been placed on a more satisfactory basis. They are closely allied to each other and come into Haase's group of Pharmacophagus or " Poison-eaters."—(" Bibliotheca Zoologica," 1891.)

First, as regards the likeness between model and mimic in either case. As seen pinned out in a cabinet the resemblance between *P. aristolochiæ* and the aristolochiæ form of *P. polytes* is, as far as general wing pattern goes, remarkably close, especially for the fore wings. Yet one cannot help feeling that one has to do with a different insect, and I think this is because of the difference in quality of the white patch on the hind wing. This patch is rather smoky in *P. aristolochiæ*, whereas in the *polytes* mimic it has a cleaner and brighter look. The other point of marked difference lies in the colour of the body, which, except for a dark stripe dorsally, is of a bright vermilion colour in *P. aristolochiæ*. This feature is not so well shown as it might be on the plate, owing to the fact that the body of the specimen had been laterally compressed in the paper to which it was transferred when caught. In the living insect, with its wings spread out at rest, the scarlet body is a most noticeable feature and at once arrests attention. In the aristolochiæ form of *P. polytes*, as the plate shows, the body is uniformly black, and this gives the resting insect quite a different appearance when its wings are expanded. In the absence of the bright vermilion colour, it lacks for the human observer the dangerous look of *P. aristolochiæ*.

The resemblance between *P. hector* and the hector form of *P. polytes* is not so striking as in the preceding case. The markings on the fore wings are remarkably similar, but the general ground colour, except in worn specimens, has a somewhat different appearance in the two species. In *P. hector* it is deeper in shade and has a distinct steely sheen, which is entirely wanting in *P. polytes*. In the hind wings there is a very distinct difference in the quality of the red. In *P. hector* it is a bright rich scarlet, while in *P. polytes* the red is much pinker, and its effect is further softened by a sparse powdering of blue scales. Perhaps the impressions which these two insects convey may be expressed by saying that the red of *P. hector* looks as if it had been got by an aniline dye, while that of *P. polytes* appears to have been put on with a more delicate water-colour. But in this case again, as in the preceding, it is the brilliant scarlet head and body of *P. hector* which at once makes it apparent that one has to do with a different insect. This feature immediately strikes the observer and, when the insects are at rest, makes it impossible to mistake *P. hector* even at a distance of several yards.

The insects, however, may be at rest with closed wings, and I have therefore represented in figs. 1 A–6 A the under surfaces of the hind wings of the same specimens used in figs. 1–6. A comparison of fig. 3 A with fig. 5 A at once brings out the great difference in the quality of the red in the two cases. The suggestion of aniline dye in *P. aristolochiæ* is very marked, and the striking difference in quality in model and mimic is even more marked in the actual insect than it appears to be on the plate. In *P. hector* (fig. 6 A) and the hector form of *P. polytes* (fig. 4 A) the under surface of the hind wing is very like the upper one, and what was written of the difference there applies here equally.

But it may be objected that though model and mimic may be readily distinguished at rest, whether with wings expanded or closed, yet the resemblance between them may be sufficient to deceive such enemies as attack them when flying. Such, however, is certainly not the case. The mode of flight of *P. polytes* is similar for all three forms, and is totally distinct from that of *P. hector* and *P. aristolochiæ*. In these two last species the flight is very peculiar. The insect steers a very even course for a butterfly, and looks as if it were flying mainly by means of its fore wings, which vibrate very rapidly. In *P. polytes*, on the other hand, the flight is of the somewhat lumbering up and down type, which is characteristic of many of the Papilionidæ. Though not easy to express in words, the difference is exceedingly marked, and the practised eye has no difficulty in distinguishing between *P. polytes* and *P. hector* or *P. aristolochiæ* at a distance of 40 to 50 yards.

During the time I was in Ceylon I spent many hours catching and watching these three species, where and whenever the opportunity presented itself, and I have come to be strongly of opinion that in the natural state the differences between these so-called models and mimics, whether resting or flying, are so distinct that they are little likely to be confounded by an enemy with any appreciation of colour or form.

And here I would draw attention to certain points in connection with the distribution of these species in Ceylon. During my stay on the Island I managed, with some assistance, to catch nearly 50 specimens of females of *P. polytes*, and I subsequently received 10 more specimens from Mr. E. E. Green, of which 4 (1 male form, 1 aristolochiæ form, and 2 hector form) were from Kandy or Peradeniya, and 6 (2 aristolochiæ form and 4 hector form) were from higher up-country, either at Pundaluoya or Hakgala. I have included these specimens in the following table, with the idea of comparing the distribution of these forms with that of the supposed models:—

	Trincomalee.	Colombo.	Anuradhapura.	Haragama.	Kandy and Peradeniya.	Pundaluoya and Hakgala.
Male form	14	5	—	—	1	—
Aristolochiæ form ..	5	2	—	1	1	2
Hector form ..	10	5	1	3	4	4

From this it appears that in the low-country, especially at Trincomalee, the male form is, generally speaking, not less abundant than either of the other two. At Colombo both *P. aristolochiæ* and *P. hector* are common, the former being exceedingly so. Most of the Trincomalee specimens came from close to the shore, between Forts Frederick and Ostenberg. The ground here is moderately open and dotted about with patches of scrub. *P. polytes* was abundant in September, but the female insect is difficult to catch, as it keeps flying rapidly across the open and diving into the heart of one thorny scrub patch after another, doubtless in search of the food plant. I managed to catch but a very small percentage of those I saw. Of the females (which were less numerous than the males), that resembling the male was far the most abundant, and was distinctly more numerous than the other two female forms together. Of these two, I caught more of the hector form than of the aristolochiæ form, because the former is more easily distinguished from the male. Wherever there were several flies to chase I gave the preference to the female, and I have no doubt that I sometimes mistook the aristolochiæ form for a male *polytes*, with which it can be easily confused at a short distance away. On the whole, after many hours spent on this collecting ground, I came to the conclusion that, though the hector form may have been slightly more common, these two forms occurred in almost equal numbers. The relative abundance of these forms is of interest in connection with the occurrence of the models *P. hector* and *P. aristolochiæ*. The former is a common insect in this locality, though at the time I was there it was certainly not nearly so common as *P. polytes*. Of *P. aristolochiæ*, I never saw a single specimen during the whole of the time I was in Trincomalee, though I was always on the look out for it.

In Colombo, *P. aristolochiæ* is very abundant, and *P. hector* is not uncommon, though not nearly so abundant as its relative. One may see a dozen or more of the former to one of the latter. My experience of this locality as regards *P. polytes* was that the male form and the hector forms were about equally abundant, and that the *aristolochiæ* form was distinctly scarcer. Col. Manders, to whom I mentioned this, expressed himself of the same opinion.

Higher up, at Kandy and Peradeniya, *P. hector* becomes very scarce, while *P. aristolochiæ* is exceedingly abundant. Nevertheless, the hector form of *P. polytes* is certainly more numerous than the aristolochiæ form. During the month I spent in this part of the country I never saw either the aristolochiæ form of *P. polytes* or *P. hector*. Higher up-country, at Hakgala and Pundaluoya, *P. hector* is no longer found. Yet if one may judge by the samples procured from these parts, the hector form is distinctly the commonest form of *polytes* female.

Summing up such evidence as exists in connection with the distribution of our three species, the following statements may be taken as a fair presentation of the facts:—

(1) In the low-country the male form of *polytes* female is at least as numerous as either of the other forms, and may be the most abundant of the three.

(2) In the north-east of the Island, in the "hector" country, the aristolochiæ form of *polytes* is nearly as abundant as the hector form, though its model is at any rate exceedingly scarce.

(3) Higher up-country, where *P. hector* is rare or absent and *P. aristolochiæ* is common, the hector form of *polytes* is more abundant than the aristolochiæ form.

It is obvious that these statements are not in harmony with the ideas of those who look to the theory of mimicry for an explanation of the polymorphism that exists among the females of *P. polytes*. For if the hector form derives an advantage where *P. polytes* is found associated with *P. hector* (*e.g.*, at Trincomalee), why is it not far more numerous than the other two forms in such places? And if the co-existence of *P. aristolochiæ* in any locality confers a benefit of selection value upon the aristolochiæ form of *P. polytes*, how are we to reconcile this with the fact that where *P. aristolochiæ* is exceedingly abundant (*e.g.*, Kandy and Peradeniya) its supposed mimic is the scarcest of the three *polytes* females? And, again, if the selection has been so stringent as to give rise to two new forms of female in *P. polytes*, how comes it that the male form is in some places still the commonest of the three? It certainly cannot be due to "the atavistic influence of the male," for, as is well known, there are localities in which all the females are of the aristolochiæ form, while the male is of the normal type.

Whatever the true explanation may be, the facts connected with the distribution of these species in the Island of Ceylon are far from lending support to the view that the polymorphic females of *P. polytes* have owed their origin to natural selection in the way that the upholders of the theory of mimicry would lead us to suppose.

Some further criticism of the theory as applied to *P. polytes* will be offered in connection with the enemies of butterflies in Ceylon.

The Enemies of Butterflies in Ceylon.

Those who maintain that the resemblances which occur between butterflies of distinct species have arisen gradually through the operation of natural selection on minute variations have several difficulties to encounter. Apart from the question whether a minute variation can in many cases be conceived as having any sensible selection value, there is the further question of the nature of the enemies which give it this presumed value. In other words, what are the chief enemies of butterflies in the imago stage, and what evidence is there that they exercise discrimination in their Rhopaloceran diet? Information of this sort is notoriously difficult to obtain, and I have therefore not hesitated to put on record the following observations, meagre though they be, which appear to bear upon the point.

(*A*) *Birds*.—To what extent butterflies are preyed upon by birds is a question which has excited much controversy in recent years, and such information as exists upon the subject has lately been brought together by Marshall.* Many birds will undoubtedly devour butterflies upon occasion, though it seems unlikely, except in a few cases such as those of *Merops* and *Microhierax*, that they make a regular practice of it. From a nutritive point of view, there is a good deal of waste material in a butterfly. At the same time it is rather a cumbrous mouthful, and it is not unnatural to suppose that with insect life of other kinds abounding the bird would devote its attention to more succulent species. But a hungry bird will probably take what it can get, without inquiring very closely whether the insect belongs to what are termed unpalatable groups or not. Marshall, for instance, quotes observations of Doflein to show that *P. hector* may be captured by *Merops* in Ceylon.

During my ten weeks' stay in Ceylon and S. India, I endeavoured to keep my eyes open as far as possible to any evidence of butterflies being attacked by birds. Only on one occasion did I observe a bird directly attacking a butterfly. In Peradeniya, one day, at the edge of some jungle, I was cautiously stalking a specimen of *Papilio agamemnon*. When within about 6 feet of it, and in hopes of transferring a desirable specimen to my pocket, a magpie robin suddenly swooped down upon it. It completely missed the butterfly, which, however, to my regret, was scared away. Upon another occasion I noticed near Trincomalee a butterfly fluttering in the middle of the road. On examination it turned out to be a specimen of *P. agamemnon*, with the wings of the right side clean shorn away near the base. The specimen was otherwise uninjured. Though there is no direct evidence, it seems not unlikely that in this case a bird may have been responsible for the damage. This was all the evidence in favour of birds attacking butterflies that I was able to collect from personal observation, but my friend Mr. MacBride, of the Public Works Department at Trincomalee, told me that he had once seen crows catching butterflies as they swarmed round a flowering tree. Unfortunately he was unable to say for certain what the butterfly was, but from his description I am inclined to think that it was a species of *Euplœa* (probably *E. core*).

On the other hand, I have frequently watched birds hawking insects on some flowering tree where butterflies abounded, but have never seen them even offer to attack. Close to the verandah of a

* Trans. Ent. Soc., Lond., 1909.

bungalow in which I stayed near Tanjore was a tree with a little greenish flower which was very attractive to insects. It was not more than 30 yards from where I sat, and I was able with a pair of glasses to see very clearly what was going on. During the earlier part of the day the tree swarmed with butterflies, among which *Telchinia violæ*, *Delias eucharis*, *Papilio demoleus*, and several species of *Ixias*, *Terias*, and *Teracolus* were most noticeable. On it several minahs were generally hawking insects, and though butterflies were all round them, and sometimes even settled within a few inches of them, they never once offered to attack them while I was watching, but confined their attentions to flies and other insects. Though it may be granted that some of these species, notably *Telchinia* and *Delias*, are distasteful to birds, yet this can hardly be maintained of *P. demoleus*, which is a fairly close ally of the presumedly palatable *P. polytes*, the larva feeding on the same food plants and being in appearance practically indistinguishable from that of the latter species.

The general impression that I got from collecting in this part of the world is, that as serious enemies of butterflies in the imago state birds may be left out of account. When driven by stress of hunger they will no doubt attack them, but in such cases it is exceedingly improbable that they would exercise that discrimination between the so-called palatable and unpalatable species which is postulated by the supporters of the theory of mimicry.

So far as one can judge by observation the chief enemies of butterflies in Ceylon are lizards and Asilid flies, and it will be convenient to consider them apart.

(*B*) *Lizards*.—Two of the commonest species of Ceylon lizards are the "blood suckers," *Calotes versicolor* and *C. ophiomachus*. Both species have considerable power of changing their colour, which may range from a dull sooty brown to a bright green that is particularly brilliant in the latter species. Apparently they derive their popular name from the fact that the head and neck may assume a bright red hue, and it is conceivable that this may serve as a lure for insects. Both species commonly attain a length of 15–18 inches, inclusive of the long tail, though larger specimens are not infrequent. Both are bold, active animals, fond of the sun, and not easily frightened by man. The staple food of both species is insects of all sorts, and an examination of the contents of a number of stomachs shows that they will devour ants, cockroaches, earwigs, beetles, caterpillars, &c. In several cases I have been able to find the remains of butterflies, the characteristic heads of which resist the digestive juices of the reptile as well as the subsequent boiling in potash. Though I have never personally seen *Calotes* catch a butterfly under natural conditions, Mr. McBride and his wife assured me that they have not infrequently seen them doing so and other observers have told me the same. I think there can be little doubt that *Calotes*, owing to its great abundance and arboreal habits, is one of the chief enemies of butterflies in Ceylon. And in support of this view may be cited the numerous instances in which one catches butterflies damaged in such a way that it is impossible to resist the deduction that something with a wide mouth has taken a bite out of the wings when they were closely apposed at rest. In such cases the shape of the injuries as well as their clean cut nature (*cf.* Pl. II., fig. 7) both point to their being the work of lizards rather than of birds.

Accepting then the lizard as being responsible for an appreciable share in the mortality of butterflies, the question arises as to whether he shows any preference for or dislike to this or that species. In order to obtain evidence on this point I kept a couple of lizards in large cages and introduced various butterflies at intervals. Owing to the wetness of the season while I was at Peradeniya, and the consequent difficulty of procuring butterflies of some of the species which I wanted during the time at my disposal, the experiments are not nearly so full as I could have wished. Nevertheless they are not without interest, and I give the record of a week's experiments with one of the lizards (" Sambo ").

Aug. 20.—Sambo was given three *P. aristolochiæ* this evening just before dark. One was damaged, and was found dead at the bottom of the cage next morning. The other two had been eaten.

Aug. 22.—Sambo ate another *P. aristolochiæ* which was given to him.

Aug. 23.—Sambo given four *Danais vulgaris* and a large diurnal moth (*Euschema maculata*), which might be regarded as a possible rough mimic of a Danaid. He at once went for the insects and ate two of the Danaids in the first 15 minutes. Eventually he ate all five.

Aug. 24.—Sambo was given a mixed lot, viz., one *Terias sp.*, one *D. vulgaris*, one *Junonia almana*, one *Mycalesis mineus*, and one *Mycalesis patnia*. He started by eating the *Terias* (a brilliant yellow Pierid) and the *Danais* in the first half hour. About 1½ hour later the others had also been devoured.

Aug. 25.—Sambo given a Hesperid, one *D. vulgaris*, and one *Delias eucharis*. He ate all without hesitation and with much apparent relish.

Aug. 26.—Sambo given in the afternoon one *Euplœa core* and one *Junonia iphita* (both are dark brown flies, the former being presumably distasteful). After a few hours he ate the *Euplœa*, while the *iphita* was eaten about 10 A.M. next morning.

From this record it is obvious that Sambo cannot be said to have exercised any discrimination in his choice of food. The presumedly distasteful *Danais* was eaten before the presumedly palatable *Euschema* or *Mycalesis*, and the so-called distasteful *Euplœa* was taken before the supposedly palatable *Junonia iphita* of not very dissimilar colouration. Nor was any hesitation manifested towards *Papilio aristolochiæ* with its postulated evil taste and marked warning colouration.

As *P. aristolochiæ* has been regarded from the nature of its food plant as one of the most unpalatable of all the Ceylon butterflies, I may mention another experiment which was made in connection with its larva. In a cage containing two specimens of the lizard *Lyriocephalus* I placed four full-grown larvæ of *P. aristolochiæ*, an imago each of *Danais chrysippus* and *D. plexippus*, together with some twenty grasshoppers. They were all introduced one evening, and on examining the contents of the cage next morning I found that the lizards had eaten several of the grasshoppers, the specimen of *D. plexippus*, and two of the *P. aristolochiæ* larvæ, and this in spite of the marked black, white, and red warning colouration of the latter. The remaining two larvæ had crawled to the top of the cage out of harm's way.

From such experiments as these one can hardly fail to draw the conclusion that *Calotes* as well as *Lyriocephalus* will readily eat anything in the way of butterflies that they come across. Nor is this surprising, in view of the fact that such noxious creatures as the large red ant (*Œcophylla smargdina*) and hairy caterpillars constitute a considerable proportion of the contents of their stomachs. They certainly do not appear to exercise that nice discrimination with regard to butterflies, which is necessary for the establishment of mimicking forms on the theory of natural selection. And here I may call attention to the series of experiments by Finn, as the result of which that author was led to a similar conclusion. The experiments were made both with lizards in captivity and with lizards at liberty, and the author sums up his impressions in the following sentence: "The behaviour of these reptiles certainly does not appear to afford support to the belief that the *butterflies*, at any rate, usually considered nauseous, are distasteful to them.*

(*C*) *Diptera.*—The large predaceous flies of the family Asilidæ are among the chief enemies of butterflies in Ceylon, and in places where they are numerous it is a common sight to see one of them carrying some butterfly whose juices it is busily engaged in sucking. To my friend Mr. C. C. Dobell I owe the first instance with which I met of one of these flies attacking a butterfly. At Anuradhapura

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* Finn, F.—Contributions to the Theory of Warning Colours and Mimicry, No. II. Experiments with a lizard (*Calotes versicolor*).—Journ. Roy. Asiat. Soc., Bengal, vol. LXV., 1897.

In a paper published in the Biological Bulletin, 1903, Miss A. H. Pritchett gives an account of some experiments with the lizard *Sceloporus floridanus*. This species took the so-called distasteful models *Anosia plexippus* and *Papilio philenor* "with evident relish," and other brightly coloured forms were also eaten readily. As the result of her experiments Miss Pritchett concludes that lizards show no preference, but eat Lepidoptera indiscriminately.

one day, while standing a few yards away from me, he netted a male specimen of *Appias paulina*. Just as he caught it a large fly darted upon it, and on examining his capture he found an Asilid astride of the butterfly, with its piercing mouth parts buried in the thorax. The butterfly was apparently killed immediately, and it seems possible that these flies inject some poisonous fluid into their prey, which at once renders them inert. Subsequently at Trincomalee I captured, within a few days, Asilids* carrying and devouring the following species, all of which were abundant at that time—*Appias paulina*, *Catopsilia pyranthe*, *Junonia lemonias*, *Terias sp.*,† *Nacaduba sp.* Generally the butterfly was carried with its wings apposed, while the Asilid sucked its juices from the side of the thorax. From the following evidence I am inclined to believe that even the larger and more powerful species are not exempt upon occasion from the attacks of these ferocious flies. One afternoon, on the road between Trincomalee and Tamblegam, I picked up a fresh specimen of *Papilio crino*, a species of larger size than *P. polytes*. All the juices had been drained out of its body, and this had evidently been done quite recently, for it had not had time to get stiff when I found it. Moreover, the scales of the fore wing were rubbed symmetrically in a little patch on either side, just where the feet of the Asilid would have come had it captured the Papilio in the position in which Mr. Dobell's *Appias* was captured. The butterfly was picked up just at the time when the males of various species, including *P. crino*, were settling on moist or otherwise attractive patches by the roadside, and in my own mind I have no doubt but that this specimen had been suddenly killed by an Asilid as it settled on such a patch, and that, after being sucked dry, it had been dropped on the road where I found it.

Whether Asilids exercise any discrimination with regard to the butterflies that they attack is a question which is not easy to answer with the little knowledge at present at our disposal. Such evidence as exists has recently been brought together by Poulton,‡ and even among the few cases hitherto recorded there are two in which the Asilid preyed upon distasteful species.

After having repeatedly watched these flies hawking along roads and jungle paths near Trincomalee and elsewhere, I am inclined to believe that they swoop at the first butterfly that comes near enough to give them a chance of catching it. As they sit watching, as a rule on or close to the ground in a sunny place, it is obvious that such butterflies as habitually fly high or keep for the most part in the jungle are unlikely to be attacked. Since the females of most of

* The commonest species was *Scleropogon piceus* (Pl. II., fig. 16). For this identification I am indebted to my friend Mr. C. Lamb.

† I took only one Asilid carrying a Lycænid, and this belonged to a smaller species than that usually met with.

‡ Trans. Ent. Soc., Lond., 1906.

the so-called mimics, which were flying when I was at Trincomalee, were jungle lovers and generally avoided open spaces, *e.g.*, *Papilio polytes*, *Hypolimnas bolina*, *Pareronia ceylonica*, &c., I cannot think it probable that, even if Asilids were discriminating in their attacks upon these butterflies, they would be afforded much opportunity of exercising that discrimination.

In these three forms, viz., birds, lizards, and Asilids, I am inclined to think that we have the most serious enemies of butterflies in Ceylon. But my friend Professor E. A. Minchin, from observations that he made in Africa, has suggested to me that monkeys may also be a factor in the establishing of mimetic likeness. As to the possibility of this I can say nothing, for I had no opportunities of making any observations myself, neither do I know of any records which bear upon the point. In the case of *P. polytes*, however, I feel doubts as to their exerting much influence, for in the northern part of the Island, where these animals occur in plenty, the male form of *P. polytes* female is the most abundant, whereas the "mimetic" forms are more common higher up, where monkeys are very much scarcer. But I would call attention to the suggestion here, in case others may have better opportunities of making observations.

Formation of Polymorphic Forms.

Those who regard natural selection as an adequate explanation of the formation of polymorphic forms hold that they have gradually arisen by the accumulation of small variations over a long series of generations; and from this standpoint we may consider how the different female forms of *P. polytes* may conceivably have arisen. And in doing so, we shall assume that the form of the male is the ancestral one, and that the hector and the aristolochiæ forms have arisen from this. In other words, we shall assume that at some former epoch the species *polytes* existed only in what we now term the male form. And for our present purpose we may confine our attention to the evolution of the aristolochiæ form. Now, on the hypothesis we are considering, this may have come about in either one of two ways, according as we admit that *P. aristolochiæ* at that time existed as the form we now know, or was different. If *P. aristolochiæ* was then as it is to-day, we must suppose that the aristolochiæ form of *polytes* ♀ arose by gradual limitation of the white area on the hind wing, by gradual extension of the red lunules, and by gradual thinning of the scales between the nervures of the fore wing. The great stumbling-block to this view is the difficulty of attributing any selection value to the initial stages of variation.

On the alternative view we may suppose the *P. aristolochiæ* bore a strong resemblance to *P. polytes* to start with, and that it gradually evolved into its present state because it was of advantage to it that the nauseous properties with which it was originally endowed should be advertised as conspicuously as possible. Meanwhile a parallel process of variation occurred in a portion of the species *polytes*, and those variations which kept pace with *P. aristolochiæ* survived and eventually formed the "aristolochiæ form" of female in *polytes*. Considerable powers of discrimination being granted to the hypothetical enemies of the species, this view minimises the difficulty of the selection value of the initial small variations. On the other hand, it has serious drawbacks. In the first place, it does not explain, any more than does the other view, the continued existence of the unchanged *polytes* living under the same conditions. And secondly, it involves the proposition that the ancestral form of the model is similar to that of the unaltered male of the mimic—a proposition which the consideration of cases where the same species serves as a model for more than one mimic at once shows to be untenable. For it is obvious that the male of *Argynnis hyperbius* (Pl. II., fig. 10 A) as well as that of *Elymnias fraterna* (Pl. II., fig. 8 A) cannot both be made to serve as the ancestral form of *Danais plexippus* (Pl. II., fig. 9 A).

We are therefore forced back upon the former view that model and mimic were in the beginning widely different, with its attendant difficulty of attributing selection value to minute variations. For this they are bound to do who desire to regard natural selection as a factor in the *formation* of these mimetic forms.

And here we may draw attention to certain other difficulties which this view involves. If the mimic has arisen by a series of transitional forms, why do these forms never occur in nature? In *P. polytes*, for example, we have a species in which some of the females remain unchanged, and we should naturally expect to find transitional forms numerous on this view of the formation of the mimetic forms. Yet they have never been known to occur, and their absence cannot but cast a doubt upon the adequacy of this view as an explanation of the facts.

The difficulty of males so seldom becoming mimetic has already been alluded to. There is yet another difficulty with regard to polymorphism among females. There are species where the females are markedly polymorphic, but cannot be regarded by any stretch of imagination as mimicking distasteful forms. No one, I think, would venture to match all the different forms of *Papilio ormenus* or *P. memnon* with appropriate models. And I doubt whether any one could find a model for the *helice* variety of *Colias edusa*, or the *valesina* form of *Argynnis paphia*. Yet a scheme which offers an explanation of the occurrence of polymorphism among the females of Lepidoptera should cover such cases, as well as those in which the polymorphic forms bear a resemblance to some distasteful species.

Apart then from the questions whether the resemblances in many cases of mimicry are sufficiently close to be of effective service to the mimic, and whether the action of natural selection can be regarded as sufficiently stringent to have brought these resemblances into being, there are still the following difficulties in the way of the acceptance of the hypothesis of those who look to natural selection as an explanation of polymorphic forms in Lepidoptera:—

(1) The attribution of selection value to minute variation.
(2) The absence of transitional forms.
(3) The frequent absence of mimicry in the male sex.
(4) The inability to offer an explanation of polymorphism, where the polymorphic forms cannot be regarded as mimics of a distasteful species.

Moreover, the hypothesis assumes that minute variations of all sorts can be inherited, a position which at present is lacking in experimental proof.

There is, however, another point of view, which not only avoids these difficulties, but is at the same time more in harmony with the facts of variation and heredity as we are coming to know them. On this view natural selection plays no part in the *formation* of these polymorphic forms, but they are regarded as having arisen by sudden mutation, and series of transitional forms do not exist because such series are not biologically possible. Polymorphic forms may arise and may persist, provided that they are not harmful to the species, and it is possible to look upon their existence as due to the absence of natural selection rather than to the operation of this factor. Nevertheless, natural selection, though unconcerned with their formation, may play a part in their *conservation*. To take a definite example in illustration. The "aristolochiæ form" of female must be supposed to have arisen from the type form as a sudden mutation, entirely independently of natural selection. But it is not unlikely that the action of natural selection may have aided it in becoming established, whether from its resemblance to *P. aristolochiæ*, or for some other reason. For once in being it is conceivable that even a very slight advantage over the normal form might enable it to hold its own with, and even replace, the latter (*cf.* p. 19, note). But whether this is so or not must for the present, in the absence of decisive evidence, remain doubtful. Though natural selection may operate in the *conservation* of the polymorphic form, it cannot on this view be supposed to play any part in its *formation*.

A Suggestion as to the Nature of Polymorphism.

That polymorphism in a species should so frequently be confined to the female sex has long been remarked upon by those who study these matters, and the explanation most favoured is that the female, burdened as she is with the next generation, is more exposed to the action of natural selection and in greater need of some protective adaptation. The weak point of such a view is that it does not explain why the male is not similarly protected. In connection with this problem recent Mendelian research on sex-limited inheritance is highly suggestive. It has been shown that certain types of inheritance receive their simplest explanation on the assumption that the female is heterozygous for a sex factor not contained in the male, and that this sex factor may, on segregation of the gametes, repel the factor for some other character for which the female is also heterozygous. From the beautiful experiments of Doncaster and Rayner* it has been inferred that inheritance of this type occurs in the common currant moth (*Abraxas grossulariata*), where a distinct colour variety, var. *lacticolor*, occurs. The factor for the *grossulariata* pattern appears to segregate against the female sex factor, with the consequence that in only one type of mating, and that a necessarily rare one, is the *lacticolor* pattern transmitted to the male sex.† It is not difficult to conceive of an extension of these principles to cover cases of polymorphism among the females of a species, and the next few paragraphs are devoted to the consideration of an imaginary scheme of this nature. In the absence of experimental evidence such a scheme can of course have only a suggestive value, and I have ventured upon these speculations, after some hesitation, with the idea that they may attract the attention of some who have opportunities for breeding from species with polymorphic females. If any such are led to regard the problem from a rather different standpoint to that which has hitherto been customary, these speculations will not have failed of their purpose.

Let us then suppose our imaginary case to be a species in which there are three distinct forms of female, α, β, and γ, of which the first (♀ α) is like the male. Let us suppose also that the forms β and γ have arisen from the original form α by the elimination of factors through some mutational process, and that β and γ are each heterozygous for a factor (A) for which ♀ α and the male are homozygous. Further, let it be assumed that the factor A segregates against the factor for femaleness in the way that the *grossulariata* factor behaves in the female of the currant moth (*Abraxas*). Lastly, let it be supposed that the difference between ♀ β and ♀ γ depends upon the presence or absence of the factor B, which is not affected by the sex factor in segregation. Then we may represent the various individuals of our imaginary species as having one or other of the following zygotic constitutions :—

♂	♀ α	♀ β	♀ γ
♂♂ AA BB	♂♀ AA BB	♂♀ A*a* BB	♂♀ A*a* *bb*
or	or	or	
♂♂ AA B*b*	♂♀ AA B*b*	♂♀ A*a* B*b*	
or	or		
♂♂ AA *bb*	♂♀ AA *bb*		

* Proc. Zool. Soc., 1906.

† In addition to the above instance this peculiar sex-limited form of inheritance has now been worked out in canaries and fowls. Inheritance of this form is certainly to be found in man also, while analogous phenomena have been met with in sweet peas. For a general account the reader may be referred to Bateson's work on "Mendels' Principles of Heredity," Cambridge, 1909, chap. X.

We are now in a position to work out the results of the various possible matings between these different individuals.

(1) ♂ × ♀ α.—Since both the male and ♀ α are in every case homozygous for the factor A such matings can only give ♂♂ and ♀♀ of the male type.

(2) ♂ × ♀ β.—Since there are three possible kinds of male differing in constitution, though not necessarily in appearance, and since ♀ β may also be either homozygous or heterozygous for B, it follows that there are six possible types of mating between these two forms, viz. :—

(i.) ♂♂ AA BB × ♀♂ A*a* BB
(ii.) ♂♂ AA B*b* × ♀♂ A*a* BB
(iii.) ♂♂ AA *bb* × ♀♂ A*a* BB
(iv.) ♂♂ AA BB × ♀♂ A*a* B*b*
} giving ♂♂ and ♀♀ β only.

(v.) ♂♂ AA B*b* × ♀♂ A*a* B*b*, giving ♂♂, ♀♀ β (75 per cent.). and ♀♀ γ (25 per cent.).

(vi.) ♂♂ AA *bb* × ♀♂ A*a* B*b*, giving ♂♂, ♀♀ β (50 per cent.) and ♀♀ γ (50 per cent.).

(3) ♂ × ♀ γ.—Since ♀ γ is on our hypothesis always of the same constitution, it follows that the only three possible matings here are :—

(i.) ♂♂ AA BB × ♀♂ A*a* *bb*, giving ♂♂ and ♀♀ β only.
(ii.) ♂♂ AA B*b* × ♀♂ A*a* *bb*, giving ♂♂, ♀♀ β (50 per cent.), and ♀♀ γ (50 per cent.).
(iii.) ♂♂ AA *bb* × ♀♂ A*a* *bb*, giving ♂♂ and ♀♀ γ only.

The experimental test of the correctness of such a scheme would lie in substantiating the following propositions :—

(1) The form of female which is like the male in pattern breeds true, and does not throw either of the other two forms of female.

(2) Neither of the other two forms of female can give the female of the male pattern.*

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* Should this be confirmed by experimental evidence, it would offer a simple explanation of the complete disappearance of the "male form" of female which seems to have taken place in most polymorphic species. Thus the Malayan *Papilio theseus* and *P. ambrax*, near allies of *P. polytes*, have only the "aristolochiæ form" of female, a condition which could rapidly come about on the above scheme if the "aristolochiæ form" were already in existence and received some slight advantage over the normal form through the operation of natural selection. For if neither female could throw the other, even a small advantage possessed by the one would lead rapidly to the other's elimination. On this view cases of sexual dimorphism in the colour patterns of Lepidoptera are cases of advanced polymorphism in which one form of female, viz., that like the male, has been eliminated, either in the history of the species itself or of its precursors.

(3) Either of the two forms of female which are unlike the male may give both forms, or may breed true.

(4) Of the two forms of female which are unlike the male, one may give females which are all of the same form and unlike herself, while the other must always throw some females like herself. (Thus, ♀ γ mated with an appropriate male can give only ♀♀ β, but ♀ β must always give some at any rate of her own type of ♀).

It is assumed here that any given female is fertilized by a single male. Where a female can be fertilized by more than one male the working out of such a case would become more difficult. Complications of this nature would however not affect (1) and (2), where the expectation would remain the same whatever male or series of males was introduced.

So far as I am aware the only breeding experiments with polymorphic females which have been recorded are with *Papilio dardanus** and *Colias edusa*,† and in either case the records are very scanty. In the *dardanus* experiments six families were raised, two from each of the three ♀ forms *cenea*, *trophonius*, and *hippocoon*, and the results, though of course too few for definite opinion, appear to me not discordant with an explanation on the lines suggested above. Of especial interest are the two families from *hippocoon* ♀♀. In one of these there were 14 ♀♀, viz., 8 *cenea*, 3 *trophonius*, and 3 *hippocoon*, while in the other all the 13 ♀♀ produced were of the *hippocoon* form. Such a result seems to point to a difference of constitution of the parents of one sex certainly, and possibly of both. Each of these eventualities is allowed for in such a scheme as that outlined above, while in harmony also with it is the fact that none of these polymorphic females appears to be capable of producing a female of the male type. The case is of course more complicated by reason of the greater number of polymorphic forms, and it is to be hoped that further experiments will be made on the breeding of this interesting species.

The single family in the case of *Colias edusa* mentioned above was bred from the pale *helice* variety which, as is well known, is confined to the ♀ sex. The eggs laid by this specimen gave 79 ♂♂, 19 *edusa* ♀♀, and 52 *helice* ♀♀. The fact that *edusa* ♀♀ can come from *helice* appears to be inconsistent with the scheme suggested above, and it is not unlikely that this particular scheme may here break down. Nevertheless it should be pointed out that in *edusa*, as in many other species, the common type of ♀ is not of the male pattern, and we may be dealing here with two forms of female of the β and γ types, the α type in this species being unknown. And

* Poulton, E. B., Trans. Ent. Soc., Lond., 1909.
† Main, H., and Harrison, A., Trans. Ent. Soc., Lond., 1905, p. vi.

here the matter may be left until more experimental evidence is forthcoming.*

It has been suggested above that the males of a species with polymorphic females may be of different constitution with regard to the factors they contain, and with this in mind I have examined the series of males of *P. polytes* which I collected. There is considerable variation in the amount of the red marking and of the lunules of the hind wing. Two distinct forms can be readily picked out, viz., that in which the red is entirely absent and the lunules are much reduced (Pl. I., figs. 11 and 11 A) and that in which the lunules are relatively large and the red markings very distinct (Pl. I., figs. 10 and 10 A). Between these two extremes are found intermediate forms which cannot be sorted with the same certainty. Generally speaking, however, the intermediates fall into two groups: (*a*) those in which the lunules are large and in the hindermost at any rate furnished with some red scales, and (*b*) those in which the lunules are small and the red is confined to the spot by the tail. These I have called respectively Int. I. and Int. II. In the appended table I have, with the help of my friend Mr. J. C. F. Fryer, classified the available males according to their markings and the locality from which they came :—

TABLE II.

	Trincomalee.	Kandy and Peradeniya.	Colombo.	Haragama.	Anuradhapura.	(Up-country) Uragala, Gonagama, Pundaluoya.
Red ..	—	9	1	2	—	1
Int. I. ..	17	7	6	2	1	4
Int. II. ..	15	—	—	2	—	6
No red ..	32	1	1	1	—	3

Several points of interest may be made out from this table. Very noticeable is the absence of really "red" ♂♂ at Trincomalee, as well as the great preponderance here of ♂♂ which show no red. While the hotter and drier climate of these parts may possibly lead to a general diminution of the red scales, this cannot be the

* Since the above was written Mr. E. E. Green has succeeded in raising a brood of *P. polytes* from the "male form" of female. All the females of this brood, 37 in number, were of the "male form," a fact which is in harmony with the scheme suggested above. And here attention may be called to an important paper by J. C. H. de Meijere on *Papilis memnon*, which has recently been the subject of breeding experiments in Java. It is suggested that the data from the three forms of female are consistent with a Mendelian interpretation of this case. (Zeitschrift fur induktive Abstammungs und Vererbungslehre, 3 Heft, 1910.) It should be mentioned that all the three forms of female here are different to the male.

sole cause of the non-red ♂♂ being so greatly in excess. For such males may occur, though in a smaller proportion, in the higher parts of the Island, *e.g.*, Kandy and Pundaluoya. I am inclined to consider that there exists a connection within certain limits between the amount of red and the constitution of the male, and to regard the "red" males (and probably those of Group Int. I. also) as being more intimately connected with the hector form of female, in which the lunules are larger than in the other forms. But whether this is really so can only be determined by breeding experiments, and breeding experiments we must have before we can hope to understand more of the nature of the various forms of *Papilio polytes*.

APPENDIX.

In addition to the instances already given of resemblance more or less marked between different species of Lepidoptera, I met with the following cases which seem of sufficient interest to place on record :—

While at Trincomalee in September I was struck with the scarcity of Hesperids. *Parata butleri* was abundant and *Badhamia exclamationis* was found occasionally, but outside these two species neither my boy nor myself took a single Hesperid. Accordingly, when I one day saw in sparse jungle an insect which looked like a Hesperid other than the above two species, I devoted my attention to capturing it. After some minutes of stalking I succeeded, and found, rather to my surprise, that the putative Hesperid was a moth (*Ophiusa mezentia*). In size and general appearance it is not unlike *Tagiades atticus* (Pl. II., figs. 4 and 5). I prefer to leave to others the decision as to which in this case is the mimic and which the model.

On Pl. II., fig. 13, is figured an insect which I took one day in Kandy, at the bottom of Lady Horton's Drive. I netted it as it flew across the road, inwardly congratulating myself upon the acquisition of a hitherto uncaptured Lycænid. On extracting it from the net my first impression was that the antennæ were missing. But on looking more closely I discovered that it was not a butterfly at all, but a bug belonging to the species *Hansenia glauca*. Here again I will leave it to those who are more expert than I to pronounce upon which is mimic and which is model.

While hunting *P. polytes* one day at the edge of the jungle at Trincomalee I caught a small dragon fly (*Rhyothemis variegata*), which I took to be a butterfly until I had actually got it within my net. In this small species (Pl. II., fig. 17) the proximal parts of both fore and hind wings are black, the distal part of either being transparent. Between the transparent and the dark part is a narrow opaque white area. During its fluttering flight the outer transparent portion of the wings is invisible, and even at close quarters this little dragon fly looks very like a butterfly. I subsequently met the insect again at Pannipitiya near Colombo, and my friends Dr. Willey and Mr. Dobell, who happened to be with me at the time, were both struck by its Lepidopteran appearance. I am doubtful whether to invoke Pseudaposematism or Pseudepisematism for the interpretation of this case.

Another dragon fly which is interesting in this connection is *Neurothemis tullia* (Pl. II., fig. 15). The general yellow-brown and black colouration of this insect, coupled with its peculiar sharp and jerky yet soft flight, so unlike that of most of its relatives, results in a distinct resemblance to the butterfly *Rahinda hordonia* (Pl. II., fig. 14) when on the wing. There may perhaps be some who would be tempted to argue that the dragon fly has developed its peculiar colour and flight in adaptation for deceiving and preying upon the butterfly. For their sake it may be pointed out that the dragon fly hawks insects in the bright sun, and I never met it in the shady localities frequented by *R. hordonia*. Whenever I saw it, moreover, it was in company with many dragon flies of larger and more powerful species, among whom it could hardly be regarded as judicious to masquerade in Lepidopteran guise. At the same time I may add that, though I frequently watched these groups of dragon flies, and though butterflies of the genera *Catopsilia*, *Appias*, and *Junonia* abounded here, I never saw a dragon fly attack any of them.

Lastly, I would draw attention to a small Chalcosid moth, *Chalcosia venosa* (Pl. II., fig. 12), which was abundant along Lady Horton's Drive during August. It has a remarkably Pierid-like appearance.* There is, however, no Pierid here with which it could possibly be confounded.

EXPLANATION OF PLATES.

Note.—With the exception of figures 7, 8, and 9 on Plate I. all the figures were made directly from the actual specimens by the four-colour process.

PLATE I.

Fig. 1.—Male of *Papilio polytes*.

Fig. 2.—Female (male form) of *P. polytes*.

Fig. 3.—Female (aristolochiæ form) of *P. polytes*.

Fig. 4.—Female (hector form) of *P. polytes*.

Fig. 5.—Male of *Papilio aristolochiæ*. In this species the colouration of the two sexes is similar.

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* The white of the wings of this moth is, however, not due to the presence of uric acid derivatives, as in the Pieridæ. For this fact I am indebted to Dr. F. G. Hopkins, who very kindly made the requisite test (*cf.* Hopkins, Phil. Trans., 1895, p. 663).

Fig. 6.—Male of *Papilio hector*. The female of this species is very similar to the male, though the red has a more orange shade.

Figs. 1 A–6 A.—Under surface of left hind wings of the above. The wing was taken from the same specimens as those figured in figs. 1–5. For fig. 6 A a separate specimen was used. since the left hind wing of that figured as fig. 6 was damaged. There is practically no difference in these two, except that 6 A has a rather shorter tail.

Fig. 7.—Caterpillar of *P. polytes*, full-fed.

Fig. 8.
Fig. 9. } Chrysalis of *P. polytes*.

Note.—For these three figures I am indebted to Mr. Green, who had them prepared for me by Mr. A. D. Alwis, the artist at the Royal Botanic Gardens, Peradeniya.

Fig. 10, 10 A.—Under surface of hind wings of males of *P. polytes*, showing variation in colour pattern.

Fig. 11, 11 A.—Upper surface of hind wings of males of *P. polytes*, showing variation in colour pattern.

Plate II.

All specimens × about ⅘.

Figs. 1 A–C.—*Pareronia ceylonica* (Pieridæ); 1 A, male; 1 B, upper surface of female; 1 C, under surface of female.

Figs. 2 A–B.—*Danais septentrionis* (Danaidæ); 2 A, upper surface; 2 B, under surface.

Figs. 3 A–B.—*Papilio clytia* (Papilionidæ); 3 A, var. *dissimilis*.

Fig. 4.—*Ophiusa mezentia*, Cram. (Heterocera).

Fig. 5.—*Tagiades atticus* (Hesperidæ).

Fig. 6.—*Hypolimnas bolina* (Nymphalidæ), female.

Fig. 7.—*Elymnias fraterna* (Satyridæ). Specimen of female with wings bitten, probably by a lizard.

Figs. 8 A–C.—*Elymnias fraterna* (Satyridæ). 8 A, male; 8 B, upper surface of female; 8 C, under surface of female.

Figs. 9 A–B.—*Danais plexippus* (Danaidæ). 9 A, upper surface; 9 B, under surface.

Figs. 10 A–B.—*Argynnis hyperbius* (Nymphalidæ). 10 A, male; 10 B, female.

Fig. 11.—*Euplœa core* (Danaidæ).

Fig. 12.—*Chalcosia venosa* (Heterocera)

Fig. 13.—*Hansenia glauca* (Rhynchota).

Fig. 14.—*Rahinda hordonia* (Nymphalidæ).

Fig. 15.—*Neurothemis tullia*, Dru. In the actual specimen the brown near the basis of the wings is brighter and more conspicuous.

Fig. 16.—*Scleropogon piceus* (Asilidæ), female.

Fig. 17.—*Rhyothemis variegata*, Joh.

ON SOME SYNGNATHIDS ("PIPE FISH") FROM CEYLON.

By George Duncker (Hamburg).

(With one Plate.)

SYNGNATHIDS or pipe fishes are known to inhabit the fresh waters of East Africa as well as of continental India, but, strange to say, not as yet from Ceylon. Last summer (1909) I determined to investigate some Ceylon rivers with reference to the occurrence of Syngnathids, with the result of finding four species, viz., *Microphis brachyurus*, Bleeker, *Doryichthys cunculus*, Ham.-Buch., *Doryichthys ocellatus*, n. sp., and *Syngnathus spicifer*, Rüpp., var. *djarong*, Bleeker.

A review of all Syngnathids hitherto observed in Ceylon may be combined with the description of the species mentioned above; further investigation certainly will lead to the discovery of many more, especially marine species.

Gastrotokeus, Kp.

Brood organ of male abdominal, not covered by cutaneous folds. Eggs isolated in open cutaneous cells. Upper as well as lower lateral edges of trunk and tail continuous; middle lateral edges of trunk nearly or entirely reaching upper ones of tail behind the dorsal fin. Interstitial scutella and lateral line absent. Dorsal, anal, and pectoral fins (referred to as D, A, and P) present, caudal fin (C) absent; tail prehensile. Trunk much depressed, its ventral surface bordered by middle lateral edges.

1. *Gastrotokeus biaculeatus*, Bl.

Kaup, 1856, p. 19; Duméril, 1870, p. 528; Günther, 1870, p. 194; Day, 1878, p. 681, Pl. 174, fig. 5; Day, 1889, p. 467, fig. 167.

Syngnathus blochii, Bleeker, 1853, p. 24.

Truncal annuli (abdominal plus caudal) 15–18 plus 40–55. Annuli below dorsal fin (annuli subdorsales) 0–2 plus 8–10. Dorsal rays (D) 37–47. Anal rays (A) 4–5. Pectoral rays (P) 19–23. Frequently with numerous short immovable cutaneous appendages, similar to algæ. Chin with two simple or little ramified short movable tentacles of reddish-brown colour. Anus papilliferous. Eggs rather large, ovoid, generally in 8 longitudinal and 23–28 transverse rows. Total length up to 25·7 cm. Mature males 16·4 to 25·7 cm.

Colour during life grayish to sea-green; edges of body with indistinct reddish blotches. Small round dark blue dots, becoming brown in spirit, ventrally along the middle lateral edges of trunk.

Living between the weeds of a Zostera, sp., the leaves of which equal in breadth that of the animal, attached to their stems by means of the prehensile tail, the head erect, and therefore not easily visible. The decaying leaves of the Zostera are covered with small mucous gray algæ, which are strikingly similar to the cutaneous appendages of the fish. Slowly and clumsily swimming.

Distribution.—From East Africa to Polynesia. In the Colombo Museum there are several specimens, without details of locality.

Sinhalese name.—Moralla (Colombo).

Microphis, mihi.

Brood organ of male abdominal, not covered by cutaneous folds, laterally protected by plates which correspond to the lower lateral edges of trunk and are ventrally divergent. Eggs small, numerous, isolated in open cutaneous cells. Upper as well as lower lateral edges of trunk and tail discontinuous; middle lateral edges of trunk continuous with lower ones of tail; keels of the several rings terminating in a free spine posteriorly. Scutella and lateral line present; D, A, C, and P present; A situated behind middle of total length.

2. *Microphis brachyurus*, Bleeker. Duméril, 1870, p. 595.

Syngnathus brachyurus, Bleeker, 1853, p. 16.
Doryichthys brachyurus, Günther, 1870, p. 184.
Doryichthys Hasselti, Kaup, 1856, p. 57.
Doryichthys auronitens, Kaup, 1856, p. 59; Günther, 1870, p. 182.
Microphis auronitens, Duméril, 1870, p. 597.
Doryichthys millepunctatus, Kaup, 1856, p. 60; Günther, 1870, p. 183.
Microphis Bleekeri (Day), Duméril, 1870, p. 599.
Doryichthys Bleekeri, Günther, 1870, p. 182; Day, 1878, p. 680, Pl. 174, fig. 3; Day, 1889, p. 465.
Microphis douanii, Duméril, 1870, p. 592.

Ann. 20–22 plus 21–23; ann. subdors. 1–2 plus 6–8; D 37–43, A 3–5, C 9, P 18–23. Operculum longitudinally keeled, with 1–8 radiating elevated ridges below the keel. Middle ray of C enlarged and somewhat elongate. Eggs small, in 4–13 longitudinal and 60–110 transverse rows. Total length up to 18·2 cm.; mature males 12·2–16·7 cm.

Ground colour dark, with numerous fine white dots. Operculum sometimes with black spots. Orange coloured and black spots at the corners of the mouth. Lower side of rostrum with light dark-edged transverse fasciæ. Caudal fin orange coloured at dorsal and ventral margin. Male with a blood-red vertical stripe on the opercle near its hind edge; a longitudinal stripe of the same colour immediately beneath the anterior half of the middle lateral edge, both these stripes disappearing in spirit. Iris brown, with golden lustre.

In fresh and brackish waters; numerous amongst grassy weeds; quickly and skilfully swimming.

Distribution.—From East Africa to Polynesia. Several specimens in the Colombo Museum, from the Panadure river at Horetuduwa, near Moratuwa, 4 miles upstream. In the Hamburg Museum (No. 11,557) 10 males, 34 females and young from the Gin-ganga and Opata-ela at Wakwella (Duncker), (No. 11,558) 3 males and 8 females from the Mahaweli-ganga, below Thalavai estate, near Trincomalee (Duncker).

Sinhalese.—Loku ela theliya (Wakwella); vetakeyiya moralla (Panadure); mudha aspaya (Negombo).

Doryichthys, mihi.

Brood organ of male abdominal, entirely covered, when filled with eggs, by broad, not coalescent, lateral protective plates, which sometimes have a narrow cutaneous fold along their free margin. Eggs large, isolated in cutaneous cells. Upper lateral edges of trunk and tail discontinuous, lower either continuous or discontinuous; in the latter case middle lateral edges of trunk continuous with lower ones of tail. All the body edges smooth in the adult. Scutella and lateral line present. D, A, C, and P present; A situated anterior to middle of total legth. Fresh and brackish water fishes.

3. ***Doryichthys cunculus***, H.B. Günther, 1870, p. 181; Day, 1878, p. 679, Pl. 174, fig. 4; Day, 1889, p. 465, fig. 166.

Microphis cunculus, Kaup, 1856, p. 64; Duméril, 1870, p. 591.

Ann. 17–18 plus 25–28; ann. subdors. 3 plus 7–8; D 50–53, A 3, C 9, P 18–20. Lower lateral edges of trunk and tail continuous; middle lateral edges of trunk subcontinuous with lower ones of tail. Anal fin just in front of middle of total length. Protective plates of brood organ well developed; no cutaneous folds found (pouch empty). Eggs rather large, according to the remnants of cells in 3–4 longitudinal and about 50–55 transverse rows. Opercle with a single longitudinal keel. Total length 13·9 cm.

Colouration grayish-brown; several indistinct narrow dark longitudinal stripes on the side of the trunk. Diffuse dark spots on the upper lateral edges of trunk, most distinct on the ring borders. A dark stripe on each side from tip of snout through the eye over opercle, above its keel, to base of P; ventral half of opercle silvery. Iris reddish-brown.

Distribution.—India (Malabar, mouth of Ganges, Bengal, Orissa), Ceylon.

Colombo Museum: one male from Panadure river at Horetuduwa.

Sinhalese.—Vetakeyiya moralla.

4. *Doryichthys ocellatus*, n. sp. Plate, fig. A.

Ann. 15–16 plus 31–32; ann. subdors. 1–2 plus 7–8; D 37–40, A 4, C 9, small, P 17–19. Lower lateral edges of trunk and tail discontinuous; middle lateral edges of trunk continuous with lower ones of tail. Opercle with a straight keel; beneath and parallel to the latter one, rarely two weaker ones, more distinctly visible in posterior half of opercle. Abdominal edge very prominent in females. Anal fin in front of middle of total length. Rings of adults smooth, of young ones spiny behind, as in Microphis. Caudal fin of young individuals comparatively large. Brood organ from second body ring to first caudal ring, with large, completely closing, but not coalescent protective plates; no cutaneous folds. Protecting plates much deeper than dorsal wings of inferior lateral scutes. Eggs large, in 4 longitudinal and about 30 transverse rows. Total length up to 13 cm.; mature males 9·5 to 13 cm.

On the middle lateral edges of the trunk, on each border of its rings, one black white-bordered ocellated spot, the white contour of which disappears in spirit. Back light reddish-brown, sides yellow-gray; protective plates of brood pouch darker. A dark longitudinal stripe on each side from tip of snout through the eye to the opercle, behind which, more or less distinct, it passes on to the trunk between upper and middle lateral edge. Caudal with yellow dorsal and ventral margins. Iris yellowish-red.

The only two females of our material happen to be regenerated specimens; in the one of 10·1 cm. length there are 24 caudal rings and 7 caudal fin rays (fin enlarged); in the other one of 9·5 cm. length there are 25 caudal rings and 8 caudal rays (fin enlarged). Evidently they have accidentally lost 6–8 caudal rings and yet been able to regenerate a caudal fin.

Distribution.—Ceylon.

Col. Mus.: one male from Kalu-ganga, near Galatura tea estate, 32 miles up river (H. Drummond Hay).

Hbg. Mus. 11,559: one female, five young, from Mahaweli-ganga, below Thalavai estate, near Trincomalee (Duncker).

Hbg. Mus. 11,560: five males, one female, four young, from Gin-ganga, at Wakwella (Duncker).

Nearly related to Doryichthys caudatus, Peters.

Sinhalese.—Punchi-ela theliya (Wakwella), mudha aspaya (Negombo).

Corythroichthys, Duncker.

Brood organ of male subcaudal, not covered, without lateral protective plates, bordered by narrow longitudinal posteriorly divergent cutaneous folds. Eggs small, numerous, incompletely isolated in very shallow cutaneous cells, cake-like, sticking to each other. Upper lateral edges of trunk and tail discontinuous; lower lateral edges of trunk and tail continuous; middle lateral edges of trunk subcontinuous with upper ones of tail. Scutella and lateral line present. D, A, C, and P present.

5. *Corythroichthys conspicillatus.*

Syngnathus conspicillatus, Duméril, 1870, p. 544; Günther, 1870, p. 174; Day, 1888, p. 808; Day, 1889, p. 463.
Syngnathus hæmalopterus, Bleeker, 1853, p. 20.
Corythroichthys fasciatus, Gray; Kaup, 1856, p. 25.
Syngnathus fasciatus, Duméril, 1870, p. 543.

Ann. 16–18 plus 33–38; ann. subdors. 0–1 plus 5–7; D 25–32, A 3–4, C 9–10, P 14–18, annuli or rings in the region of the brood pouch (referred to as B R) 10–16. Middle lateral edges of trunk and upper ones of tail terminating near to each other, as a rule on the border between last ring of trunk and first of tail. Opercle with a straight keel in its entire length. Forehead and eyes prominent. Eggs small, numerous, in 6–11 longitudinal and 28–37 transverse rows. Total length up to 17·3 cm.; mature males 9·7–17·3 cm.

Ventral surface of head and opercles with dark longitudinal, of rostrum with dark transverse, fasciæ. A black transverse fascia ventrally on each of the first three body rings, frequently resolved into spots. All the rings with fine black reticulated lines.

During life the three black bands on the throat as well as the posterior margin of the anal opening seamed by orange colour. In the males light bluish-silvery stripes between the dark bands at the throat, missing or little developed in the females. Ground colour of ventral surface of head brassy-yellow to coral-red. Rostrum, upper edges of trunk, and subdorsal region wine-red, the latter with coral-red blotches. When not disturbed this fish moves snake-like on the bottom, but swims rapidly if disturbed. Frequent on coral sands.

Distribution.—From East Africa to Polynesia.

Col. Mus.: males and females, from Jaffna (Day-Haly, 1888).

Hbg. Mus. 11,563: two males, three females, from Trincomalee harbour (Duncker).

Tamil.—Kudira.

Trachyrrhamphus, Kp.

Brood organ of male subcaudal, without lateral protective plates, not covered, bordered by narrow longitudinal cutaneous folds, diverging posteriorly. Upper lateral edges of trunk and tail discontinuous; lower lateral edges of trunk and tail discontinuous: middle lateral edges of trunk continuous with lower ones of tail. Scutella and lateral line present. D, A, C, and P present; C small; base of D elevated.

6. *Trachyrrhamphus serratus*, Schleg.

Kaup, 1856, p. 23; Duméril, 1870, p. 538.

Syngnathus serratus, Schlegel; Günther, 1870, p. 167; Day, 1878, p. 677, Pl. 173, fig. 4; Day, 1889, p. 461, fig. 164.

Trachyrrhamphus cultrirostris, Peters, 1870, p. 710; Duméril, 1870, p. 539.

Trachyrrhamphus intermedius, Kaup, 1856, p. 24; Duméril, 1870, p. 538.

Syngnathus intermedius, Günther, 1870, p. 168; Day, 1878, p. 678, Pl. 173, fig. 6; Day, 1889, p. 462.

Syngnathus ceylonensis, Günther, 1870, p. 168.

Ann. 22–24 plus 44–49; ann. subdors. 2–4 plus 2–3; D 25–29, A 4, C 9–10, rudimentary, P 14–19, B R 20–22. Generally with short cutaneous appendages, similar to algæ, on the surface of the body, especially on the dorsal surface. Opercle with a very short basal keel and fine radiating striæ. Dorsal median line of rostrum with a serrated crest. Forehead and eyes prominent. Eggs very small and numerous, in 8–10 longitudinal series. Total length up to 26·8 cm. Uniformly brown coloured.

Distribution.—From Zanzibar to Japan.

Col. Mus.: 1 ♂, Ceylon.

Urocampus, Günth.

Brood organ of male subcaudal, with or without weak lateral protective plates, with broad longitudinal cutaneous folds, converging posteriorly and coalescent during the breeding period. Upper lateral edges of trunk and tail continuous; lower lateral edges of trunk and tail discontinuous; middle lateral edges of trunk continuous with lower ones of tail. Scutella and lateral line present. D, C, and P present, A (always ?) absent; D commencing for more than its own length behind anal ring.

7. *Urocampus southwelli*, n. sp. Plate, figs. B (♂) and C (♀).

Ann. 8 plus 49–50; ann. subdors. 7 plus 12; D 14, A 0, C 10, well developed, P 8–10, B R 8, without protective plates. Opercle keeled in anterior two-thirds of its length. Body-edges very indistinct. Subdorsal tail-rings somewhat elevated. No cutaneous appendages. Rostrum longer than postorbital region of head. Eggs comparatively very large, biserial, 8–10, longitudinally arranged in seven anterior rings of B R—♂ 45 mm., ♀ 40 mm. Uniformly yellowish-brown.

From *U. guntheri*, mihi (W. Australia), with similar numbers of rings, distinct through the absence of cutaneous appendages, the greater length of D, and the shorter opercular keel.

Distribution.—Ceylon.

Col. Mus.: 1 ♂, 1 ♀, from Marichchukkaddi bay, in 2¼ fathoms, in tow-net. (T. Southwell.)

Syngnathus, L.

Brood organ of male subcaudal, generally with lateral protective plates, always with broad longitudinal cutaneous folds, converging and coalescent during the breeding period. Upper lateral edges of trunk and tail discontinuous; lower lateral edges of trunk and tail continuous; middle lateral edges of trunk subcontinuous with upper or with lower edges of tail.

8. *Syngnathus spicifer*, Rüpp.; var. *djarong*, Bleek.

Distribution.—Madagascar, India, Ceylon, Borneo, Java, Philippines, New Guinea.

Hbg. Mus. 11,561: 3 ♂♂ from Opatha-ela, near Wakwella (Duncker).

Hbg. Mus. 11,562: 11 ♂♂, 16 ♀♀, 21 juv. from Mahaweli-ganga, below Thalanai estate, near Trincomalee (Duncker).

Sinhalese.—Eta theliya (Wakwella).

Among the forms united by Günther under the name of *Syngnathus spicifer* there are at least three to be distinguished, two of which may be considered salt and fresh water varieties of the same species, while the third one represents a separate species. They are :—

(*a*) Syngnathus spicifer, Rüpp.; var. gastrotænia, Bleek.
Syngnathus spicifer, Rüpp.—Kaup, 1856, p. 36 partim; Duméril, 1870, p. 546 part; Günther, 1870, p. 172 part; Day, 1878, p. 662 part, and Pl. 174, fig. 1; Day, 1889, p. 462 part; Peters, 1869, p. 276.
Syngnathus gastrotaenia, Bleeker, 1853, p. 22.
Syngnathus Kummii, Bleeker; Duméril, 1870, p. 548; Günther, 1870, p. 172.

Salt and brackish water.

(*b*) Syngnathus spicifer, Rüpp.; var. djarong, Bleek.
Syngnathus spicifer, Rüpp. Synonyms see above, except Day, 1879, Pl. 174, fig. 1.
Syngnathus djarong, Bleeker, 1853, p. 22; Duméril, 1870, p. 545.
? Syngnathus Helfrichii, Bleeker; Duméril, 1870, p. 547.
Syngnathus spicifer, Rüpp.; var. rivalis, Peters, 1869, p. 276.

Brackish and fresh water.

(c) Syngnathus argyrostictus, Kuhl et Van Hasselt; Kaup, 1856, p. 33; Duméril, 1870, p. 545.
Syngnathus spicifer, Günther, 1870, p. 172 part.
? Syngnathus biserialis, Gray; Kaup, 1856, p. 33.

Diagnoses of the two Species.

Syngnathus spicifer, Rüpp.

Ann. 14–16 plus 38–43; ann. subdors. ÷ 2–0 plus 6–9; D 23–30, A 2–3, C 10, P 13–18, B R 14–21. Middle lateral edges of trunk subcontinuous with lower ones of tail. Opercle keeled in its entire length. Sides of trunk without ocellated spots. Total length up to 15·4 cm.

Distribution.—From East Africa to Polynesia.

Syngnathus argyrostictus, Kuhl et Van Hasselt.

Ann. 15–16 plus 33–41; ann. subdors. ÷ 1–0 plus 6–8; D 25–29, A 3, C 10, P 15–17, B R 16–19. Middle lateral edges of trunk subcontinuous with upper ones of tail. Opercle keeled in its entire length. Length of rostrum equal to distance of præorbital margin from base of P. Sides of trunk with numerous small white black-bordered ocellated spots in 3–7 longitudinal series. Total length up to 13·6 cm.

Distribution.—Malay Peninsula, China, Japan.

Diagnoses of the Varieties of Syngnathus spicifer, Rüpp.

(a) Var. *gastrotænia*, Bleek.

Rostrum longer than the remaining part of the head. Trunk rather deep, but without a particularly prominent abdominal edge. Abdomen with about 14 dark cross bars. Total length up to 15·4 cm. Mature males 10·0–15·4 cm.

(b) Var. *djarong*, Bleek.

Rostrum about as long as the postorbital length of the head. Trunk deep; abdominal edge very prominent. Abdomen unicoloured, lighter than the bluish-black abdominal edge. Total length up to 14·1 cm.; mature males 8·3–12·6 cm.

The formulæ of numbers of rings, &c., taken from 44 specimens of the first and 29 of the second variety are :—

(a) Ann. 14–15 plus 38–42; ann. subdors. ÷ 2 ÷ 1 plus 7–9; D 25–30, P 14–18, B R 15–21.

(b) Ann. 14–16 plus 39–43; ann. subdors. ÷ 2–0 plus 6–7; D 23–29, P 13–16, B R 14–17.

More distinctly these differences will come out from the corresponding average values :—

(a) Ann. 14–73 plus 39–81; ann. subdors. ÷ 1–32 plus 7–41; D 27–61, P 16–37, B R 18–26.

(*b*) Ann. 14–79 plus 40–63; ann. subdors. ÷ 0–53 plus 6–31; D 26–28, P 14–76, B R 15–06.

The dorsal fin of var. *djarong* therefore stands somewhat more forward and is shorter than that of var. *gastrotænia*, which latter has more pectoral rays and a larger brood pouch than the former. In both varieties the protective plates of the brood organ are very small, scarcely developed. Eggs of var. *djarong* small, in 4 longitudinal and about 60 transverse series.

Colouration of var. *djarong* during life:—Abdomen of male purplish-red, of female grayish-green, with blue-black abdominal edge. Ventral surface of rostrum and opercles silvery or brass-coloured, with blackish spots and stripes more or less irregularly arranged. C brown, with lighter dorsal and ventral margins. D with dark spots. Some specimens from the Mahaweli-ganga had the lip of the rostrum orange-coloured. Iris brass-coloured.

In New Guinea and the Bismarck Archipelago I collected var. *gastrotænia* at ten, and var. *djarong* at four localities, but once only found the two varieties together at the mouth of a draining ditch of a coconut plantation at the seashore; everywhere else the var. *gastrotænia* preferred the water more saline than the var. *djarong*.

Hippocampus, L.

Brood organ of male subcaudal, without protective plates; its two cutaneous folds entirely united, forming a bag-like brood pouch, which has a small muscular orifice anteriorly, immediately behind the anal ring. Upper lateral edges of trunk and tail discontinuous; lower lateral edges of trunk and tail discontinuous; middle lateral edges of trunk continuous with lower ones of tail. Trunk compressed, generally deep. Head in an angular position to the longitudinal axis of trunk. No scutella; lateral line present. Scutes of body rings with narrow elongated wings and shortened keel. D, A, and P present, C absent; tail prehensile. Base of D elevated.

Of Hippocampus I have seen only three specimens from Ceylon, which seem to belong to two different species. It is impossible, however, at the present state of our knowledge to safely distinguish between the South Asiatic species of Hippocampus, with the single exception of *H. kuda*, Bleek. Characters traditionally applied, such as shape of the corona, of the spines of the body, colour, size of cutaneous appendages, are useless for the distinction of species; they vary considerably according to age and individuality, as I have convinced myself on larger series of the two European forms, *H. guttatus*, Cuv., and *H. brevirostris*, Cuv.

Description of the three specimens :—

Col. Mus. : ♂, ann. 11 plus 40; ann. subdors. 2 plus 1; D 18, A ?, P 19–18, B R 8. Rings subequal. Head and trunk with numerous fine white dots arranged in reticulated lines. Ceylon.

Col. Mus. : ♀, ann. 11 plus 38; ann. subdors. 2 plus 1; D 17, A 5, P 16. Rings subequal. Uniformly dark brown. Ceylon.

Hbg. Mus. : ♀, ann. 11 plus 37; ann. subdors. 2 plus 1; D 18, A 4, P 16. Rings subequal. Head and body with numerous fine white dots arranged in reticulated lines. Gulf of Mannar.

According to the number of caudal rings and of pectoral fin rays, which are systematically important, the two latter specimens may belong to the same, the former one to a different species; they certainly are not *Hippocampus kuda*, Bleeker. *Hippocampus guttatus*, Cuv. (*cf.* Günther, 1870, p. 202; Day, 1878, p. 682), is exclusively a European species, which is found from the Mediterranean to the North Sea. The synonym in the places cited above therefore is erroneous.

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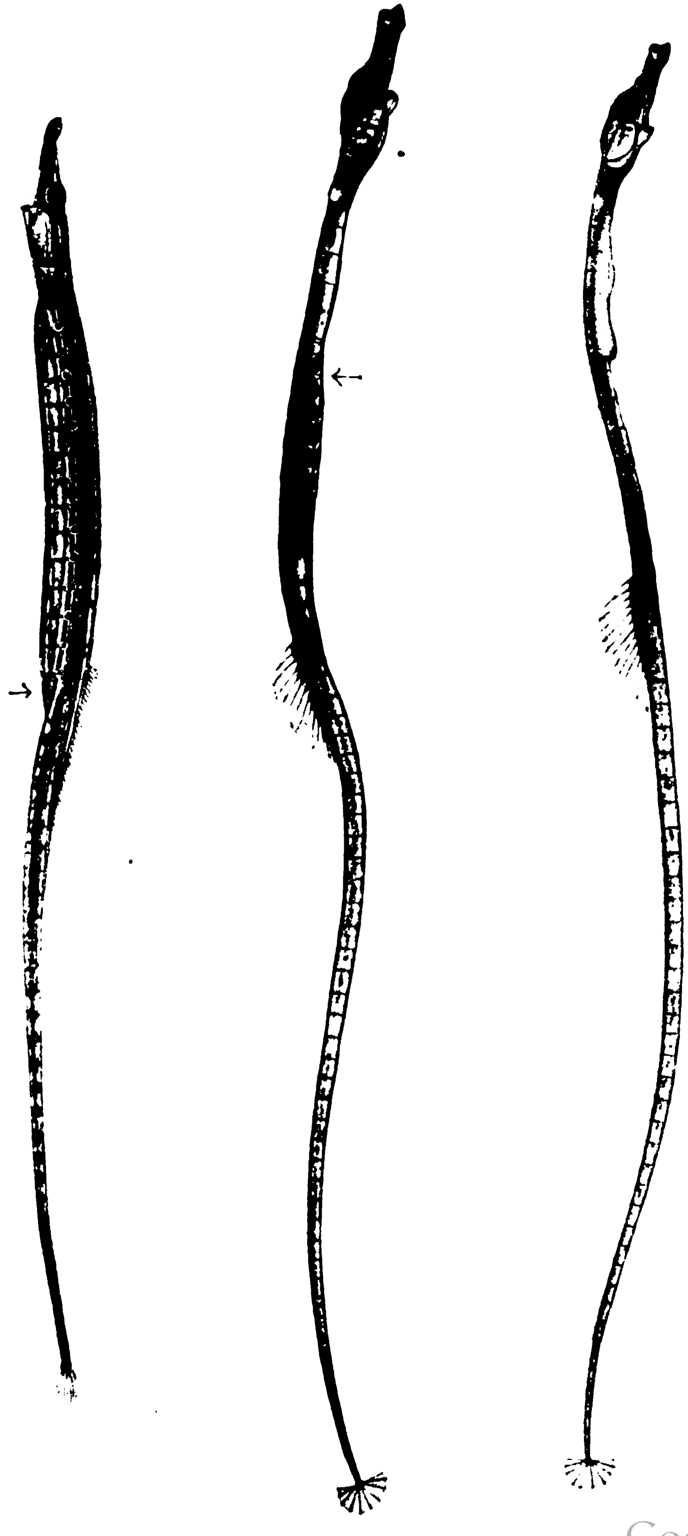
Explanation of Plate.

A.—*Doryichthys ocellatus.*

B.—*Urocampus southwelli*, ♂.

C.—*Urocampus southwelli*, ♀.



A B C

Syngnathids of Ceylon.

REMARKS ON SOME RECENTLY ACQUIRED CEYLON SNAKES.

By Major F. WALL, I.M.S.

TO Dr. Willey I am indebted for a specimen of the Ceylon water-snake *Tropidonotus asperrimus*, and to Mr. E. E. Green for six other snakes, all of which are worthy of special remarks.

Tropidonotus asperrimus, Boulenger.

The specimen sent convinces me that this snake is not entitled to rank as a species, but is better considered as merely an insular colour variety of *T. piscator*, Schneider, comparable to the Andaman variety *tytleri* of the same species. Its markings accord well with the figure in Mr. Boulenger's Catalogue (Vol. I., Plate XV., fig. 2), but the last two costal rows are quite smooth, so that it is evident that some specimens perfectly agree with typical forms of *piscator* in the only character, excepting colour, upon which it is separated from that species. Mr. Boulenger claims that only the last row is without keels.

I prepared the skull, and this and the dentition perfectly accord with those of typical forms of *piscator* from India. The teeth are as follows: maxillary, 21 left, 22 right; palatine, 11 left, 12 right; pterygoid, 22 left, 24 right; mandibular, 22 left, ? right (broken). The dentition of four other skulls of Indian *piscator* in my collections is: maxillary, 21 to 25; palatine, 11 to 15; pterygoid, 24 to 27; mandibular, 23 to 27.

Dendrelophis tristis, Daudin.

Two specimens were received, one head and neck only, the other a gravid ♀, measuring 3 ft. 11½ in., killed at Peradeniya at the end of December, 1909, and containing 7 nearly mature eggs.

The Ceylon form of this snake appears to be an insular variety, at least I cannot remember ever having seen it in any part of India. It differs from the Indian form in (1) the absence of a light round spot on the back of the head in the interparietal suture; (2) the light vertebral stripe is very conspicuous, being bright yellow, and limited to a small extent of the forepart of the spine; (3) there is no black line between the dark brown dorsal colouration and the buff flank stripe; (4) all the scales, including the vertebral, are heavily bordered with black basally and apically. The variety is very nicely shown in Plate XII. of the Bombay Natural History Journal, Vol. XIX., Part 4, which accompanies my article on this snake, and which should be called *Dendrelophis tristis*, not *Dendrophis pictus*. I have little doubt now that the British Museum artist painted this from a Ceylon specimen. This variety, which may be called *taprobanensis*, agrees with the Indian form in the following ways: (1) the narrow vertebral row of scales, which, though enlarged, are considerably longer than broad; (2) having only two supralabials, the fifth and sixth normally touching the eye; (3) narrow black posterior borders to the second, third, and fourth supralabials (and first, too, sometimes); (4) a narrow, short, and rather obscure postocular black stripe.

I have prepared and examined the skull of one of these specimens, and find the nasal bones, the ridges on the parietal bones for muscular attachment, and the maxillary dentition—in that the posterior teeth are shorter than the anterior—all agree with the Indian form, figures of which appear in the diagram accompanying my article in the Bombay Journal (*A*, *a* to *g*). The only difference is in the number of the maxillary and pterygoid teeth, which exceed those in the usual Indian form.

The dentition of this is herewith given with that of all my Indian skulls for comparison:—

No. of Specimen.	Side of Head.	Teeth. Maxillary.	Palatine.	Pterygoid.	Mandibulars.	Habitat.
1	Left	?	?	19	20	Eastern Himalayas (Parhok)
	Right	18	13	19	21	
2	Left	17	11	20	22	do.
	Right	18	12	20	?	
3	Left	19	12?	20	20?	do.
	Right	18	11	21?	21	
4	Left	18	11	24	22	do.
	Right	17	11	22	?	
5	Left	19	11	19	23	Eastern Himalayas (Parhok or Tindharia)
	Right	18	11	22	21?	
6	Left	21	12	22	21?	?
	Right	21	12	23	21?	
7	Left	21	13	?	22	Madras
	Right	19	11	21	21	
8	Left	20?	12	24	?	South India (Madras ?)
	Right	22	13	25	24	
9	Left	20	13?	26	21?	Western Ghats (Matheran)
	Right	22	13	24	22	
10	Left	21	14	28?	26	Nilgiri Hills (Kotagiri)
	Right	22	14	29	24	
11	Left	21	13	29	25	Ceylon (Peradeniya)
	Right	21	13	30	24	

It will be seen that the dentition agrees with that of a specimen from the Nilgiri Hills, collected many years ago, in which I omitted to note the distinctions in colour and markings given above, so that it is possible that the Ceylon form may, as in many other cases, be found also in the South Indian Hills.

Oligodon sublineatus, Dum et Bib.

A single ♂ specimen of this snake from Matale, measuring 8½ in., was specially interesting, in that the scale rows were aberrant, numbering 13 instead of 15. Studying this specimen, it was observed that the sixth and seventh rows above the ventrals coalesced, reducing the normal 15 to 13 rows, and in several places the row so formed divided to bring the number to the normal 15 and then fused again. I have seen a similar aberration arising in the same manner in other species of *Oligodon* and its nearly allied genus *Simotes*. The ventrals numbered 140, and the subcaudals 32. The general appearance of this snake is remarkably like that of its poisonous relative, *Callophis trimaculatus*. There are the same black spots in a single costal series down each side of the back, and the same head marks, but the dark collar is broken in the median line, unlike *trimaculatus*. The median row of ventral spots was absent in this specimen.

An examination of the skull I prepared from this specimen is interesting. There is an edentulous interval that would take at least two teeth in the front of the maxillary and mandibular bones, the palatine bone is edentulous, and a long edentulous interval is seen in the front of the pterygoid bone, so that the few teeth in this are situated in the middle. It is to be noted that Boulenger (Cat., Vol. II., p. 233) states that the pterygoid teeth are wanting in this genus, but I find them present in all the species of which I have skulls, viz., *venustus*, *dorsalis*, *subgriseus*, *erythrogaster*, as well as this species.

The maxillary teeth in this specimen number 7, the pterygoid 5 or 6, and the mandibular 10.

Bungarus ceylonicus, Günther.

Two well-grown specimens of the "Karawella" killed at Peradeniya were sent to me, a ♂ measuring 2 ft. 2½ in., with 233 ventrals and 32 subcaudals, and a ♂ ? measuring 2 ft. 5½ in., with 223 ventrals and 37 subcaudals.

I prepared both skulls, and find the dentition as follows: the maxillæ are provided with 3 small grooved teeth behind the paired fangs. There are from 11 to 12 palatine, 8 to 10 pterygoid, and 15 to 17 mandibular teeth.

Callophis trimaculatus, Daudin.

One specimen of this very rare snake was sent to me, killed at Matale, an adult measuring 1 ft. 3½ in. The species has only twice before been recorded from Ceylon, once by Haly (First Report, Snakes, Colombo Museum, 1886, p. 16), from Tissamaharama, 20 miles north-east of Hambantota, and once by Dr. Willey (Spol. Zeylan., Vol. V., Part XX., p. 186), from Niroddumunai, near Trincomalee.

The ventrals in the Matale specimen are 228 and subcaudals 28.

I have prepared the skull, and find the dentition as follows: maxillary, 2 to 3 small grooved teeth behind the paired fangs; palatine, 6 to 7; pterygoid, 6; mandibular, 8 to 9.

Reference to Boulenger's Catalogue (Vol. III., p. 396) shows that the genus *Callophis* has no maxillary teeth behind the fangs. It is obvious from this that the characters made use of by this authority to differentiate this genus must be altered, or this species removed therefrom; and in this connection I may mention that in a specimen of the species *Maculiceps* lately received from Tenasserim (Kawkariek, Amherst District) I find three grooved teeth in the maxilla behind the paired fangs.

NOTES ON KANDYAN ART.

By ANANDA K. COOMARASWAMY, D.Sc.

(With two Plates.)

CHANK IN THE MUSEUM AT KANDY.

THE Kandy Museum has lately acquired a very beautiful chank, mounted in damascened brass, and comparable with the fine specimen which is figured in "Mediæval Sinhalese Art," Pl. XLI., I. As in that case, the termination is in the form of a *serapendiya* head, and a continuation of the metal work runs round the mouth of the chank. The foliar scrolls proceeding from the animal's mouth are partly broken. The chank itself is plain, and not inlaid as in the other example. Like the other, it comes from Uda Nuwara; in this case, from the Dewale at Lankatilaka. The other example was given by Narendra Sinha to a Dewale at Eldeniya (or Aludeniya ?), and it may be assumed that this specimen also is at least as old as the earlier part of the eighteenth century. It measures $10\frac{7}{8}$ inches in full length.

CARVED POWDER HORN.

Mr. A. B. Casse Lebbe possesses a very fine carved Kandyan powder horn. The material is buffalo horn, and the delicate carving a fine example of *liya pata* work.

WEIGHT OF A STOCK-DRILL.

When last in Ceylon I obtained a beautifully carved stock-drill (*torapanaya*) weight, elaborately carved in serpentine. This material is probably derived from the exposure near Ragalla, which was examined by Mr. Parsons, and is described in the Administration Report of the Mineralogical Survey for 1906. It is interesting to note that the carved weight shows signs of local abrasion, where it has evidently been rubbed down in recent times for medicinal purposes, as described in the report referred to.

Seen from above, the weight has a pentagonal section; there is a ring of *pala peti* ornament round the bore, and below this are the five angular ornaments of *naga bandha* form; below this again is a simpler form of *pala peti*, followed by several delicate mouldings. The total height of the weight is $3\frac{1}{8}$ in., the diameter of the bore is $\frac{3}{4}$ in. above and $\frac{7}{8}$ in. below. Other illustrations of stock-drill weights from Ceylon will be found in "Mediæval Sinhalese Art," fig. 91, and in Mr. Parker's "Ancient Ceylon," figs. 240, 241.

The present specimen is said to have belonged to Devendra Mulacariya, and was obtained from one of his descendants.

Photograph of a Kandyan Kendiya.

The accompanying photograph of a *kendiya* was taken some years ago by Messrs. Skeen & Co., and lately given to me by Mr. F. Skeen; the present whereabouts of the original is unknown. It represents a fine specimen, probably made in silver, and no doubt formerly the property of a Buddhist temple. It is scarcely distinguished in form from an ordinary *kotalaya*, except by the presence of a lid.

Filigree and other Beads.

The great variety of beautiful gold beads found in Kandyan jewellery, whether of local or Tamil origin, is very remarkable, and I illustrate here a selection, which should not, however, be regarded as exhausting all the varieties obtainable. All the principal types are known by name. Any filigree bead is *wayiramuni;* one with stars (No. 1) is called *taruka wayiramuni*, "star filigree bead"; one with dots (No. 16) is called *arimbu wayiramuni*, "dot filigree bead"; one chased like No. 4 *arimbu surulu wayiramuni* (but this appears to be an error, as this is not actually a filigree bead, but belongs to the other class).

Beads other than filigree are called *bubul*. Ribbed varieties (Nos. 14, 19, and 21) are called *reli bubul*, "waved beads," or "undulated"; those with a sharp angle, diamond-shaped in section, are called *dippatan*, "two-facetted"; those chased (Nos. 3 and 7) are called *ketayan bubul*, "chased beads," or "cut beads"; those covered with dots, *arimbu bubul*, "dotted beads" (No. 5). All these are made in two halves, and soldered along the median line. They are, of course, hollow, and very light and delicate.

Another small Kandyan bead, not shown here, is the *gotamuni*, resembling a grain of rice in size and shape; these are made, not in two halves, but by rolling round a piece of thin gold of the requisite size upon itself.

The following are some names of gold necklaces, additional to those given in my "Mediæval Sinhalese Art." I should have been glad to illustrate some, but could not obtain permission to take the photographs of the jewellery at the Dalada Maligawa, from a list of which the names are taken. The names are: *muna-mal malaya*, *pusu-vandan malaya*, *hunu-vel malaya*, *dan-vel malaya*, *arimbu surul malaya*, *mohana malaya*, *sakra malaya*, *torapat sangili malaya*, *sinamuni malaya*. The previously recorded names, *peti malaya*,

KENDIYA.

POWDER HORN.

KANDYAN ART (A. K. COOMARASWAMY).

Bemrose, Collo., Derby.

polmal malaya, and *gedi malaya*, also occur in the list.* It would be exceedingly interesting, and to local and European art students a very valuable thing, if the Ceylon Government would arrange to publish an adequately illustrated account of the Maligawa treasure, in co-operation with the temple authorities; it is a work which could hardly be accomplished in any other way.

I am indebted to Mr. T. B. Keppitipola for some of the above information; he is one of the few Kandyan chiefs who, at the present time, take an interest in the arts and legends of the Kandyans.

Bo-leaf as a Decorative Motif.

The well-known Sinhalese bo-leaf ornament, considered as a Buddhist symbol or decorative motif, is certainly of considerable antiquity in India and Ceylon. It appears probable, however, that the form belongs to that large class of ornamental motifs which, like the classical "acanthus," owe their name and later significance to an accidental resemblance in a form of quite different origin. General Beylié writes as follows on the bo-leaf of India :—

"Lanceolate ornament, or, more exactly, conventional leaf ornament, has had its own special history in each country, but particularly in Egypt, where we constantly meet with it on the tombs of Antinoe. It formed later the foundation of the decorative system of Musulman art (13th century) and by reaction of the figured work of Louis XIII. It is not impossible that the lanceolate ornament of the Musulman style, although of Assyrian and Egyptian origin, was only adopted in its ordinary form after having undergone a final transformation in the Indies. The leaf of *Ficus religiosa* appears as a nimbus in many statues of Buddha in memory of the sacred bo-tree under which he attained wisdom. We may anyhow regard it as certain that the temples of Cambodia (9th–12th centuries) and the palace of Angkor-Vat ...... have never felt any other than Hindu and Chinese influence.

"We may add that the principal of the lanceolate or conventional leaf is not Indian, but Oriental, while the multi-lobed ornament, evidently of a leafy character, which appears to originate in Musulman art in the 13th century, on the belly of the vases of Mossul, is very probably of Hindu origin."

In other words, the bo-leaf *form* is of Assyrian or Egyptian origin—like the majority of motifs in decorative art, traced to their ultimate source—and was adopted as a Buddhist symbol in India,

* Another well-known form is the *siri-bo-malaya*, erroneously described as *Sri-bo-malaya* in the index to my "Mediæval Sinhalese Art," where it is illustrated (Plate XLIX., 5). This form comes mainly from the Galle District, and does not appear to be Kandyan.

Other necklace names which I have heard are *kalamediri malaya* and *patteya malaya*. Another kind of bead is called *karawila eta*. It would be very advantageous if examples of all these named varieties could be exhibited in the Colombo Museum.

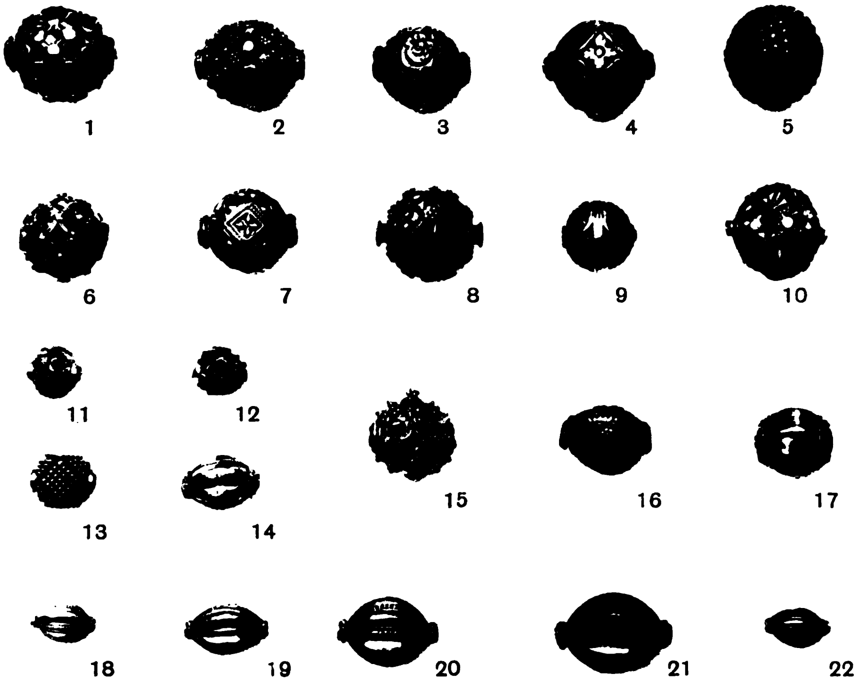
and then more deliberately based on the actual bo-leaf outline; and this Indian type again influenced Musulman, and through Musulman, European types of ornaments.

Since writing the above, Mr. Keppitipola has kindly sent me a full list of the names of the beads illustrated. The names are as follows:—

1, *Arimbupeti wayiramuni*; 2, *Arimbu wayiramuni*; 3, 4, 7, *Ketayan bubul*; 5, *Arimbu bubul*; 6, *Silamuni*; 8, *Murukasa wayiramuni*; 9, *Surulu silamuni*; 10, 15, *Murukasa arimbu wayiramuni*; 11, *Wayiramuni*; 12, 13, *Pattan arimbu bubul*; 14, 18, 20, *Arimbu palakka*; 16, *Surulu palakka*; 17, *Dipattan bubul*; 19, 21, 22, *Reli palakka*.

It will be seen that *wayiramuni* is the term applied to a filigree bead, *bubul* to a bead not of pierced or trellis work; an ovoid or elongated bead is called *palakka*. The term *pattan* is used, as in gemming phraseology, to signify "facetted." *Arimbu* signifies a grain or dot.

BRASS MOUNTED CHANK.



GOLD BEADS.

1 2 3 4 5

(Inch scale for beads only.)

KANDYAN ART (A. K. COOMARASWAMY).

Bemrose, Collo, Derby.

PEDIPALPI OF CEYLON.

By F. H. Gravely.

(With three Text Figures.)

THE Pedipalpi are a group of Arachnids, or spider-like creatures, which have as yet been very imperfectly studied, as specimens are scarce in the museums of Europe. They include the whip-scorpions (*Thelyphonidæ*) and scorpion-spiders (*Phrynichidæ*), of which the latter at least must be familiar to many residents in Ceylon, as one species (*Phrynichus lunatus*) is not uncommonly met with in bungalows. It is somewhat like a large and very

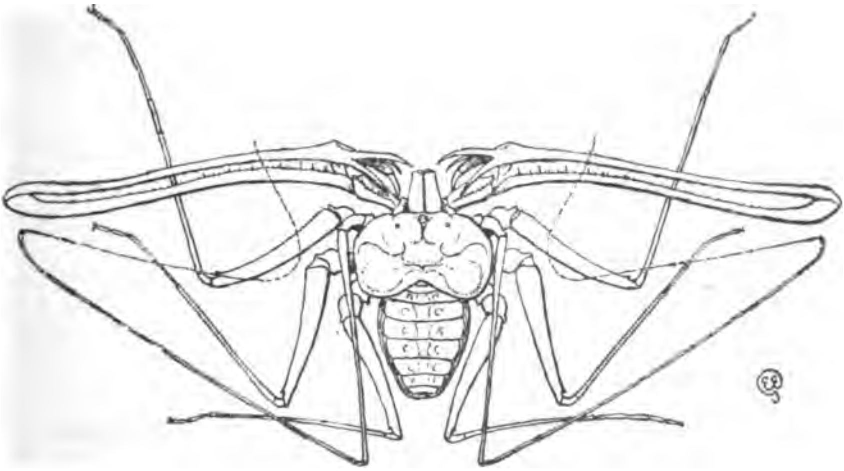


Fig. A.—" Scorpion Spider " (*Phrynichus lunatus*), ♂, natural size.

much flattened spider, having an almost disc-shaped body and long legs, which spread out from it close against the wall on which it rests and over which it darts, usually sideways like a crab, with quite startling rapidity when disturbed. But instead of the four pairs of walking legs found in the spider there are only three pairs, as the first is enormously lengthened and many-jointed, resembling both in form and in function the antennæ of an insect; for with these the creature feels its way about. And in front there is a pair of long arms, corresponding to the claws of a scorpion, terminated by a small claw and some stout curved spines; as a rule, these arms project straight outwards as far as the elbow, where they bend straight inwards again, the forearm being in contact (or almost in contact) with the upper arm throughout its entire length, as shown in the accompanying figure; but when in a hungry state the creature sees a juicy cockroach or cricket near by, these arms are extended forwards, thus enabling it to catch its prey without approaching it too closely. The arms vary considerably in length and are usually shorter, often much shorter than in the specimen figured, the abdomen, moreover, being frequently larger. The female carries her eggs about with her in a capsule attached to the lower surface of the abdomen.

Another and somewhat smaller and more moisture-loving species of scorpion-spider (*Phrynichus pusillus*) is fairly abundant under stones in the jungles of the Kandy District, and is known to extend to a considerably higher elevation than this; but further information as to the distribution of this, and indeed of all the

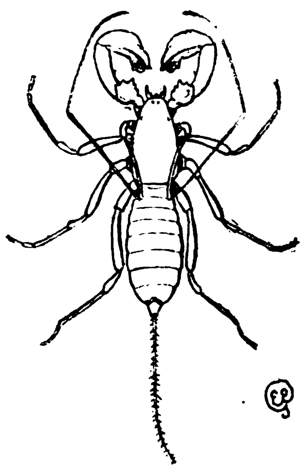


FIG. B.—"Whip Scorpion" (*Labochirus proboscideus*), ♂, natural size.

Pedipalpi in the Island, is very much to be desired, and specimens from any part would be much appreciated both by Mr. Green (Peradeniya Gardens) and myself (Indian Museum, Calcutta) for the elucidation of this matter. It is possible that there may be two distinct species of the small form found in the jungle: one with very long arms and commonest, like the larger species, in the low-country (up to 1,000 feet); and another with shorter arms, which is the commonest at higher levels. But this, too, is a matter which cannot be settled until more material is available.

Whip-scorpions, as the name implies, resemble scorpions rather than spiders; indeed, at first sight the only noticeable difference between whip-scorpions and scorpions lies in the slender whip-like "tail" of the former, which, moreover, lacks the much-dreaded sting of the latter. But in these creatures, as in the scorpion-spiders, the appendages corresponding to the first pair of walking legs of other Arachnids are modified so as to form feelers, though not such extraordinarily long and slender ones.

In the Kandy District I have only met with one species of whip-scorpion (*Labochirus proboscideus*), a creature of about the size of the small brown scorpions often seen about the verandahs of bungalows, but black and of a stouter build; a much larger species (*Thelyphonus sepiaris*) is, however, recorded from the low-country. The small species is to be found under stones and logs of decaying wood in the neighbourhood of water-courses—but not on marshy ground—and in other parts of the jungle when the ground is thoroughly moistened by the rains. This species digs a burrow

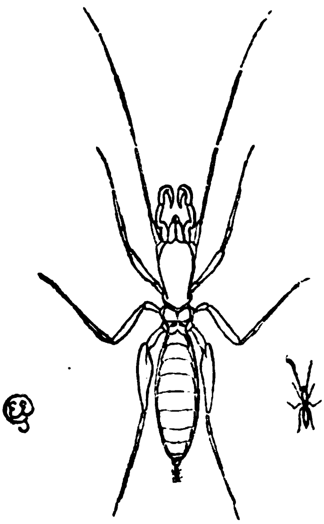


FIG. C.—"Tartarid" (*Schizomus crassicaudatus*), ♀. Magnified 6 diameters, and small figure natural size.

for itself beneath the stones under which it lives; and when its surroundings become dry, it appears to retire underground and remain there; but on this point also further evidence is wanted. Moreover, males (with long arms) appear to be three or four times as common as females (with shorter arms), a condition which again needs explaining.* Mr. Green tells me that the larger low-country

* Further observations have proved this statement to be erroneous, or at least that it only holds good at a definite season of the year. My first specimens (all males) were obtained on May 5, before the break of the monsoon. The first female was obtained on July 20, a day or two after the commencement of the second period of wet weather this season. From that date to the present time—August 3—females have been much more and males much less frequently found. As the total number of specimens found, however, is little more than a dozen, and as my observations have been confined to a visit of three months, it is impossible to state with certainty that this apparent seasonal appearance of the sexes separately is an actual fact without further evidence; but if so, it is a very remarkable one.

species is probably much less dependent on moisture than the small species; and like the large species of scorpion-spider it sometimes gets into bungalows. On one occasion, indeed, a friend of his found a fine specimen occupying his bed in a resthouse on the Trincomalee road.

But, beside these large and conspicuous kinds of Pedipalpi, there is yet another family, the *Tartarides*, which contains only very small and inconspicuous forms, characterized by the presence of a very short tail (flattened into a plate in the only species of male definitely known), and a form otherwise resembling that of the whip-scorpions. This family is confined, so far as has been ascertained, to Ceylon and Burma, and scarcely anything is known about it, as specimens are very rarely seen. This is not due to their being scarce, however, for they are quite abundant in the thick deposit of dead leaves in certain parts of the shrubberies of Peradeniya Gardens, and not at all uncommon under stones among grass sheltered by trees or bushes, both at Peradeniya and above Lady Blake's Drive between there and Kandy. Mr. Green tells me that he obtained a specimen at an altitude of about 4,000 ft., and no doubt they are in reality very widely distributed in the Island. But they require very careful looking for in suitable places, and when found they bear such a close superficial resemblance to a largish ant—the sensory legs being directed forwards so as to assume very much the appearance and position of the antennæ of an ant—that their true nature may easily be overlooked. The body of these creatures, however, is somewhat more cylindrical than that of most ants, the "waist" being less distinct; their jaws work vertically side by side as in spiders, instead of horizontally as in ants, and so are quite inconspicuous; and their spasmodic darting movements as they search for a hiding-place are also very characteristic; once a specimen has been seen and recognized there will be no difficulty in recognizing others.

Two species are recorded from Ceylon: the common pale brownish or olivaceous one, $\frac{5}{32}$–$\frac{1}{4}$ in. in length, exclusive of the appendages, when (apparently) mature (*Schizomus crassicaudatus*); and a scarcer and more inconspicuous one of a dark olive-green colour, never more than $\frac{5}{32}$ in. in length (*S. suboculatus*). Pocock, in the Arachnid "Fauna of British India," places this species in the Burmese genus *Trithyreus*; but an examination of living specimens shows that it really belongs to the purely Ceylonese genus *Schizomus*. Only in the former is the male known; it is much scarcer than the female, and easily recognizable by the flattened and expanded tail. A curious fact about this species, which I am quite unable to explain, is that males and females of a fairly definite and approximately equal size ($\frac{5}{32}$ in.) are found under stones, whilst apparently only females, and these of a larger size, occur among dead aves.

Apparently none of the Pedipalpi are poisonous. If a whip-scorpion be molested with a finger bearing a cut or raw scratch, this cut or scratch will probably begin to smart violently with the acetic acid ejected by the whip-scorpion from near the base of the tail; but this is the worst they can do.

Specimens of all these forms of Pedipalpi may be readily kept in captivity and great interest derived from the study of their habits. The larger species of scorpion-spider and whip-scorpion will live comfortably in a bare insect breeding cage, feeding on insects, &c., cockroaches and crickets (not *too* large) being much appreciated. The smaller species of both forms require a layer of light soil—which must never be allowed to get very dry—on the floor of the cage, and will feed on similar insects. Even the largest species like to have water sprinkled in occasionally, so that they may suck up the drops; and they all prefer to have some shelter—a piece of stone or rotten wood or bark of a tree—under which they may hide by day, their wanderings in search of food being entirely nocturnal.

The common Tartarid *Schizomus crassicaudatus* will live in quite a small glass collecting tube. I have kept one now for several weeks with a little soil and a few of the tiny white insects (Podurids) often found among decaying leaves or under old coconut husks. I presume that it eats these insects, for it has had no other food, and is still perfectly healthy; but I am by no means sure, as its small size makes its habits in captivity much less easy to study than are those of the scorpion-spiders and whip-scorpions. Probably all the Pedipalpi will turn cannibal in an emergency.

The large scorpion-spider when seen upon a flat wall is most easily captured by lowering a broad glass tumbler over it and then slipping a piece of stout paper or thin card in beneath. The smaller form when met with in the jungle is easily managed by holding him down by the tip of a finger placed on the body, whilst the thumb secures him from beneath. Whip-scorpions I usually seize suddenly in the middle of the body with a pair of forceps. Tartarids are too small to pick up in this way, and too shiny to be easily secured with a camel hair brush. I usually scoop them and some of the surrounding soil with the blade of a penknife into a glass tube, emptying each specimen out into a second tube as I secure it, thus always leaving the first free for another catch. But the extraordinary facility with which they completely conceal themselves in the soil when once they have hit upon a suitable place makes it practically impossible to secure every specimen found.

I have to thank Mr. Green for the very useful figures (all of which have been drawn from life) accompanying this note. These are probably the first published figures drawn direct from the living animals, and they present them in one of their most characteristic attitudes.

NOTES.

1. *Bee-eaters as Fish-eaters.*—The following correspondence appeared in the columns of the "Ceylon Observer" between May 4 and May 11, 1910:—

I shall be glad to hear if any of your readers have noticed bee-eaters fishing. There are a pair of chestnut-headed bee-eaters, which nest pretty regularly in a steep bank on a road below my bungalow, and about 150 yards distant from my pond. Almost any bright afternoon, between 2 and 3 P.M., they may be seen fishing in the pond. They come down from a dead tree, which stands on a knoll some 50 yards away; sometimes hovering for a moment over the water to locate their prey, but more commonly marking it in their swoop, and dashing headlong into the water like a kingfisher, and very rarely missing their fish. I have seen the pair account for a dozen fish in as many minutes; all quite small fry.

When there is a flight of white butterflies on, these birds devote most of their attention to them throughout the day, but on warm bright days nearly always have a go at fishing in the afternoon.

I have heard one or two Tamils call these birds *Min kottu kuruvi*, but this was after I had pointed out the birds dipping the water; it is *possible* they mistook them for kingfishers, though *not* likely, as most of the Tamils here seem to have a very fair knowledge of birds.

I have always hitherto associated bee-eaters with the one diet of insects; and I could not quite trust the accuracy of my eyesight until I brought a strong pair of field glasses to bear on the actors at the short range of 15 to 20 yards. I think it probable that many so-called insectivorous birds change their diet when some chance has put them up to the taste of a new article which happens to suit them.

E. GORDON REEVES.

Wiltshire, Matale, May 2, 1910.

With reference to the interesting observation recorded by Colonel Gordon Reeves, as to the occasional fish-eating or rather fry-eating habits of the chestnut-headed bee-eater, I may point out that it very rarely happens that an opportunity for making such an observation presents itself under ordinary circumstances. There is no reason whatever to doubt the accuracy of the observation. Other cases of birds varying their diet are known, although the change from an insectivorous to a piscivorous diet is perhaps rather abrupter than usual. The opposite change from fish-eating to insect-eating habits is to be noted in the kingfisher family, to which the bee-eaters are somewhat distantly related. I remember being much surprised, many years ago, to find a kingfisher's stomach full of insect remains.

The different kinds of food consumed by omnivorous birds, such as the crow, do not, of course, afford such striking examples of discontinuous dietary as do those of more eclectic birds.

In *Spolia Zeylanica* for March, 1909, Mr. John Still states that he saw a paradise flycatcher plunge from its station on a tree and capture something in the water, just like a kingfisher. I have seen the same species catching butterflies on the wing. So that here we have an exact parallel to Colonel Reeves's observation.

Flycatchers are not related to kingfishers, but they are distantly related to the shrikes or butcher-birds. One might put it that bee-eaters are to kingfishers what flycatchers are to shrikes. All these birds have the habit of sitting on a perch, swooping down from it to their prey, and afterwards returning to it. The late Grant Allen stated positively that among the animals which he had seen in butcher-birds' larders were mice, shrews, lizards, robins, tomtits, and sparrows; but he added that, in spite of its occasional carnivorous tastes, the shrike is at heart an insect-eater. In this variation of diet, on the part of the shrike, we may perceive another parallel to the cases mentioned above.

A. WILLEY.

Colombo, May 4, 1910.

Colonel Gordon Reeves's observation is a most interesting one. I have never noticed these birds fishing, but as they are known to take insects from the surface of water there is no reason why they should not learn to pick up small fry in the same manner.

The "bee-eaters" (*Meropidæ*) are closely allied to the "kingfishers." The two families come next each other in Legge's "Classification of the Birds of Ceylon." Speaking of the habits of the "blue-tailed bee-eater" (*M. Philippinus*), Legge remarks :—"I have seen it dash on to the surface of ponds and rivers and seize insects which were passing over the water. Mr. Holdsworth has observed it hunting close to the surface of the sea, at a distance of a quarter of a mile from the shore."

Again, under *Merops viridis* (the green bee-eater) is a note to the effect that "Blyth has seen them assembled round a small tank seizing objects from the surface of the water, after the manner of a kingfisher." But in his description of the habits of the "chestnut-headed bee-eater" (*M. Swinhoii*), no such custom is noted, though he remarks upon its habit of frequenting "the topmost or most outstretching branches of high trees overhanging water."

E. ERNEST GREEN.

Royal Botanic Gardens, Peradeniya, May 5, 1910.

I must thank Dr. Willey and Mr. E. E. Green for their interesting replies to my query *re* the fish-eating bee-eater. Since the pair, which I convicted of fishing, hatched out their young, they have abandoned their fishing expedition, and may be seen sitting on the tree facing their burrows catching insects (chiefly white butterflies) to feed their nestlings.

By the end of the month they will have departed north. Thrush species have been abnormally common here this year, and migratory Raptores, such as harriers, equally scarce. Not long ago I noticed an India swiftlet with a large white "yoke" or collar. It was very conspicuous amongst its "all dark" associates, and remained in the same locality for some weeks.

E. GORDON REEVES.

Wiltshire, Matale, May 7, 1910.

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2. Extracts from "Entomological Notes" by the Government Entomologist, from the "Tropical Agriculturist," Vol. XXXIV., April, 1910:—

A Blood-sucking Bug.—A correspondent has sent me specimens of an evil-looking bug which had been gorging itself at his expense. It is quite distinct from the notorious "B-flat" (or bed-bug, *Cimex lectularius*), though it has acquired the same objectionable tastes and habits. The examples first received were small and immature, but their bodies were fully distended with blood. My correspondent reports that he was disturbed at night by the bites of these creatures, and found several of them crawling about the bed. The consequent irritation was severe. Subsequently the adult insect (probably the parent of the troublesome brood) was discovered in the same situation. It proves to be a Reduviid bug (*Conorhinus rubrofasciatus*), an insect of quite formidable size, measuring over an inch in length.

Bugs of this family normally prey upon other insects; but several species of *Conorhinus* have gained an evil reputation as systematic blood suckers. *C. sanguisugus* is a troublesome domestic pest in parts of the United States; Darwin, in his "Voyage of the Beagle," describes a species of *Conorhinus* that attacks travellers when camping out on the Pampas of South America. As far as I know the present record is the first of the kind from Ceylon. The insects frequent outhouses, hiding amongst the rafters during the day-time and sallying out to feed at night.

The Colombo Lake Fly.—I have at last received the scientific name of the notorious "Lake Fly." It can now be definitely labelled as *Chironomus ceylanicus*. I fear, however, that this knowledge will not appreciably mitigate the inconvenience occasioned by the pest.

E. E. GREEN.

3. *Crows as fishers.*—I lately had an opportunity of watching a flock of crows doing a bit of "fishing" on their own account just after dusk, as they wended their homeward way, along the Bentota coast. Every time the waves receded they swarmed on the shore, picking up whatever was left in the track of the water. As the waves broke again they rose in air, all the time travelling along the shore in the direction of their flight home.

Colombo, May 20, 1910. C. DRIEBERG.

"*Crows as fishers.*"—In the second volume of his entertaining "Curiosities of Natural History" (reprinted in 1903 from the fifth edition: Macmillan, London), Mr. Frank Buckland has the following remarks on crows, which will be of interest *apropos* of Mr. Drieberg's note. The passage occurs in the chapter entitled "The Gamekeeper's Museum" (see p. 95):—

"As the museum was situated near the sea coast, I was therefore not surprised to see in the collection a Royston, or hooded crow. This bird's proper home is the seashore, where his business is to follow the retiring tide, and to eat what is left thereby. Nor does he object to small crabs and those curious sea-anemones which the good folk of Guernsey so aptly call "bloody-fingers." Having capital wings, he often takes a look at the rocks, where the gulls and other sea-birds build their nests and place their eggs. When these fail him, he will take an inland journey, and very naturally mistakes a game bird's egg for a gull's egg. The keeper, in his turn, very naturally seeing what he is after, mistakes him for a carrion crow, shoots and gibbets him—hence his appearance in the museum. The keeper calls him the saddle-back crow; a good name again, for his head, tail, and wings are black, and the rest of his body of a fine ash-gray colour, so that he looks very like a common crow with a saddle on his back. Our French neighbours too, whose shores he also visits, have evidently, with the same idea, christened him *Corneille mantelée*, or crow with a cloak on. These crows are very quick in finding out dead or wounded birds. A great sportsman tells me that he has often gone at daylight to pick up wild fowl which he had shot the previous evening, and found that these saddle-back crows had anticipated him and made a meal of his wild duck and teal."

At Sea, June 14, 1910. A. WILLEY.

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4. *Rambling Notes*:—

(*a*) **Life-history of a common Ceylon Butterfly.**—*Ypthima ceylonica* is—I should say without exception—the commonest of our Ceylon butterflies. It occurs throughout the year, and is a familiar object in every compound, wayside hedge, or grassy field, up to an elevation of about 4,000 feet. And yet, to the best of my belief, no published description of its early stages or transformations has yet appeared. *Y. ceylonica* is now considered to be a local race of the Indian form *huebneri*, Kirby, of which the larva and pupa are known; but our Island race of the insect has not apparently been bred up to the present time.

Having taken a pair of the butterflies *in coitu* on November 23 last, I placed them under a glass shade with some living grass plants in hopes of obtaining ova. The male insect died on the 25th. No eggs had then been deposited, though the female was still active. On the following morning I found two small globular eggs, laid side by side, near the base of a blade of grass; two more eggs were attached to the extreme tip of another blade, and three others on the under-surface of a broad leaf of ribbon-grass. When magnified it is seen that the egg is not truly globular, but has a slightly longer vertical diameter. It is wider towards the base, and very slightly flattened above and below. The surface is closely pitted with irregular polygonal depressions. The longer diameter is approximately 0·75 mm.

The eggs hatched on December 3. The young larvæ are of a very pale pinkish white tint, with a reddish median-longitudinal line and a similar dorso-lateral line on each side. The sides are more or less completely suffused with rosy red. Every segment, including the head, has a transverse series of colourless tubercles, each supporting a longish obtuse white hair. Head large, fully twice the width of the following segments.

December 10.—The young larvæ are undergoing their first moult. At the end of the first stage the pink colour of the newly hatched larva has entirely disappeared, being replaced by whitish green; the body has thickened until it has exceeded the width of the head; the tubercles have become less prominent and conspicuous; the dorsal, subdorsal, and lateral lines are dull green. After the moult the most marked difference is the appearance of a pair of pointed, conical, divergent processes on the terminal segment.

December 18.—The larvæ have moulted for the second time. There is no marked change in their appearance.

December 24.—The larvæ are preparing to moult for the third time. They are now of a uniform whitish green tint above, with a conspicuously paler lateral line, below which the underparts are of a clear grass-green colour. Upper parts with fine longitudinal darker stripes; the derm roughened with minute spicules, some of which carry a fine blackish hair.

Absence from headquarters prevented observation of subsequent moults; but on January 7 the larvæ appeared to be fully grown, and one of them had suspended itself preparatory to pupation.

The full-fed larva is of a uniform grass-green colour. Vertex of head with a very minute conicle tubercle on each side; terminal segment with two longer tapering pointed processes directed backwards. Under a lens the derm is seen to be roughened with numerous minute white or colourless specules, some of which give rise to fine short hairs—those on the dorsum black, the others colourless. The points of the posterior processes are tinged with pink. Spiracles minute, black.

During development the caterpillars fed only at night. They retired towards the roots of the plant at daylight.

January 8.—Two of the larvæ have pupated. The chrysalis is of robust form; the dorsum of the thorax strongly convex; four prominent transverse ridges across dorsum of abdomen. The two pupæ are dissimilar in colour. One is pale grayish-brown, faintly streaked and mottled with darker brown and purplish markings; the abdominal ridges pale ochreous, bordered in front with dark brown; a pale ochreous lateral stripe. The second is of a grass-green colour, mottled with blackish streaks and spots.

January 19.—The butterflies have emerged, the total developmental period having occupied fifty-four days, of which seven were passed in the egg, thirty-six in the larval, and eleven in the pupal stages.

(*b*) **Curious minatory action of a harmless Snake.**—A young example of *Dipsas ceylonensis*, in my vivarium, exhibits a curious action when handled or disturbed. The terminal 2 inches of its tail are vibrated rapidly in short spasms. This is probably a minatory action, and is suggestive of the vibration of the tail of the rattle snake of the Western Hemisphere. The genus *Dipsas* (or *Dipsadomorphus*) contains several species of tree snakes, all of which have a distinctly viperine appearance both in form and colouration, though they are really quite harmless. The fact that they have grooved fangs (though destitute of poison gland) suggests that they may have descended from a venomous ancestor; and the habit of vibrating the tail noticed above rather strengthens this idea.

(*c*) **A living chain of Ants.**—(*January 8.*)—Mr. T. Petch has just drawn my attention to a living chain of "red ants" (*Œcophylla smaragdina*) spanning a gap 3 inches in extent between the leaf of a shrub occupied by the insects and a plant immediately below. When first observed the chain was some 3 insects thick and bifurcated above, being supported at the upper extremity by two ants to each branch of the chain. These supports held on to the leaf by their feet, and each firmly held in its jaws the foot of one of the next links in the chain. These, in their turn, were gripped by the members below, and so on, until the base of the chain or column was held taut by the lowest members on the leaf below. This living chain was being utilized as a bridge, or rather ladder.

and other members of the colony were passing up and down over the bodies of their devoted comrades. Owing to a strong breeze, which swayed the branches of the shrub, the chain was kept under great tension. After about ten minutes it weakened, by the defection of some of its members, until it consisted of a series of six links, each represented by a single ant. These six insects held on pluckily for some minutes in spite of the increasing strength of the breeze. One member was held by the foot of the middle leg on each side; another was gripped by one anterior and one posterior foot; these two insects appeared to be in imminent danger of being torn asunder. The rupture finally occurred by the failure of the lowest members to retain their hold of the supporting leaf; the chain swung up, and the component members scrambled over each other up to the leaf above. This chain must have been let down—link by link—from above, and indicates a remarkable degree of organization amongst the members of the colony, some of whom must have been deliberately told off for the purpose.

(*d*) **A case of Snake-bite.**—Mr. P. C. Briscoe, of Columbia estate, Hewaheta, sends me particulars of a case of snake-bite. The snake, which was sent for identification, proved to be the small viper *Ancistrodon hypnale*, the bite of which has never been known to prove fatal to man.

It appears that the cooly was bitten at 8.30 A.M. on the second finger of the right hand. His comrades tied a ligature above the elbow and sent the man down to the factory, where he was seen by the superintendent ten minutes later. He was very frightened, and was crying and trembling. There were two distinct punctures from which blood was oozing. The hand was bathed in a strong solution of permanganate of potash, the punctures were lanced with a penknife, and crystals of permanganate rubbed into the cuts. The man was then sent to the local dispenser, who again lanced the place and dressed it with boric acid. About three quarters of an hour after the infliction of the bite the cooly was given a wine-glassful of neat brandy. At 4 P.M. the hand and forearm were swollen, but the man was suffering no pain and complained of no other symptoms. By the next day he had apparently recovered completely.

(*e*) **Reproduction of Leaf-insects by Parthenogenesis.**—I have long suspected that our common leaf-insect (*Pulchriphyllium crurifolium*) can on occasion produce fertile eggs asexually. I have now proof of the fact.

The Rev. L. Lacombe, of St. Joseph's College, Trichinopoly, tells me that three years ago he obtained eggs of the leaf-insect from Ceylon and reared them at Trichinopoly. The eggs produced females only, and these females laid fertile eggs, from which a second generation of fertile females was raised. The third generation proved to be sterile. No males appeared at all.

(*f*) **Homoptera infested by Stylops.**—A small Jassid (*Thompsoniella arcuata*), abundant in the short grass outside my laboratory, is very commonly parasitized by a Stylopid insect, probably a species of *Elenchus*. I have been unable to breed out the adult male insect, but have extracted fairly perfect specimens by boiling the dead pupæ in liquor potassæ. I have seen as many as five of the parasites projecting from between the abdominal rings of the living Homopteron. The same parasite occasionally occurs upon other species of Jassidæ in the same locality.

(*g*) **Hare attacked by Crow.**—A curious incident was observed in these Gardens a few weeks ago. A full-grown hare was seen racing across the lawns, closely followed by a crow. The hare repeatedly dodged and doubled, but the crow—flying quite low—kept up with it, making repeated dabs at it with its beak. Eventually the pursued and pursuer disappeared round a corner, and the finish of the hunt was not observed.

(*h*) **An effective Butterfly Trap.**—A large wire netting enclosure—originally designed as an aviary, but now unoccupied—is proving itself a very effective butterfly trap. For a few weeks, during the migrating season, many different kinds of butterflies entered through the open door and seemed incapable of finding their way out again. Each day fresh arrivals appeared, and remained there until captured and liberated. The most constant tenants have been *Euplœa asela*, *Danais aglea*, *Ornithoptera darsius*, *Papilio parinda*, and *P. polites*. Smaller species also enter, but are able to make their way through the wire mesh. The height of the trapping season was at the end of May and early in June. Since the middle of June no further captures have been effected. The door was open towards the south-west, and the opposite side of the enclosure was occupied by a blank whitewashed wall.

(*i*) **Characteristic odour of Leaf-cutting Bees.**—I do not know if the peculiar odour of many species of *Megachile* (leaf-cutting bees) has ever been noticed or recorded in print. It is so distinctive that I could guarantee to recognize a freshly caught *Megachile* though blindfolded. It is a decidedly unpleasant smell, suggestive—more than anything else—of sour bile.

(*j*) **Food of the Reduviid Bug, Physorhynchus linnæi.**—In Vol. III. (p. 159) of this Journal I gave an account of the slaughter of a large millipede by a comparatively small Reduviid bug. I have since had repeated evidence that this bug (*Physorhynchus linnæi*) preys habitually upon millepedes. I have on several occasions seen the Reduviid perched upon the top of its recently vanquished victim, and its body distended with the blood of its prey. On turning over a large stone I found a full-grown *Physorhynchus* surrounded by a perfect charnel-house of the remains of *Polydesmidæ*, upon which it had been feeding. I have now in captivity two nymphs of this species, which attack, without hesitation, the largest sized millepedes that may be placed in their cage. The millipede is very quickly overcome, the poison injected by the bug having a rapidly paralysing action. I have just measured a 5½ in. millipede that had been killed by a bug only three-quarters of an inch long.

(*k*) **The Call of the Green Grasshopper.**—(*June 24.*)—I have just been watching a common green Locustariid emitting its call. The insect had flown into my room, attracted by the lamps, and was perched upon some cut flowers in a vase. I was able to approach quite close without disturbing it. The call note may be written phonetically as "Tic-a-tic-tic-tic-tic-tic-tic-tic-zzeett," the final note drawn out, while the others were produced in a rapid *staccato*. At the commencement of the call the wings and elytra are a little raised and partially separated; at each sharp note there is a slight downward movement, and the final drawn-out "zzeett" is emitted as the wings are returned to their normal position.

(*l*) **Sudden appearance of an African Snail in Ceylon.**—The East African snail, *Achatina fulica*, seems destined, before long, to be distributed throughout the Oriental region. It has been established for many years in Mauritius; and the progeny of a single pair known to have been introduced into Calcutta about fifty years ago are now said to have overrun the whole of Northern Bengal. This same snail has recently attracted attention in the neighbourhood of Beruwala, in the Kalutara District. The fact that they are present in millions shows that the introduction must date back for a considerable number of years, and it is extraordinary that a snail with a shell measuring 5 inches in length has not been noticed before. The recent heavy rains have probably excited unusual activity amongst the snails, but they must have been in evidence on many previous occasions.

E. ERNEST GREEN.

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"SAND-FLIES" (PHLEBOTOMUS) FROM PERADENIYA.

By N. ANNANDALE, D.Sc., F.A.S.B.,

Superintendent, Indian Museum.

(With seven Text Figures.)

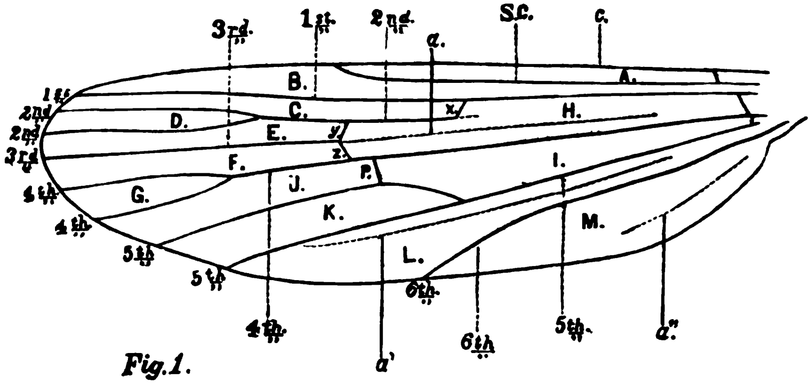
FLIES of at least three families are commonly known in the East as sand-flies, viz., of the Chironomidæ or true midges (*Ceratopogon* and its allies), the Simuliidæ (*Simulium*, known as the "potu" fly in the Himalayas), and the Psychodidæ, which are commonly called moth-flies on account of their relatively large hairy or scaly wings. The only genus of moth-flies that habitually sucks blood has received the appropriate name *Phlebotomus*, and includes the species most frequently called sand-flies, at any rate in the plains of India.

Much evidence has lately been obtained by Grassi* and by the Austrian doctors Doerr, Franz, and Taussig † that fever of a type common in the East,‡ and known by various local names, is transmitted from man to man in the countries round the Mediterranean by *Phlebotomus papatasi*, a species which occurs in northern India, and also probably in Java. It is therefore important, not only from an entomological point of view, that the distribution of flies of the genus should be carefully studied. They may easily be recognized by their narrow, pointed, hairy wings, which are held in a semi-erect position when the animal is at rest, by their silvery sheen, and long slender legs. In general appearance and structure they are not unlike minute mosquitoes. The adults fly to light at night and rest during the day in dark corners in damp places, often in bathrooms. They have the unpleasant habit of biting one's ankles under the dinner table in the evening, and are said to crawl through mosquito nets and under bed clothes for a similar purpose. The larvæ § are peculiar little maggots with four very long bristles at their posterior extremity, and are found on the walls of latrines, among damp moss on stones, in damp earth, and probably in other situations abounding in moisture, but not actually aquatic.

Specimens of the flies are best preserved in small tubes of spirit, but dried specimens packed not too tightly with tissue paper (*not*

* Mem. Soc. Ital. Sci. (iii.), XIV., p. 353 (1907).
† Das Pappatacifieber (Leipzig and Vienna, 1909).
‡ See Wimberley, Ind. Med. Gazette, XLV., No. 8, p. 281 (1910).
§ See Howlett's figure in Maxwell-Lefroy's "Indian Insect Life," p. 559 (fig. 158).

cotton wool) in pill boxes or match boxes are useful. I shall be glad to examine specimens sent to the Indian Museum, Calcutta.



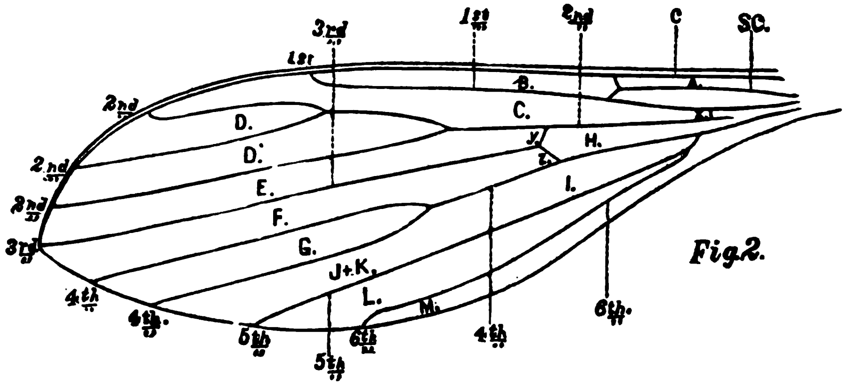


Fig. 1.—Wing of *Culex* (after Theobald). Fig. 2.—Wing of *Phlebotomus argentipes.*

c., costal vein; s.c., sub-costal; 1st to 6th, first to sixth longitudinal veins; a, a′, and a″, incrassations (a′ called by Austen the 6th vein, a″ the 8th); y., supernumerary cross-vein; z., mid cross-vein; P., posterior cross-vein; A., costal cell; B., subcostal cell; C., marginal cell; D , first submarginal cell; E., second submarginal cell; F., first posterior cell; G., second posterior cell; J., third posterior cell; K., anal cell; H., first basal cell; I., second basal cell; L., auxiliary; M., spurious cell.

The most important specific characters reside in the venation of the wings, the structure and proportions of the male genitalia, and the proportions of the various joints of the legs. Diagrams of the wing and of the external male genitalia are here produced by permission of the Trustees of the Indian Museum. Further particulars will be found in the "Records of the Indian Museum," Vol. IV., No. II. (1910).

It has long been known that *Phlebotomus* occurred in Ceylon, but no specimens appear to have been identified specifically. In a small collection made at Peradeniya by Mr. E. E. Green and Mr. F. H. Gravely four species are represented, two of them already known from many localities in India and two new to science. The four species may be distinguished as follows :—

(1) The tip of the first longitudinal vein of the wing but little in advance of the anterior fork of the second longitudinal vein.

(*a*) Colour silvery brown; the area of the wing paler than the anterior border; the coxæ yellowish; the anterior branch of the second vein about twice as long as the distance between the two forks of the vein .. .. *P. marginatus.*

(2) The tip of the first longitudinal vein far in advance of the anterior fork of the second.

(*a*) Dorsal surface of the thorax dark brown, the sides yellow. The anterior branch of the second vein slightly longer than the distance between the two forks .. *P. argentipes.*

(*b*) Thorax brown; coxæ yellowish; the whole of the wings paler than the abdomen. The anterior branch of the second vein about five times as long as the distance between the two forks .. *P. zeylanicus.*

(*c*) Colour uniform, dull yellowish gray. Wings very narrow; the anterior branch of the second vein shorter than the distance between the two forks .. *P. babu.*

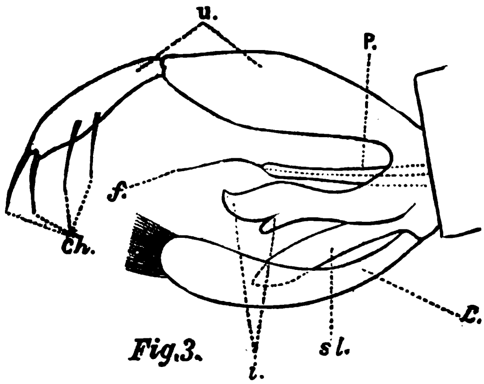


Fig.3.

° Diagram of the external male genitalia of *Phlebotomus:* u., upper or superior appendage; ch., chætæ; f., genital filament; i., intermediate appendage; P., intromittent organ; s.l., subgenital lamella; L., lower or inferior appendage.

Phlebotomus argentipes, Annandale and Brunetti.

Rec. Ind. Mus., IV., p. 44, Pl. IV., fig. 3; Pl. VI., fig. 6.

Several specimens of this common Indian species were taken at Peradeniya in March, June, and July.

Phlebotomus zeylanicus, sp. nov.

o, o. *Size and Proportions.*—Total length of dried specimen about 3 mm. Length of wing 3 mm. Hind leg more than two and a half times as long as the thorax and abdomen; its femur less than three-quarters, but more than half as long as its tibia, slightly longer than the first joint of the tarsus, which is distinctly shorter than the three distal joints together.

FIG. 4.—*Ph. zeylanicus* ♀ (enlarged).

Colour.—Head, thorax, and abdomen brown, paler in the female than in the male; coxæ yellowish; femora, tibiæ, and tarsi silvery gray; wings pale brownish-gray, uniform in colour.

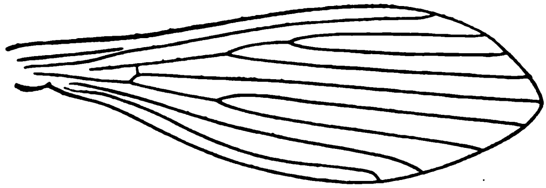


FIG. 5.—Wing of *Ph. zeylanicus* (enlarged).

Wings.—Lanceolate, not very broad, with the two borders not unlike in curvature. The first longitudinal vein extends far forwards, overlapping the anterior branch of the second vein by more than three-quarters of its length. This branch is nearly five times as long as the distance between the two forks, which is much shorter than the distance between the posterior fork and the point at which the vein joins the third vein. The fork of the fourth vein is almost on a level with the posterior fork of the second. The course of the sixth vein, which bends down almost at an angle at the tip, is sinuous.

Male Genitalia.—The distal joint of the superior appendage is slightly shorter, and much more slender than the proximal joint; its outlines are somewhat sinuous, and it bears five long, stout, curved, sharp chætæ, which are arranged as follows: A pair at the tip of the appendage, a pair on the outer margin at about half the length of the joint, and a single chæta on the inner margin nearer the base. The chætæ are equal or subequal. The intermediate appendage (morphologically the lower branch of the superior one) is slender, pointed, and turned upwards at the tip. It bears a minute, pointed, naked lobe on its ventral surface, and a similar one on its external lateral surface. The inferior appendage is much longer than the proximal joint of the upper one; it is slender as viewed from the side, and of almost uniform width; the tip is narrowly obliquely truncate, and bears a brush of very long and slender hairs; the rest of the appendage is sparsely covered with rather shorter hairs, but there are no spines.

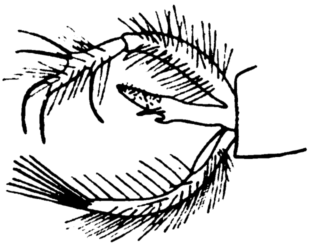


FIG. 6.—Male genitalia of *Ph. zeylanicus* from the right side, × 75.

The genitalia of this species closely resembles those of *P. argentipes*. from which it is distinguished among other characters by the venation of the wing. The venation closely resembles that of *P. malabaricus* (from Travancore) and *P. himalayensis*, but the insect is paler than the former and darker than the latter species. Its genitalia are also very different from those of either.

Several specimens of both sexes were taken at Peradeniya in May, June, July, and August.

Phlebotomus babu, Annandale.

? *Hebotomus minutus*, Rondani, Ann. Soc. Ent., France, 1843 (I.), p. 265, Pl. X., fig. 4.

Phlebotomus, sp., Howlett in Maxwell-Lefroy's "Indian Insect Life," p. 559, fig. 358.

Phlebotomus babu, Annandale, Rec. Ind. Mus., IV., p. 49, Pl. IV., fig. 1; Pl. VI., figs. 3, 3*a* (1910).

This species, which is easily recognized by its small size (length about 1·5 mm.), narrow pointed wings, and pale grayish-yellow colour, is common all over the plains of India; specimens have been taken recently by Major F. Wall, I.M.S., in Chitral in the Hindu Kush mountains. A specimen was obtained at Peradeniya in May.

I have little doubt that my *P. babu* will ultimately prove synonymous with "*Hebotomus*" *minutus*, Rondani, but the original description of the latter is very short and the figure clearly incorrect, and it is impossible, without examining European specimens, to be sure of the identity of the two "species." *P. minutus* was found in Italy on the banks of the river Po.

Phlebotomus marginatus, sp. nov.

o. *Size and Proportions.*—Total length of dried specimen about 2·5 mm. Length of wing 2·5 mm. Hind leg less than two and a half times the length of the thorax and abdomen; its femur about half as long as its tibia, of the same length as the first joint of the tarsus, which is equal in length to the three distal joints together.

Colour.—Rather darker than that of *P. zeylanicus*, the costal border of the wings distinctly darker than their area.

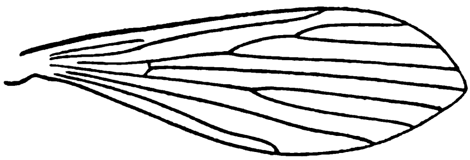


FIG. 7.—Wing of *Ph. marginatus* (enlarged).

Wings.—Resembling those of *P. zeylanicus* in shape, but longer. The first longitudinal vein only reaching forward for a short distance beyond the anterior fork of the second vein. The anterior branch of the latter about twice as long as the distance between the two forks, and approximately equal to the distance between the posterior fork and the point at which the vein joins the third. The fork of the fourth vein distinctly nearer the tip of the vein than the posterior fork of the second.

Unfortunately I have only been able to examine a single female, which was taken at Peradeniya in May, but the venation is so characteristic that the species must be distinct. The wing resembles that of *P. angustipennis*, Meijere,* from Java, which may be a form of *P. papatasi*, but the tip of the first longitudinal vein is nearer that of the anterior branch of the second, and the fly is larger, the latter not a point of much importance. Dr. de Meijere's description is unfortunately very short.

* Tijd. v. Ent., LII., p. 202., Pl. XII., fig. 14 (1909).

NOTE ON A FRESH-WATER SPONGE AND POLYZOON FROM CEYLON.

By N. ANNANDALE, D.Sc., F.A.S.B.,

Superintendent, Indian Museum.

(With Plate I.)

SHORTLY before leaving Colombo Dr. A. Willey was kind enough to send me a fresh-water polyzoon that he had obtained from a pool on the roadside between Maradankadawala and Galapitagala, in the North-Central Province of Ceylon, on February 18, 1909.

At the base of the polyzoon is a minute sponge which represents a species widely distributed in the East, but only recognized as distinct in 1907, viz., my *Spongilla proliferens*.* This sponge was originally described from Bengal, but is now known to occur in most parts of India and Burma, and has been found in Yunnan. The specimens recorded by Prof. Max Weber † from the Malay Archipelago as *Spongilla cinerea*, Carter, also belong to this species. The only fresh-water sponge hitherto recorded from Ceylon is *Spongilla carteri*,‡ from which *S. proliferens* may easily be distinguished by the fact that there are numerous little pointed and spiny spicules free in its substance, and by the structure of the gemmule, which is covered with what appears to be a granular coat instead of the layers of cellular air spaces in which the gemmule of *S. carteri* is enclosed, and is armed with numerous little spined spicules. The sponge is of a brilliant green colour, and always small and very soft. *S. proliferens* may be distinguished from *S. lacustris*, a race of which is common in Madras, by the fact that the aperture of its gemmule is provided with a small chitinous tube.

The polyzoon itself, as Dr. Willey suggests, appears to be identical with the species I recently described as *Pectinatella burmanica*,§ but differs from that species in several features, probably due to environment. The genus *Pectinatella* consists of Phylactolæmatous Polyzoa with horseshoe-shaped tentacular crowns and statoblasts (resting reproductive bodies) of large size, and entirely surrounded by little hooked processes. The individual colonies (zoaria) have a

* Journ Asiat. Soc., Bengal, 1907, p. 15, fig. 1.
† Zool. Eregeb. Niederl. Ost-Ind., Vol. I., p. 35.
‡ Willey, *Spolia Zeylanica*, Vol. IV., p. 184.
§ Rec. Ind. Mus., Vol. IV., p. 56 (1910).

strongly developed gelatinous investment or synœcium, and are bound together when fully adult in a gelatinous investing membrane. In this way gigantic compound colonies are sometimes formed. In a form allied to *P. burmanica*, namely, the Japanese *P. gelatinosa*, these compound colonies sometimes reach six feet in length, while those of *P. burmanica*. as it grows in the Sur lake in Orissa, are often more than two feet long and several inches thick. The statoblast of this species is nearly round, and its hooked processes are very short, only being visible under a high power of the microscope. Dr. Willey's specimens are peculiar, on account of their small size and of the relatively poor development of the synœcia. The compound colonies consist of only two or three zoaria each, and no zoarium measures more than 10 mm. in greatest diameter; but compound colonies from Orissa often contain hundreds of zoaria, some of which measure over 20 mm. in diameter. The polyps of the Ceylon specimens are correspondingly small, and their zoœcia (the cases in which the individual polyps reside) are much more distinct from one another than they are in Indian examples of the species. Probably these differences are due to differences in nutrition.

The only fresh-water polyzoon hitherto recorded from Ceylon is a *Plumatella* from Colombo, identified by Apstein* as *P. princeps*, Kræpelin (? *P. emarginata*, Allman), a cosmopolitan species or rather group of species common in India.

Explanation of the Plate.

Fig. 1.—Gemmule of *Spongilla carteri*, × 140.

Fig. 2.—Gemmule of *S. proliferens*, × 140.

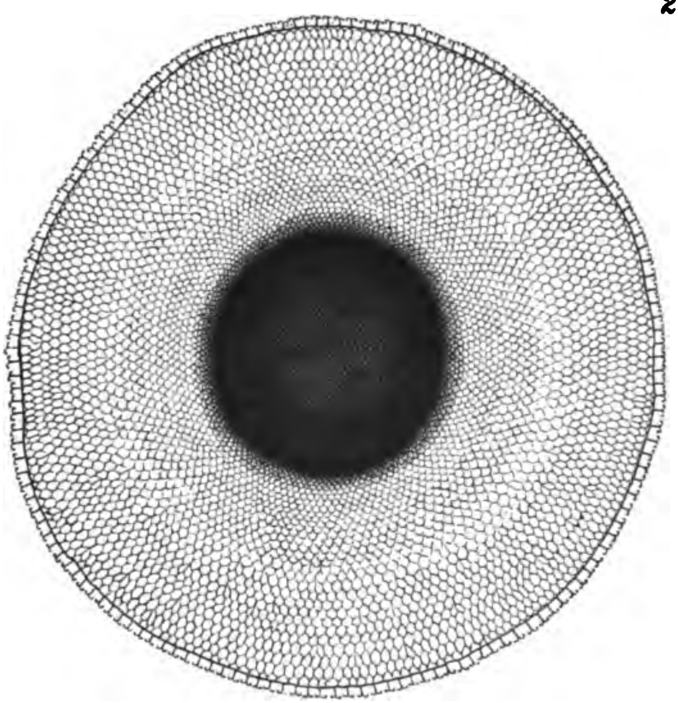
Fig. 3.—Statoblast of *Pectinatella burmanica*, × 70. 3*a*.—Part of the edge of the same, × 240.

Fig. 4.—Free statoblast of *Plumatella*, sp., × 70.

* Zool. Jahrb. (Systematic Part), p. 233, 1907.

1×140.

2×140.



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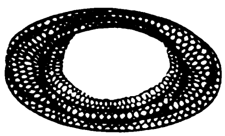

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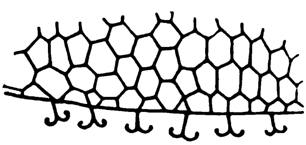

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A. C. Chowdhary, del. Engraved & printed at the Offices of the Survey of India, Calcutta.

Freshwater Sponges & Polyzoa of Ceylon.

ON SOME PARASITIC PROTOZOA FROM CEYLON.

By C. Clifford Dobell,

Fellow of Trinity College, Cambridge; Lecturer in Protistology and Cytology at the Imperial College of Science and Technology, London, S.W.

(With Plate II.)

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Introduction.
Record of Animals examined, with Results and Comments.
Descriptions of some new Forms.
Concluding Remarks.
Literature References.
Description of Plate.

INTRODUCTION.

THE following pages are the outcome of a recent visit which I made to Ceylon whilst holding the Balfour Studentship of Cambridge University. During my stay in the Island, which dated from the beginning of July until the end of September, I examined a number of animals from various parts of the country, with a view to discovering parasitic Protozoa. A good deal of my work was attended with entirely negative results, though a certain number of new forms were found, which are here recorded. Both negative and positive results, however, are given in the following pages, in order to assist future workers who may take up the investigation of Ceylon Protozoa.

The work was carried out chiefly in the laboratory attached to the Museum at Colombo, in the laboratory at the Botanic Gardens, Peradeniya, and in the resthouse at Trincomalee.

I wish here to offer my warmest thanks to those who have helped me, in one way or another, in my work—especially to Mr. E. E. Green, Government Entomologist, and to Mr. R. H. Lock, Acting Director of the Botanic Gardens, for their assistance during my stay in Peradeniya; and to Dr. Willey, the late Director of the Colombo Museum, for his unfailing aid and kindness throughout my visit. Though the results of my work here recorded are inconsiderable, they would have been far less but for Dr. Willey's assistance. His extensive knowledge of the fauna of Ceylon, and his untiring zeal in obtaining material for me, proved of incalculable value. Whatever merit attaches to the results here set forth is due in a large

measure to Dr. Willey's enthusiastic collaboration. I am glad to have this opportunity of thanking him once more, and of acknowledging my great indebtedness to him.

This paper was completed, after working through a part of the material which I brought back to England, at the Imperial College of Science and Technology, London, S.W.

I have divided the account of my work into two main parts :—

(1) A record, with notes, of the animals examined; and
(2) A description of some new forms which I found in the course of examining these animals.

I.—RECORD OF ANIMALS EXAMINED, WITH RESULTS AND COMMENTS.

A.—Record of Animals whose Blood was examined for Protozoa.

FISHES.

With the exception of *Saccobranchus fossilis*, all the seven species of fresh-water fish, whose blood I was able to examine, proved negative.

A.—*Infected.*

1. *Saccobranchus fossilis.*—The record of the examination of the blood of this species is as follows :—

One individual from Colombo lake (part not recorded) (July). Blood negative. Twelve specimens from Colombo lake (Hunupitiya and Kollupitiya) (Sept.). Blood of all negative.

Four specimens from Nugegoda (Sept.). Blood negative.

Two specimens from Fort side of Colombo lake (Sept.). Both infected with trypanosomes. (See comments below.)

B.—*Not infected.*

2. *Anabas scandens.*—One individual, Colombo (July).
3. *Clarias magur.*—One individual, Colombo (Sept.).
4. *Etroplus suratensis.*—Two individuals, Colombo lake (Sept.).
5. *Gobius giuris.*—Four specimens, Colombo lake (Sept.).
6. *Ophiocephalus punctatus.*—Two specimens, Colombo (Sept.).
7. *Ophiocephalus striatus.*—A single individual, Colombo (Sept.).

Comments.—The trypanosome found in *Saccobranchus* is that already described by Castellani and Willey (1904) under the name *Trypanosoma saccobranchi*. For the benefit of future workers who may seek this trypanosome, I would call attention to the curious distribution which it seems to have in the fishes of the Colombo lake. My experience indicates that only those fish taken from the *Fort side* of the lake are infected.

Castellani and Willey also failed to find trypanosomes in the blood of *Ophiocephalus striatus*, though they note that Lingard found trypanosomes in this species in India.

The same observers also record a trypanosome as occurring in the blood of *Gobius giuris*, although—as recorded above—the four individuals of this species which I examined proved negative.

Castellani and Willey also record a trypanosome from *Macrones cavasius*, a Silurid.

AMPHIBIANS.

The common frog, *Rana tigrina*, is the only amphibian in which I have found blood parasites.

A.—*Infected.*

1. *Rana tigrina.*—My records are as follows :—Two individuals (Colombo, July), both infected with trypanosomes and hæmogregarines. One individual (Colombo, July) infected with hæmogregarines only. Two individuals (Colombo, Aug.), blood negative. One very young specimen (Peradeniya, Aug.), blood negative. Two individuals (Colombo, Sept.), blood of both negative.

B.—*Not infected.*

2. *Bufo melanostictus.* — Three individuals (Colombo, July). One young individual (Peradeniya, Aug.).

3. *Ixalus leucorrhinus.*—A single specimen from Peradeniya (Aug.).

4. *Rhacophorus maculatus.*—One individual from Peradeniya (Aug.) and one from Trincomalee (Sept.).

Comments.—Castellani and Willey examined *R. tigrina*, with negative results. The parasites which I encountered are therefore recorded for the first time from Ceylon frogs. I have little doubt that the hæmogregarine which I found in *R. tigrina* is the same as that described from this species in Bombay by Berestneff (1903), and named *Hæmogregarina berestneffi* by Castellani and Willey (1905).* I encountered intracorpuscular individuals of various forms and sizes, many of them showing the characteristic pink-staining sheath described by Berestneff. In addition to these forms, there were also many free gregariniform individuals in the blood plasma. These were actively motile. I several times observed small forms enter red blood corpuscles. They did this by boring directly into the corpuscle, very much in the way described by Schaudinn (1903) in the case of the sporozoites of *Plasmodium vivax*, but the time taken was very different, as entry was effected in a few minutes. Occasionally, the animal, after reaching the inside of the corpuscle, rested for a few minutes and then wriggled

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* Patton (1908) states that he has "had the opportunity of studying no less than five hæmogregarines in *Rana tigrina* and *Rana hexadactyla*, not only in the frogs, but in the leech which transmits them."

its way out again into the blood plasma. The curious method of entry by being engulfed by the corpuscle—recently described in detail by Neresheimer (1909) in *Lankesterella*—I never saw.

Figures of some of the forms of the hæmogregarine encountered are given in Plate II., figs. 3–8.

Berestneff also recorded a trypanosome from the Indian frogs. No name was given to it, and as I believe other observers have also seen this same parasite, which is probably the same as the one I found in Ceylon, I have contented myself with a brief description and figure of the organism, without bestowing a new name upon it. (See p. 74.)

Reptiles.

I had opportunities of examining the blood of a number of different reptiles, including crocodiles, tortoises, lizards, and snakes. The results obtained are as follows :—

Crocodiles.

I was able to examine the blood of two crocodiles, *Crocodilus porosus*. The first, a small specimen from Dadugan-oya, Veyangoda (July), contained a hæmogregarine. (See p. 79.) The second, a very young individual from Ja-ela, near Colombo (Sept.), was negative.

No hæmogregarines have been described from Ceylon crocodiles before, though several other crocodiles from other parts of the world have been found to harbour these parasites. (See p. 79.)

Tortoises.

The three following species of tortoise were examined :—

1. *Emyda vittata*.—Of five specimens examined in Colombo (July), the presence of trypanosomes could be demonstrated in only one individual, and in very small numbers.

2. *Nicoria trijuga*.—Three individuals from Colombo lake (July) : one heavily infected with hæmogregarines, one slightly infected, and one in which no parasites could be detected.

3. *Testudo elegans*.—Two individuals from Sigiriya (Sept.) showed no blood parasites.

Comments.—The trypanosome found in *Emyda vittata* is that already described by Miss Robertson under the name *T. vittatæ* [Robertson (1908) and (1909)]. The hæmogregarine from *Nicoria* is *H. nicoriæ* (Castellani and Willey, 1904).

Lizards.

Examination of the blood of twelve species of Lacertilia gave the following results :—

A.—*Infected.*

1. *Hemidactylus leschenaultii*.—At Trincomalee (Sept.) nearly every individual examined was infected with *Hæmocystidium*

simondi, Castellani and Willey. Some individuals harboured trypanosomes and hæmogregarines in addition. A single specimen from Habarana (Aug.) was infected with trypanosomes. (See remarks below.)

B.—*Not infected.*

2. *Calotes ophiomachus*.—Eight individuals (Colombo, July).

3. *Calotes versicolor*.—Twenty-five specimens from Colombo (July) and one from Peradeniya (Aug.).

4. *Ceratophora stoddartii*.—Three individuals (Peradeniya, Sept.).

5. *Hemidactylus depressus*. — Six individuals (Trincomalee, Sept.).

6. *Hemidactylus frenatus*. — A single specimen (Trincomalee, Sept.).

7. *Hemidactylus triedrus*.—One individual from Colombo (Aug.), one from Peradeniya (Aug.), and two from Trincomalee (Sept.).

8. *Lygosoma punctatum*.—Five specimens (Peradeniya, Aug.).

9. *Lyriocephalus scutatus*.—Three specimens (Peradeniya, Aug.).

10. *Mabuia carinata*.—Three individuals from Colombo (July), two from Peradeniya (Aug.), one from Colombo (Sept.), and one from Peradeniya (Sept.).

11. *Sitana ponticeriana*.—One individual (Trincomalee, Sept.).

12. *Varanus bengalensis*.—A single specimen (Trincomalee, Sept.).

Comments.—It is curious to find that all the lizards—geckoes excepted—harbour no blood Protozoa. In Europe and in Africa (*cf*., for example, Wenyon's recent work, 1908*a*) the lizards are frequently infected with hæmogregarines, but Asiatic lizards appear to be much less frequently so. The absence of Protozoa in the blood of Indian lizards was remarked by Berestneff (1903). Since then Minchin (1907) has described a hæmogregarine (*H. thomsoni*) from a Himalayan lizard (*Agama tuberculata*), but facts with regard to the infection of other Asiatic lizards are extremely scanty.

Hæmocystidium simondi, which I found in the Trincomalee specimens of *Hemidactylus leschenaultii*, was discovered and described by Castellani and Willey (1904), and has since been observed by Miss Robertson (1908). I was fortunate enough to be able to work out a part of the life-cycle of this organism, the description of which I shall publish elsewhere.

The trypanosomes which I found were those described by Miss Robertson (1908) as *T. leschenaultii*. Another form which she observed in *H. leschenaultii* and *H. triedrus*, and named by her *T. pertenue*, I never encountered.

It is perhaps worthy of comment that I have—in common with previous workers—never found Protozoa in the blood of *Hemidactylus depressus*, although it lives in the jungle in company with the infected geckoes.

Filariæ were found in the blood of several *Calotes versicolor*. These have already been described by Castellani and Willey. I found a similar *Filaria* in the blood of the *Varanus* from Trincomalee.

Miss Robertson (1908) apparently also found no Protozoa in the blood of most Ceylon lizards, for she says: "The common *Calotes* and the beautiful Brahminy lizard ...... and the skink and the horned up-country lizard were all negative, so also the common little house gecko who lives on the wall and eats flies."

SNAKES.

I have been able to examine sixteen different species of snakes. As I hope shortly to describe in detail the results of my investigations into the life-histories of the hæmogregarines of Ceylon snakes, I will here give merely a brief record of my observations:—

A.—*Infected.*

1. *Dipsadomorphus forstenii.*—Blood containing hæmogregarines in large numbers. A single individual (Colombo, Aug.).
2. *Dipsadomorphus ceylonensis.*—One individual, slightly infected with hæmogregarines (Peradeniya, Aug.).
3. *Dryophis mycterizans.*—The green whip snake was found to harbour a hæmogregarine (though not invariably) at Colombo (Aug.) and Peradeniya (Sept.). A single individual examined at Trincomalee (Sept.) was negative.
4. *Naia tripudians.*—A single cobra (Peradeniya, Sept.) was infected with hæmogregarines.
5. *Tropidonotus stolatus.*—Out of four individuals examined, two showed no blood parasites (Peradeniya, Aug.; Trincomalee, Sept.). One individual (Colombo, July) had spirochæts in its blood. (See p. 77.) One individual (Peradeniya, Aug.) was infected with trypanosomes (see p. 77) and hæmogregarines.
6. *Zamenis mucosus.*—Rat snakes were always infected with hæmogregarines at Colombo (Aug.) and Peradeniya (Aug.). One individual examined at Trincomalee (Sept.) was not infected.

B.—*Not infected.*

7. *Ancistrodon hypnale.*—Two individuals from Hakgala (Sept.) and one from Kandy (Sept.).
8. *Cerberus rhynchops.*—One individual from Negombo (Sept.) and two from Colombo (Sept.).
9. *Dendrelaphis tristis* (=*Dendrophis pictus*).—Two from Sigiriya (Sept.), one from Trincomalee (Sept.), and one from Peradeniya (Sept.).
10. *Helicops schistosus.*—Two specimens: one small (Colombo, Aug.), the other very large (Colombo, Sept.).
11. *Hydrus platurus.*—A single specimen (Colombo, July).

12. *Lycodon aulicus*.—A single young individual (Colombo, Aug.).

13. *Oligodon sublineatus*.—Four individuals from Peradeniya (Aug. and Sept.).

14. *Python reticulatus*.*—A single snake caught in Colombo (July).

15. *Tropidonotus asperrimus* (= *T. piscator*).—One individual from Colombo (Aug.), five from Trincomalee (Sept.), and four from Colombo (Sept.).

16. *Viper russellii*.—A single young specimen (Peradeniya, Sept.).

Comments.—Hæmogregarines have not been previously recorded from *Dipsadomorphus forstenii* or from *D. ceylonensis*. Hæmogregarines are recorded already from *Zemanis mucosus* and *Dryophis mycterizans* in India by Patton (1908), and from *Z. mucosus* in Ceylon by Miss Robertson (1908). The latter also found hæmogregarines in three other Ceylon snakes: *Chrysopelea ornata*, *Naia tripudians*, and "a large python."

A hæmogregarine has been described from *Naia tripudians* by Simond (1901), Laveran (1902), and Patton (1908). Patton (1908) gives a list of eleven Indian species of snake which harbour hæmogregarines.

I did not succeed in finding *Hæmogregarina mirabilis* (Castellani and Willey) in *Tropidonotus asperrimus*.

Birds.

The only bird I examined was a kingfisher shot at Peradeniya. No Protozoa were found in its blood. Castellani and Willey (1905) record *Hæmoproteus* (*Halteridium*) from the blood of crows (*Corvus splendens* and *C. macrorhynchus*), from the babbler (*Crateropus striatus*), and from the owl (*Scops bakkamœna*).

Mammals.

I examined very few mammals. None showed Protozoa in the blood.

Uninfected.

1. *Funambulus palmarum*.—A single individual (Colombo, July).
2. *Lepus nigricollis*.—One young individual (Peradeniya, Sept.).
3. *Pteropus medius*.—A single specimen (Peradeniya, Sept.).
4. *Tragulus meminna*.—Two individuals (Colombo, Aug.). A peculiarity in the blood corpuscles of these animals seems worthy of record. It was found that, although the leucocytes are large, the red corpuscles are extremely small. In fact, I have never encountered such small erythrocytes in any animal before. In *T. meminna* they have a diameter of only about 2·5 μ.

* This, of course, is not a native Ceylon snake. It is not known how it came to be in Colombo.

B.—Record of Animals examined for Intestinal Protozoa.

An examination of the alimentary canal of various animals was undertaken, in addition to the examination of the blood just recorded. Below are the results. The animals examined were few compared with those in which a blood examination was made.

Amphibia.

1. *Bufo melanostictus.*—I examined the contents of the large intestine in a few individuals both at Colombo and at Peradeniya. In all the animals examined both *Trichomonas* and *Trichomastix* were found. These animals were indistinguishable from *Trichomonas batrachorum* and *Trichomastix batrachorum* which occur in the European frogs and toads. As I have given a detailed description of these forms elsewhere (Dobell, 1909), I will say no more about them here.

A flagellate, which appeared to be identical with the *Octomitus* of the English frog, was also found (*cf.* Dobell, 1909).

In one *B. melanostictus* from Peradeniya a new species of *Nyctotherus* was present. (See p. 75.)

2. *Ixalus leucorhinus.*—A single individual examined in Peradeniya appeared to have absolutely no Protozoa of any sort in its gut.

3. *Rana tigrina.*—Individuals were examined both in Colombo and in Peradeniya. The following Protozoa were found :—

In the large intestine :—An *Entamœba*, indistinguishable from *E. ranarum*, Grassi (*cf.* Dobell, 1909); three flagellates—*Trichomonas*, *Trichomastix*, and *Octomitus*—which appear to be identical with the corresponding organisms in *Rana temporaria* in Europe (*cf.* Dobell, 1909); the following Ciliata :—*Opalina*, a small multinucleati species, which was not examined in stained preparations; large and small *Balantidium* (see p. 74); and *Nyctotherus macropharyngeus* (Bezzenberger, 1904). At Peradeniya the oocysts of a coccidian (?) were found. (An examination of the epithelium of the small intestine proved negative.)

In the duodenum :—*Balantidium*, sp. (See p. 74.)

4. *Rhacophorus maculatus.*—This animal was found (Peradeniya) to harbour an *Opalina* and a *Nyctotherus*, both apparently new. (See pp. 76 and 75.) The latter appears to be the same as that found in *Bufo melanostictus* from the same locality.

Remarks.—No intestinal Protozoa seem to have been described from Ceylon frogs and toads hitherto, though Bezzenberger (1904) has described a number of ciliates from various "Asiatic" Anura (localities not given). Further remarks upon the intestinal Protozoa of Amphibia will be found on p. 74.

LIZARDS.

1. *Hemidactylus leschenaultii.*—One specimen (Habarana) had Trichomonads, and another undetermined flagellate in the large intestine. These were not studied further.

2. *Lygosoma punctatum.*—Several animals were examined at Peradeniya, but no Protozoa were found in the gut.

3. *Lyriocephalus scutatus.*—One individual examined at Peradeniya. Beyond the spores of a coccidian (?) nothing was found. (Epithelium of small intestine negative.)

4. *Mabuia carinata.*—All the individuals examined were found to harbour both *Trichomastix* and *Trichomonas*. (See p. 77.)

SNAKES.

I examined only three snakes for intestinal Protozoa:—*Zamenis mucosus* and *Lycodon aulicus* were both negative; *Dryophis mycterizans*, however, contained *Trichomonas* and a *Trichomastix*, which closely resembled the organism which I have already described from *Boa constrictor* (Dobell, 1907). I did not make a careful study of these organisms.

MAMMALS.

At the instigation of Dr. Willey I made an examination of the contents of the stomach of the two mouse deer (*Tragulus meminna*), which came into my hands at Colombo. In both animals the stomach was literally seething with oligotrichous ciliates, belonging to the family Ophryoscolecidæ, Stein.

These ciliates were discovered by Dr. Willey, but have not as yet been described. At his suggestion I preserved a quantity of the organisms, of which I hope to publish a full description shortly.

MOLLUSCS.

Whilst at Trincomalee, in September, I examined eight species of lamellibranchs, in order to find out whether they harboured spirochæts. These organisms were found in the crystalline style of only two species: *Venus* (*Meretrix*) *casta* and *Soletellina acuminata*.

Dr. Willey had previously noticed spirochæts in these two species, but had not described them. I hope to publish a full account of my observations on these organisms shortly.

ARTHROPODS.

I examined several specimens of the large scorpion, *Palamnæus indus*, in Colombo (July), all with negative results so far as Protozoa were concerned.

Six individuals of the common myriopod, *Polydesmus saussurii*, Humb., collected at Avisawella in July, also showed no Protozoa, though all were infected with a nematode worm, an *Oxyuris* or allied genus.

Another myriopod, *Spirostreptus lunelii*, Humb., from Avisawella (July), also proved negative.

Some white ants, *Calotermes militaris*, from Peradeniya (August), were more interesting. They contained Trichonymphids, a *Nyctotherus*. and a spirochæt, all apparently new. (See p. 80.)

II.—DESCRIPTIONS OF SOME NEW FORMS.

In this part of the paper some of the new, or hitherto undescribed, forms which are recorded in the preceding section are described in greater detail.

The Parasites of Frogs and Toads.

I have already noted the presence of a hæmogregarine in the blood of *Rana tigrina* (p. 67). As I have already remarked, it seems to be identical with *H. berestneffi* of the Indian frog. There is only one other blood parasite which I have to describe.

(1) *Trypanosoma*, sp., of *Rana tigrina*.

This organism resembles the more slender forms of *T. rotatorium* of the European frog. When living the posterior end is bluntly pointed, and the animal usually has a ribbed appearance like that of *T. rotatorium*, but the ribs are only one or two in number (*cf.* fig. 12). There is a well-developed undulating membrane extending about halfway along the organism and ending in a free flagellum of moderate length (*cf.* fig. 12). The trophic nucleus is ovoid, and situated near the anterior end. The kinetic nucleus is a small deeply-staining granule about midway between the trophic nucleus and the extreme posterior end.

Like *T. rotatorium*, this trypanosome is difficult to fix in blood smears. Most of the stained specimens which I obtained were badly distorted. Fig. 12 is drawn from one of the most favourable fixed and stained animals which I encountered, but it makes the animal appear a good deal stouter than it appears when alive.

The average length of the trypanosome, so far as I have been able to determine from the few well-preserved specimens which I obtained in my preparations, is between 30 μ and 40 μ, including the free flagellum.

Balantidium.

As already recorded, I found species of *Balantidium* inhabiting the duodenum and the large intestine of *Rana tigrina*.

(2) *Balantidium ovale*, n. sp.

This name I propose for the common species of *Balantidium* which occurs in the large intestine of *R. tigrina*. The animal is very like several other species already described. It differs from *B. helenæ*, Bezzenberger, only in size. Bezzenberger describes this species as occurring in *R. tigrina*, *R. cyanophlyctis*, *R. limnocharis*, and *R. hexadactyla*, but he does not state from what parts of Asia the frogs came. He gives 110 μ × 60 μ as the average dimensions. The average size of my forms, however, is about 80 μ × 50 μ. Apart from this, Bezzenberger's description of *B. helenæ* applies equally well to *B. ovale*. The peristome has the same form, the meganucleus is kidney-shaped, lying posteriorly, with the micronucleus in the hollow. I have omitted to figure the organism, as Bezzenberger's figure of *B. helenæ* is almost identical.

I found numerous animals undergoing division, and also found encysting and encysted forms. These present no essential differences from what has already been described in other members of the genus. The cysts are ovoid, and measure ca. 54 μ × 44 μ.

In addition to the large forms just described, I found numerous smaller forms—also dividing actively—which were identical in every way except in size. They were only about two-thirds the size of the larger animals. Whether these represent another species or not, I am unable to decide.

(3) *Balantidium hyalinum*, n. sp.

I propose this name for the organism which occurs in the duodenum of *R. tigrina*. It does not differ markedly from other duodenal forms, namely, *B. duodeni*, Stein (in *Rana esculenta* and *R. temporaria*), and *B. rotundum*, Bezzenberger (in *R. esculenta*, var. *chinensis*). It is often present in large numbers in the small intestine, and when alive its protoplasm is more hyaline than that of any other *Balantidium* which I have seen.

The organism (fig. 19) is oval, with a straight mouth extending almost to the middle of the body. The meganucleus is posteriorly placed, and is ovoid. The micronucleus can nearly always be seen at one end of the meganucleus, not in the middle (*cf.* fig. 19). There is one contractile vacuole. In the anterior region the curious striated or granular triangular area, which is characteristic of *B. duodeni* and *B. rotundum*, is usually clearly seen (see fig. 19). As in these forms also, the cilia are long and well developed over the whole body. The average dimensions are ca. 74 μ × 56 μ.

(A curiously long and slender form has been described by Bezzenberger—under the name *B. gracilis*—from the small intestine of *Rana hexadactyla* and *R. cyanophlyctis*.)

NYCTOTHERUS.

In addition to *Nyctotherus macropharyngeus*, Bezzenberger,* which I found in *R. tigrina* in Colombo, I found a species of *Nyctotherus* in *Bufo melanostictus* and *Rhacophorus maculatus* at Peradeniya. It appears to be the same species in both hosts, and I propose to name it—

* This is a very large species. Its most striking feature is its very long and spirally wound pharynx.

(4) *Nyctotherus papillatus*, n. sp

The animal has the usual reniform appearance characteristic of the genus. Those taken from the large intestine of *B. melanostictus* measured ca. 120 μ in length, whilst those from *R. maculatus* were distinctly larger, the largest attaining a length of 170 μ. In other respects they were identical.

The pharynx extends to the median line, is sharply curved into an almost perfect semi-circle, and has a well-marked spiral twist. The anus opens just dorsally to a well-marked papilla at the extreme posterior end of the animal. There is one contractile vacuole, situated close to the anus. The meganucleus is in the usual position anteriorly, but appears to be reniform or horseshoe-shaped, with the ends directed ventrally, so that it appears to be ovoid when seen from the side. A micronucleus was not always seen, but was sometimes visible lying on the meganucleus.

A curious little diverticulum of the pharynx just at its point of junction with the mouth was nearly always observable. It passes dorso-posteriorly for a very short distance, and then appears to end blindly. I have never seen this curious little structure in other species of the genus.

OPALINA.

Rana tigrina, as I have already noted, was found to harbour a multinucleate species of *Opalina*, which I observed in the living state only. A pretty species of *Opalina* was found in *Rhacophorus maculatus* at Peradeniya, and I was able to study it more carefully. As it seems to be new I propose the name—

(5) *Opalina virgula*, n. sp..

for the organism. Its characteristics are as follows. The general shape of the body is that of a large flattened comma; that is to say, there is a large bulge on one side anteriorly (see fig. 17). It thus resembles *O. obtrigona* (parasitic in the European tree frog *Hyla arborea*) more closely than any other of the dozen or so species of *Opalina* hitherto described.* Some of the individuals are long and slender, and others are stouter and more rounded, but all have this general appearance. The body is flattened, *i.e.*, elliptical in transverse section, and the cilia are distributed over the body in lines, as in other species. Large individuals may measure 170 μ, or rather over, in length, and 50 μ in breadth at the broadest part of the anterior end.

The animal is multinucleate. All the nuclei in my preparations (picro-acetic acid, Delafield's hæmatoxylin) appear as rather loose masses of chromatin granules (see fig. 17). Other slightly stained bodies are also present in the endoplasm. They appear to be the bodies which Metcalf calls "endosarc spherules," and which occur in other *Opalinæ*.

* *Cf.* Metcalf's (1909) recent monograph on the genus.

In company with these larger forms were a number of smaller forms. These I take to be young forms. They are the shape of a flattened spindle, and contain few nuclei (see fig. 18). Possibly they are organisms which are on their way to encystment. The small form figured (fig. 18) measured 38 μ × 13 μ.

Bezzenberger (1904) has described *Opalinæ* from *Bufo melanostictus*, *Rana cyanophlyctis*, *R. limnocharis*, *R. hexadactyla*, and *R. esculenta*, var. *chinensis*, but he does not state from what part of Asia these animals came.

Intestinal Parasites of Lizards.

Parasitic flagellates were found in the gut in only two lizards: *Hemidactylus leschenaultii* and *Mabuia carinata*. Both these hosts contained both *Trichomonas* and *Trichomastix*, but a careful study was made of those in *Mabuia* only.

{ *Trichomonas mabuiæ*, n. sp.
{ *Trichomastix mabuiæ*, n. sp.

I have elsewhere described (Dobell, 1909) in detail the structure of *Trichomonas* and *Trichomastix batrachorum*. The two organisms from *Mabuia* have a structure which is exactly similar. My chief reason for noting these organisms here is that they furnish a striking confirmation of what I have already described in the structure of the frog and toad parasites.

Trichomonas mabuiæ (fig. 11) attains a length of 30 μ, and it is quite easy to observe *in the living animal*, under an oil immersion, all the details of structure which I have already described in the much smaller *T. batrachorum*. Structures which, in the latter, were frequently only made out in stained preparations, and with considerable difficulty, can be seen in *T. mabuiæ* with the greatest clearness. The relations of the nucleus, axostyle, blepharoplast, and undulating membrane are exactly as I have already described them. To describe the forms from *Mabuia* would be merely to repeat what I have already written. I will therefore content myself with figuring *Trichomonas mabuiæ*, and would refer any one interested in the structure of these organisms to my earlier paper.

The Parasites of Tropidonotus stolatus.

As recorded on p. 70, I found three parasites in the blood of this snake: a hæmogregarine, a spirochæt, and a trypanosome. The last two are new; the first is probably the same as the "*Danilewskya*" described in *T. stolatus* from Tonkin by Billet (1895). [*Cf.* also Dobell (1908).]

(1) *Trypanosoma tropidonoti*, n. sp.

I propose to give this name to the new trypanosome which I found in the blood of a *T. stolatus* at Peradeniya (see figs. 13, 14).

When observed in the fresh blood of the snake the organism exhibited no characteristics which would distinguish it readily from many other trypanosomes. It was actively motile, with a short free flagellum terminating the undulating membrane, which extended along about half the length of the body. The posterior (aflagellar) half of the body was drawn out to a sharp point. Though the trophic nucleus was easily visible in the living animal, the kinetic nucleus was observed only after staining. The cytoplasm was finely granular in appearance and uniform throughout.

In smears stained by Giemsa's method, the following structure was observable (see figs. 13, 14):—

The body is sharply pointed at both ends, with the trophic nucleus lying near the middle as a homogeneous pink mass of granules. The flagellum and undulating membrane appeared the same as in the fresh preparations, but the kinetic nucleus, with the origin of the membrane, &c., could now be made out accurately. The kinetic nucleus itself is a small granule staining a deep purple with Giemsa's stain. It is remarkable on account of its position. Sometimes it was situated well behind the trophic nucleus (fig. 13), but at other times it was placed actually in contact with it (fig. 14). Intermediate positions were also seen. The latter arrangement, *i.e.*, in contact with the trophic nucleus, gives the animal an appearance suggesting an organism which is halfway between a *Crithidia* and a *Trypanosoma*. The average length of the organism (including the free flagellum) is 30 μ–40 μ.

So far as I am aware, only two trypanosomes have been recorded from snakes hitherto: *T. erythrolampri* (Wenyon, 1908) from *Erythrolamprus æsculapii* (tropical America), and *T. naiæ* (Wenyon, 1908*a*) from *Naia nigricollis* (Africa). Only one of these was satisfactorily investigated as regards its nuclear apparatus (*T. erythrolampri*), and it is a curious fact that it shows the same peculiarity which I have pointed out above in the case of *T. tropidonoti*. The two organisms are, in fact, very closely similar in other respects also.

Another trypanosome in which the kinetic and trophic nuclei are in close proximity has recently been described—under the name *T. pertenue*—by Miss Robertson (1908) from the blood of the Ceylon geckoes, *Hemidactylus triedrus* and *H. leschenaultii*.

(2) *Spirochæta tropidonoti*, n. sp.

This is the first record of a spirochæt from the blood of a snake. It is therefore much to be regretted that my observations on it are exceedingly scanty.

Only a single *T. stolatus* was found harbouring the organism. In the fresh blood preparations the spirochæts were rare, and in the stained smears made from the same blood they were still more difficult to find. Through a most unfortunate accident most of my stained preparations were lost before they had been carefully examined.

No ticks were found on the snake, but one is tempted to suggest that these animals, which are common on many snakes, are the carriers of the spirochæt.

The living spirochæts (fig. 15) appeared as slender, flexible, corkscrew-like organisms, actively motile, and closely resembling *S. duttoni* in general form. In length they measure ca. 15 μ, and their breadth is probably about 0·5 μ, though I have not been able to obtain sufficiently accurate measurements of the latter.

In the films stained by Giemsa's method the organisms were coloured a uniform pink.

In a single instance (fig. 16) I observed an organism which appeared to be on the point of dividing into two. But whether division had been longitudinal or transverse it was impossible to decide. The thickness of the organism certainly suggests the latter mode of division.

The Hæmogregarine from Crocodilus porosus.

Hæmogregarines have already been described from crocodiles in various parts of the world. Simond (1901*a*) appears to have been the first to record hæmogregarines from Crocodilia. He described (1901, 1901*a*) a form, under the name *H. hankini*, from the Indian gavial; and he further noted (1901, p. 320) that the same organism occurred in *Crocodilus porosus* (?), and stated that Marchoux had found a similar parasite in a Senegal crocodile.

Börner (1901) almost simultaneously described a hæmogregarine from *Crocodilus frontatus* and *Alligator mississippiensis*, and gave it the name *H. crocodilinorum*. If these prove to be the same species, then the priority of name rests with *H. hankini;* for, as Simond points out, his account was published a month before that of Börner. It is probable, therefore, that the Ceylon form from *C. porosus* is *Hæmogregarina hankini*, Simond.

Minchin, Gray, and Tulloch (1906) figure a hæmogregarine from a Central African crocodile, and this organism is repeatedly mentioned in subsequent reports of various sleeping sickness commissions.

The form which I found in the Ceylon crocodile bears a close resemblance to many of the figures of Simond and Börner.

All the individuals which I examined were in red blood corpuscles from the circulating blood. They all presented the appearance shown in figs. 9, 10; that is to say, they were all large, doubled-up individuals. Sometimes the two halves were approximately equal in thickness (fig. 9), but sometimes one was considerably thicker than the other (fig. 10). In preparations stained by Giemsa's method the nucleus always appeared as a compact mass of deep purple granules (figs. 9, 10). In length the animals (doubled up) measured from 12 μ to 15 μ.

In the absence of more material, I can do little more here than record and figure the organism.

The Parasites of White Ants.

(1) *Gymnonympha zeylanica*, n. g., n. sp.

As already recorded (p. 74), I found the termites* (*Calotermes militaris*) which I examined at Peradeniya infected with a protozoon belonging to the family Trichonymphidæ.

The Trichonymphids are characterized by possessing a large number of flagella, which originally gave rise to their inclusion among the Ciliata. [See Butschli (1887), S. Kent (1882), &c.] I have little doubt, however, that they are really referable to the Mastigophora (*cf.* Doflein, 1909). It is curious to note that Leidy (1877), who first gave us an accurate description of these organisms, remarks—speaking of *Trichonympha*—that they are "of obscure affinity, but probably related with the Turbellaria on the one hand, and by evolution with the Ciliate Infusoria on the other."

The organisms which I found in Ceylon do not appear to belong to any of the genera hitherto described. [See Leidy (1881), Grassi (1888), Grassi and Sandias (1893), Frenzel (1891).] *Leidyonella* (Frenzel, 1891) is the form which appears to approximate most nearly to my organisms.

As far as I am aware, no Trichonymphids have been described from Asiatic white ants before, but it seems highly probable that these parasites occur in white ants throughout the world. They were apparently discovered by Lespes in Europe in 1856, and were subsequently described in North America (Leidy), in the Argentine (Frenzel), and in Europe (Grassi and others). The closely allied form *Lophomonas* is a frequent parasite of the common cockroach, *Stylopyga orientalis*.

Gymnonympha zeylanica, as I propose to name the new organism, is distinguished by possessing comparatively few flagella, which are confined entirely to the anterior end of the body, as in *Jœnia* and *Lophomonas*, but there is no axostyle present.

The general form of the animal (see fig. 1) is roughly ovoid or pyriform, but the body is so plastic that its shape is constantly undergoing change during life. At the extreme anterior end the body is drawn out into a small conical process surrounded by a curious vesicular cap (fig. 1). Where the cap unites, by its edges, with the conical process, the flagella arise, apparently in a single ring round the base of the cone. The length of the largest forms is about 150 μ. The flagella measure only about one-half of the length of the body. Running backwards from the point of origin of the flagella, a series of striations can be seen extending for about one-third of the length of the organism. These striations appear to be situated in the investing cuticle.

* All the individuals examined were workers.

The nucleus is round, and measures about 15 μ in diameter. It is composed of a mass of small chromatin granules surrounded by a clear achromatic membrane. It usually lies at the anterior end of the animal.

Inside the body, especially in the posterior region, a number of particles of wood can usually be seen. How they are ingested I am unable to say, as I have never observed an animal in the act of taking them up, nor is a mouth present, as far as I have been able to make out.

In addition to these larger forms just described, I always found smaller animals possessing a somewhat different structure. The anterior end and arrangement of the flagella was different, and the nucleus was situated posteriorly (fig. 2). I think these small forms probably represent young stages in the life-history of *Gymnonympha*, but in the absence of any very definite intermediate forms, I must leave this an open question for the present. These small forms were usually about 30–40 μ in length.

No animals in division, or at different stages in the life-cycle, have I been able to find.

(2) *Nyctotherus termitis*, n. sp.

I propose this name for the new species of ciliate which I found in the termite. Hitherto no *Nyctotherus* has, I believe, been recorded from white ants.

N. termitis differs but slightly from several other members of the genus. It resembles *N. ovalis*, Leidy, of the common cockroach (*Stylopyga orientalis*) closely in general structure. The body is roughly ovoid, with the gullet situated near the middle, and running in obliquely with a very slight curvature (see fig. 21). It does not extend more than about halfway across the animal. There is a well-marked, though narrow, anus, near to which—on the ventral side—the single contractile vacuole is situated (see fig. 21). The meganucleus is ovoid or slightly horseshoe-shaped, and a micronucleus can sometimes be seen lying in close contact with it. At the level of the meganucleus the body shows a more or less strongly marked constriction. Another similar constriction can be seen about halfway between this and the extreme anterior end. (*Cf.* fig. 21.)

The animal attains a length of 60–70 μ, and a maximum breadth of rather more than 40 μ.

It is rather a striking fact that the white ant should harbour a *Nyctotherus* so closely resembling that of the cockroach, when it is remembered that the Trichonymphids are also confined to these two hosts.

(3) *Spirochæta termitis*, n. sp.

Some of the termites which I examined proved to be heavily infected with spirochæts. As these have not been previously described—so far as I am aware—I propese the name *S. termitis* for them.

It is of interest to note that Leidy (1877) found "a Spirillum" present in the gut of *Termes flavipes* (North America); and Grassi and Sandias (1893) also record "Spirilla" in the European termites which they investigated (*Calotermes flavicollis* and *Termes lucifugus*). It seems to me highly probable that reinvestigation of these organisms would show them to be really spirochæts.*

When alive, *S. termitis* is a long, slender, and very active organism. It moves rapidly backwards and forwards with the wriggling, flexible motion characteristic of the spirochæts. A well-marked bending and rolling up of the body may frequently be seen.

The organisms which I observed (fig. 20) varied considerably in size, both as regards length and breadth. The longest individuals measured rather over 60 μ, but the breadth was never more than 1 μ, and often less.

The ends are pointed, and do not appear to bear free flagellar processes, such as are said to occur in some spirochæts (*e.g.*, *S. buccalis*). Neither in the living organism nor in stained preparations have I seen an undulating membrane.

In films stained by Giemsa's method the organisms stained a uniform pink, or occasionally showed an indistinct granular structure. Owing to their slenderness it is exceedingly difficult to make out their internal structure.

I found no forms which could be regarded with certainty as showing stages in division, though some of the longest organisms—in stained preparations—occasionally exhibited a break towards the middle of the body (fig. 20, longest individual), which suggested that transverse division takes place.

Concluding Remarks.

I wish, in conclusion, to summarize some of the more interesting points which the observations recorded in the foregoing pages have brought to light.

In the first place, I would emphasize the fact that my investigations are not, and do not pretend to be, in any way exhaustive. I have merely examined such animals as chance allotted to me. Also in no case did I examine more than a small number of individuals of any one species. Many animals, moreover, were examined with entirely negative results, and I am fully sensible of the fact that no definite deductions can be drawn from these few negative instances. The record of these cases has been given solely for the use of subsequent workers along similar lines. Nevertheless, apart

* Since writing the above, I have been able to consult the full account of these organisms by Leidy (1881). His description and figures leave no doubt in my mind that his organisms were really spirochæts. Curiously enough, he has named the organisms *Vibrio termitis*. If mine are the same as the North American forms, the correct name is therefore *Spirochæta termitis*, Leidy emend. Dobell (non *Sp. termitis*, Dobell).

from these inconclusive negative results, I have obtained a few positive records, which appear to me to justify a few general remarks before I conclude.

A point of some interest is in connection with the distribution of the protozoan parasites is frogs. I have found, as recorded in previous pages, that the Ceylon frogs harbour a set of Protozoa exactly parallel to the set which one finds in European frogs. In both one finds two kinds of blood Protozoa: Hæmogregarines and Trypanosomes. In both one finds three genera of flagellates in the large intestine: *Trichomonas*, *Trichomastix*, and *Octomitus* (*Hexamitus*). In both one finds an *Entamœba* in the large intestine. In both one finds ciliates—belonging to the three genera: *Opalina*, *Balantidium*, and *Nyctotherus*—in the large intestine. In both, finally, one finds a ciliate of the genus *Balantidium* inhabiting the duodenum. The three flagellates and the amœba correspond in general appearance so closely in the Ceylonese and European frogs that I cannot distinguish them from one another.

Again, the Ceylon crocodile has been found to harbour a hæmogregarine, which resembles not only that described from the Indian gavial, but also those found in African crocodiles and the Mississippi alligator.

Then in the snakes. Apart from the new spirochæt which was found, one finds hæmogregarines which resemble not only those found in snakes from other parts of Asia (India, Tonkin, China, Java, &c.), but also those in snakes from Europe, from Africa, from North and South America, and from Australia. The only snake trypanosome which I found is closely similar to another previously described from a tropical American snake. Further, one Ceylon snake was found to possess a *Trichomastix* very like that which I have already described from a South American *Boa constrictor*. A similar organism occurs in all probability in European snakes.

Then, in the case of the white ants, similar interesting finds have been recorded. Ceylon termites harbour a flagellate belonging to the remarkable family Trichonymphidæ. These parasites have previously been found in termites in Europe, North America, and South America. The only other host of trichonymphids is the cockroach. It is therefore of interest to find that the Ceylon termite harbours a ciliate of the genus *Nyctotherus*, which very closely resembles that of the common cockroach, *Stylopyga orientalis*. This is a fact not without interest for the systematic entomologist. Lastly, the Ceylon termite possesses a spirochæt, and there are indications that the North American and European termites harbour a similar parasite.

Some further parallels could be added to this list, but it is perhaps unnecessary to develop this theme any further. Yet it seems to me that these facts are of something more than purely protozoological interest.

It will not perhaps be superfluous to point out once more that I have, in company with other workers on Indian and Ceylon forms, found that lizards do not appear to be infected with blood Protozoa to anything like the same extent that European and African lizards are.

One other point, in conclusion, appears to me worthy of comment. Wherever I have found trichomonads, I have always found both *Trichomonas* and *Trichomastix* associated together. This supports, I think, to some extent the view of Doflein, who believes that these two "genera" are in reality merely forms of one and the same organism. For my own part, however, I prefer to consider them as distinct genera for the present, mainly on the ground that no real intermediate forms have ever been discovered. This is, however, a matter of but small importance.

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DESCRIPTION OF PLATE.

(The figures are not drawn to scale. The actual dimensions of the various organisms depicted are given in the text. Figs. 1, 2, and 20 were drawn under Zeiss 3 mm. apochromatic oil immersion × comp.-oc. 12. Figs. 3–10 and 12–15 were drawn under Leitz 1/12 in. oil immersion. Figs. 11, 16–19, and 21 were drawn under Zeiss 2 mm. apochromatic oil immersion, comp.-oc. 6.)

Fig. 1.—*Gymnonympha zeylanica*, n. g., n. sp., a trichonymphid from the intestine of *Calotermes militaris*. (Picro-acetic acid, Delafield's hæmatoxylin and eosin.)

Fig. 2.—Small trichonymphid, from same preparation as preceding. (Probably a young form ?)

Figs. 3–8.—*Hæmogregarina*, sp., from *Rana tigrina*. (Osmic vapour, Giemsa.)

Fig 3.—Large intracorpuscular form.

Figs. 4, 5, 6.—Various free forms from the blood plasma.

Fig. 7.—Encapsuled form in a red blood corpuscle. (Living animal.)

Fig. 8.—Empty sheath of parasite lying in red corpuscle. (Dry film ; absolute alcohol, Giemsa.)

Figs. 9, 10.—*Hæmogregarina*, sp. (? *H. hankini*, Simond), from blood of *Crocodilus porosus*. (Dry films ; absolute alcohol, Giemsa.)

Fig. 9.—Doubled-up organism, with limbs approximately equal in thickness.

Fig. 10.—Form with slender doubled-up "tail."

Fig. 11.—*Trichomonas mabuiæ*, n. sp., from the large intestine of *Mabuia carinata*. Large individual. (Sublimate alcohol, Delafield's hæmatoxylin and eosin.)

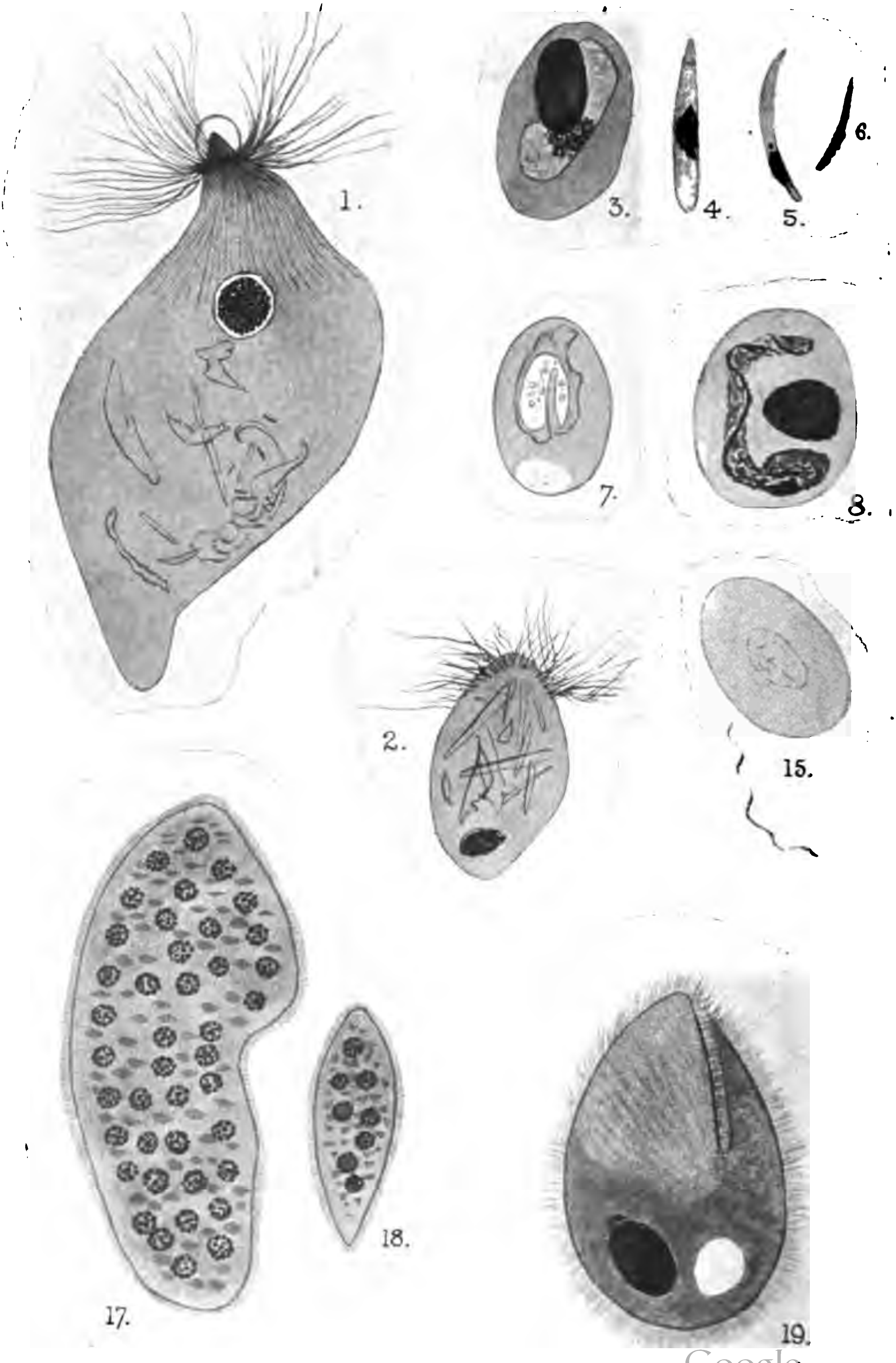
Fig. 12.—*Trypanosoma*, sp., in blood of *Rana tigrina*. (Osmic vapour, Giemsa.) A red corpuscle is shown in outline.

Figs. 13 and 14.—*Trypanosoma tropidonoti*, n. sp., from the blood of *Tropidonotus stolatus*. (Osmic vapour, Giemsa.) The body is stained blue, the trophic nucleus pink, edge of membrane with flagellum red, the kinetic nucleus deep purple.

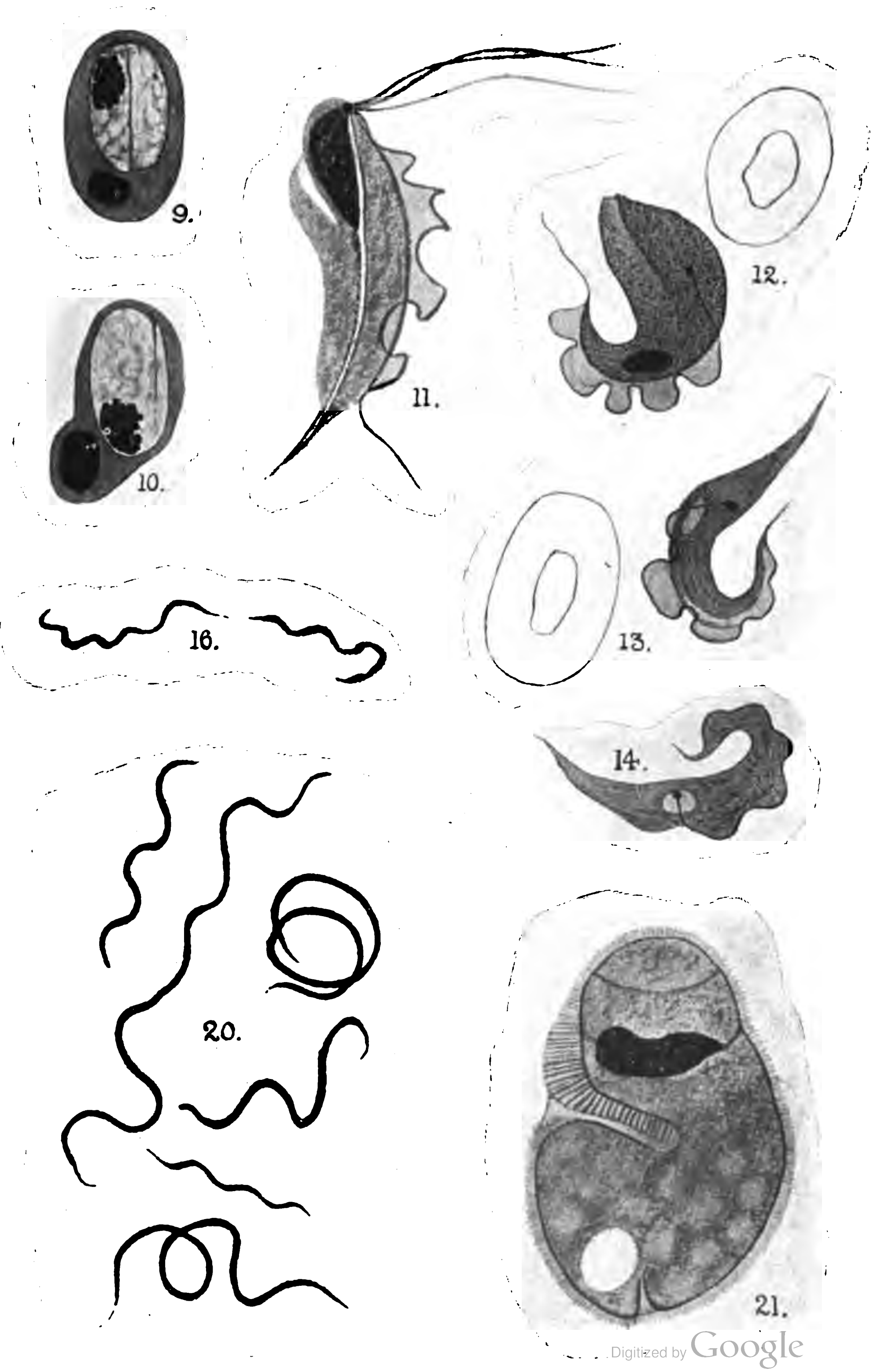
Fig. 13.—A form in which the kinetic nucleus is situated some distance posterior to the trophic nucleus. (Red corpuscle in outline.)

Fig. 14.—Form in which the kinetic nucleus is in contact with the trophic nucleus.

Plate I.



DOBELL—PARASITIC



PROTOZOA FROM CEYLON.

Figs. 15, 16.—*Spirochæta tropidonoti*, n. sp., in the blood of *Tropidonotus stolatus*.

Fig. 15.—Living organism, beside a red corpuscle. Heart blood.

Fig. 16.—Organism dividing into two. (Dry film; absolute alcohol, Giemsa.)

Fig. 17.—*Opalina virgula*, n. sp., from large intestine of *Rhacophorus maculatus*. (Picro-acetic acid, Delafield's hæmatoxylin.)

Fig. 18.—Small *Opalina*, from same preparation as preceding. Probably a young individual.

Fig. 19.—*Balantidium hyalinum*, n. sp., from duodenum of *Rana tigrina*. (Sublimate alcohol, Delafield's hæmatoxylin.)

Fig. 20.—*Spirochæta termitis*, n. sp., from the gut of *Calotermes militaris*. Various forms are depicted. (Dry film; absolute alcohol, Giemsa.)

Fig. 21.—*Nyctotherus termitis*, n. sp., from intestine of *Calotermes militaris*. (Picro-acetic acid, Delafield's hæmatoxylin and eosin.)

NOTES ON THE FRESH-WATER FISHERIES OF CEYLON.

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(With one Plate and three Text Figures.)

[The following notes are taken from Dr. Willey's preliminary account of the Inland Fisheries of Ceylon in the Administration Reports of 1908 and 1909.—Ed.]

THE object of the inquiry is to obtain biological and, as far as may be possible, statistical information about the indigenous marketable fishes, to devise measures for arresting a decline of the fisheries, and to introduce one or more useful species from abroad. As no records have been kept in former years, it is impossible to demonstrate that a progressive reduction in the amount of the catches is in fact taking place. There seems to be a general impression that this is the case ; and it is evident that the clearing of forests for plantation purposes must re-act upon the water systems of the cultivated districts by silting up the tributaries of the rivers. The more the country is brought under cultivation, by so much the more should attention be directed to the habits of the food-fishes. And this is about all that can be, and perhaps all that need be, said on the subject of the decline of the fisheries. The illegal use of dynamite and narcotic poisons is not a danger which threatens the entire fish-fauna ; and it may be assumed that the steps which are already taken to prevent the application of these objectionable methods of capturing fish are adequate.

The present investigation is mainly concerned with the fresh-water fisheries of the Western and the North-Central Provinces, the former being selected as typical of river fishing, the latter of tank fishing. In this part I shall refer chiefly to certain aspects of the fishing industry in the Western Province. In the first place, however, it is necessary to note that for the understanding of this question it is important to realize at once and for all the essential economic difference which exists in Ceylon between sea fishing and estuarine fishing on the one hand and inland fishing on the other. Speaking generally, it may be said that there is no independent fresh-water fishing industry in Ceylon. What takes place is merely a collateral pursuit subservient to paddy cultivation and cattle raising. Sea and estuarine fishing is a main industry of the maritime districts ; river and tank fishing is a collateral industry of the interior.

Fig. 8.—Man holding a "kemina" at Hanwella. The narrow end is covered by a coconut cap.

The Barawe Fishery.—The Barawe reserve near Hanwella is a low-lying wooded tract, through which the Pusweli-ganga flows into the Kelani-ganga. After heavy rain the country is under water, and I have myself been compelled, in the month of May, to travel by boat for some distance down the high road from near the Hanwella resthouse. Hanwella is a good type of inland fishing station, people said to belong to the "Padduwa" caste being more or less permanently engaged in fishing by various methods; and the produce is brought into the village bazaar for sale in improvized markets at the roadside.

On the Pusweli-ganga, upwards of a mile from the resthouse, the Barawe line-fishermen work singly from very small log boats called "mas marana oruwa," from which they catch excellent food-fishes, such as the walaya (*Wallago attu*), telliya (*Mastacembelus armatus*), and modà (*Lates calcarifer*), besides several species of the carp family (*Cyprinidæ*). Fishes caught in the water-courses are called "ela malu," in contrast with "weli malu," which are taken from inundated fields. Of the latter, the lula (*Ophiocephalus striatus*) is the most important, and the batakola-telliya (*Rhynchobdella aculeata*)* one of the most interesting. They also capture in baskets great quantities of a small cyprinoid fish called saliya (*Amblypharyngodon melettina*); females of this species, three inches in total length, are egg-laden in December. In the Ihivetiya-ela, an arm of the Pusweli-ganga, a portion was fenced off at either end from the main stream in December, 1907, and I saw about thirty men, women, and children paddling about in the muddy water, each provided with a large conical hand basket ("eswattiya"), with which they scooped up small fishes, transferring them to bags carried on their backs, occasionally also capturing a large river prawn.

Stretching a wattle fence (vetiya or veta) across an ela is a frequent practice. A narrow passage may be left at one end of it, and this will be occupied by a long bamboo fish-trap, closed at the narrow end by a half coconut shell. The fence is made of impenetrable, close-set slips of bata-li or wild bamboo; the fish-trap ("kemina") (fig. 8),† about 7 feet long, is made of slips of una-li or plantation bamboo. Strips of bamboo are steeped in water to season them, and are kept soaking for eight days preparatory to the final splitting.

The "karakgediya" is a basket open at both ends, shaped like a truncated cone, about 25 inches high, made of Ixora sticks (ratamvela); each stick is pointed below, and the whole bound together above, leaving a hole just large enough to receive a man's arm. It is used in swampy fields; the broad end with the pointed sticks is presented to the bottom at a venture, and the hand inserted through the arm-hole to grope for a possible catch.

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* I recorded this species from Ceylon for the first time in "Nature," Vol. 77, 1908, page 345.

† For the three illustrations accompanying this report I am indebted to Mr. O. S. Wickwar, who accompanied me on one of my visits to Hanwella.

They also construct elaborate fixed traps called "mas-ge" or "mas-kotuwa"; these are tall fish-mazes, about 20 feet high, made of the same materials as the fences. They project high out of the water when the latter is low, but during flood time they may be entirely submerged. For example, May 9 was a day of great rain at Hanwella, and the entrapped fishes could only be taken in the early part of the day, before the waters had covered up the mas-kotu. Up to the present I have not found an opportunity of seeing fish taken out of a mas-kotuwa. When I visited Hanwella in December, 1907, they had fallen into temporary disuse, only being worked during the rains; and I was told that there had been a mas-kotu fishery in the previous month of November; May and June are the chief months for this fishery in the Kelani Valley. The mas-kotu may thus be defined as flood kraals, in contrast with the ja-kotu, which are fair weather kraals. An important carp, the hiri-kanaya (*Labeo dussumieri*), is taken in the mas-kotu at Hanwella; and occasionally, though not in my experience, the lela (*Barbus tor*).

Another piece of fishing gear employed by the Barawe fishermen is the "baru-dela" or casting net, the manipulation of which requires a great deal of skill. Other nets are the "atanguwa" or hand net; and the "pala-dela," a net stretched between two poles, terminating in a small-meshed bag.

Being much impressed by the intensive character of the Barawe fishery, I applied to the Mudaliyar of the Hewagam korale (Mr. H. A. Pieris) for information as to whether it had ever been more productive than it is now; whether there had been any notable fluctuations in the annual catches; and whether or not he considered the methods of fishing unduly destructive of immature fish, leading to the diminution of the local fish supply. The Mudaliyar replied that the fishery had been more productive in times past owing to the fact that "the forest is now being gradually cleared of its timber, which causes the streams to dry up faster than in former years"; there had been no noticeable fluctuations; and he did not think that the present methods of fishing in his district were unduly destructive. This, of course, is a matter of opinion, which should be discussed by a competent local fishery committee. I would point out here, however, that the fencing of natural water-courses so as to hinder the normal migrations of fishes, and the "muddying" of permanent waters so as to inhibit the normal respiration of fishes, are practices which call for comment. The deliberate stirring up of the mud in order to foul the water belongs to the same category as the use of dynamite and vegetable poisons; or at least modern conditions of existence render it necessary to classify them together. The stirring up of mud is done sometimes by men, sometimes by buffaloes. Wakwella on the Gin-ganga, near Galle, seems a likely enough place for a fishing station, but in fact is disappointing. In August I tried to obtain a sample of the fishes frequenting those waters. The boatmen offered to put up a fence across the creek opposite to the resthouse at midnight; then they would place a buffalo at some distance away towards the head of the creek, to trample up the mud, thus causing the fish to collect at the fence in their efforts to escape from the source of disturbance, where they could be taken in the early morning in baskets. I decided, rightly or wrongly, against it.

It should be added that, besides the species which I have mentioned above, several other first-rate food-fishes are habitually caught by the Barawe fishermen, *e.g.*, river-eels, ganga-anda (*Anguilla bengalensis*), the butter-fish, walapota (*Callichrous bimaculatus*), the eight-barbed three-spined catfishes, ankutta (several species of *Macrones*), the fresh-water gobies, weligowa (*Gobius giuris*) and kudupuwa (*Eleotris fusca*), the fresh-water garfish, moralla (*Belone cancila*), the climbing perch, kavaiya (*Anabas scandens*), and the koraliya (*Etroplus suratensis*). These are retained for home consumption and for sale in the roadside market at Hanwella opposite to the resthouse, although the neighbouring planters derive their fish supply from Colombo through the Kelani Valley Railway. When there is a superabundance, some of the larger fishes may be salted and kept for a few days.

The "Wala" Fishery.—The floods of this country are a principal factor in the inland fisheries, exercising as they do a beneficent, protecting, and distributing influence. They afford natural close seasons for river fishes; and they enable mud-loving and air-breathing fishes to spread themselves over the surrounding lowlands. A wala is a pit or depression in the ground in which flood water will remain for a long time after the inundation which filled it has subsided. They vary in extent from a few square yards to about a quarter of an acre; the esteem in which they are held can be gauged from the fact that each wala has its own distinctive name; the fishing of them requires co-operation, and the fishing rights are therefore vested in a body of related families, the time of fishing being decided by the able-bodied men. It would be possible to register the recognized fishing walas of a district, but it has not occurred to anybody to do so; such a return would be useful, and might be advantageously ordered by Government.

As an example of primitive pond-culture the wala fishery is both interesting and important, and should on no account be stigmatized as "puddling," or mentioned disparagingly as one of those methods which "ought to be stopped." On the contrary, it is the beginning of systematic pisciculture, and is, or should be, capable of further development.

The pits are left to be watered and stocked by floods, there being little attempt to assist nature, except by slight excavation and banking. At the proper time the water is baled out by means of winnowing baskets ("hal-kula"), or by large, wooden, irrigating scoops (yotu-kanda) suspended from crossed poles (figs. 9 and 10), according to the size of the wala. Wala-fishing goes on in places where no other fishing is available, and is one of the most prolific sources of fish supply for villages throughout the low-country, including the immediate environs of Colombo.

At Tebuwana on the Kalu-ganga there is no river fishing worth mentioning, but a considerable wala-fishery takes place during the dry weather which follows floods. The ponds contain stagnant water, and by repeated baling out of muddy water deep pools are formed in them, where fish accumulate sometimes in large numbers. I inspected one such pond, and witnessed the operation of emptying it; it was called the Kohila-wala, because formerly an edible root (kohila) grew where the pond now is, some still remaining on the banks. The digging out of the yams and the subsequent flooding and scooping out of fish from the mud at certain spots has made three deep holes, in one of which there were signs of abundant fish. The baling took place on January 25. They commenced by deepening an efferent channel and allowing the surface water to flow away through it; then they dammed it up and started baling the water over the dam. In this case the baling was done by four men working two "hal-kula," each provided with two pairs of flexible handles held by a man on each side with both hands. The men swing the baskets between them and work away for three hours or more. The catch they said was not up to the average; it consisted chiefly of madaya (*Ophiocephalus punctatus*), kavaiya (some were egg-laden), magura (*Clarias magur*), a few hunga (*Saccobranchus fossilis*), lula, ankutta, and batakola-telliya. Each hunga was knocked on the head before being taken out, on account of the dangerous pectoral spines. The total weight of fish caught was about 22 lb., and the value in the local market was put at Re. 1·50 only, an absurdly low figure,* but then it was not going to be sold for cash. As it was, the division of the spoil gave rise to much bickering, and one woman apparently refused to be comforted.

The walas occur in places where shade is afforded by adjoining vegetation; an overhanging tree makes a difference to the inhabitants of a pool. One of the symptoms of the decline of fisheries in certain parts of late years is the failure of the old walas; and this is attributed to forest clearing in the neighbourhood, which has a two-fold effect, removing shade and increasing silt, large quantities of soil being washed down from the adjacent clearings. The filling up of walas by the deposition of sediment in consequence of forest clearing has been noted by the Maha Mudaliyar in connection with the Attanagala-oya, which flows past Henaratgoda. It may be mentioned here that the alleged decline of inland fisheries as a whole

* Of course, this only applies to one small wala; the total value of the wala catches in a given district would be something considerable; and the same wala may be baled out three or four times in the year.

FIG. 9.—A "wala" at Hanwella being baled out by means of an irrigation scoop ("yotu-kanda") over a low bund.

FIG. 10.—Another view of the same "wala."

has been attributed to various causes from first to last, but not once I believe publicly to what is perhaps the most deep-seated cause of all, namely, forest clearing.

Undersized fishes are destroyed in the wala system of fishing, but not to such a great extent as by netting; and it should not be forgotten that the capture of egg-laden females is as wasteful as the netting and trapping of immature young. It would appear that there is no practical method of stopping the waste; if it is excessive, the only way to counterbalance it is by establishing nurseries and hatcheries; and when one considers the small monetary value of the inland fisheries at their best, the idea that hatcheries in connection with the rivers of the Western Province would repay the expense of their upkeep seems to be excluded, at least for many years to come. There can be no doubt that they would be beneficial, and the installation of one inland hatchery should be seriously contemplated.

Night-lines and River-fishing.—As with the Kelani-ganga, so with the Kalu-ganga, the main rivers do not yield the main fishery; this is found in their affluents, the Pusweli-ganga and the Kuda-ganga respectively. The main rivers are, however, exploited to some extent by means of night-lines. At Tebuwana, on the occasion referred to in the preceding section, having taken a large number of madaya from the wala, two men who were noted experts at moda-fishing said they would go that evening between 7 P.M. and midnight to fish for moda or other large fish with rod and line, using madaya as live bait. Only one of them kept his courage to the sticking point, and, after some persuasion, was induced to go; but there was a deval-maduwa close by, and the noise of people crossing the river to attend the festival was fatal to good fishing. The man said afterwards that he had had two bites of "guru-tambaya," but had failed to land the fish.

The rod employed is a strong inflexible bamboo rod, which is supported over crossed or forked sticks from the shore. At several points along the banks of the river when travelling by boat one may notice a forked stick driven into the ground with a low semi-circular rampart in front of it, an ambuscade for lying in wait for moda, &c. The whole is called "malu bana."

There is no doubt of the fact that river fish as food are scarce in Ceylon; a trivial indication of this state of things is to be found in the circumstance that, as a rule, the last place in which to expect a dish of fresh fish is at a riverside resthouse. At Tebuwana estuarine fish from Kalutara are procurable; at Badureliya and Anguruwatota sardines are offered.

On February 12 I travelled from Badureliya to Anguruwatota on an untented raft supported by three dug-outs, in order to ascertain whether there might be any sign of an active fishery along the tributaries of the Kalu-ganga. Gliding gently along the Magura-ganga we passed deep pools in which large fish are known to lurk;

and here and there are cylindrical fish-traps (kemina). A place called Maguruwaka overlooks the confluence of the Kuda-ganga, Pelen-ganga, and Magura-ganga. This is the likeliest looking situation for a hatchery and fresh-water biological station that I know of in the Western Province. Here there were fishing boats at work, netting and angling, whipping the side deeps and catching black-blotched, four-barbed petiya (*Barbus pinnauratus*) and black-striped dandiya (*Rasbora daniconius*). This region is known as Molkawa, and the fishery may be conveniently referred to as the Molkawa fishery.

Farther down the Kuda-ganga I came upon a catch of fish made by two canoes with pole net (pala-dela), pan-rena (a fish-guide or trace of bleached coconut leaves),* and kalavel (poisonous creeper). Small carp kept rising in a helpless floundering fashion to the surface, whence they were lifted by hand and thrown ashore; a great quantity of frothy scum covered the surface of the water at this point. In one of the boats there were two large walaya, 24½ and 25½ inches long respectively, with a combined weight of 4¼ lb. The complete outfit for a Kuda-ganga fishing boat consists of a mass of bleached coconut leaflets, a net between two stakes, and some kalavel. A mile or so farther down the river I picked up a dead petiya (*B. pinnauratus*), 8½ inches long, weighing ¼ lb., a male in an immature condition.

A lethal weapon sometimes employed along these rivers is the "kaduwa," consisting of a series of iron barbs riveted to an iron shaft. One in use on the Magura-ganga had 19 barbs placed close together, so as to form a toothed blade about a foot long; the handle, 2 feet long, was secured by a rope. The man who held it was waiting near some rocks for an "ara" (*Ophiocephalus marulius*) to appear. If he should succeed in striking a large fish, it might swim away with the implement were it not secured by a line after the manner of a harpoon.

A Koraliya Nursery.—As I have indicated above, the native walas are merely used as collectors. If anything is to be done for their improvement and development, some scheme of protected walas will have to be devised so that some of them can serve as nurseries. The obvious difficulty, namely, the circumvention of floods, is one which can only be met by concerted action based upon local knowledge.

The carp family (*Cyprinidæ*), though numerically strong, does not figure so prominently in the list of marketable fresh-water fishes in Ceylon as it does elsewhere. Of the non-predaceous indigenous low-country fishes which are amenable to cultivation, one of the most important, numerically and dietetically, is the koraliya (*Etroplus suratensis*), a member of the family Chromides. This

* For further remarks on pan-rena, reference may be made to my fishery observations in *Spolia Zeylanica*, Vol. V., 1908, page 150.

species is one of those which, like the lula, nurse their brood, standing by to keep off the many enemies which prey upon spawn and fry. Its habits are known to the fishermen. It is captured in nets and in kraals, and unfortunately is netted on its spawning grounds. I inspected some of the latter in February and saw a koraliya, as it appeared, selecting a spot amongst aquatic roots in the river at Kalutara, for the purpose of depositing its eggs, as early as February 6. The spawning season is from the middle of February to the middle of April, and again about November, according to the statements of the fishermen. The aggressive pursuit of the spawning and brood-nursing fishes, involving the destruction of the eggs by the dragging of the nets, should be discouraged. Early in March I suggested to the Assistant Government Agent (Mr. J. Conroy) a method of protection of the breeding sites as an experiment. Three weeks later when I went to Kalutara to see how the experiment was working I found the river in flood and the sites concealed. This observation explains the assertion contained in an earlier part of this report, that the floods provide natural close seasons for the river fishes. The spawn is the most vulnerable part of the koraliya's economy ; and the systematic capture of fishes during the exercise of their parental care cannot be defended.*

The koraliya is known to attain the length of a foot ; and as the body is very high in proportion to the length, a full-sized fish is an object worthy of attention. It is netted in large numbers at a very tender age, 2 to 3 inches in total length (including the tail-fin), being utilized at this stage as curry stuff. It is also netted in quantity at a middle age, 5 to 7 inches, still immature.

Introduction of Gourami.—The gourami (*Osphromenus olfax*) is a fresh-water fish belonging to Java, which has been introduced into Europe as an aquarium fish, and into Mauritius, Cayenne, and India as a food-fish. It is recorded as attaining a length of 2 feet and a weight of 20 lb. ; but it seems doubtful whether 20 lb. of muscle can be concentrated into a length of 2 feet. However that may be, it has long been known to possess an " exquisite flavour " ; and has quite recently been characterized in the Cambridge Natural History as " one of the best flavoured fishes of the Far East."

Under these circumstances I had no hesitation in recommending Government to communicate with the Government of Mauritius in order to ascertain definitely whether the culture of the gourami is carried on there with conspicuous success. This was done, and a reply duly arrived, forwarding papers relating to this matter, and adding " that if it is desired to introduce the gourami in Ceylon, this Government will be glad to arrange for a supply of young fish being sent." The gourami, it appears, is not made the object of methodical cultivation in Mauritius, but, when desired, it is

* River fishermen throughout the Panadure and Kalutara Totamune have been warned against the practice.

transplanted from one place to another. A gentleman who has interested himself in acclimatization experiments in Mauritius, Mr. A. Daruty de Grandpré, states that the rearing of the gourami is very easy, as it will exist in any kind of fresh water, flowing or stagnant; its habits are herbivorous and insectivorous, and it is therefore valuable as a consumer of mosquito-larvæ; it constructs a nest amongst aquatic herbs, where it deposits its eggs, which are defended by the male.

About the middle of the year (1909), hearing that Mr. M. Kelway Bamber, F.I.C., F.C.S., was leaving on a visit to Java, and would be willing to secure some gourami for Ceylon, I wrote to him a letter giving recommendations for dealing with the fish in transit, and on September 15 Mr. Bamber returned to Colombo with a small consignment of young gourami, from 6 to 8 inches in length. Soon after their arrival in Colombo one or two died, and the remainder, 24 in number, were placed in a circular cement tank, 8 feet in diameter, in the grounds of the Colombo Museum, in which top-minnows had been kept for a long time previously. The tank was covered over by a cadjan roof, but the heat was too great and the light too intense, and in spite of all that was done for them they did not thrive. Some of them were afflicted with a skin disease; in others the eyeballs began to protrude, and this went on to such an extent that half of the eyeball projected from the socket. The symptoms of *malaise* finally became so distressing that I decided to send 20 of them to Peradeniya in three tubs covered with mosquito netting on October 14. The three remaining survivors, with eyes starting out from their sockets in a pitiful manner, were removed to a glass aquarium situated in a verandah and provided with bamboo cylinders and tiles, into and under which they could retreat; here they have subsisted upon boiled rice, minced raw liver, and worms; to my surprise, in course of time, the eyes gradually worked back into the sockets. These three individuals have been transferred once more to the Museum tank; one of them blind in one eye.

The score of gourami arrived in Peradeniya in good condition, and were turned into the large pond in the Gardens. As mentioned, this happened in October last, and it will be interesting to ascertain, in due time, whether the fishes have spawned; to encourage and assist them to spawn, fascines or small bundles of twigs should be placed here and there in the pond.*

Anguluwa.—The largest fishes taken in the Panadure river, besides eels, are "tambalaya" (*Lutjanus jahngarah*) and "moda"

[* On November 5, 1910, Mr. E. E. Green and I made an examination of the pond at Peradeniya and found no signs of the gourami. Two native fishermen were employed, and they used a vertical net somewhat like a Seine net. After an exhaustive search they declared that there were no fish in the pond. The pond overflows into the Mahaweli-ganga, and it is probable that the fish have escaped to the river, although the ledge which guards the overflow would render this difficult but not impossible.—ED.]

(*Lates calcarifer*). Some of the most abundant fish caught in the weir traps are called "anguluwa," of which there are two kinds : "tora-anguluwa" (*Arius falcarius*) and "wel-anguluwa" (*Macrones gulio*). The former species produces large yolky eggs ; the latter produces the usual small eggs of bony fishes. After the female of the "tora-anguluwa" has laid a batch of eggs, each measuring about half an inch in diameter, enclosed in a transparent membrane, the male takes the soft eggs into his capacious mouth and keeps them there for many days until they hatch out as large fry, retaining the fry until the yolk is absorbed. The eggs which are thus carried about in the mouth of the male are called "kate-viju," as distinguished from the "bade-viju" in the ovaries of the female ; the fry in the mouth are the "kate-petaw." The actual process of ingesting the eggs has not been observed.

When the mouth of an ovigerous male is examined, the cavity is found to be stretched to its utmost capacity so as to hold 15 or more eggs (see Plate, fig. 1). In this position the eggs are exposed to the respiratory current of water as it passes through the gill clefts, and at the same time they are protected from enemies. The œsophageal passage at the back of the pharynx is closed, and the palatine teeth are usually found to be greatly reduced as compared with those of females and of normal males (see Plate, fig. 7). The palatine teeth attain their greatest development in the female, and very rarely a small paired round group of vomerine teeth is to be found (see Plate, fig. 6). The intestine of the ovigerous male is generally shrunken to very narrow dimensions and devoid of contents.

The ovaries of an adult female contain a very great number of eggs in different stages of growth, but of these only a few become mature at a time, and there is a great contrast in size between the mature and the immature ovarian ova. In one case there were only 10 large eggs in the right ovary and 8 in the left. In another there were 21 large eggs in the right ovary, 24 in the left.

Anguluwa is also caught in the Angulu Eliya lake on leaded lines baited with prawns, attached to kitul floats, resembling the "thathe" used in Nuwarawewa, as described above.

Atukotuwa.—A very common and at the same time a very dainty fish in the Panadure river is the "koraliya" (*Etroplus suratensis*). Some time ago a statement appeared in the local press to the effect that this species is a bony fish of no importance. As it is one of the best of the estuarine fishes in Ceylon, the statement was probably based upon a misunderstanding, perhaps a confusion with the "kavaiya," which has the reputation of being bony and thick-skinned, though a valuable agent in the destruction of mosquito larvæ.

In the Panadure lake it is captured in a wide-meshed "baru-dela" in the following manner. Two men proceed in a boat on a prospecting tour, carrying with them a quantity of leafy twigs, which they place upon the bottom, near the shore, in ½ to ¾ fathom, marking the spot in the centre with a long branch surmounted by a leafy crown which rises above the surface. They bait the ground with a meal consisting of fried poonac mixed with plain kurakkan, which they call "koraliya-kema." Then they retire to a distance for about half an hour, and on returning cast the "baru-dela" over the central mark, picking out the "koraliya," if any happen to be caught, from under the leaded edge of the net as it lies upon the bottom.

In the Angulu Eliya lake "koraliya" is caught in an ingenious manner in artificial submerged thickets, called "atu-kotu" (singular atu-kotuwa). Twigs and branches are piled up in a circular area 8 or 10 feet across, surrounded by poles driven into the bottom to mark it out and to keep the branches from drifting away with the current. This is left for two or four weeks, until the sticks exhibit a copious growth of algæ, called "penda," upon which the koraliya feeds. When ripe for the catch, the whole is enclosed within a close-set bamboo tat preparatory to the fishing. The circumference of an "atu-kotuwa" measures about 60 feet; the tats or "peleli" rise 2½ to 3 feet out of the water, in spite of which some "koraliya" succeed in leaping over it and in making good their escape.

If the arrangements are completed in the afternoon, the fishing takes place early on the following morning. Two men get inside the enclosure, where the water has a depth of 4 to 5 feet, and commence handing out the larger branches to a third man outside, who places them in another pile close by. When the place is clear, a man takes a deep hand net (atanguwa) and carries it round the circle, keeping close to the tat all the time. The other man is meanwhile continuing the clearing and splashing in the centre to drive the fishes to the circumference. When the net has collected a fair number of fishes, it is emptied into a boat outside and returned for a fresh supply. In this way about 150 "koraliya" of all sizes up to 7½ inches in total length were collected in my presence, and very few fishes of other kinds besides. The larger sizes of "koraliya" are worth about 6 cents each; the bulk of the catch was taken immediately to Moratuwa; they said the total value was Rs. 2, but the value was probably under-estimated.

The custom of erecting "atu-kotu" commences in the Panadure lake abreast of Kaduruduwa, a coconut-planted islet about half a mile long, opposite to the Durawa village of Gorakana.

Many other important and interesting food-fishes abound in the Panadure river. I will only mention here another prominent kraal fish, the "ileya" (called "lilawa" at Weligama), *Megalops cyprinoides*, which also frequents the Kelani-ganga estuary; and a large line fish, the "kana-magura," *Plotosus canius*. Both of these species live for many hours out of water, rather an exceptional fact in the herring family, to which *Megalops* belongs.

Moda Fishery at Kalutara.

Koraliya, anguluwa, and other fishes are caught in quantity in the Kalu-ganga estuary, but the chief speciality of this station is the moda fishery. The moda (*Lates calcarifer*) is an estuarine perciform fish of superior quality and large size, which so far as is known spawns in the sea. It is captured at many other stations in the low-country, including Elephant Pass, wherè it occurs in company with another well-known game fish, *Polynemus tetradactylus*, which is called kalawa in Sinhalese, kalemin in Tamil, bamin in Malayalam.

Other food-fishes observed at Elephant Pass in November, 1909, may be mentioned here incidentally as showing an interesting association of species at that station.

Arius falcarius, 15 inches long; anguluwa Sinh., kelaru Tam.

Belone strongylura, 15 inches; the usual vernacular name for species of Belone is morala. Also in Panadure river under name habareliya.

Chanos salmoneus, the milk fish; weka Sinh., palei Tam. Not actually taken during my stay, but occurring during flood time.

Chatœssus nasus; koiya Tam., katu-goiya Sinh. A Clupeoid fish, remarkable in possessing a hard muscular gizzard such as occurs in the gray mullets. It is also found in lake Tamblegam and in the Panadure river, wheie it is called katu-massa.

Chrysophrys berda, the calamara or black teralei.

Elops saurus; manna Tam., renawa Sinh. Also in the Panadure river.

Etroplus suratensis; o'ti Tam., koraliya Sinh.

Gerres limbatus; teralei Tam.

Gerres lucidus; teralei Tam.

Hemirhamphus xanthopterus.

Mugil olivaceus, a gray mullet; manalei Tam., godaya Sinh.

Platycephalus insidiator; eriyal Tam., mudu-weligowa Sinh. Also frequents the Panadure river.

Plotosus canius.

Sillago sihama, the kalanda; common at Panadure and Negombo.

Synaptura orientalis, a flat fish.

These are all common food-fishes, but I have not seen the bamin elsewhere than at Elephant Pass. I have examined another species, *Polynemus plebeius*, from the sea at Weligama.

The moda is frequently seen in the Kalutara fish market, and I obtained some returns from a party appointed for the purpose through the Kachcheri in order to ascertain the average quantity and value of this particular species put upon the Kalutara market within a limited period. It is caught mostly by angling near the railway bridge, sometimes by netting near the mouth of the river, presumably as the fishes are entering from the sea or descending from the river. It is rather remarkable that, so far as I know, there is no record at Kalutara of moda having been caught in the sea. The weight ranges from 1 lb. to 20 lb., and the value from 30 cents to Rs. 9.

Ophiocephalus marulius.—This fish, which has been mentioned above, attains a larger size than does its relative the lula, reaching a weight of 12 to 15 lb. Colonel Gordon Reeves informs me that some small fishes called "gunarow," 3 to 4 inches long, were sent to him in May from Rajjammaana on the Amban-ganga, which he took to be the young of *O. marulius*. He liberated them into his stew pond at "Wiltshire," Matale. They are described as having "large irregular blotches of claret colour on their upper parts, more especially towards the tail." The exact identification of these young fishes would be interesting, as nothing is known about the reproduction of *O. marulius*.

Improvement of Inland Fisheries.

Pisciculture means the preservation of the spawn and fry of fishes, the stripping or expressing of ova from mature fishes and their artificial fertilization, the prohibition of certain methods of fishing, and the regulation of existing fisheries in tanks and rivers.

There are many instructive analogies between agriculture and pisciculture sufficient to justify the conjunction of a Board of Agriculture and of Fisheries. The variations in the growth of plants according to quality and elevation of soil is comparable with the growth of fishes in correlation with the size and latitude of rivers. The quantity of fish which can be raised as food in a given bulk of water depending upon the area and depth, but above all upon the usually unknown richness or poverty of the primary food supply in the water, is comparable with the quantity of vegetable food which can be raised per acre of ground; and the liability of cultivated fishes and plants to fungoid and other pests is another common character. Besides these points of correspondence, there are other contrasts which should not be lost sight of, *e.g.*, the difficulty of transporting the ova of fish as contrasted with the ease with which the seeds of plants can be carried about; the expense of maintaining a nursery of young fishes as compared with the automatic working of a nursery of young plants; the migratory habits of grown fishes as compared with the stationary habits of grown plants. When a thousand selected plant seeds are put into the ground, a thousand seedlings may germinate on the spot and be subsequently planted out; but when a thousand fish fry are emptied into a river or tank, they "swim gaily away," and unless very particular attention is paid to them they may never be heard of again.

Prohibition of certain methods of fishing and the establishment of close seasons for certain fishes are difficult measures, which can only be based upon a close familiarity with local conditions. Each river system and each tank area have to be treated separately on their own merits. Illegitimate fishing, such as the use of poison and dynamite and the wholesale damming of water-courses, does not usually take place in the vicinity of towns, but in more or less remote tributaries. On the other hand, the destruction of young fishes in paddy fields is a matter which calls for special attention, and reference should be made on this subject to the Report on Pisciculture in South Canara, by H. S. Thomas, Collector of South Canara, 1870, a copy of which has been procured through Government at my recommendation for the Museum Library. The point which requires comprehensive discussion is the destination of the waste water from paddy fields. If this water flows back into a river, or into an irrigation canal, the inundated paddy fields act as an efficient nursery for young fishes, provided that they are allowed free scope and are not trapped prematurely. Under such conditions a system of paddy fields is the model for a combined hatchery, nursery, and stock pond.

Artificial fertilization and hatching require hatcheries and stock ponds which would be useful for re-stocking, with due discrimination, both village tanks and city tanks. Replenishing the supply of fishes means turning immature fishes into fishable waters, where they can continue to grow to a marketable size; unfortunately no size is too small for curry. But if Government undertook this work, somebody would have to pay and be paid. Recourse to artificial fertilization may be unnecessary in certain cases where the seasons and localities of natural spawning are known. I have published in *Spolia Zeylanica*, Part XXIII., December, 1909, an account of my observations on the nesting habits of lula, the principal fresh-water food-fish of Ceylon, though not the largest. I am now in a position to add that an allied species of *Ophiocephalus*, also used extensively as food and as bait for larger fishes, namely, *O. punctatus*, called "madaya" or "mada-karaya," makes its nest amongst inshore rushes, though without the definite clearing that lula prepares, and in such spots, where there is an abundance of microscopic food for the ensuing fry, it deposits pale amber-coloured eggs with a single glistening oil-globule, which float at the surface like the eggs of lula, from which they could hardly be distinguished unless their parentage was known. I had seen a shoal of very young fry of "madaya" accompanied by their parents in a paddy field "wala" at Bellana, near Matugama in the Kalutara District, in April, 1908; and on October 29, 1909, I saw a nest of the floating eggs in the Hunupitiya arm of the Colombo lake, behind Bishop's College, close to the shore, where there was a great quantity of the spherical aggregates of the colonial infusorian, *Synura*. I brought away some of the eggs and hatched them out, feeding the fry, after the yolk had been absorbed, on lake plankton, which I collected myself.

The "kavaiya" (*Anabas*) and the "koraliya" (*Etroplus suratensis*) occur almost entirely in the maritime districts, and are therefore not suitable for stocking waters too far inland.* The eggs of "koraliya" are attached to the lower surfaces of stones and logs and are watched over by the male. On May 21, 1909, a koraliya nest was found in the Wellawatta canal, in the part called Pamankada-ela, near the Spinning and Weaving Mills, beyond the Hilapane palama on the road to Nugegoda. I went there about 11.30 A.M. and saw the adults, both male and female, keeping guard. When the man who was with me advanced his hand to the small stone projecting from the bank of the canal under which the eggs were attached, the smaller, male, with cross markings conspicuous over fore body, approached and pecked at the man's fingers. The larger, female, kept a little in the background in deeper water. Each time the man touched the stone the male bit at his hand. The eggs were attached contiguously in a single layer on the underside of the stone, which was partially imbedded in the earth at the base of the bank of the canal. Some of the eggs were white, indicating failure and death. The living eggs were in an advanced stage of development, the embryo being formed and the yolk pigmented. The yolk is yellow, opaque, and darkly pigmented, but no pigment was present in the eye. The circulation of the blood is active, and the embryo can change its position within the egg membrane. In an egg under observation the free end of the membrane was already ruptured, and at one moment the head was partially extruded, exposing the eyes and the heart, and was then withdrawn again. The surface of the egg appeared minutely rogulose. The length of the egg, without the short stalk, is 2 mm., the width 1 mm., slightly narrower at the free end. Within 24 hours after finding the nest one of the eggs hatched out, the top of the egg membrane lifting up like a lid; there is still no pigment in the eyes, and no mouth; length 5 mm. On the second day after hatching pigment begins to appear in the eyes, and on the third day, when the larva is 6 mm. long, the mouth opens and respiratory movements commence; foreign particles were noted adhering to what looked like a cement organ at the front of the head. The eggs of koraliya are very difficult to rear when removed from their proper habitat. On May 23, and again on June 1, more eggs were found attached to coconut husks, branches, and stones at Hunupitiya, Colombo, opposite the Buddhist temple. On October 28, 1909, another series of koraliya eggs containing formed embryos with pigmented yolk sac was found at Hunupitiya, in the Colombo lake, attached to the outer surface of a short length of water-logged bamboo stem. This species is, therefore, a perennial spawner.

On May 26 a native tile (uluketa) was brought to me from Welikada with a large patch of green waving spawns attached in

* Kavaiya occurs in the great tanks, as at Kanthalai and Minneriya.

contiguous clusters to the concave side of the tile on long transparent stalks. Out of water the appearance was that of a growth of green algæ, or like a green scum. The egg tubes, each of which contains a single egg at the slightly swollen distal free extremity, are connected with a shapeless basal stolon which adheres to the tile and is beset with débris, whereas the tubes are clear and separated from the stolon by constrictions. The length of the egg tubes varies from 3 to 8 mm. The egg, as stated, lies in the distal dilated extremity; it has green yolk with many oil-globules, and a diameter of about 0·5 mm. When the head of the embryo is formed and the tail detached from the yolk, the embryo lies at full length with the head pointing towards the base of attachment; later, when the tail begins to jerk, the embryo can change its orientation, but just before hatching it is again found with head pointing to the base of the egg tube. The latter is nothing more than the enormously extended egg membrane; a tube with its contained larva stretched at full length measured 6½ mm., the larva 2 mm.; at hatching the total length of the larva is 2·25 mm. These remarkable eggs proved to be the spawn of the fresh-water goby, *Gobius giuris*, called "weligowa," an important food-fish; they are, however, difficult to rear without special appliances. On June 6 a fresh lot of weligowa eggs was found in a piece of iron piping, together with the parent fish, in the Hunupitiya division of the Colombo lake; and on July 28 I saw another deposit of the spawn, attached to the underside of a coconut leaf stalk in about 3 feet of water in the Colpetty arm of the lake.

On August 31 a half-spent spawning "kendeya" (*Barbus dorsalis*), accompanied by a batch of adhesive eggs, was brought from the Colombo lake. The eggs measured 0·75 mm. in diameter, with a pale grayish translucent yolk nearly uniformly granular. The eggs had been caught in the act of being laid, and were apparently unfertilized.

The above notes, necessarily fragmentary, will be found useful as giving indications of spawning seasons and habits, of which very little has been previously known in Ceylon. It seems to be the rule that solitary fishes or those that go about in pairs make nests and guard them; gregarious fishes or those that go about in shoals do not generally make nests. The deposited eggs of such common fishes as kavaiya (*Anabas*), hunga (*Saccobranchus*), and magura (*Clarias*) are still unknown.

Lula is a predatory fish with excellent qualities. As mentioned above, it can be dried when obtained in superabundance; a statement to the effect that lula is unsuitable for salting or drying in *Spolia Zeylanica*, Vol. V., 1908, p. 145, &c., requires to be modified; the practice of drying is carried out locally, but not generally. Other fishes in Ceylon which are worth cultivating on account of their value as nutriment are also predatory. There seems to be no non-predatory, nest-building species in Ceylon of equal value with the lula. The mahseer occurs in up-country rivers (Maskeliya), but apparently is not very common in Ceylon; and it is unsuitable for tank cultivation, being a migratory river fish of a pronounced type.

It thus appears that there is a distinct scope in Ceylon for the cultivation of a non-predatory food-fish, such as the gourami, which would fill a gap in the fauna without displacing any native species. The recognition of a natural deficiency in the fauna of the inland waters of Ceylon is one of the chief practical results of this investigation, and indicates clearly that the already attempted introduction of the gourami should be persevered with. Whenever the fishes arrive in Ceylon from abroad they should be carefully acclimatized in a Government stock pond, and by no manner of means turned loose indiscriminately. When in due course the time comes for them to be distributed amongst selected public waters, it would be useful to mark them by affixing to the base of the dorsal fin with silver wire a small silver or aluminium label with a current number impressed upon it, the fishes so marked to be returned to the water if by chance they are captured; and every time they are taken to be noted by some arrangement with local headmen. Whatever method of marking and recording be adopted, the principle remains the same, namely, to effect the introduction systematically and at considerable pains.

EXPLANATION OF THE PLATE.

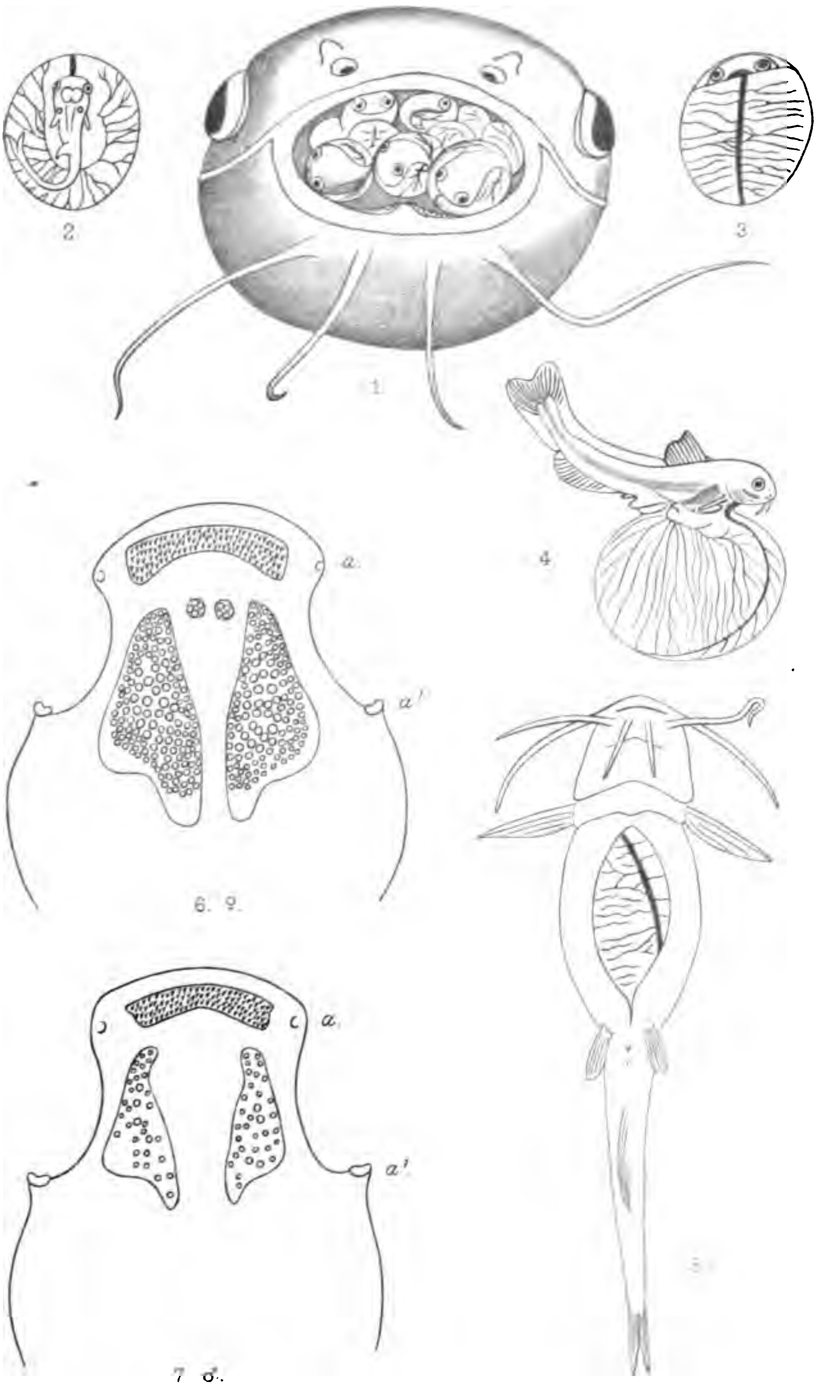
Arius falcarius from Angulu Eliya, August, 1909.

Fig. 1.—Frontal view of ovigerous male, with mouth agape, exposing the eggs with their contained embryos in the buccal cavity. Note the convexity of the gular region.

Fig. 2.—Embryo lying upon the yellow yolk inside the egg membrane, showing the paired efferent vessels of the yolk sac. The distal end of the efferent vessel is seen in front of the head, below which it enters the heart. Very slightly enlarged.

Fig. 3.—Lower view of preceding, to show the unpaired efferent vessel of the yolk sac.

Fig. 4.—Embryo (same stage as fig. 2) released from the tough elastic egg membrane by puncturing the latter with a needle. Total length of embryo about 21 mm.



A. W. del ad nat.

West, Newman lith.

ARIUS FALCARIUS.

Fig. 5.—Ventral view of advanced mouth fry to show partial enclosure of yolk sac by the larval parietes. Total length 50 mm.; tail-fin deeply forked, lobes rounded. When alive there is a prominent white brow-spot on the level of the hinder quarter of the eyes in dorsal view.

Fig. 6.—View of palate of adult female 14½ inches long. The palatine tract on each side measures 25 × 12 mm., and the teeth are present in full strength; between their anterior ends there is an exceptional pair of round vomerine groups. *a*, angle of gape; *a′*, angle of jaw, acetabulum formed by the quadrate; the lower jaw has been removed.

Fig. 7.—View of palate of adult male 11 inches long; size of palatine tract 17 × 8 mm.; no vomerine teeth; palatine teeth weak and sparse.

NOTES.

5. *Rambling Notes:—*

Life of the Leaf Insect.—The development of the common "Leaf Insect" (*Pulchriphyllium crurifolium*) is very slow. When kept in captivity eggs are constantly hatching out, and it is difficult to keep count of the separate broods. By isolating an insect, immediately after its emergence from the egg, I have ascertained that it takes about eight months to complete its development. This particular insect was isolated on November 25, 1909, and appeared in its mature form on July 26 of the present year. The actual time occupied in its development has been 243 days. In its adult stage the insect may live for a month or more. These figures are for the female insect. The development and subsequent life of the male will be much shorter.

A Cannibal Bat.—(*August 7.*)—I found the remains of a small bat in my verandah this morning, together with the wings and feathers of a "sun-bird" (*Cinnyris zeylonicus*), under circumstances plainly indicating that it had fallen a victim to a carnivorous bat, probably a species of *Megaderma*, of which we have two species (*lyra* and *spasma*) in Ceylon. Of *Megaderma lyra* (the Indian Vampire Bat), Blandford writes: "During the day this bat hides in caves, old buildings, roofs of houses, &c. The food may consist partly of insects, but it is certain that *Megaderma lyra* feeds on smaller bats, for one was detected and observed in the act by Blyth, and it probably lives chiefly on small vertebrata."

A large Green Viper.—(*September 15.*)—An unusually large specimen of the "Green Viper" (*Trimeresurus trigonocephalus*) was brought to me to-day. It had been suspended by the neck, and was almost dead. However, it appeared to recover when the ligature was removed.

September 16.—The recovery of the viper was only temporary. It died this afternoon, after bringing up a half-digested rat. It is quite the largest specimen that I have seen. Boulenger quotes 31 inches as the limit of size. This specimen has a total length of 40 inches, of which the tail occupied only 6¾. Its girth across the middle of the body is 3½ inches. The head, which is very evil-looking, has a breadth of 1¾ inches. It is of a beautiful grass green colour, with irregular elongate black dorsal patches, from which branches are given off enclosing large rounded areas on each side; these enclosed areas are disposed asymmetrically.

This viper, in spite of its villainous physiognomy, is reputed to be the least dangerous of any of our venomous snakes, with the possible exception of the tiny *Callophis*, about the venom of which little or nothing is known. There are no recorded cases of death or of serious illness from the bite of the Green Viper. It is possible, however, that the amount of venom that could be injected by such a large specimen as that here described might result in more serious consequences.

A Passenger-carrying Beetle.—The "Dung Beetles" (*Coprini*) are very generally infested by large numbers of parasitic mites, which can scarcely be classed as passengers. But a specimen of *Scarabœus gangeticus* recently flew into my room and—when captured—was found to be carrying a number of small winged flies These flies appeared to be in no way inconvenienced by the somewhat complicated process of unfolding and furling of the wings of the beetle. Nor did they willingly leave the insect when handled, but accompanied it into the poison bottle. It is probable that the flies (which have been determined as a species of *Borborus*) breed in the store of dung laid up by the beetle for its own family, and find this method of transport an easy way of obtaining access to a store of suitable food.

Palm Squirrel and Butterfly.—I do not think that the common little striped squirrel (*Sciurus palmarum*) has ever been considered in the light of a possible enemy to butterflies; but the following occurrence apparently shows that this animal may occasionally indulge in an insect diet. I have some large open-air breeding cages in front of my laboratory. A pair of *Papilio polytes* (the female of the *hector* form) occupied one of these cages. Looking across at the cage one morning I noticed the female butterfly fluttering about in a rather excited manner, and a squirrel following every movement—from the outside of the cage. It continued its fruitless chase for at least a quarter of an hour. When the butterfly flew off to the opposite side of the cage, the squirrel raced round to meet it, making repeated pounces at the insect as it fluttered against the wire gauze. This particular butterfly, by the way, is supposed to mimic *Papilio hector*—a species that exhibits warning colours, and is credited with distasteful properties. It is doubtful if a squirrel would have much chance of capturing an uninjured butterfly in the open.

Crows and their Ways.—In the last number of *Spolia* I described the chase of a full-grown hare by a crow. I have since rescued a young leveret from the unwelcome attentions of a pair of these omnivorous birds. When I came upon the scene the baby hare had its back against a high bank and was pluckily fighting the two crows, making feints at them with its front feet whenever they tried to approach too close. The crows appeared to be distinctly afraid of a front attack. They sidled about, just out of striking distance, but showed their impatience by picking up bits of sticks and biting them viciously. I am afraid that the defenceless little animal would have had small chance of eventual escape if I had not interfered. I drove the birds away and placed the hare in a cage, liberating it the next day when the crows had found other occupation.

Our local crow is the larger and more formidable hill species, *Corone macrorhyncha*. They are most pertinaceous marauders of the fowl yard. Newly-hatched chickens have to be confined within coops where these birds abound. They are systematic robbers of birds' nests, and frequently kill other birds. I saw a pair of crows single out a parrot from a small flock, drive it away from its companions, and knock it to the ground. There the parrot showed fight, and kept the crows at bay until I came to the rescue. I picked up the parrot (getting severely bitten for my kind intentions), drove off the crows, and liberated the victim, which appeared to be uninjured. In a moment the crows reappeared and took up the chase. The parrot was brought to earth again, and was rescued a second time. On this occasion I thought it best to keep it in confinement until the crows had lost sight of their anticipated prey.

The amusing manner in which a crow will bamboozle a dog out of a bone has been described more than once, but may be repeated again from personal experience, as I have seen the game played with my own dog on my own lawn. The manœuvre is always worked by a pair of the birds. The dog is happily engaged with a bone on the grass. One of the conspirators quietly takes up his position behind, while the other approaches the dog from in front. The dog growls, but the crow gradually sidles nearer. Finally the dog leaves his bone and drives off the intruder. Having easily effected this, he returns expecting to enjoy his meal in peace. But, in the meantime, the second crow has seized his opportunity and has removed the bone of contention to the branch of a neighbouring tree, where he is joined by his comrade. I have seen the same tactics employed against a domestic fowl that had secured a savoury morsel.

E. ERNEST GREEN.

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6. *The Ceylon Giant Tortoise.*—The following letter was written by me to the "Indian Field" in answer to a correspondent who had confused the famous Colombo tortoise, which died in 1894, with one which is supposed to be still living at Matara:—"I have had my attention drawn to an article in the 'Indian Field,' which speaks of a giant tortoise at Matara. There is no doubt that if such a tortoise exist at Matara, it is not the one which was found in Colombo at the time of the British occupation in 1796. This famous tortoise lived for many years in the grounds of a villa called 'Uplands,'

in Mutwal, near Colombo. When 'Uplands' was sold to the Government in 1894, for the purpose of building a graving dock, the animal was removed to Victoria Park, Colombo, where it survived only a week. It must have been considerably over a hundred years old at the time of its death. For nearly twenty years before its death the tortoise was totally blind, but this infirmity did not prevent it from roaming over the 'Uplands' grounds. It is stated that when the bell was rung for meals, the tortoise would make its way to the bungalow to be fed. The shell and stuffed skin of this famous old tortoise are now in the Colombo Museum, so that I am able to supply the measurements of the animal. Total length from snout to tip of tail, 5 feet; highest point of carapace above the ground, 2 feet; length of shell, 3 feet 4 inches; width of shell, 2 feet; circumference of shell, 10 feet. This 'Uplands' tortoise was a specimen of *Testudo elephantina*, a species which is still to be found in Aldabra, an island to the north of Madagascar, where it is preserved by the British Government. There appears to be no record of the circumstances in which this interesting specimen was brought to Ceylon."

Since the above was written, the Librarian of the Museum has directed my attention to an article by M. Sauzier on "La tortue terrestre gigantesque de Colombo" in "La Petite Revue." The writer throws doubt on the suggestion made by the "Ceylon Observer" (April 25, 1870) that the tortoise was sent from Java as a present to one of the Dutch Governors of Ceylon, since Java does not possess any indigenous giant tortoise. He is disposed to believe that the Colombo tortoise came from Mauritius, which was occupied by the Dutch up to 1710. He agrees with the "Observer" that the tortoise was over two hundred years old at the time of its death. There appears to be no reliable information on this point.

Lydekker in his book "Mostly Mammals" has erroneously stated that the Colombo tortoise died in 1897, and was a specimen of *Testudo sumeirei*, and Gadow in his volume of "Amphibia and Reptiles" in the Cambridge Natural History has repeated these errors. The Colombo tortoise differs from *T. sumeirei* in having a small nuchal plate at the anterior end of the carapace.

There are four closely allied species of Testudo found in Aldabra, and these are now grouped together as one species. These are *gigantea*, *elephantina*, *hololissa*, and *ponderosa*, and as the name *gigantea* is the oldest, it claims priority. So that the Colombo tortoise now bears the name *Testudo gigantea*.

Since writing this note I have been informed by Mr. P. E. Pieris, C.C.S., that there is a giant tortoise living at present near Galle. This is probably the "Matara tortoise" referred to by the correspondent of the "Indian Field." Mr. Pieris has promised to get further information on this point.

JOSEPH PEARSON.

7. *An interesting Frog.*—Mr. E. E. Green has handed over to me a curious frog from Maha Illuppallama, which has been identified as *Cacopus globulosus*, described by Günther in "The Reptiles of British India." Its chief interest lies in the fact that it is distended in an extraordinary manner so as to look like a ball, from which the head and limbs project. Günther states that this distension is caused by a fluid contained in the abdominal cavity. A brief examination shows that this is not the case, and that the fluid-containing cavity is none other than the subcutaneous lymph sinuses which are greatly enlarged in this form. The dorsal sinus is especially spacious, and has a height of 15 mm. from floor to roof. (The length of the frog from mouth to vent is 75 mm.) In Günther's account he speaks of the distension of a female specimen being due to the growth of the ovaries, and his description suggests that the ovaries grow into the large cavity on the back. This is not possible, as the subcutaneous lymph sinuses are separate from the cœlom. There is only one other species in this genus, namely, *Cacopus systoma*, which differs but slightly from *C. globulosus*, and which resembles it in the robust appearance due to the enlargement of the subcutaneous lymph sinuses. This interesting character is not given in the diagnosis of the genus either by Günther or Boulenger.

JOSEPH PEARSON.

8. *The African Land Snail in Ceylon.*—A very large specimen of *Achatina fulica* was sent to me in September by the Hon. Mr. C. T. D. Vigors, Government Agent, Western Province, from a garden at Moragalla, in Beruwalbadda of the Kalutara Totamune. The total weight of the animal and shell was 13 ounces, and the length of the shell from the apex to the base was 6½ inches. This appears to be the largest specimen of this species recorded from Ceylon.

JOSEPH PEARSON.

9. *Symphyla of Ceylon.*—When turning over stones and logs of wood, both in the neighbourhood of Kandy (1,500–2,500 ft.) and at Pattipola (6,000 ft.), a minute white centipede is frequently found. The group—Symphyla—to which it belongs is one of exceptional interest anatomically, as it helps us to bridge over the wide gap between insects and the centipede-like ancestor, from which they are commonly supposed to have been derived. In spite of the interest of the group, however, hardly anything is known of its embryology and little of its habits.

The common species in Ceylon is identical with one found abundantly during the rains, and more rarely in dry weather in the compound of the Indian Museum, Calcutta. I have already described it (1910) under the name *Scutigerella unguiculata*, Hansen, sub sp. *indica*, and recorded its known distribution.

On going through my Ceylon material prior to incorporating it in the general collection of the Indian Museum, two specimens of another species of Symphyla—*Scutigerella orientalis*, Hansen—were discovered. Hansen records the species from Java, Sumatra, Koh Chang Island (Gulf of Siam), and Bankok; but I know of no previous record from Ceylon. These two specimens were found at Pattipola on July 2 or 3 of this year (1910), but I have no recollection of the circumstances under which they were found. It is, however, almost certain that they came from the jungle, as almost the whole of my collecting was done there. *S. orientalis* is both longer and stouter than *S. unguiculata* (*indica*), this difference being very evident even to the naked eye. The latter attains a length of little (if at all) over 4 mm.; but my specimens of the former are both about 6 mm. long.

The Symphyla are always minute, but when examined under a strong hand lens they can at once be distinguished from the young of other centipedes by the presence of a pair of (stout and unjointed) cerci, which project backwards from the last segment of the body. Hansen (1904) gives tables, descriptions, and figures, from which it is easy to identify any of the species known to him. Since he wrote, Imms (1908) has described one additional Oriental species, *Scutigerella subunguiculata*, found by himself in the Himalayas; and I have described (1910) the common Ceylon and Calcutta form—*S. unguiculata* (*indica*).

List of Works referred to.

1904. Hansen, H. J. .. "The Genera and Species of Symphyla," Q. J. M. S. (N. S.), XLVII., 1904, pp. 1-101, Pl. I.-VII.

1908. Imms, A. D. .. "On a New Species of Symphyla from the Himalayas," Journ. Linn. Soc., Zool., XXX., 1909, pp. 252-255, Pl. XXXI.

1910. Gravely, F. H. .. "On a Subspecies of *Scutigerella unguiculata*, Hansen, found in Calcutta," Rec. Ind. Mus., V., 1910, pp. 157-159, text fig.

F. H. GRAVELY.

NOTES ON A NEW LAND PLANARIAN FROM CEYLON.

BY DR. IWAJI IKEDA.

(With Plate IV. and one Text Figure.)

IN March last Professor R. C. Punnett kindly handed me an interesting animal which was caught at Namunukula, Ceylon, by Dr. Willey, then the Director of the Museum at Colombo. At first I took the animal to be a land nemertean, but it soon became clear that I was dealing with a land planarian. Further examination has revealed the fact that the animal is not only an undescribed form of the Rhynchodemidæ, but it also possesses several remarkable characters, some of which are quite new to the family. Moreover, some of these peculiarities are similar to certain typical characteristics of the family Cotyloplanidæ. The following is a brief description of this curious land planarian, representing a new genus and a new species. I wish to record my thanks to Professor Punnett, who kindly gave me the valuable specimen in connection with my studies.

Pseudartiocotylus ceylonicus, n. gen. et n. sp.

The single specimen (Plate IV., fig. 1) was preserved in formaline and was in a fairly good condition, except that it was torn near the posterior end. The body, which is nearly round in section, is about 28 mm. long and 2 mm. thick at its broadest part. The anterior end is much broader than the posterior, which is pointed. Anteriorly the body is conspicuously compressed dorso-ventrally so as to form a distinct head-flap, which is turned upwards. On the ventral side of the head-flap there is a small depression, which is shallow but well defined, lying just in front of the anterior termination of the sole. Anteriorly and laterally the depression is bordered by a prominent ridge of a horseshoe shape, while posteriorly it becomes shallower, and gradually merges into the general ventral surface. By means of sections it has been ascertained that this ridge represents anterior portions of the so-called glandular margins ("Drüsen-Kante"), which are developed slightly below the lateral margins of the body, and extend backwards to about 3·5 mm. from the head-apex. Fuller description of this structure will be given later. At the very tip of the head there is present a small colourless spot (see Plate IV., figs. 1 and 3) measuring about 0·6 mm. in diameter, which is, as I shall try to prove later, a sensory organ not hitherto described in land planarians. Two small deeply-pigmented eye-spots (see Plate IV., figs. 1 and 3) are situated slightly behind the above organ.

On the dorsal side the colour of the animal is dark brown mixed with a light violet tint, both ends, especially the anterior, being much more lightly coloured. There are three black dorsal stripes, the medium one being narrower than the two others. On account of the deep ground colour on the greater part of the body the stripes are more clearly defined at the two extremities, particularly at the anterior end, where the ground colour is much lighter. The colour of the ventral surface of the body is grayish, excepting a median colourless band represents the sole, which is slightly elevated.

The sole extends almost the whole length of the body, but ends abruptly behind the ventral depression of the head-flap. Near its anterior end the sole is a little broader, so as to show a special area (see Plate IV., fig. 4) about 0·4 mm. long. Close to both lateral edges of this swollen area are two fine parallel ridges (see Plate IV., fig. 4). On examining the sections it is seen that these two ridges are ciliated, as also is the shallow groove between them. The mouth is a small elliptical slit near the middle of the sole. The genital opening is about 5 mm. behind the mouth.

All three kinds of the "Stäbchen" (von Graff) are met with in the epidermal layer. Rhammites and chondrocysts generally occur together, and are very widely distributed almost over the entire body-surface, excepting the sole and that part of the head-surface which lies above the brain and is dorsal to the horseshoe-shaped glandular ridge. The chondrocyst (see Plate IV., fig. 5, *ch*) is a relatively large and oblong body, nearly homogeneous in structure, which is lightly stained with hæmatoxylin. It is found almost always surrounded by a number of long and slender rhammites (*rm*). The latter are easily distinguished from other "Stäbchen" by their thread-like shape and curled, pointed endings. In those narrow regions which are hemmed in between the sole and the glandular margins (inclusive of the ridge), the two "Stäbchen" are sparsely scattered, and the chondrocysts are rather indistinctly outlined (see Plate IV., fig. 8). The rhabdites are straight thick bodies pointed at both ends (see Plate IV., fig. 8, *rd*), and are moderately stained by hæmatoxylin, more lightly than the rhammites, but more deeply than the chondrocysts, so that they are readily distinguished. The rhabdites are remarkably scarce. They are only found in those regions which lie between the sole and the glandular margins, and extend posteriorly only as far as the ventral ciliated organs. They are never found in company with chondrocysts or rhammites. The presence of the three sorts of "Stäbchen" and the peculiar distribution of the rhabdites mark definite, though not very important, points of distinction between the present species and other members of the Rhynchodemidæ, since the latter, according to von Graff,* form a group in which the three "Stäbchen" rarely occur together, and the rhabdites, if present, are usually scattered over the whole body-surface (as in *Dolichoplana*), or over both the dorsal and ventral

* Von Graff, Ludwig: Monographien der Turbellarien, II. Triclada Terricola (Land Planarien). Liepzig, 1899.

surface of the head. Further description of the distribution of the rhabdites in the horseshoe-shaped depression of the head will be given later in connection with the sensory and the glandular margins.

Among the various epidermal glands, the erythrophile and the marginal glands need only be referred to here, as the others have less direct relation to the classification. The erythrophile glands (Plate IV., fig. 5, *ep*) are in this species uniformly distributed over the entire surface, though they are a little more densely aggregated in the sole-epithelium. They are readily recognized by their coarse granular contents, which have a strong affinity for eosin stains. The presence of the erythrophile glands and the chondrocysts in the epidermis seems to preclude any direct generic relationship of the present form to *Platydemus*, in which the two structures are completely absent.

The marginal glands in this species are well developed, and have their openings on the glandular ridges and on the glandular margins. Their posterior limit is about on the same level as that of the ovaries, being about 3·5 mm. from the head-tip. The glands are very large and long, reaching nearly to the brain or the lateral nerve cords and the gut (Plate IV., figs. 6 and 8, *mg*). They have an extremely oblique course from behind forwards, except at the head-apex, where they run directly downwards to open on the prominent ridge of this region (see Plate IV., fig. 6). The present species is peculiar in having both the erythrophile and the marginal glands, since, according to von Graff, these two glands rarely occur together in the land planarians. Hence he states that "im Allgemeine en erythrophile Körnerdrüsen der Haut und Kantendrüsen einander ausschliessen scheinen, da es nur zwei Formen giebt, bei welchen beide zusammengefunden werden. Es sind dies *Dolichoplana feildeni* und *Polycladus gayi*, doch kann ich wenigstens von letzter Species bestimmt angesehen, dass die Kantendrüsen derselben gar nicht den Charakter der Kantendrüsen der übrigen Landplanarien an sich tragen, sondern sich mehr als eine lokale Anhäufung von birnförmigen erythrophile Drüsen darstellen. Es liegt dem nach hier derselbe Fall vor wie bei *Rhynchodemus terrestris*, wo in der Umgebung der Sinneskante—also an der Stelle pflegen—eine dichtere Anhäufung erythrophile Körnerdrüsen zu beobachten ist."* It may be mentioned here that the present species is only remotely related to the genus *Dolichoplana*, since it lacks the important generic character of having the longitudinal parenchyme muscles developed only on the ventral side of the body. Von Graff's view of the relation between the erythrophile and the marginal glands may explain the nature of another kind of marginal glands which are found in the present species on the inner or ventral border of the glandular ridge (see Plate IV., fig. 8, *mg*). These

* Von Graff, *op. cit.*, p. 66.

secondary marginal glands, as they may be termed, appear to have several characters which are intermediate between those of the erythrophile glands and the true marginal glands; for instance, they are larger than the first, but much smaller than the second; they are stained less intensely with eosin than the first, and are also stained very lightly with hæmatoxylin. The erythrophile granules are more minute than those of the true erythrophile gland. As fig. 8 represents, these secondary marginal glands form a thin layer (two or three cells thick in section) immediately below the glandular ridge. The two zones in which both sorts of marginal glands open to the exterior are separated from each other by a narrow area of the epidermis, which is characterized by containing a few closely-set rhabdites (see Plate IV., fig. 8, *rd*). There is a similar distinct layer of rhabdites more ventral to that just mentioned (see Plate IV., fig. 8, *rd*). Between the two rhabdite layers is interposed a narrow clear space of the epidermis (see Plate IV., fig. 6 and 8, *sm*), probably corresponding to the so-called sensory margin known in many land planarians.

The structure, which may be compared with the "Sinneskante," is seen, in transverse sections through the glandular ridges, to be a narrow clear space of the epidermis (about 0·02 mm. wide) lying between the two rhabdite-layers. Its most characteristic features are the total absence of nuclei in the epidermis of this region, and also the absence (probably apparent) of the basement membrane (see Plate IV., fig. 8, *sm*). The epidermis is here represented by a group of faintly stained fine threads which frequently anastmoose. These threads are directly continuous with a small, clear, and compact mass of elongated cells, which are certainly nucleated. The cells run parallel to each other and obliquely to the epidermal surface. I have not been able to detect any distinct connection of the above cells to the nerve-fibres, which abound in the neighbouring parenchymatous tissue. Nor have I found any ciliary appendages either on the sensory margin or on the whole epidermis, excepting that of the sole.

Although there are still some points to be elucidated in the histology of the sensory tissue described above, I cannot entertain any doubt as to the homology of this structure with the "Sinneskante" observed by von Graff in many land planarians. Three chief points of homology may be noticed: (1) the absence of nuclei in the external plasmic layer; (2) the direct connection of the latter to the underlying nucleated spindle-shaped cells; and (3) the absence or imperfect formation of the basement membrane. If the above homology be accepted, the species under examination differs in a striking manner from other land planarians with regard to the relative positions of the sensory and glandular margins. In all previously known cases the former invariably lies to the latter, while in the present case the relative positions are reversed. Lastly, it must be added that that horseshoe-shaped depression which is bordered by the glandular ridge of similar shape has nothing to do with the so-called "Sinnesgrübchen," but seems rather to be an artificial effect, due to the contraction of the radial parenchyme muscles, which are specially well developed in this region, and extend from the ventral side of the brain to the dermal layers forming the roof of the depression (see Plate IV., figs. 6 and 8).

The structure of the single eye-like organ (see Plate IV., fig. 9, *ao*) at the head-tip presents some points of interest. Fig. 9 represents a median saggital section through a small portion of that region of the head which contains the organ. Here it is represented by a special clear part of the epithelium, which lies above a region of parenchyme, which is peculiar in having none of the fine pigment granules which are elsewhere present in great abundance. In this region the epidermis (*ao*) contains neither nucleated cells nor any sort of epidermal glands, but consists merely of a plasmic layer, which takes the stain faintly, and which contains minute vacuoles and irregular radial striations, as if to indicate cell boundaries. In the parenchyme underlying this part of the epidermis there are ordinary parenchyme-cells, together with a few muscle-fibres and numerous nerve-fibres (*npl*). There is also a thin cell-layer composed of slender nucleated cells, which lie vertically on the basement membrane and the dermal musculature. Owing to the inadequate fixation of the specimen, I have not been able to make out what relations exist between the outer non-nucleated plasmic layer and the inner nucleated layer. But from the close resemblance to the similar structures already described on the sensory margin, I am inclined to regard both layers as actually continuous with each other through the basement membrane.

A striking feature of the present species is the presence of paired ciliated organs on the sole. Seen in sections the groove itself (Plate IV., figs. 7 and 10, *co*) is rather shallow, and is bordered on either side by a comparatively prominent ridge. The cilia which cover the surface of the organ as well as the sole (see Plate IV., fig. 10, *s*) are longest on the ridges, shortest on the sole, and of an intermediate length in the groove. The epithelium lining the groove and ridges is formed of nucleated cells, which stain fairly, and have a coarsely reticulated plasma. The nuclei are perceptibly smaller than those of the neighbouring epithelial cells. The ciliated epithelium which lines the groove and ridges does not contain any "Stäbchen" or epidermal glands, and is sharply separated from the overlying parenchyme by the distinct basement membrane and the two dermal layers (*dm*). The parenchyme in this region is rich in fine branches of the nerve fibres (see Plate IV., fig. 10, *npl*), which are probably connected with the ciliated organ. When I detected these curious organs, I supposed they might be something similar to the suckers of the Cotyloplanidæ. But this is merely superficial, since both organs are entirely different in their histological structure.

No particular mention need be made of the epithelial layer of the sole, except to point out that the epithelium is composed of a single layer of cubical ciliated cells, which are interrupted by numerous erythrophile and cyanophile glands. The "Stäbchen" never occur in this region, though a very few rhammites are often found in that part of the epithelium which passes over from the sole to the inner ridge of the ciliated organ (Plate IV., fig. 10, *rm*). I have carefully examined the sections of the sole to ascertain if there were any sinking of the sole-epithelial cells into the parenchyme, as von Graff has observed in many species of the genus *Rhynchodemus*. But I have not recognized this phenomenon in a single case. This fact and the presence of the well-developed marginal glands must be regarded as evidence against the direct relationship of the present form to the genus *Rhynchodemus*.

The structure of two eyes is essentially the same as described and figured by von Graff* in *Platydemus grandis*, Spencer. The only point of difference is that the vitreous body filling the interior of the eye-camera is represented in the present case by a homogeneous substance perforated by many irregular clear spaces; consequently there is no indication of any trace of the prismatic structures, which are, according to von Graff, always present in the so-called "Retina-Augen." But I fear that the deviation shown in the present instance is not actual, but is probably due to the improper fixation of the eye tissues.

As mentioned above, the longitudinal parenchyme muscles (see Plate IV., fig. 7, *lpm*) are, as in all genera of the Rhynchodemidæ, except *Dolichoplana*, developed all round in the parenchyme as a thick and continuous sheet surrounding the gut and the central nerve cords.

The two ovaries are situated about 3·5 mm. from the head end. They give rise to two slender oviducts, which run straight backwards along the dorso-lateral side of the two nerve cords. The testes are numerous, roughly 50 to 60 on each side, and are arranged generally in two irregular alternate rows. Their anterior extremities are about 0·5 mm. behind the ovaries, and they extend posteriorly as far as the mouth. The two vasa deferentia run posteriorly along the inner side of the oviducts. I regret that owing to my careless manipulation while cutting the body with the scissors the connection of the common duct of the vasa deferentia with the penis was destroyed. Consequently I have not been able to determine how the common male duct enters into the penis, and how the latter opens to the male atrium. In the attached semi-diagrammatic figure representing the copulatory organs the broken parts are indicated by dotted lines. At the level of the common genital opening (*go*) the male atrium (*ma*) communicates with the underlying female atrium (*fa*).

* Von Graff, *op. cit.*, p. 144, figs. 1 and 2, in Taf. L.

which is about 0·2 mm. wide. This female atrium is connected posteriorly with a long tubular cavity (*ut*). which is about 1 mm. long and 0·1 to 0·15 mm. wide. The walls of the atrium and the tubular cavity are of the same structure, that is, the inner columnar ciliated cells, the outer thick muscular layer, and the outermost thick covering of the tubular glands. The glandular duct (*gd*), which is also invested with the tubular glands, opens into the female atrium by a small pore which lies on the left side and at the anterior end of the tubular cavity. The short proximal portion (*va*) of this duct is much narrower and less glandular than the greater distal part; the former may probably be the so-called vagina. The glandular duct gives off a slender canal, which swells abruptly into a spacious cavity (*sr*) directed posteriorly and nearly horizontally.

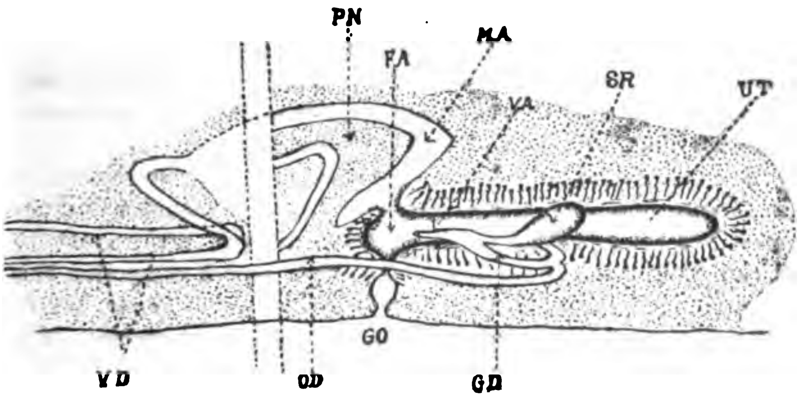

FIG. 1.

A semi-diagrammatic figure showing the copulatory organs seen from the left side: *fa*, female atrium; *gd*, female glandular duct; *go*, common genital opening; *ma*, male atrium; *od*, oviduct on the left side; *pn*, penis; *sr*, seminal receptacle; *ut*, uterus; *va*, vagina; *vd*, vas deferens.

The latter cavity communicates in a peculiar manner with the middle part of the tubular cavity (*ut*) through a broad aperture. The walls of this cavity, too, are essentially of the same structure as those of the atrium and the tubular cavity, so that we may admit that these three cavities were originally derivatives of one cavity or primary female atrium. It is, however, somewhat difficult to clearly identify these different compartments with von Graff's diagrams illustrating the types of the copulatory organs. From the point of view of some structural and topographical analogies, I will call the three cavities respectively the female atrium, the uterus (the tubular cavity), and the seminal receptacle. That the uterus and the glandular duct communicate with each other by a connecting passage is a remarkable fact, which has been known only in *Artiocotylus speciosus** (the Cotyloplanidæ). Von Graff states:

* Von Graff, *op. cit.*, pp. 201 and 209. Text figs. 58 and 59.

"Die merkwürdige Erscheinung an den weiblichen Copulationsorgan der vorliegenden Art (*A. speciosus*) ist nun aber der Umstand, dass von der Stelle, wo der unpaare Drüsengang in die Vagina einmündet, ein kurzer Verbindungsgang zum Trichter des Uterusstieles abgeht und dadurch eine Communication mit dem Uterus herstellt...."* In that species, too, the connecting passage "empfängt ebensowenig als der Uterus Schalendrüsen." Then, the two structures in question differ slightly from each other in their respective relative positions and degrees of development; that is, in *Artiocotylus speciosus* the structure is a simple canal passage, which arises from the proximal part of the uterus and ends in the vagina, while in the present species it is a spacious thick-walled cavity connecting the middle part of the uterus to the proximal end of the glandular duct. Thus, the female genital ducts are compared in this manner, and also when the probably superficial resemblance shown by the ventral ciliated organs and the suckers is borne in mind, the two otherwise remotely related forms may appear to exhibit a very close relationship. But at present I am not in a position to decide whether this interesting similarity has any phylogenetic significance.

From the description and some collations so far given with regard to the principal specific characteristics, it will be manifest that the present species belongs to the Rhynchodemidæ, and cannot be legitimately attached to any of the seven genera composing this family. In some external characters several of the seven genera bear more or less close relationships to the present species. The following table will make clear the comparison :—

X means that the animal possesses the character of the heading under which it is placed. O means that the animal does not possess the character of the heading under which it is placed.

	Sole Ridge.			Sensory Margin.		Glandular Margin.		Body Form.			Cephalic Furrow.	
	Narrow.	Wide.	Absent.	Present.	Absent.	Present.	Absent.	Roundish and Elongate.	Roundish, Long, and Slender.	Depressed and Elongate.	Present.	Absent.
Rhynchodemus ..	X	O	O	X	O	O	X	X	O	O	O	X
Microplana ..	O	O	X	O	X	?		X	O	O	O	X
Amblyplana ..	X	O	O	O	X	O	X	X	O	O	O	X
Nematodemus ..	O	O	X	?		?		X	O	O	O	X
Platydemus ..	O	X	O	X	O	X	O	O	O	X	O	X
Dolichoplana ..	X	O	O	X	O	X	O	O	X	O	O	X
Othelosoma ..	X	O	O	?		?		X	O	O	X	O
Present species ..	X	O	O	X	O	X	O	X	O	O	O	X

* Von Graff, *op. cit.*, pp. 210–211.

Thus, as regards the above-mentioned characters, *Dolichoplana* seems to most resemble the present form, next *Platydemus* and *Rhynchodemus* in order. Even *Dolichoplana* can hardly claim direct relationship to the present species, when we take into consideration those characters relating to the distribution of the longitudinal parenchyme muscles and the structure of the female copulatory organs. *Platydemus* is characterized by having a broad sole and by lacking the erythrophile glands and the chondrocysts of the integument. Besides, the unpaired sensory organ, the paired ciliated organs, and the reversed relative positions of the marginal and the sensory margins are remarkable characters, all of which indicate clear points of difference between the present species and the established genera of the Rhynchodemidæ.

For these reasons I propose to establish a new genus and species for the animal as follows :—

Pseudartiocotylus ceylonicus, n. g. et n. sp.

The genus may be diagnosed as follows : The body is elongate and rounded, and the anterior end is blunt and flattened on the ventral side. The glandular margins are well developed in the head region and lie dorsal to the sensory margins, which are poorly developed. The sole is narrow but distinct, and in its anterior part is modified into two-paired ciliated organs. Beside the two "Retina-Augen," a single unpaired sensory organ is present at the head-apex.

As already referred to, *Pseudartiocotylus ceylonicus* bears a curious resemblance to *Artiocotylus speciosus* in having similarly constructed female genital organs. Whether this implies more than a chance resemblance ought not to be hastily decided from the present observations made on the single specimen. Similar hesitation must be expressed with regard to the resemblance between the ciliated organs of the present species and the suckers of *Artiocotylus speciosus*. I hope to have in the future a further opportunity of studying these interesting points. Here is von Graff's view of the origin of the suckers of the Cotyloplanidæ : "Auch die Familie der Cotyloplanidæ ist keine natürliche Gruppe und die Gattungen *Cotyloplana* und *Artiocotylus* weisen nach dem Baue ihres Nervensystems und ihrer Musculatur—von dem aberranten Typus der Geschlechtsorgane bei *Artiocotylus* gang abgesehen—auf völlig getrennte Ursprünge hin. Der für die praktische Systematik so brauchbare Charakter der Saugnäpfe dürfte also in jeder der beiden Gruppen selbstständig erworben sein." *

* Von Graff, *op. cit.*, p. 285.

The following eight species of the Rhynchodemidæ have been described from Ceylon :—

(1) *Rhynchodemus nematoides*, Loman.
(2) *Rhynchodemus ceylonicus*, von Graff.
(3) *Amblyplana teres*, von Graff.
(4) *Amblyplana hæckeli*, von Graff.
(5) *Nematodemus lumbricoides*, von Graff.
(6) *Platydemus thwaitesi*, Moseley.
(7) *Dolichoplana feildeni*, von Graff.
(8) *Dolichoplana nietneri*, Humbert.

All the above species have been found to be distinct from the present species in their external characteristics. Some principal points of difference may be mentioned as follows :—

(1) *Rhynchodemus nematoides :* yellow ground colour; four dorsal stripes.

(2) *Rhynchodemus ceylonicus :* yellow ground colour; three dorsal stripes are distinct throughout the length of the body.

(3) *Amblyplana teres :* body is relatively short and thick; a deep reddish-brown colour; no dorsal stripes.

(4) *Amblyplana hæckeli :* yellow ground colour; four dorsal stripes.

(5) *Nematodemus lumbricoides :* grayish-brown ground colour; one dorsal stripe.

(6) *Platydemus thwaitesi :* ground colour is nearly the same as in the present species, but the three dorsal stripes are distinct from the ground colour.

(7) *Dolichoplana feildeni :* the body is very large; six dorsal stripes.

(8) *Dolichoplana nietneri :* body is very large; six dorsal stripes.

Lastly, it may be added that I have examined some references* dealing with a few species of the Rhynchodemidæ which appeared later than von Graff's Monograph, but no allied forms have been found in them.

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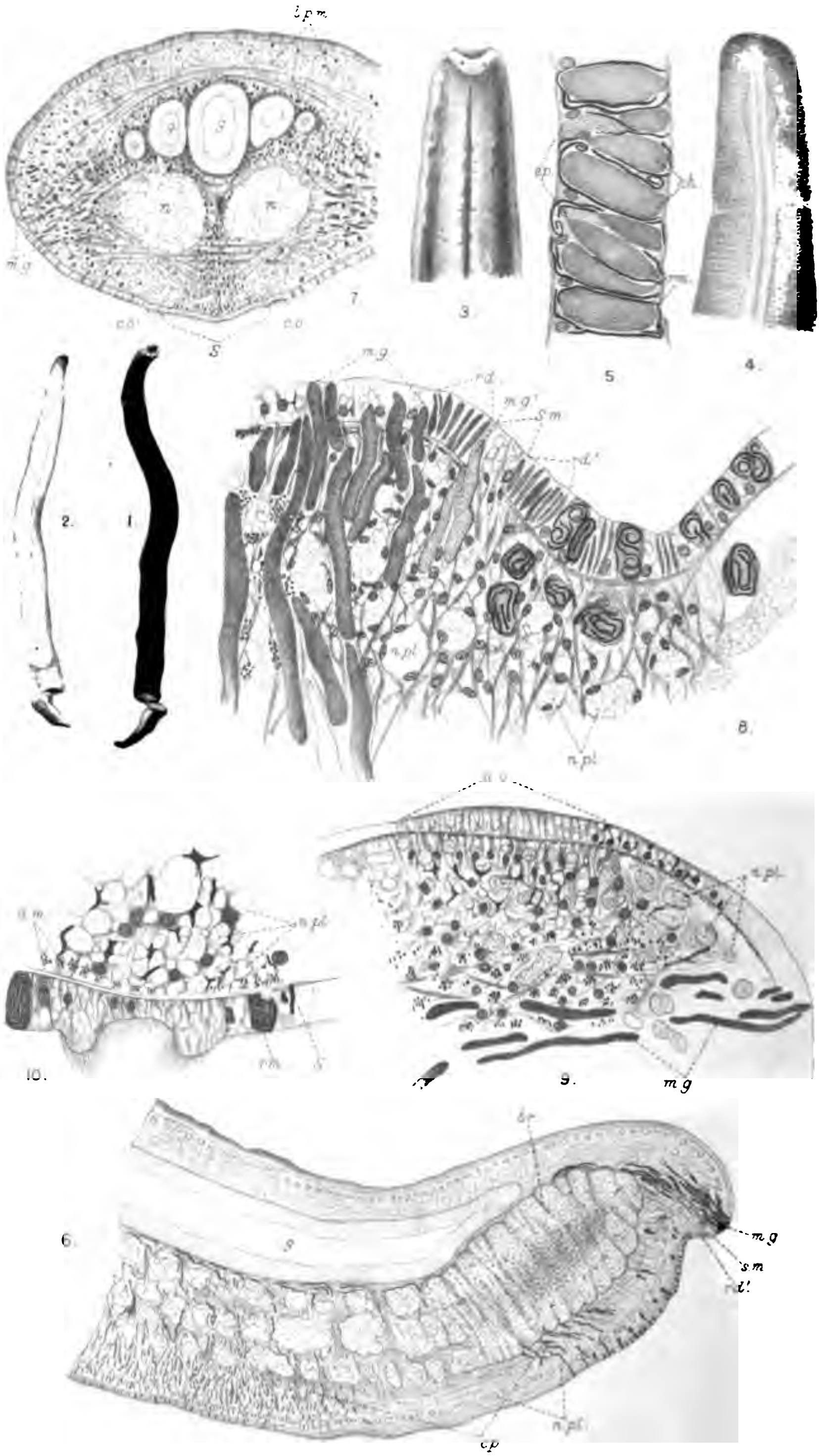
* Mell, C.—Die von Oscar Neumann in Nordost-Afrika gesammeltan Land Planarien (4 n. sp. of *Amblyplana*, 3 sp. of *Platydemus*), Zool Jahrb., Abt. Syst., Bd. 20, 1904.

Laidlaw, F. F.—On a land planarian from Herule, Male Atoll, with a note on *Leptoplana pardalis*, Laidlaw (*Rhynchodemus ceylonicus* ?), Fauna and Geogr. Maldive Laccadive Archip., vol. 2, 1903.

Scharff, R. F.—New planarian (*Rhynchodemus Howesi*), Abstr. Journ. Roy. Micro. Soc., London, 1900.



E. Wilson, Cambridge.

EXPLANATION OF THE PLATE.

Fig. 1.—Coloured sketch of the animal in the preserved state, seen from the dorsal side. × 2.

Fig. 2.—Ventral view of the animal; the mouth and the genital opening are represented at the middle and the hinder part of the sole. × 2.

Fig. 3.—Enlarged dorsal view of the head-end, to show the glandular ridge, the eyes, and the apical (sensory) organ. × 14.

Fig. 4.—Enlarged ventral view of the head-end, to show the sole and the paired ciliated organs on the sole. × 14.

Fig. 5.—Portion of the epidermal layer, taken from a lateral side of the skin. × 400. *ch* chondrocysts, *ep* erythrophile glands, *rm* rhammites.

Fig. 6.—One of the median sagittal sections of the head-end. × 40. *br* brain, *cp* cyanophile glands, *g* anterior termination of the gut, *mg* glandular margin and marginal glands, *npl* nerve-plexus of the skin, rd^1 rhabdites-layer below the sensory margin (*sm*).

Fig. 7.—Cross-section through the ciliated organs. × 40. *co* ciliated organs, *g* gut, *pm* longitudinal parenchymatous muscles, *mg* marginal glands and glandular margin, *n* nerve-cords, *s* sole in section.

Fig. 8.—Portion of the ventral side of the head, taken from a median saggittal section of the head. × 400. *mg* marginal glands and glandular margin, mg^1 secondary marginal glands, *npl* nerve-plexus, *rd* and rd^1 outer and inner rhabdites-layers, *sm* sensory margin.

Fig. 9.—Portion of the head-apex with the apical sense-organ, taken from a median saggittal section of the head-end. × 230. *ao* apical organ, *mg* marginal glands, *npl* nerve-plexus.

Fig. 10.—Ciliated organ in a cross-section. × 400. *dm* dermal longitudinal muscles, *rm* rhammite, *s* sole-epithelium.

SOME NOTES ON THE CEYLON PEARL-INDUCING WORM.*

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THE present series of barren years on the Ceylon Pearl Banks has provided opportunities for extensive scientific research, which under other conditions would have been impossible. It is, however, extremely unfortunate that during these blank years the few oysters essential for scientific work have been almost unavailable. The only bed which now exists is confined to an inshore area, and the oysters found thereon only rarely contain the pearl-inducing parasite. Consequently the investigations on this interesting worm have been severely hampered by lack of material, and the research work has had to be directed into other channels, such as the investigation of the part played by currents with relation to exotic spat, the examination of rays and sharks for Cestode parasites, &c. Whereas normal oysters often each contain from 30 to 100 pearl-inducing parasites, the scattered oysters now remaining rarely contain a single one, and 200 to 300 oysters may commonly be examined without finding a single larva. This condition is doubtless due to the inshore position of the oysters.

Most people are familiar with the old ideas as to the nature of pearls, viz., that they were the tears of Nereids, or mysteriously consolidated drops of dew, or caused by lightning flashes. These poetic beliefs were subsequently superseded by others, which attributed the origin of pearls to grains of sand, abortive eggs, calculi, and the like.

It was only in 1859 that the naturalist Kelaart, working on the spot, made the discovery that the formation of pearls was intimately connected with the occurrence in the oyster of "worms," and all subsequent work by other naturalists has only further proved and elucidated Kelaart's statements and observations. In 1894 Thurston confirmed Kelaart's results, and further identified the worm as the larva of some Platyhelminthian (flat worm). The extensive investigations made by Professor Herdman in 1902 further showed that the worm was a Cestode (Tape-worm), round the larvæ of which pearls are formed.

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* From the Ceylon Marine Biological Laboratory (Ceylon Company of Pearl Fishers, Limited).

A pearl is therefore the sarcophagus of a parasite, whose nearest relations include human and other animal tape-worms, all varieties of human hydatids (or Echinococcus), as well as those parasites which cause the "stagger disease" in sheep and goats, &c.

The normal and typical life-history of Cestodes in general is too well known to require full repetition here. The adult worms occur exclusively in vertebrates (with the exception of *Archigetes*, which may become adult in the cœlom of *Tubifex*), where they inhabit the internal organs. The larva or cysticercus may occur either in an invertebrate or in a vertebrate. The transference of the larvæ to the final host takes place quietly, during a meal. Thus, the larvæ of *Tænia solium* occur in the tissues of the pig. If present, and if the flesh of this animal is eaten by man in an improperly cooked condition, the larvæ become adult tape-worms in the human intestine. From these adults, eggs are passed out in the fœces, and the omnivorous habits of the pig lead to the re-infection of this animal, and thus the cycle goes on. Homologous stages of *Tænia serrata* occur between dogs and mice, and many other instances might be cited.

The life-history, however, is not always of this type. In *Hymenolepis murina* both stages occur in the rat without the intervention of a second host, the larvæ inhabiting the villi and the adult worm the intestinal cavity of the same animal. Such a life-history is said to occur in *Hymenolepis nana* found in man.

The larvæ of *Bothriocephalus latus* probably first enter some invertebrate host, and are then eaten by a pike or trout. If the infected fish are eaten by man, the parasites develop in the intestine into adult worms, which often attain a length of 30 feet. There are thus three hosts. With reference to this particular tape-worm, it is interesting to note that the primary larvæ are the only larvæ in the group Cestoda known to be ciliated.

Further complications in the life-history of Cestodes are also known. Thus, *Tænia solium* is found adult in man. "The danger of its presence in the body of man, or in the flesh of the pig, lies in the fact that the larva or bladder worm (known as *Cysticercus cellulosæ*) can live in the most varied organs. Thus, if by accident a mature proglottis be eaten, the embryos bore their way into the wall of the stomach, and entering the portal vein may reach in time the muscles, the brain, the eye, or even the heart itself, and attain the cystic condition. Even more disastrous may be the result should some ripe joints of a mature worm work their way from the intestine back to the stomach. Should this happen (and though it has not been directly proved, the possibility is to be reckoned with) the result would be the release of vast numbers of embryos capable of inflicting fatal injury on the host. An abnormal Cysticercus of this species is probably *Tænia* (*Cysticercus*) *acanthotrias*, Weinl.*

* Gamble: "The Cambridge Natural History." Worms, Rotifers, and Polyzoa, p. 79.

The hydatids thus produced represent culs-de-sac in the life-history of the parasite. It is to be noted that whilst the life-history of a Cestode is usually—almost always—completed in two hosts, the parasites may vary their hosts and occur adult in many genera. Instances of this kind are too numerous to mention here. The cysticercoid stages are in many instances equally adaptable with reference to their hosts, but it is to be noted that should the cysticercoid enter a primary host which is not eaten, or does not form the food of the second host, the life-history is never completed, and the larvæ eventually die.

The preceding details have been given in order to elucidate more fully the life-history of the pearl-inducing parasite, and to facilitate the understanding of what are obviously abnormal conditions and situations which occasionally befall the larvæ found in the pearl oyster.

Professor Herdman found that the globular cysts which normally occur in the tissues of the oyster were the larvæ of a Cestode, which was named *Tetrarhynchus unionifactor*, Shipley and Hornell. When the infected oysters were eaten by the ray, *Rhinoptera javanica*, the worm became adult in the latter fish. A further stage also occurred in the oyster in the form of an encysted but young Tetrarhynchid occurring on the intestinal wall, but no stage was found strictly intermediate in development between the widely different globular cyst in the oyster and the encysted but young Tetrarhynchid occurring on the wall of the oyster's gut.

Free-swimming Cestode larvæ were found in the tow-net taken on the banks, but, as Herdman says, "it is still uncertain whether the free-swimming larvæ found on the Muttuvaratu Paar really belong to the life-history."*

In addition to the two stages found in the oyster, and the adult found originally in *Rhinoptera javanica*, and later in *Tæniura melanospilos* (large rays), other megacestoid stages were found in *Balistes* (a small file-fish). Since these file-fish were known to feed on oysters, it was pointed out that, although the life-history was probably direct from oyster to Rhinoptera, it might be found that *Balistes* formed an intermediate host. "A more minute examination, however, renders the connection between the parasites of the pearl oyster and those of the file-fish a doubtful one,"† and, again, "the more advanced larvæ from the pearl oyster have arrived at a later stage in development than the larvæ found in *Balistes*." ‡

The life-history of this interesting parasite was worked out thus far as a result of Professor Herdman's investigation. Since that time the life-history has been further studied as time and material

* "Ceylon Reports," Vol. V.
† Shipley and Hornell. Vol. II., Herdman's "Ceylon Reports."
‡ *Loc. cit.*

allowed, and the following notes indicate some of the results obtained.

(1) *The Free-swimming Stage.*

Although the plankton, both superficial and deep, has been collected and examined three times daily for two seasons, no Cestode larvæ have ever been found. This negative result falls in line with results obtained elsewhere. In any case it would be obviously impossible to identify an adult specimen from a free-swimming larva, even should such larvæ exist. So far as is known, only the larvæ of *Bothriocephalus latus* are ciliated and free-swimming, although it is possible that some larvæ may be free-swimming without being ciliated.

Little indeed is known regarding the earliest stages of many genera of Cestodes.

Whilst examining the ripe proglottides from a specimen of *Tetrarhynchus rubromaculatus* (?) obtained from the spiral valve of *Trygon kuhli* (which feeds exclusively on Polychætes and small bivalves), I noted that the segmenting eggs, issuing in immense numbers from a rupture in a proglottis, were ciliated, a phenomenon I have not seen noted elsewhere.

Up to the present nothing is known as to how the larvæ of *Tetrarhynchus unionifactor* enter the oyster, and the same may be said of most marine species of Cestode larvæ. We do not know whether the larva is free-swimming, or whether it bores its way into the primary host, or whether it is ingested along with the food. In pearl fishing this question is of little importance, but the exact condition of affairs would be interesting as rounding off our knowledge of this interesting parasite.

(2) *The Globular Cyst in the Oyster.*

Figures of these cysts are given in Vols. II. and V., "Ceylon Reports," and they represent the earliest stages known of *Tetrarhynchus unionifactor*. They are considered to be post-hexacanth stages. They vary in size. Some are as large as a pin's head, whilst others are quite microscopic. There are all sizes intermediate between them, but they are all exactly similar in structure and development, and their only point of difference is purely that of size. It has been shown that these larvæ multiply endogenously, that is to say, daughter cysts may arise within the parent cyst, and become liberated by a temporary rupture of the parental wall. Although the initial infection of the oyster is but slight, it may become extensive merely by endogenous reproduction of this kind, quite apart from a further infection from outside sources. This endogenous multiplication also accounts for the very varying sizes of larvæ found in the oyster.*

* Southwell: "Ceylon Marine Biological Reports," Part IV., 1910.

These cysts are widely distributed in the tissues of the oyster, and occur particularly in the liver, in the mantle, and along the base of the gills. As many as 120 have been counted in a single oyster, although the number varies very considerably.

The globular cysts which occur in *Placuna placenta* (the window-pane oyster found in the backwaters of Trincomalee) are exactly similar to those found in the pearl oyster. In the cystic stages found in *Placuna*, Willey* also observed endogenous reproduction. In the examples quoted and figured by him the reproduction was polygenetic, as several cysts were liberated at a time from the parent cyst. In the globular cysts found in the pearl oyster the endogenous reproduction has only as yet been observed to be monogenetic (one cyst being born at a time from each parent cyst), but there can be little doubt that, when more oyster material is available, this endogenous reproduction will be found to be polygenetic, as in the larvæ inhabiting *Placuna*. A similar multiplication has also been noted in *Polycercus*—bladder stage of *Tænia nilotica* from *Cursorius europæus*.†

It is round the cystic stages which occur in the pearl oyster that the orient or cyst pearls are formed. Other pearls are also found in the oyster, but they have no organic nucleus. Such pearls are termed muscle or seed pearls. Their origin is obscure, but they are always found near the muscle insertions, and are believed to be formed round a calcospherule of excretory origin, or by the sheer of muscles moving in different planes.

The percentage of globular cysts in the oyster which ever become the nucleus of a pearl is very insignificant indeed. Occasionally several hundred oysters can be examined each containing 20 or 30 cysts, and not a single pearl is to be found. This fact lends colour and probability to the belief that only such cysts which, for some unaccountable reason, die in the tissues of the oyster become nuclei of pearls.

Figures of sections of decalcified pearls showing a nucleus exactly similar to the larva found in the tissues of the oyster are given by Herdman in Vol. V., "Ceylon Reports" (Pearl Production, Plate II.), and there can be no doubt that this larva is the prime factor in pearl production, although very rarely grains of sand have been found in the centre of pearls.

It has already been observed that no stage in the life-history of the pearl-inducing worm has as yet been obtained earlier than the globular cyst occurring in the oyster. This globular cyst is in many ways different from stages known to occur in the life-history of other Cestodes. such as *Bothriocephalus latus* or *Tænia nilotica*.

* "Report on the Window-pane Oyster of the Eastern Province," June, 1907. *Spolia Zeylanica*, Vol. V., Part XVII.

† Haswell and Hill: "On Polycercus, a proliferating Cystic Parasite of the Earthworms" (Proc. Lin. Soc. N. S. Wales (2), Vol. VIII., 1894.

This fact was emphasized by Shipley and Hornell, who remarked: "Under slight pressure, as first seen it (the pearl-inducing larva) exhibited a striking resemblance to a tiny Trematode, or it might be mistaken for a large Gregarine." * The figure nearest approaching that of the larva found in the pearl oyster is that of the onchosphere of *Tænia cucumerina* given by Gamble in Vol. II., "Cambridge Natural History" (after Grassi and Rovelli).† There can be no doubt, however, that the larva is a Cestode. The possession of calcareous corpuscles, of spines on the collar, and of the protrusible proscolex-like head are all essentially Cestode characters, and doubt only arose on account of the isolated and more or less unconnected state of development of the globular cyst.

(3) *Encysted Tetrarhynchids on the Wall of the Gut in the Pearl Oyster.*

These are by no means rare, and are in almost every case confined to a particular part of the wall of the gut, about one inch from the anus and on the terminal part of the gut. They often occur in clusters of three or four. They are small (about 1 mm.), but appear to be adult in every way, save that strobilization has not commenced. This encysted young Tetrarhynchid is quite dissimilar to the globular cysts found in the same oyster. In the latter case the larvæ are so young that the Cestodian characters are but ill-defined. In the former case a normal and full-grown Tetrarhynchid head is present. No stage or stages have been found intermediate between them, and the evidence that they are both stages in the life-history of the same parasite rests on circumstantial evidence and on evidence obtained by feeding experiments. We shall, however, refer to this matter again later.

(4) *The Adult Pearl-inducing Worm, "Tetrarhynchus unionifactor."*

The adult stage of the pearl-inducing worm was obtained by Hornell from the stomach of *Rhinoptera javanica*—a gregarious ray—and also later from the intestine of *Tæniura melanospilos*. In spite of the fact that hundreds of fish, including at least fifty large rays of various genera and species, and also a large number of Carchariidæ, have been repeatedly and carefully examined during the last five years, the adult has never since been found, except in *Ginglymostoma concolor*, during the feeding experiments of 1909 and 1910, described in Parts IV. and V., "Ceylon Marine Biological Reports." This is a most remarkable fact, especially as the research, having been repeatedly fruitless, was carried on with increasing energy.

* Shipley and Hornell. Herdman's "Ceylon Reports," Vol. II., p. 20.
† And Herdman notes the resemblance in many ways to the larva of Acrobothrium figured by Giard and to the "figures idéales" of early stages of Tetrarhynchids given by van Beneden.

Trawling has been almost continuous during every season. The fish caught have all been carefully examined, and although not less than 8,000 Cestodes, distributed over 24 genera and 77 species, have been collected, the adult *Tetrarhynchus unionifactor* has never been obtained.

It would almost appear that this fact in itself is sufficient proof that the adult of the pearl-inducing worm is not *Tetrarhynchus unionifactor*. We have noted that (1) no larvæ have been found in an earlier stage of development than the globular cysts found in the oyster, (2) that although encysted Tetrarhynchids occur in the oyster, no stage intermediate between the globular cyst and the young Tetrarhynchid has been found to *prove* that both these stages in the development belong to the same worm. Finally, we have seen that the adult has never been found in any of the Plagiostomi trawled on the banks during the last five years.

The evidence afforded by the feeding experiments, described in Part IV., "Ceylon Marine Biological Reports," is important. An area was isolated in the open sea by means of expanded metal having a 4-inch mesh. Into this area large specimens of the following fish were placed: *Trygon walga*, *Tæniura melanospilos*, *Ginglymostoma concolor*, *Rhynchobatus djeddensis*, *Serranus undulosus* (4 feet), *Tetrodon stellatus*.

These fish were first medicated with male fern extract and castor oil, and then fed exclusively on oysters for several weeks.

The results were roughly as follows :—

Tetrodon stellatus and Serranus undulosus lived in a healthy state, but no adult Cestodes were found in them.

Rhynchobatus djeddensis.—These specimens all died within three days. They are dwellers on mud, and I attribute their death to the fact that they do not feed on oysters. No Cestodes found.

Ginglymostoma concolor.—Adductor muscle of oyster found in stomach. Thirty-eight specimens of *Tetrarhynchus unionifactor* in spiral valve (other Cestodes also found), and fifty-one *Tetrarhynchus unionifactor* in another specimen.

Tæniura melanospilos.—*Tetrarhynchus herdmani* only in spiral valve.

These results are described fully elsewhere,* and the point that immediately concerns us is the fact that *Tetrarhynchus unionifactor* was obtained in numbers on two separate occasions.

Since the adult worm was never obtained by me on any other occasion, even though numbers of the same species of fish were examined, it seems almost certain that these specimens were developed from the larvæ in the oysters eaten, and there are many points which favour this view. The mere fact that the adults were obtained by feeding is in itself almost sufficient to prove that they

* "Ceylon Marine Biological Reports," Parts IV. and V.

are the adult of the pearl-inducing worm, for it is difficult to believe that their occurrence in the *Ginglymostoma* was a mere coincidence each year.

The line sketch given of this worm in Vol. V., "Ceylon Reports," gives no details of the adult structure, which is somewhat unfortunate. A figure is, however, given in Part V., "Reports from the Ceylon Marine Biological Laboratory."

The absence of the adult worm in the fish caught during the last five years is doubtless incident on the fact that oysters have practically been absent from the banks over this period.

My own observations point to the fact that the fish found on the banks have steadily decreased in number during the last few years. It seems probable that the fish have migrated to other feeding grounds, particularly those species which feed on molluscs. Whereas the molluscan fauna of the banks is usually abundant, I have not found more than six specimens during the last two years, even though diving, trawling, and dredging has been carried on almost daily. This fact serves to show that other molluscs suffer equally with the oyster, and it seems natural to explain the absence of predatory fish as due to the lack of food over the plateau.

We have seen that the adult pearl-inducing worm has up to the present been found in three species of fish, viz., *Rhinoptera javanica*, Hornell; *Tæniura melanospilos*, Hornell; and *Ginglymostoma concolor*, Southwell.

There seems to be no reason for associating the adult worm exclusively with *Rhinoptera javanica*. In fact, it is somewhat surprising to find that the adult worm has been found in this species, since the fish has only as yet been caught on the muddy basins of Dutch Bay, Portugal Bay, and near the Mannar channel. It seems likely that the adult worm occurs in all Plagiostomes which eat oysters, and I should not be surprised to find that subsequent research proved this to be the case.

It is now well known that very many species of Cestodes occurring in marine fishes in Ceylon have several hosts, and there is every reason for believing that the same is true of *Tetrarhynchus unionifactor*.

Some species of fish, such as *Rhynchobatus djeddensis*, possess tremendously powerful jaws with undulating, continuous, plate-like rows of teeth. It seems natural to suppose that fish possessing a powerful apparatus of this kind should feed on oysters and other molluscs. I have, however, had numerous proofs that they do not. Of ten specimens of *Rhynchobatus djeddensis* placed in the nursery for feeding experiments, not one survived the third day. Their normal habitat is on muddy and weedy basin in two to four fathoms, where they feed almost exclusively on crabs. They will die of starvation with oysters under their nose, and it may be taken as a general rule that fish normally living on a muddy basin of this kind do not eat oysters. Examples include *Rhynchobatus djeddensis*, *Myliobatis nieuhofii*, *Pteroplatea micrura*, *Pristis cuspidatus*, and possibly *Rhinoptera javanica*, all of which most probably have their own particular article of food.

(5) *Encysted Tetrarhynchids in Teleosts.*

There are many Teleosts which feed on oysters. Amongst them may be mentioned—

(1) All members of the genus *Tetrodon*.
(2) *Balistes mitis*, *Balistes undulatus*, and *Balistes stellatus*.
(3) *Lutjanus argentimaculatus*, and possibly other members of this genus.
(4) *Serranus undulosus*, and possibly other members of this genus.

The above list is not intended to be a complete one, but oysters have been found in the stomachs of all the species named. Tetrarhynchid cysts only are in almost every case (and particularly in *Balistes*, *Lutjanus*, and *Serranus*) found in numbers in the intestines. Cysts have not been found in any species of the genus *Tetrodon*. These combined facts led to the original idea that *Balistes* might be an intermediate host of the pearl-inducing worm, although later Shipley and Hornell pointed out the difference between the Tetrarhynchids found encysted in the oyster and those encysted in the intestines of *Balistes*. Several species of Tetrarhynchids occur encysted in the intestines of the Teleosts previously named, and they are undoubtedly derived from the cysticercoids present in the different molluscs eaten.

Encysted forms of *Tetrarhynchus unionifactor* also occur, particularly in *Balistes* and *Serranus*. Recent work has shown that the encysted form of *Tetrarhynchus unionifactor* which occurs in *Serranus* and *Balistes* is exactly similar to that encysted in the oyster. Shipley and Hornell appear to have been wrong in stating that " The more advanced larvæ from the pearl oyster have arrived at a later stage in development than the larvæ found in *Balistes*."* It is certain that my encysted *Tetrarhynchus unionifactor* from *Balistes* is not the same species as those described by these authors from *Balistes*. However, the fact remains that encysted Tetrarhynchids have been obtained from *Balistes* and *Serranus* which are exactly similar to the encysted Tetrarhynchid found in the oyster. The spines and general appearance are exactly similar, and the only difference noted was that those found encysted in Teleosts were very slightly larger than those obtained from the oyster.

* " Ceylon Reports," Vol. II., p. 78.

It is to be noted here that we have been referring above to the *encysted Tetrarhynchid*, and not to the globular cyst found in the oyster.

What is the significance of the stage of *Tetrarhynchus unionifactor* found in these Teleosts?

There can be no shadow of doubt that they are derived from the oyster. But in no case are the cysts further developed than those normally found in the oyster. These fish are not intermediate hosts, but carriers, and they illustrate the fact that the larvæ of *Tetrarhynchus unionifactor* can live in various hosts and in various organs, just as we have seen to be the case in the cysticercus of *Tænia solium* and other Cestodes. If oysters are eaten by *Balistes* (or *Serranus* and *Lutjanus*), two things happen to the cysts in the oyster:—

(i.) The encysted Tetrarhynchids in the oyster are transferred to the *Balistes*, where they encyst in the mesenteries, without developing any further.

(ii.) The globular cysts in the oyster are dissolved, and the larva is liberated; it migrates, develops into a young Tetrarhynchid—the same stage is in (i.)—and encysts on the mesenteries.

It might be argued from the preceding, that since the globular cysts develop into young Tetrarhynchids in *Balistes*, that therefore *Balistes* is a secondary host.

We would point out, however, that the globular cysts often develop into young Tetrarhynchids in the oyster itself, and further, that if oysters are eaten by certain Elasmobranch fish, both the globular cyst and the young Tetrarhynchid become adult directly in the Elasmobranch. Similarly, it is almost certain that should *Balistes* be eaten by a suitable Elasmobranch, the young Tetrarhynchid would become adult. The stages occurring in *Balistes* and in the oyster are the same. *Balistes* is not an intermediate host, but merely a carrier. In this way it may be useful in the life-history of the parasite, without being in the least necessary. If the species or specimen of *Balistes* is small, the encysted larva has a favourable chance of completing its life-cycle.

In the case of *Serranus undulosus*, which likewise contains encysted and young Tetrarhynchids of many species, and including *Tetrarhynchus unionifactor* (but more rarely than in *Balistes*), specimens often measure 4½ feet in length and 10 to 12 inches in diameter. It is difficult in these cases to postulate a Plagiostomous host large enough to eat a fish of these dimensions. In these cases we can but logically assume that the life-cycle of the various Tetrarhynchids contained in these large Teleosts are never completed. They are culs-de-sac in the life-history of the parasite, a circumstance simulating the occurrence of hydatids in man, where the larvæ giving rise to the disease have, owing to their adaptability within various hosts, lost themselves in the maze of their own liberties, and where the life-history is, of course, never completed.

It is a significant fact that in Ceylon no adult Cestodes have ever been found in any Teleosts, even though larvæ are numerously distributed within the order. This fact is most peculiar, but so far as I know it is a usual and well-known phenomenon, except amongst the family of Cestodes named Bothriocephalidæ, adult forms of which occur in the salmon and in *Gadus*.

Possibly adult forms of Cestodes may be found later in Ceylon Teleosts, but up to the present a most careful scrutiny has been fruitless.

Conclusion.—It will be obvious from the preceding that there still remains much to be done before all the stages in the life-history of the pearl-inducing worm are fully known. Work on the elucidation of this problem has been seriously hampered during the last few years by the lack of material.

There can be little doubt, I think, that the life-history of this parasite is direct from the oyster to such fish of the group Plagiastomi as feed on them, and that the stage found in various Teleosts is accidental, not necessary, and may be useful or otherwise. It would be interesting (1) to discover undoubted larvæ prior to their entering the oyster; (2) to ascertain the exact way in which they enter the oyster; (3) to ascertain why certain cysts produce pearls and the vast majority do not; (4) to find stages between the globular cyst and the young Tetrarhynchid. These details are necessary to round off our knowledge of this worm.

Although these questions remain unsolved, infection of the oyster continues, and is never found faulty, except in such reef forms as occur in very shallow water where one supposes that the necessary fish seldom approach.

THE SPECIES OF CEYLON PEDIPALPI.

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(With one Text Figure.)

IN a recent paper on the Pedipalpi of Ceylon (1910) I published some notes on the habits of these curious creatures. Since this was written I have been able to inquire into their specific characters more fully than was then possible, and have in consequence to correct my identifications of some of the Tartarides. And further specimens of the long-armed form of the small jungle species of *Phrynichus* have now been obtained, which place beyond doubt its claim to rank as at least a definite variety. The object of the present paper is to supply correct identifications of the Tartarides, referred to in my previous one, which will involve the description of two new species, and to describe more completely this long-armed variety of *Phrynichus pusillus*.

TARTARIDES.

Mr. Pocock, when writing the Arachnid volume of the "Fauna of British India and Ceylon," was able to fit all the species there referred to into two genera, *Schizomus*, Cook, and *Trithyreus*, Kraep., following the classification adopted by Kraepelin in a volume of "Das Tierreich." He distinguished the genera by the width of the division of the posterior plate of the carapace, a character which I found to be greatly affected by the method of preservation adopted.

In 1905, several years after Pocock's volume in the "Fauna" series was published, Hansen and Sörensen succeeded in getting together for study a very representative collection of Tartarides of both sexes from various localities in both hemispheres; and together they published a monograph, in which the classification and specific characters of the tribe were dealt with by Dr. Hansen in a way that had never been possible before. In this paper the number of species is extensively added to, but no additional genera are recognized. Indeed, the distinction between the old genera *Schizomus* and *Trithyreus* is regarded as of only sub-generic value. These sub-genera, moreover, are re-defined, so that the distinction between them comes to be not the actual width of the median suture of the posterior thoracic plate, but, whether (in *Schizomus*) or not (in *Trithyreus*) the reticulate markings of these plates are continued across it.

Hansen records from Ceylon only the two species of Tartarides referred to in the "Fauna" volume as having been found there: *Schizomus* (*s. str.*) *crassicaudatus*, Cambr., from Peradeniya, where they were found "under dead leaves and rubbish by M. Ferdinandus in the Royal Botanic Gardens," and *Schizomus* (*Trithyreus*) *suboculatus*, Poc., from Pundalu-oya and Maturata.* With regard to the latter species, he states that the type (and only) specimen described by Pocock was immature—when full grown it is rather

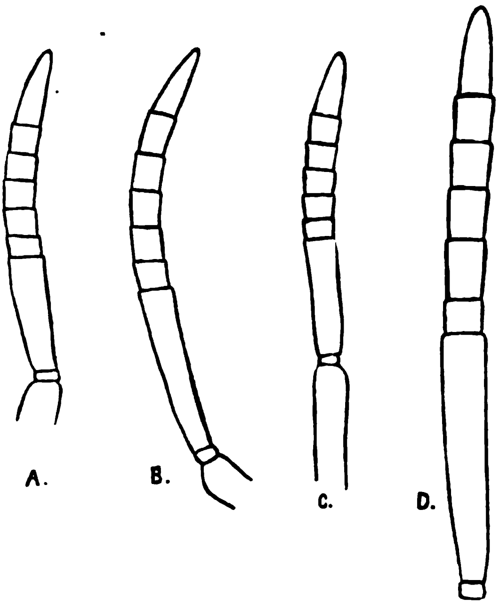

FIG. 2.

Foot of first leg of female of each species of Tartarides known from Ceylon. × 60.

A. *Schizomus* (*s. str.*) *crassicaudatus*, Cambr. (camera-lucida drawing).
B. *Schizomus* (*Trithyreus*) *peradeniyensis*, n. sp. (camera-lucida drawing).
C. *Schizomus* (*Trithyreus*) *vittatus*, n. sp. (camera-lucida drawing).
D. *Schizomus* (*Trithyreus*) *suboculatus*, Poc. (after Hansen).

a large form; and he re-describes both species very fully. A comparison of my specimens with these careful descriptions shows that only the specimens found under bricks, &c., belong to the species *Schizomus* (*s. str.*) *crassicaudatus*. This is in apparent

* The original label of the Maturata specimens bears the inscription "Maturata. Galles" according to Hansen. This, however, is unintelligible as it stands, and I am indebted to Mr. Green for a suggestion that "Galles" refers to the Sinhalese word "gala" (= a rock), and that what is probably meant is "Maturata hills."

contradiction to the type of habitat recorded for the specimens found by M. Ferdinandus, from which the species was originally described; but although the majority of my specimens were found under bricks, a few came from under stones, &c., among the sticks and dead leaves between the roots of the huge rubber trees near the Curator's office in the Gardens, and from small piles of stones mixed with rubbish, but always on or bordering upon open ground; presumably, therefore, the rubbish from which M. Ferdinandus's specimens came had accumulated in some open situation.

The similar but larger form, the female of which was found so abundantly in the shrubberies of the Gardens, and which in my previous paper was confounded with *Schizomus crassicaudatus*, proves to be distinct, and to belong to the sub-genus *Trithyreus*, as defined by Hansen; it is a new species allied to *S.* (*T.*) *suboculatus*, Poc. The small green form also belongs to this sub-genus, and is also new. It is not, however, very closely allied to *S.* (*T.*) *suboculatus*, Poc., with which I identified it before seeing Hansen's elaborate description of mature specimens. These two new species may be described as follows:—

Genus **Schizomus,** Cook (Sub-genus **Trithyreus,** Kraep.).

Schizomus (*Trithyreus*) *peradeniyensis*, n. sp.

S. crassicaudatus (part), Gravely, 1910.

♂ Unknown.

♀ Resembles the female of *S.* (*T.*) *suboculatus*, Poc., in all points described by Hansen, except the following: Eye-spots wanting.* In the first (antenniform) legs the femur is slightly longer than the tibia, and the foot is barely two-thirds as long as the tibia and about fourteen times as long as deep; the second metatarsal joint is only two-thirds as long as the tarsus, being slightly shorter than the sum of the five proximal tarsal joints; the second tarsal joint is not unusually long, being scarcely as long as the third; the terminal tarsal joint is somewhat longer than the sum of the two proximal tarsal joints, and about two-fifths as long as the metatarsus. In life the dorsal colour is greenish-gray or brownish (never dark olive-green), varying considerably in different specimens, and passing into a somewhat reddish tint at the anterior end of the carapace and towards the extremities of the legs, the whole of the chelicerae being reddish-brown; ventrally the colour is paler and more

* When specimens are seen from above, a pair of ill-defined whitish patches will almost invariably be noticed in the position occupied by eye-spots in forms which bear them; but a careful examination of well-illuminated specimens in different positions under a Zeiss binocular microscope leads me to believe that these patches are in all cases due to the reflexion of light from the polished sides of the head immediately above the bases of the chelicerae, the chelicerae being partially visible through the carapace.

distinctly reddish at the anterior end. In spirit the ground colour is brown.

Length.—Up to five and a half millimetres.

Schizomus (*Trithyreus*) *vittatus*, n. sp.

S. suboculatus, Gravely, 1910.

♂ Unknown.

♀ *Cephalothorax.*—Eye-spots present, whitish, in marked contrast to the surrounding green colour. Cephalic sternum longer than broad.

Arms.—Moderately slender, slightly less than half as long as the body. Trochanter with its lower front angle (about 90°) inconspicuous and much rounded, anterior margin convex. Lower angle of femur not very sharp, very slightly further from the basal than from the distal end of the upper margin of the joint. Patella almost three times as long as deep. Claw a little less than half as long as the upper margin of the tarsus.

First legs.—Rather slender, about equal to the body in length. Coxa terminating a little behind the anterior border of the gnathobase of the chelicera. Femur a little longer than tibia. Foot not quite as long as tibia (about seven-eighths of its length), scarcely nine times as long as deep, deepest at the end of the metatarsus; second metatarsus scarcely as long as the sum of the five proximal joints of the tarsus; terminal tarsal joint not quite as long as the sum of the three proximal joints, and slightly more than half the length of the whole metatarsus.

Fourth legs.—About as long as body; femur rather more than half as long as deep.

Tail.—Short and stout, scarcely four times as long as deep, somewhat swollen in the middle; three jointed, the third joint slightly longer than the sum of the other two.

Colour.—Dorsal sclerites dark olive-green, in striking contrast with the pale integuments which connect them together, and which appear on the abdomen as whitish or somewhat orange-coloured, intersegmental bands nearly one-fourth as broad as the dark green tergites, the posterior ones being somewhat narrower than the anterior. Abdomen with a large ventral dull ochraceus patch bordered with green at the sides and behind. Cephalothoracic sterna whitish; coxæ pale olive-green below, whitish above; trochanters and all connecting membranes of the appendages also whitish; the whole of the chelicerae, the terminal joint of the arms, and all four feet reddish; a crimson spot on the anterior surface of each leg on the connecting membrane between the femur and patella, these spots being most conspicuous on the last pair of legs. Eye-spots whitish, one on each side of the rostrum. Colour scarcely affected by spirit.

Length.—Up to three and a half millimetres.

This species is very closely allied to *S.* (*T.*) *modestus*, Hansen, from New Guinea and New Britain. It differs chiefly in having the anterior angle of the trochanter of the arms rounded and the anterior margin convex; in having the foot of the antenniform legs proportionally shorter and stouter; and in the greater stoutness of the tail, which is, moreover, always somewhat swollen at about the middle of its length.

The colour of *S.* (*T.*) *vittatus* is very constant even in young specimens, and quite distinct from that of *S.* (*T.*) *modestus*, resembling rather that of another allied species, *S.* (*T.*) *procerus*, Hansen, from Singapore. The sharply defined white and green segmental bands of the abdomen are always present, and are distinctly visible to the naked eye.

Sections show that the specimens here described include without doubt many mature females.

The chief interest of these two new species lies in the abundance in which they were obtained. Hansen had but a few specimens of each of the species he described, and can have had little direct evidence as to which points were likely to be constant and which were not. He found the proportions of different parts of the antenniform legs to be among the most useful characters by which to distinguish the species, especially in the female sex; and the value of this selection is confirmed by the fact that in each of the long series of *Schizomus* (*s. str.*) *crassicaudatus*, *S.* (*Trithyreus*) *peradeniyensis*, and *S.* (*T.*) *vittatus* which I have examined these characters remain perfectly constant. Only in one instance have I noticed any abnormality, and as this occurred on one side of the specimen only, and affected the *number* of joints in the foot, it was presumably a malformation caused by some accident to the appendage in question.

The form of the lower anterior portion of the trochanter of the arm is another useful character; but this is less fixed, and should not be relied upon unless a good series of specimens are available. Thus, Hansen states that in *Schizomus* (*s. str.*) *crassicaudatus* "the best distinguishing mark between this species and all other forms hitherto known is the presence of a process from the lower front angle of the trochanter of the palps"; this process, as they point out, is smaller in the female than in the male, and in the former I find it to be extremely variable in size, often minute, and sometimes entirely absent. The distinctive proportions of the parts of the foot of the antenniform legs being constant are of much greater systematic value, and it may not be out of place here to reiterate Hansen's emphatic statement that "measurement by the eye of such parts *is quite insufficient*"; the use of an eye-piece micrometer is absolutely necessary.

TARANTULIDÆ.

(= **Phrynichidæ.**)

Genus **Phrynichus,** Karsch.

P. pusillus, var. ***gracillibrachiatus***, n.

♂ Resembles *P. pusillus* (*s. str.*) in all points, except the greater length and slenderness of the arms. In full-grown specimens the femur of these appendages varies from 19·5 to 29·5 mm. in length in the variety, and from 9·0 to 13·5 in the typical form, the " mode " in both cases being intermediate between the two extreme measurements.

♀ Body distinctly larger than in the male, arms proportionately somewhat shorter and stouter. Second abdominal sternum as in *P. pusillus* (*s. str.*), *i.e.*, with the pair of semi-lunar lobes small or absent.

As intimated in my previous paper, this appears to be chiefly a low-country form, but I am very anxious to obtain if possible further information as to its distribution in the Island before committing myself to any more precise statement than this.

LIST OF PAPERS REFERRED TO.

1899. *Kraepelin, K.*, " Scorpiones und Pedipalpi " in " Das Tierreich."

1900. *Pocock, R. I.*, " Arachnida " in " The Fauna of British India, including Ceylon and Burma."

1905. *Hansen, H. J., and Sörensen, W.*, " The Tartarides, a Tribe of the Order Pedipalpi." Arkiv för Zool., vol. II., No. 8.

1910. *Gravely, F. H.*, " Pedipalpi of Ceylon." " Spolia Zeylanica," vol. VII., pp. 43–47.

NEW HYMENOPTERA FROM CEYLON.

Mutillidæ and Scoliidæ.

By ROWLAND E. TURNER, F.Z.S., F.E.S.

THE species described in this paper are mostly from the collection of Mr. O. S. Wickwar, who is generously depositing the types in the British Museum. Most of the Mutillidæ were collected by Mr. T. Bainbrigge Fletcher at Hambantota; from him the Museum has also received long series of some species. Most of the larger species are identical with those collected by Yerbury at Trincomalee and described by Cameron, but few of the smaller species are identical with those from Trincomalee. Most characteristic of the Ceylon Mutillidæ is the abundance of species in which the posterior margin of the thorax in the female is furnished with a row of rather long teeth; this group, though not confined to Ceylon, seems to be much richer in species there than elsewhere. The range of many of the species is probably extremely limited; for climatic conditions at Trincomalee and Hambantota are very similar, and the difference of the species in the two localities is not likely to be entirely due to insufficient collecting. The means of locomotion in the female are so limited that local forms are much more likely to be developed than in other families. In the genus *Tiphia* I have observed that the part most affected in local races is the median segment; and in the female Mutillidæ the shape of the thorax seems especially subject to local influence, the median segment in the female sex being combined with the thorax.

Mr. Wickwar has pointed out to me that the colour of the head and thorax, used as the main points of recognition in Bingham's Key, is not a reliable character; in this I fully agree with him and with other authorities.

Family *MUTILLIDÆ*.

Genus **Spilomutilla,** Ashm.

Spilomutilla eltola (Cam.).

Mutilla eltola, Cam. Mem. Manchester Lit. and Phil. Soc., XLII., p. 3, 1898. ♀.

Spilomutilla eltola, André. Deutsch. Ent. Zeitschr., p. 251 1907. ♂ ♀.

The male closely resembles *S. ocdipus*, Cam., but has no central spine on the posterior margin of the median segment. The ocelli are present though small, and are not absent as stated by M. André. The genus *Spilomutilla* is not rich in species, and seems to be confined to Southern Asia. While agreeing with Bingham that *M. ocdipus*, Cam., may well be regarded as the male of *M. rothneyi*, Cam., I consider that his suggestion that the wings have been accidentally lost is quite wild, as Cameron has pointed out. The name *ocdipus* has priority over *rothneyi*, and should be used for the species. *Mutilla cotesii*, Cam., which I have not seen, appears to belong to *Spilomutilla*, but there is no mention in the description of spines on the sides of the thorax. I consider that *consolidata*, Cam., is a synonym of *eltola*.

Hab.—Colombo (*Wickwar*); Hambantota (*Fletcher*).

Genus **Mutilla**, Linn.

Key to the Species of Mutilla *described here.*

I.—Posterior margin of the thorax with a row of acute spines:—

- A. Second dorsal segment with a spot of white pubescence on each side; third and fourth segments with bands of white pubescence.
  - (*a*) The bands on the third and fourth segments partly interrupted in the middle; head red .. *M. ianthis*.
  - (*b*) The bands on the third and fourth segments continuous; head usually black .. .. *M. bainbriggei*.
- B. Second dorsal segment immaculate .. *M. porcella*.

II.—Posterior margin of the thorax without spines:—

- A. Second dorsal segment of the abdomen immaculate.
  - (*a*) Second dorsal segment longitudinally rugose-striate; thorax scarcely broadened posteriorly.
    - *a*[1]. Second dorsal segment almost as broad in the middle as long .. *M. pinguicula*.
    - *b*[1]. Second dorsal segment much narrower in the middle than long .. .. *M. fumigata*.
  - (*b*) Second dorsal segment punctured; thorax much broadened posteriorly .. .. *M. thermophila*.

B. Second dorsal segment with one spot or more of pubescence.

(*a*) A spot at the base and a band of golden pubescence on the apex of the second dorsal segment.

a^1. Head and thorax red; sides of the thorax slightly concave .. *M. fletcheri*.

b^1. Head red, thorax black; sides of thorax slightly rounded .. *M. wickwari*.

(*b*) Second dorsal segment marked with spots of white pubescence.

a^1. The spots not lateral.

a^2. A spot at the base and at the apex of the second dorsal segment.

a^3. Third dorsal segment covered with white pubescence .. *M. pondicherensis*, Rad.

b^3. Third dorsal segment without white pubescence .. *M. ocellata*, Sauss.

b^2. A spot at the apex only of the second dorsal segment .. *M. desiderata*.

b^1. The spots lateral; third and fourth segments also with lateral spots.

a^2. Thorax strongly narrowed anteriorly; a spot on each side on the apex as well as on the middle of the second dorsal segment .. .. *M. melanota*.

b^2. Thorax not much narrowed anteriorly; no spots on the apex of the second dorsal segment .. .. *M. hexaops*, Sauss.

Mutilla pondicherensis, Rad. and Sich.

Mutilla pondicherensis, Rad. and Sich. Hor. Soc. Ent. Ross., p. 204, 1869. ♀.

Mutilla rufitarsis, Sm. Descr. New Spec. Hym., p. 199, 1879. ♀.

Hab.—Colombo (*Wickwar*); Hambantota (*Fletcher*).

I have not seen the type of *pondicherensis*, but *rufitarsis* agrees well with the description, and I think there can be little doubt that both names refer to one species. Many Ceylon specimens have the head red, but I cannot see that the difference is specific. *M. blanda* Sm., is very closely related.

Mutilla ianthis, sp. nov.

♀. Ferruginea, abdomine nigro, secondo segmento maculis duabus albopilosis lateralibus, segmento tertio quartoque albopilosis in medio nigro-maculatis, area pygidiali longitudinaliter striata. thorace postice pectinato.

Head and thorax strongly longitudinally rugose, pleura smooth and shining, abdomen closely and rather finely punctured, the pygidial area finely longitudinally striated. Eyes oval, situated a little nearer to the posterior margin of the head than to the base of the mandibles, the head rounded behind them, no broader than the thorax. Mandibles acute at the apex, with one very small blunt tooth on the inner margin. Scape shining and almost smooth, the second joint of the flagellum distinctly longer than the third. Thorax about one-third longer than the breadth on the posterior margin, slightly rounded anteriorly and a little broadened posteriorly, the sides crenulate and slightly concave, the posterior truncation vertical, shining, and almost smooth, the margin above the base of the truncation with ten strong teeth increasing in length towards the middle, the row of teeth continued by two or three very small ones on the sides of the truncation. No scutellar ridge. First abdominal segment much narrower than the second, which is broadest in the middle.

Ferruginous, the abdomen black; a large round spot of white pubescence on each side of the second abdominal segment before the middle, the third and fourth segments covered with white pubescence with a large black spot on the middle of each. Flagellum and the apex of the mandibles black.

Length, 7 mm.

Hab.—Hambantota, Ceylon (*Fletcher*); November.

In some specimens the pile on the abdomen is golden instead of white.

Somewhat allied to *M. pectinospinata*, Magr., but is a much smaller species. In the serration of the posterior margin of the thorax it approaches the group of *serratula*, Cam., but the markings on the abdomen are very different.

Mutilla bainbriggei, sp. nov.

♀. Nigra, thorace pedibusque ferrugineis, abdominis segmento secundo maculis duabus lateralibus albopilosis, segmentis tertio quartoque apice albopilosis, thorace postice pectinato.

Head and thorax coarsely rugose, abdomen finely punctured, pygidial area elongate ovate, very finely longitudinally striated, pleura concave, smooth. Eyes oval, situated nearer to the posterior margin of the head than to the base of the mandibles, the head rounded behind them, the scape shining and finely punctured, the second joint of the flagellum distinctly longer than the third. Thorax as wide as the head, very feebly rounded on the anterior margin, broadened posteriorly, the sides slightly concave and crenulate, about one-third longer than the breadth on the posterior margin, vertically truncate posteriorly, the surface of the truncation shining, with a few indistinct longitudinal striæ, the margin above the truncation pectinate, the four teeth near the middle long, the others scarcely developed.

Black; the thorax ferruginous; legs, scape, and base of the flagellum fusco-ferruginous; second abdominal segment with a small round spot of white pubescence near the middle on each side, third and fourth segments with a transverse band of white pubescence at the apex; pygidium dark fusco-ferruginous. Ventral segments with a sparse apical fringe of long whitish hairs.

Length, 4 to 5 mm.

Hab.—Hambantota, Ceylon (*Fletcher*); November to February.

Very similar to *recondita*, Cam., but differs in the sculpture of the pygidium and in the presence of teeth on the posterior margin of the thorax.

Mutilla porcella, sp. nov.

♀. Ferruginea, rugosa, thorace arcuato, postice truncato, sex dentato, abdomine nigro, tertio segmento albopiloso.

Head and thorax rugose, the posterior truncation of the thorax coarsely longitudinally striated, abdomen finely punctured, the second ventral segment strongly punctured, the second dorsal segment longitudinally rugose-striate. Head scarcely broader than the thorax, not rounded behind the eyes, the posterior margin straight; eyes oval, as near to the base of the mandibles as to the posterior margin of the head. Scape finely punctured, the antennæ not very stout, the second joint of the flagellum twice as long as the third, which is as broad as long. Thorax arched from the base to the apex, moderately convex, the anterior and posterior margins both very broadly rounded, more than half as long again as broad, the sides nearly parallel, slightly broadened on the median segment, the scutellar tubercle distinct but small, the posterior margin with six well-defined teeth, the two median the longest, the posterior truncation almost vertical. Pleura smooth and shining, very slightly concave. Abdomen convex, the first segment much narrower than the second, the pygidial area much longer than broad, very narrowly truncate at the apex and finely punctured. Tibiæ with three or four well-developed spines on the outer margin.

Ferruginous; the abdomen black; the third segment and the ventral segments at the apex clothed with long whitish pubescence; calcaria white; flagellum fuscous.

Length, 6 mm.

Hab.—Hambantota, Ceylon (*Fletcher*); November.

Easily distinguished from *pinguicula*, which is very similar in size, colour, and sculpture, by the teeth on the apex of the median segment.

Mutilla pinguicula, sp. nov.

♀. Ferruginea, punctata, abdomine nigro, secundo segmento longitudinaliter rugose strigato, segmentis 3to, 4to, quintoque in medio sparse cinereo-pilosis.

Head and thorax punctured-rugose, more finely and closely on the head than on the thorax, abdomen punctured, the second dorsal segment longitudinally rugose-striate, pygidial area not defined. Head rounded behind the eyes, very little broader than the thorax; the eyes broadly oval, situated a little nearer to the posterior margin of the head than to the base of the mandibles. Antennæ stout, the scape very finely punctured, the second joint of the flagellum nearly half as long again as the third. Thorax almost twice as long as broad, the anterior margin straight, the sides parallel, obliquely sloped posteriorly, the surface of the posterior slope rugose, the scutellar tubercle absent, a faint longitudinal carina on the median segment; pleura shining and almost smooth, not concave, the dorsal surface of the thorax convex. Abdomen short and broad, strongly convex, the second segment less than half as long again as the breadth at the apex. Tibiæ with only two or three very feeble spines near the apex.

Ferruginous; the abdomen black; the third, fourth, and fifth segments sparsely clothed with gray pubescence in the middle; spines of the tibiæ white.

Length, 6 mm.

Hab.—Hambantota, Ceylon (*Fletcher*); November.

Mutilla thermophila, sp. nov.

♀. Ferruginea, tennessime punctata, abdomine nigro, subsessile.

Head, thorax, and abdomen finely and closely punctured, the punctures on the second dorsal segment of the abdomen often confluent longitudinally. Head not quite as broad as the thorax, rounded behind the eyes, which are a little nearer to the posterior margin of the head than to the base of the mandibles, oval and not very prominent. Antennæ moderately stout and rather short, the second joint of the flagellum short, equal in length to the third. Thorax convex, nearly half as broad again posteriorly as anteriorly, about one-third longer than the breadth on the posterior margin, the sides not emarginate or crenulate; the anterior margin straight, very slightly prominent at the angles. Pleura finely punctured, very slightly concave, the propleura almost smooth. Abdomen subsessile, strongly convex, the first segment depressed, the second very broad, nearly as broad in the middle as long, sixth segment without a pygidial area. Second ventral segment coarsely punctured, deeply depressed transversely at the base. Tibiæ almost smooth, with only one or two very slender spines near the apex.

Ferruginous; the abdomen black; the pubescence sparse and whitish; calcaria whitish.

Length, 4 mm.

Hab.—Hambantota, Ceylon (*Fletcher*); January.

Mutilla fumigata, sp. nov.

♀. Ferruginea, abdomine nigro, segmento quinto in medio albopiloso.

Head finely punctured-rugose, a little broader than the thorax, the eyes separated from the posterior margin of the head by a distance equal to about half their breadth; antennal tubercles rather large, smooth, and shining, scape shining, finely and sparsely punctured, flagellum rather thick, the third joint as long as the second. Thorax coarsely rugose longitudinally, about twice as long as broad, the sides almost parallel, very slightly emarginate in the middle, obliquely sloped posteriorly, a low transverse carina a little before the apex. Pleura concave, shining, the metapleuræ finely punctured. Abdomen closely punctured, the second dorsal segment longitudinally rugose; pygidial area not very clearly defined, much longer than broad, shining, very finely and closely punctured. Ventral segments finely punctured, the second very coarsely and closely punctured. Ferruginous, the apical half of the flagellum more or less fuscous; the apex of the mandibles and the whole of the abdomen black; a spot of white pubescence on the fifth dorsal segment.

Length, 6 mm.

Hab.—Hambantota, Ceylon (*Fletcher*); November.

Mutilla fletcheri, sp. nov.

♀. Ferruginea, rugose punctata, abdomine nigro, segmento secundo basi macula magna aurea, apice aurea late fasciata.

Head and thorax coarsely rugose-punctate, more coarsely on the thorax than on the head, pro- and meso-pleuræ rather indistinctly, metapleuræ more distinctly punctured. Abdomen finely and closely punctured, the second dorsal segment coarsely longitudinally rugose. Pygidial area small, elongate, nearly twice as long as broad, shining, very minutely punctured at the base. Head no broader than the thorax, rounded behind the eyes, which are situated much nearer to the posterior margin of the head than to the base of the mandibles; the tubercles at the base of the antennæ rather large, scape shining, the second joint of the flagellum longer than the third. Thorax nearly twice as long as broad, slightly rounded anteriorly; the sides almost parallel, very feebly emarginate before the middle; the pleura slightly concave. The carina on the first ventral segment of the abdomen is rounded at the apex.

Ferruginous; the abdomen black; the flagellum (except the basal joint) fuscous; a large spot of golden pubescence at the base of the second dorsal abdominal segment, a broad band, broadest in the middle at the apex of the second segment, and a narrow band at the apex of the third and fifth segments.

Length, 6 mm.

Hab.—Hambantota, Ceylon (*Fletcher*); November. Three specimens.

This seems to be nearer to *M. pulla*, André, than to any other species.

Mutilla wickwari, sp. nov.

♀. Nigra, capite ferrugineo, pedibus testaceis, abdominis segmento secondo basi macula magna, apice fascia lata transversa, segmentoque tertio toto aureopilosis, area pygidiali nulla.

Head closely punctured, thorax punctured rugose, pleura shining and almost smooth, abdomen finely and closely punctured, the punctures on the second segment more or less confluent longitudinally. Head no broader than the thorax, the eyes situated rather nearer to the posterior margin of the head than to the base of the mandibles, the head rounded behind the eyes. Antennal tubercles rather small, the scape finely punctured, the second joint of the flagellum half as long again as the third; an indistinct longitudinal carina on the front. Thorax half as long again as broad, a little narrower posteriorly than anteriorly, the sides very slightly convex, the pleura not concave. The carina on the first ventral segment is rather broad, with a small tubercle at the apex. No pygidial area.

Black; head and prosternum ferruginous; legs testaceous brown; a large spot at the base of the second segment, a transverse band, broadest in the middle, on the apical margin, the whole of the third segment and the fourth less densely convered with golden pubescence. The two anal segments with long pale hairs on the sides. The ventral segments narrowly fringed with golden hairs on the apical margin. An obscure ferruginous spot on each side near the angles of the median segment.

Length, 6 mm.

Hab.—Hambantota, Ceylon (*Fletcher*); November. Two specimens.

Easily distinguished from *M. fletcheri* by the absence of the pygidial area, the finer sculpture, especially on the second dorsal segment, and the shape of the thorax, the sides of which are slightly convex instead of concave.

Mutilla desiderata, sp. nov.

♀. Ferruginea, punctata, abdomine nigro, segmento 2do, 4to. quintoque macula albopilosa apice signatis, area pygidiali longitudinaliter striata.

Head and thorax punctured-rugose, second dorsal segment longitudinally rugose, pygidial area very finely longitudinally striated, rounded at the apex. Eyes nearer to the posterior margin of the head than to the base of the mandibles. Head orbicular, no broader than the thorax, the second joint of the flagellum a little longer than the third. Thorax nearly twice as long as broad, very slightly rounded posteriorly, a little more strongly anteriorly, the sides almost parallel, very feebly emarginate, the posterior truncation almost vertical and coarsely rugose. Pleura concave, almost smooth, with a few fine and shallow punctures. Ventral abdominal segments very finely punctured, the second coarsely and closely punctured. Tibiæ with two rows of spines.

Ferruginous; antennæ fuscous towards the apex; legs rufotes taceous; abdomen black, a spot of white pubescence on the apical margin of the second, fourth, and fifth segments; calcaria whitish. Pubescence white on the sides and ventral surface, black on the dorsal surface of the abdomen, pale ferruginous on the head and thorax.

Length, 6 mm.

Hab.—Hambantota, Ceylon (*Fletcher*).

This seems to be allied to *nigrigena*, André, and *rufiventris*, Sm., neither of which are known to me except by the descriptions.

Mutilla hexaops, Sauss.

Mutilla hexaops, Sauss. Ann. Soc. Ent. Fn., p. 356, 1867. ♀.
Mutilla ceylanensis, Rad. and Sich. Hor. Soc. Ent. Ross., VI., p. 247, 1869. ♀.

I cannot see that these forms are distinct. Bingham's distinctions between the two are not accurate; Saussure distinctly says of *hexaops* "pedes ferruginei," and this corresponds with a specimen named by him in the British Museum collection, but Bingham says "legs black, antennæ ferruginous." The antennæ in hexaops are fuscous, the scape fusco-ferruginous.

♂. Niger, abdomine rufo, segmento primo, apice excepto septimoque nigris; alis flavo-hyalinis, scutello tuberculato.

Black; the pubescence gray; segments 2 to 6 of the abdomen and the apex of the first ferruginous with light ferruginous pubescence. Wings hyaline, tinged with yellow, nervures pale testaceous.

Clypeus shining in the middle and sparsely punctured, with a median carina, the sides covered with long pubescence. Antennæ stout, the second joint of the flagellum scarcely longer than the third. Head closely punctured, thorax rugosely punctured, a shining median line on the anterior half of the mesonotum, the posterior half more coarsely sculptured, with a deep longitudinal sulcus on each side. Scutellum raised in the middle into a low shining tubercle, with a deep, shining transverse depression at the base. Pleura coarsely punctured, the metapleuræ and median segment coarsely reticulate, two narrowly separated longitudinal carinæ at the base of the median segment converging towards the middle. Abdomen shining and sparsely and finely punctured, more closely at the apex of the segments than at the base, and with a fringe of pubescence near the apex of the segments. The carina on the first basal segment is very shallowly emarginate beneath. Third abscissa of the radius equal in length to the first, the second half as long again; first recurrent nervure received before two-thirds from the base of the second cubital cell, second at three-quarters from the base of the third cubital cell.

Length, 14 mm.

Hab.—Colombo, Ceylon (*Wickwar*). ♂ ♀ in copulâ.

The male is near *foreata*, Cam., but differs in the distinct, though low, tubercle on the scutellum, the shape of the carina on the first ventral segment, the clypeus, and the proportions of the cubital cells. *M. acidalia*, Cam., is doubtfully distinct. In most specimens of *hexaops* the wings are fuscous at the apex.

Mutilla melanota, sp. nov.

♀. Nigra, rugosa, abdomina delicatissime punctato, segmentis 3–4 albo bimaculatis, secundo quadrimaculato, pedibus fusco-ferrugineis.

Head and thorax coarsely rugose, the mesopleuræ smooth and concave, abdomen finely punctured, the sixth segment closely punctured, flattened, the pygidial area not defined. Eyes large, situated nearer to the posterior margin of the head than to the base of the mandibles, separated from the posterior margin of the head by a distance less than their greatest breadth. Scape shining and almost smooth, the second joint of the flagellum more than half as long again as the third. Thorax scarcely as wide as the head, broadened posteriorly, the anterior margin rounded, almost vertically truncate posteriorly, the sides slightly crenulate, emarginate before the middle, the sides of the posterior truncation with small teeth, the thorax nearly twice as long as the breadth at the base of the truncation.

Black; the apex of the scape and the legs fusco-ferruginous; the second abdominal segment with an elongate ovate spot of dull white pubescence on each side before the middle, another smaller and transverse on each side on the apical margin, the third and fourth segments with a large spot on each side, the sides of the abdomen and the apex of the ventral segments with long whitish pubescence, the apex of the second segment fusco-ferruginous.

Length, 7 mm.

Hab.—Hambantota, Ceylon (*Fletcher*); November.

Allied to *M. sexmaculata*, Swed., but the shape of the thorax is different.

Genus **Promecilla**, André.

Promecilla cyanosoma, sp. nov.

♀. Ferruginea, abdomine cyaneo, segmentis 2–5 apice macula parva albopilosa, thorace elongato, postice contracto.

Head and abdomen finely and closely punctured, thorax rather more coarsely punctured, the posterior slope reticulate, the pleuræ shining and sparsely punctured. Head scarcely broader than the thorax, narrowed behind the eyes and rounded posteriorly, the eyes nearer to the posterior margin of the head than to the base of the mandibles. Thorax more than twice as long as the head, rounded anteriorly, arched to the middle and strongly sloped posteriorly, nearly three times as long as the greatest breadth, narrowed posteriorly. Second abdominal segment long, twice as long as broad, apical segment shining, without a pygidial area.

Ferruginous, the abdomen dark shining blue. A small spot of white pubescence on the middle of the anterior margin of the thorax, and one in the middle of the apical margin of each dorsal abdominal segment from the second to the fifth inclusive; the first ventral segment ferruginous.

As in most other species of the genus the second joint of the flagellum is much longer than the third. There are only one or two spines on the posterior tibiæ near the apex.

Length, 7 mm.

Hab.—Hambantota, Ceylon (*Fletcher*); February.

This species differs from *ariel*, Cam., in the colour of the legs and antennæ and the smaller size and different distribution of the spots of white pubescence. In the latter point it also differs from *regia*, Sm., and *metallica*, Cam. *P. hesitata*, Cam., has the head much broader posteriorly, and *P. præstabilis*, André, has no spots of white pupescence on the abdomen.

Genus **Stenomutilla**, André.

Stenomutilla egregia (Sauss.).

Mutilla egregia, Sauss. Ann. Soc. Ent. France (4), VII., p. 351, 1867. ♀. (nec Klug.)

Mutilla aureorubra, Sich. and Rad. Horae. Soc. Ent. Ross., VI., p. 304, 1869. ♀.

Mutilla placida, Sm. Descr. n. spce. Hym., p. 198, 1879. ♀.

Mutilla nobilis, Sm. (Cat. Hym. B. M., III., p. 33, 1855, ♂), is almost certainly the male of this species, but it is better to keep them separate for the present. I have not seen Saussure's type, but Smith's species, the type of which is from Bombay, answers well to his description and figure.

Sub-family METHOCINÆ.

Genus **Methoca**, Latr.

Methoca bicolor, Cam.

Methoca bicolor, Cam. Mem. Manch. Lit. & Phil. Soc., XLI., p. 52, 1897. ♀.

Hambantota, Ceylon (*T. B. Fletcher*). 1 ♀.

Not previously recorded from Ceylon. The specimen differs from Cameron's description in having the head finely and sparsely punctured; the tibiæ, as well as the tarsi, are testaceous, also the mandibles and the six basal joints of the antennæ. The thorax is distinctly more slender than in Cameron's figure, especially the median segment; but this may be an error in the figure. The size as in Cameron's description is 5 mm.

This seems to be the first authentic record of *Methoca* from Ceylon, for *M. rugosa*, Cam., does not belong to the genus.

Family *SCOLIIDÆ*.

Genus **Plesia**, Jur.

Plesia petiolata (Sm.).

Myzine petiolata, Sm. Cat. Hym. B. M., III., p. 72, 1855. ♂.
Myzine ceylonica, Cam. Ann. & Mag. Nat. Hist. (7), V., p. 18, 1900. ♀.

Male specimens from Colombo taken in June are rather smaller than the type, measuring only 9 mm. in length. The female varies much both in the closeness of the puncturation and the colour of the wings, and there is also much difference in the comparative length of the abscissæ of the radius. It is quite possible that two species are represented in the series, but I can find no constant distinguishing character. Some of the specimens are almost identical with *Myzine claripennis*, Bingh. The differences do not appear to be seasonal.

Genus **Tiphia**, Fabr.

Tiphia oswini, sp. nov.

♀. Nigra, nitida, alis subhyalinis, ubique sparse punctata, segmenti mediani carina mediali subobsoleta, pro- et metapleuris tenuiter oblique striatis.

♂. Niger, nitidus, alis subhyalinis, apice leviter violaceo micantibus, clypeo apice inciso, sparse punctatus.

♀. Clypeus transverse; head shining, sparsely punctured; scape and two basal joints of the flagellum shining, finely and closely punctured, the second joint of the flagellum twice as long as the first and about equal in length to the third, the flagellum from the third joint opaque and very finely pubescent. Posterior ocelli more than twice as far from the eyes as from each other. Pronotum coarsely, but rather sparsely, punctured, the posterior margin very broadly smooth; mesonotum very sparsely punctured; scutellum sparsely punctured, very broadly rounded at the apex. Propleura and metapleura finely and closely obliquely striated, mesopleura finely and very sparsely punctured. Median segment as long as the mesonotum and scutellum combined, subopaque, very minutely punctured, the three carinæ near together, the median one almost obsolete, the two lateral ones nearly parallel, a little nearer together at the apex than at the base, the apex distinctly margined, the posterior truncation almost vertical. Abdomen shining, very sparsely punctured, most sparsely on the second segment, the first segment rounded at the base, the second segment with a transverse longitudinally striated groove at the base; the sixth segment rounded at the apex, coarsely punctured, and with long sparse pubescence at the base, smooth at the apex. Second recurrent nervure received at about two-thirds from the base of the second cubital cell.

Black, with whitish pubescence; calcaria fusco-ferruginous; wings pale fusco-hyaline, nervures fuscous.

Length, 13 mm.

♂. Differs from the female by the usual sexual characters; more closely punctured, the clypeus incised at the apex; posterior ocelli only half as far again from the eyes as from each other; the second joint of the flagellum distinctly shorter than the third, median segment in the middle shorter than the mesonotum, very feebly and broadly emarginate posteriorly, the three carinæ distinct, the two outer ones a little nearer together at the apex than at the base. Radial cell narrowly rounded at apex, extending beyond the apex of the second cubital cell; stigma rather large, nearly three times as long as broad.

Black, wings subhyaline, tinged with fuscous on the apical half and with violet reflections.

Length, 8 mm.

Hab.—Pattipola, Ceylon (*Wickwar*), 1 ♂ 1 ♀; Matale (*Braine*). 1 ♂.

This is a larger and more sparsely punctured species than *consueta*, Sm., the sculpture of the propleura is different, and the first abdominal segment is more strongly rounded at the base. The three carinæ on the median segment are all clearly defined in *consueta*, and the colour of the wings is different, though somewhat variable.

Genus **Scolia**, Fabr.

Scolia (Discolia) histrionica, Fabr.

Scolia histrionica, Fabr. Ent. Syst. suppl., 256, 1798. ♀.

Hab.—Colombo.

Scolia vivida, Sm., is almost certainly the male of this species, as suggested by Saussure.

Genus **Dielis**, Sauss. and Sich.

Dielis rubromaculata (Sm.).

Scolia rubromaculata, Sm. Cat. Hym. B. M., III., p. 99, 1855. ♀.

Elis (Dielis) rubromaculata, Sauss. Spec. Gen. Scolia, p. 196, 1864. ♀.

Ceylon specimens, as far as I know, are without red markings on the abdomen, and very closely resemble *Scolia (Discolia) indica*, Sauss. The male of *indica* is almost certainly *eliformis*, Sauss. The male of *rubromaculata* is smaller, 20 to 25 mm. in length, is closely punctured, black, the abdomen strongly glossed with blue, the three apical segments with a fringe of long fulvous hairs. The wings are fuscous, slightly glossed with purple.

Hab.—Kandy (*Turner*); Maskeliya (*de Mowbray*).

A NEW MASON WASP.

Odynerus wickwari, n. sp.

By Geoffrey Meade-Waldo, B.A.

Description of Female.

BLACK; broadly at base and narrowly along the sides of clypeus, scape of antennæ beneath, narrow line running from between base of antennæ to the most anterior of the ocelli, sinus of the eyes, the inner orbits bordered with a line which branches off towards the ocelli above, the cheeks entirely, anterior margin of pronotum broadening laterally; two spots, the upper ovate, the lower elongate ovate, on mesopleuræ, base of tegulæ, a line on anterior margin of scutellum broader laterally, a narrow line interrupted medially on the post-scutellum, two triangular marks on medium segment yellow. Abdomen, apical margin of first abdominal segment above, second abdominal segment, both dorsally and ventrally, much enlarged on ventral surface, two small spots about the middle of first abdominal segment, four spots at even distances apart placed transversely on segment 2, a series of three spots on segments 3, 4, and 5, and the apical margin on ventral surface of segments 3 and 4, yellow. Anterior and intermediate legs, except the tarsi, posterior legs, with exception of femora, yellow. Apex of mandibles, entire median segment (except where yellow), first abdominal segment at base above and wholly on ventral surface, red. Posterior femora red above, the tarsi ferruginous-red. Wings hyaline, fuscous along the costa and in radial cell. Clypeus about as broad as long, truncate, and narrowed towards apex. Pronotum broad in front, median segment slightly depressed rounded at the apex; first abdominal segment not petiolate, rather narrower than the second. Head and thorax coarsely and evenly punctured, abdomen shining impunctate, clypeus and abdomen clothed with a sparse gray pile.

Length, $7\frac{1}{2}$ mm.

Description of Male.

The male differs from female in several points in colouration. Clypeus yellow and slightly emarginate. Horseshoe mark on disc of mesonotum yellow. The following yellow markings present in female are not visible on the male, *i.e.*, the spots on the first and second abdominal segments, the lines bordering the inner orbits and branching in above the ocelli.

Length, 7½ mm.

Habitat: *Female*, Oddichudan, Ceylon, N. P., Nov., 1908 (*O. S. Wickwar*). *Male*, Anuradhapura, Ceylon, N.C. P., Nov., 1908 (*O. S. Wickwar*).

This species would come next to *O. diffinis* in Bingham's Key ("Fauna of British India, Hymenoptera," Vol. I.).

I have pleasure in naming this species after Mr. O. S. Wickwar, who has done so much to further the study of Aculeate Hymenoptera in Ceylon.

THE EGG-TOOTH IN THE CEYLON KRAIT, OR KARAWELLA (BUNGARUS CEYLONICUS).

By Major F. Wall, I.M.S., C.M.Z.S.

In this Journal* some time ago Mr. E. E. Green recorded a most interesting discovery of Kraits (*Bungarus ceylonicus*) with eggs and hatching young. In January, 1907, visiting Peradeniya, I was able to examine the hatched young and three of the eggs, and suggested to Mr. Green opening the eggs with a view to investigating the egg-tooth. Accordingly the three eggs were incised, the embryos extracted, and we searched for the egg-tooth with the aid of a microscope, but were doomed to disappointment. I am fairly certain, however, that we did not examine the jaws of the two hatched young. At that time I had never seen the egg-tooth of any snake, but since have been able to do so in several species. It occurred to me the other day to re-examine these specimens in the hope of success, now that I know what to look for, and the exact site of this structure. Mr. Green very kindly presented me with the specimens, five in all, and the eggs which we had despoiled of their contents. I have re-examined these with the aid of a microscope, with the following results. In the three young extracted by us, which are (1) ♂ measuring $5\frac{3}{8}$ inches, (2) ♂ $6\frac{7}{8}$ inches, and (3) ♀ $6\frac{5}{8}$ inches, I failed to discover any rudiment of the fœtal-tooth, but in the smaller of the two hatchlings, which measures 9 inches, I was successful. I dislodged the structure from the præmaxilla, and viewed it under the microscope, and find it is exactly like the fœtal-tooth I recently alluded to in the "Bombay Natural History Journal," which I extracted from the fœtus of a pit viper. It bears a striking resemblance in form to a duck's head, the convexity of the head filling the aperture in the front of the mouth, through which the tongue in later life is exserted while the jaws remain closed. The beak-like process projects forward slightly beyond the snout and ends in a horizontal cutting edge, with which the embryo is able to effect its freedom.

I think it worth while drawing attention to the close resemblance in shape of this egg-tooth in an oviparous colubrine snake and the corresponding structure in the young of a viviparous viper. In the one case a tough membranous investment has to be opened by the

* Part III., October, 1905.

young snake, and in the other a delicate diaphanous membrane. I am puzzled to know the facts concerning the report given to Mr. Green that the parents were in the "nest" with the eggs and hatching young. There seems to be no doubt that there were two adult snakes in attendance, but were these ♂ and ♀, *i.e.*, the parents, as supposed? It appears to me that there were undoubtedly in the "nest" two distinct broods of eggs. From one lot the young were hatching, and two of these measured 9 and $10\frac{3}{16}$ inches respectively, the other were far less advanced in incubation, the contained embryos being little more than half the length of hatchings. These measurements have been already given. Now, if we assume that the two adults were the parents as originally supposed, then the existence of two broods must point to superfœtation, a condition which I do not think has ever been established in the breeding of snakes. Unfortunately the adult snakes were never sent with the eggs, and the point cannot be cleared up, and there is no proof of superfœtation. Another solution presents itself, and that is that both the adults were females, in different stages of impregnation. This seems to me the more likely explanation of the two broods, though it appears to me remarkable that two snakes should select and retire within the same hole to deposit and incubate their eggs. I have had a considerable number of opportunities of investigating the incubation of snake's eggs in a state of nature, and only once have I known a ♂ in company with its mate after the deposition of eggs. In this case the species was Shaw's Wolfsnake (*Lycodon striatus*).

NOTES.

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10. *Correction as regards the Ceylon Species of "Phlebotomus."*—In my account of the species of *Phlebotomus* that occur in Ceylon (*Spolia Zeylanica*, Vol. VII., Pt. XXVI.) I divided these species into two groups, distinguished by the relative positions of the tip of the first and the anterior fork of the second longitudinal vein of the wing. In my key on page 59 *P. argentipes* was placed by some error in the wrong group. The key may be amended as follows :—

(1) The tip of the first longitudinal vein of the wing but little in advance of the anterior fork of the second longitudinal vein.

(*a*) Colour silvery brown ; the area of the wing paler than the anterior border ; the coxæ yellowish ; the anterior branch of the second vein about twice as long as the distance between the two forks of the vein .. .. *P. marginatus.*

(*b*) Dorsal surface of the thorax dark brown, the sides yellow. The anterior branch of the second longitudinal vein less than twice as long as the distance between the two forks .. .. *P. argentipes.*

(2) The tip of the first longitudinal vein far in advance of the anterior fork of the second.

(*a*) Thorax brown ; coxæ yellowish ; the whole of the wings paler than the abdomen. The anterior branch of the second vein about five times as long as the distance between the two forks .. *P. zeylanicus.*

(*b*) Colour uniform, dull yellowish-gray. Wings very narrow ; the anterior branch of the second vein shorter than the distance between the two forks .. *P. babu.*

N. ANNANDALE.

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11. *The Ceylon Jungle Fowl in Captivity.*—During the experiments carried on by members of the Ceylon Poultry Club with the Ceylon jungle fowl several interesting incidents occurred which are worth recording. The following notes record some of these incidents.

They occurred mainly in the experimental run put up by Mr. Clement Johnson, who was the only experimenter who succeeded in producing some thirty hybrid chicks from a mating of a jungle cock with a domestic hen.

At one time he secured two jungle hens, which he placed in a large covered-in run with a jungle cock and two domestic hens. These hens tamed down wonderfully quickly, and were great friends with the cock. After a time one jungle hen developed gapes, so it was caught and set at liberty. Writing of this hen, Mr. Johnson says: "The jungle hen that I released interests me greatly. Its one object is to get back into the pen. It walks round and round outside or perches on the top Any sudden or unusual noise alarms it, and it flies or runs into cover. On the other hand, you can approach within a few yards' length of it, when it just calmly walks out of your path like a very tame domestic fowl, no hurry or flurry about it at all. It avoids fowls that cross its path. Since its release the jungle cock inside the run calls more or less all day long, and is undoubtedly distressed at seeing this hen at liberty outside his run. He gets frantic when she makes a run and disappears from view. I will give her a week or ten days' liberty, and then drive her back into the run again."

This hen after haunting the scene of her captivity for many days disappeared one night. It is presumed that she was destroyed by one of the jungle cats that patrol the neighbourhood.

A little later the second jungle hen developed chickenpox. Fearing that infection would spread, Mr. Johnson had this hen also caught and liberated, but she likewise refused to depart from the scene of her captivity. But as her removal was deemed necessary, she was caught and taken away across a ravine and liberated in the jungle some quarter of a mile away. Next day, however, she turned up again, trying to get into the run. She was caught a second time and taken further afield and liberated. After this, as she did not return, it was thought she had gone for good. However, some days later she was back again. She was now quite cured of the chickenpox, having evidently cured herself in the jungle, either by eating some herb or by living in surroundings natural to her. After this she continued to live in the garden outside the run, and used to walk about with some of the young hybrids which Mr. Johnson had bred, roosting at nights in the branches of a tree along with the hybrids. The fact of consorting with the wild hen rendered these hybrids a little less tame than usual. This hen eventually made a nest in the garden and laid three eggs and sat on them. As she was running with immature hybrid cockerels and had always rejected their advances, these eggs were not expected to be fertile. They were, however, removed from the nest and set under a domestic hen, and, as expected. all proved infertile. There is little doubt that, if Mr. Johnson had not left for England at this period, this jungle hen would shortly have produced fertile eggs by running with the more matured hybrid cockerel in the garden, and he would have produced the unique cross of hybrid cock and jungle hen.

When her own eggs were removed from the jungle hen's nest, they were replaced by three eggs laid by the domestic hen running with the jungle cock, and these she incubated. Just at the time of hatching one egg got broken in the nest; it was an addled one. This attracted thousands of ants to the nest, which not only drove off the sitting hen, but killed and partly devoured the two chicks just hatched from the other two eggs. It would have been a strange sight to have had a jungle hen strutting about the garden with some hybrid chicks.

Jungle hens have never bred in captivity. Mr. Johnson's opinion is that this hen would never have bred with the hybrid cock or any other cock if it had been confined within wire netting walls.

On the other hand, the late Mr. Young of Udabagie had two jungle hens in captivity for considerably more than one year, and they were mating up with a domestic cock, and Mr. Young was very hopeful of producing hybrids from this mating, when his tragic death by lightning put a stop to the experiment.

It was just at this period that Mr. Johnson left Ceylon for England. Before he left this jungle hen was enticed into the run and caught, and with the jungle cock was sent to Mr. G. C. Bliss at Atagalla. The cock did not take kindly to the close confinement necessary while his big run was being put up in the new locality, and began to sicken; when turned into the big run he did not recover, so he was let out and given his liberty. At night time, however, he returned to this run (in which the jungle hen had been also placed) and was allowed to go in. Next morning he was found dead. Thus, after captivity of sixteen months, ended the life of a most interesting bird—the progenitor of all the thirty hybrids that were produced during the experiments. This jungle cock only mated with the one domestic hen, and would have nothing to do with any other hen, in fact he drove them all away. Even when his own particular hen had been removed for a month owing to illness, he still would have nothing to do with any other. After the death of this cock the jungle hen became excited and wild, so she was given her liberty, and flew away to be heard of no more. The history of this hen is surely unique. She had lived either in the experimental run or in the garden just outside it for eighteen months.

J. LLEWELLYN THOMAS.

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12. *Pelenda Nuwara.*—" A rampart of forest-clad mountains encircle the great plain, which forms the adjacent villages of Morapitiya and Pelenda ; the earthworks which guarded the entrance can still

be easily traced, while a raised *Murapola* of stone commands the mountain path which leads across the Atweltota to Kukul korale. Crowning a gentle eminence, which is surrounded by several thousands of acres of *owita* lands, and close to the limpid waters of the Pelen-ganga, are the plain squared stone columns of the palace of Vidiye Bandara ; alongside them stands the house of the Colombo Arachchige family, the descendants of some faithful follower of the Prince. The position, intersected as it is by the numerous streams which fall into the river, is one of great natural strength, while the *owita* lands are capable of supporting a large population. Close by there are two villages of Porowakarayas of the Karawe caste and two of Chaliyas, no doubt the descendants of the Prince's camp followers ; while the Moorish villagers claim a similar ancestry. A stone cannon ball was discovered by me among some of the ruins during a recent visit, and there are numerous traces of ancient iron works. The road taken by the Prince must have been the ancient path through Badureliya, Boralugoda, Hewesse, and Hinidumkanda, into the Galle korale. At the Saman Dewale at Latpandura, 2 miles from Pelenda, is still preserved a cloth which is said to have been taken from a Portuguese elephant."

The above is a footnote from page 40 of the second edition of my translation of Ribeiro's Ceilão (printed 1909). On June 4 last Mr. G. F. Plant, the Assistant Agent at Kalutara, and I commenced excavating the low mound which marked the site of the palace of the brave father of " Don João, by the Grace of God, King of Ceilão, Perea Bandar." Ten pillars of stone, some large and some small, but only one in complete preservation, marked the outlines of the original building. The upper couple of feet of the mound consisted of broken flat tiles, nearly all ornamented or grooved. Below appeared the cinders of the stout beams which had once supported the roof. And under these lay the piles of earth, the walls which had filled the spaces between the stone supports. Iron nails, varying in length from 2 to 11 inches, were found in large numbers, but the results were disappointing. The chief find was a plain box of soft copper, 1½ inches square and fitted with a tight cover. Within, this was divided into 25 compartments, the central one containing a fragment of gold. In the others were recognized a pearl, still beautifully lustrous after 350 years underground, silver, a ruby, sapphire, topaz, coral, &c. In fact, this was a miniature *Yantragala*. One other object of interest there was, the quaint tile shown in the illustration. What its purpose was it is difficult to say. The circular hole in the forehead would seem to show that it was meant to be secured by a nail to the end of a wooden beam. With tender care the tile was carried under shelter in its bed of clay, and dried by a fire of coconut branches. But the transport to Kalutara in a hired Kalutara gharry proved too much for its enfeebled powers of resistance. The fragments, carefully backed

Fig. 3.

with cement, now repose in the dignified atmosphere of the Colombo Museum. That is the last relic of the refuge of "Tuttarayakandan Taniyanwallan Ekangaviran Madiyantramantran,"* from where he fled, leaving his standard and his book of war songs, before the victorious arms of the boy of twelve, the Lion King of the future.

One word more. Sixty-two villagers assisted us in the work of excavation. No one demanded payment. Their breakfast cost us Rs. 10·69, and we were enabled to show Government a saving of Rs. 39·31 on the sum which had been allowed us. (The photograph is by Mr. A. de Abrew, Proctor, of Kalutara.)

P. E. PIERIS.

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13. *Child's Play.*—Capt. F. R. Barton thus describes a children's game in British New Guinea [*vide* Journ. R. Anthrop. Inst. (Great Britain), 1908, p. 273]. "Four girls or more sit upon the ground in a circle facing inwards. They then place their hands, each girl nipping with forefingers and thumbs the skin on the back of the hand next to her. They then move their collected hands up and down in unison to the rhythm of the following song :—

Kinimala Kinimala
Lepa lepa maloa taitu
Kepa kepa anaurio
Melaule malare palaia.

The song finished they leave go of each other's hands and drop them limply in a heap."

Sinhalese children play an identical game, and sway their flexed hands up and down to the following jingle :—

Kaputu kák kák kák
Goraka dén dén dén
Umutu váv váv váv
Dorakada gahe puvák puvák
Batapanduré bulat bulat
Kaputage katé vela madulayi
Kaputige katé ran massayi
Magata kanta bat mallayi
Vekande kande udin yan yan
Peli doren usi kaputá usi.

ARTHUR A. PERERA.

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* The honorific assumed by the Prince while at Pelenda, according to an ancient *ola* copy of the *Rájáwaliya*.

14. *A convenient method of storing Butterflies in Paper Envelopes.**—Triangular paper envelopes have been employed by travelling entomologists for the temporary storage of butterflies, for many years. But it has been usual to lay these envelopes haphazard in plain boxes, in such a manner that it is impossible to find any particular specimen without turning over the whole contents of the box.

By the use of the special boxes here described the envelopes occupy very much less space, the contents are less liable to damage, and any individual specimen can be found and removed with the greatest ease without disturbing the remainder.

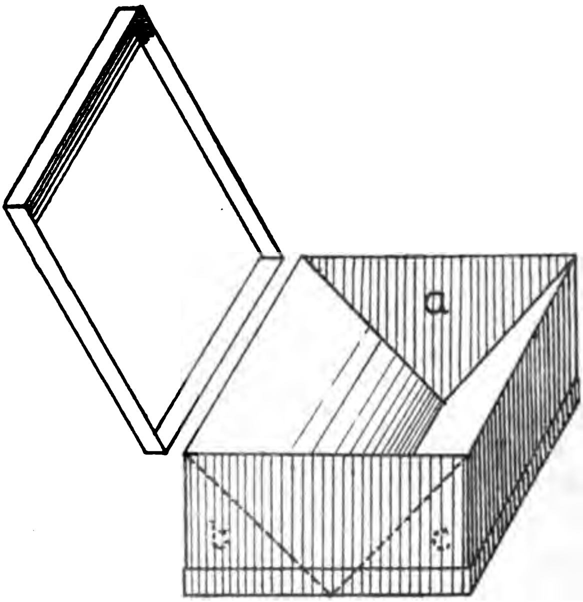

Fig. 4.

The boxes are made of tin plate, with partitions dividing them into trough-shaped spaces. The envelopes rest edgeways in the troughs. The boxes are fitted with two lids, above and below.

Fig. 4 shows a box with the upper lid removed and the lower one in place. The box measures 9 in. by 6 in. by 3 in. The upper space contains a single trough (*a*), and carries envelopes with a base of 5¾ inches.

* The above is abstracted, with some alterations, from the Proc. Ent. Soc., Feb., 1910, p. 3. The figures are reproduced through the kindness of the Entomological Society of London.—Ed.

Fig. 5 represents the reverse of the same box, with two smaller troughs (*b*, *c*) to contain envelopes of half the size.

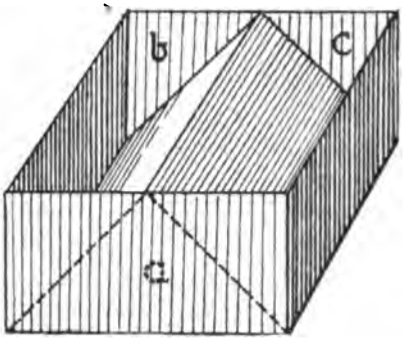

Fig. 5.

Fig. 6 shows a box of the same size, but designed for the smaller-sized envelopes alone, and containing four troughs (*d*, *e*, *f*, *g*).

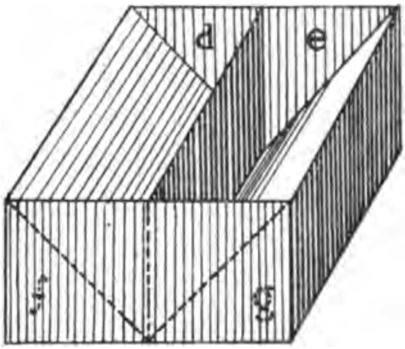

Fig. 6.

Fig. 7 is a larger box, of just double the depth of the others, measuring 9 in. by 6 in. by 6 in., with a diagonal partition forming

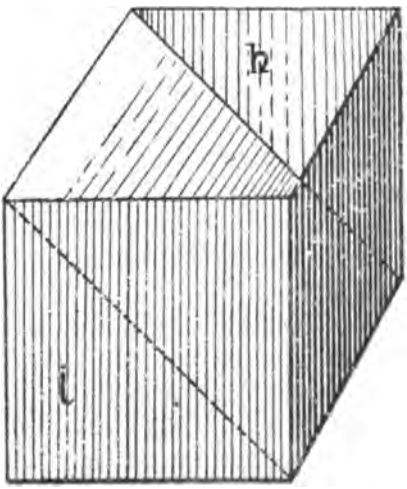

Fig. 7.

a single trough above and below (*h*, *i*), capable of carrying envelopes of a larger size.

(In figs. 5, 6, and 7 the two lids have been omitted for sake of clearness.)

These boxes are designed for three sizes of envelopes, which gives a sufficient range for butterflies of any size. Size 1 is made from a rectangle 8 in. by 5 in. Size 2 from a rectangle 6 in. by 4 in. Size 3 from a rectangle measuring 4 in. by 2¾ in.

It is found in practice that a box made according to fig. 4 will carry, without overcrowding, from 100 to 130 full envelopes in the larger trough, and from 175 to 200 in each of the two smaller spaces. Design 2 will hold in each of the four spaces 225 Lycænidæ, making a total of 900 insects. Design 3 will hold 75 or more filled envelopes in each of the two spaces.

For convenience of examination the insects should be arranged in families: the genera alphabetically in each family, and the species alphabetically in each genus. Subsequent additions can be slipped into their places without disturbing those already in position. To keep the envelopes in place when the troughs are only partly occupied, triangular blocks of cork about ¾ inch thick can be employed. For use as collecting boxes the troughs can be charged with empty envelopes, and the cork triangles will serve as markers to separate the unused envelopes as they are filled.

The boxes illustrated are of the simplest design, as made by a local tinsmith in Ceylon. They can be improved by a coating of black japan on the outside.

Messrs. Watkins & Doncaster have adopted this design, and are turning out boxes (to suit their special-sized envelopes) in stout japanned zinc, with perforated partitions at the end of each trough for the reception of naphthalene or camphor.

E. ERNEST GREEN.

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15. *On a curious Scolopendriform Caterpillar* ("*Homodes fulva*," *Hampson*).—Three species of *Homodes* (*crocea*, Guen.; *vivida*, Guen.; and *fulva*, Hampson) are recorded from the Indian region, but the larva of none of these species has been described.

A small dull-coloured larva was recently found wandering about in the verandah of my laboratory. Its form and movements were so peculiar that I had to examine it with a lens to assure myself that it was really the caterpillar of a Lepidopterous insect.

Fig. 8*a* shows a bird's-eye view of the larva (natural size). The lateral processes, which might at first sight be mistaken for the limbs of a myriopod, are stout spatulate hairs.

During the progression of the insect they are kept in constant movement, being raised and lowered consecutively, simulating the action of the legs of a Scolopendra, but at a much lower speed. While at rest both the head and the posterior extremity are elevated, and the latter is frequently jerked from side to side in a minatory manner. On closer examination it is seen that the posterior extremity simulates a second head. There is a pair of prominent black chitinous spots on the dorsum of the terminal segment which might readily be mistaken for eyes, and the spatulate hairs are suggestive of an arrangement of antennæ and palpi. Even the terminal claspers lend to the deception, for they occupy the position of a pair of mandibles, and are held distended, as though ready for action (see fig. 8*b*).

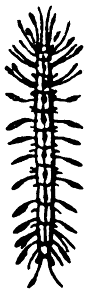


Fig. 8*a*.

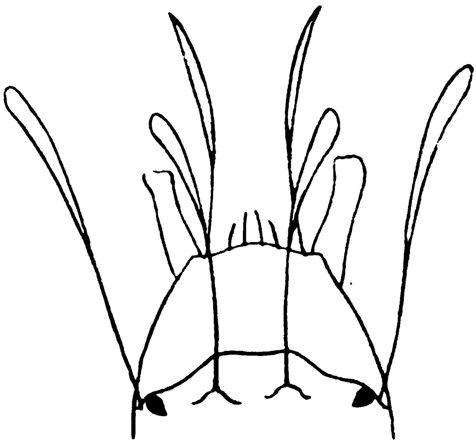


Fig. 8*b*.

This caterpillar pupated in a tightly rolled section of the leaf upon which it had been feeding. It had fed up on *Terminalia catappa*, which happened to be the first food plant with which it was presented.

The moth, which proved to be *Homodes fulva*, was disclosed on December 20.

The fully-grown caterpillar measures 1¼ inches in length. It is of a brownish-green colour, with inconspicuous maculations of a darker shade. Head reddish-brown. The first pair of abdominal claspers are small and practically obsolete, the others normal. The second segment carries ten long spatulate hairs directed forwards. There are two similar hairs on each side of the third and fourth segments. A single spatulate hair springs from each side of the fifth to the eleventh segments. The twelfth has a pair on each side, and the terminal segment has six of these hairs directed backwards, with a prominent black chitinous spot at the base of the outer hair on each side.

E. ERNEST GREEN.

16. *On the Larva of "Panilla albopunctata," Wlk.*—The larva of this Noctuid moth feeds commonly on the under surface of a large Polyporid fungus that vegetates on decaying stumps of trees. It is found more occasionally upon other woody fungi.

The caterpillar is of the normal form of Quadrifine larvæ, having only two pairs of abdominal claspers, and, when young, may easily be mistaken for that of a Geometrid moth.

Its colouration renders it very inconspicuous, being of a pale translucent ochreous tint, usually with an irregular blackish blotch on the dorsum of the fourth and fifth segments, and a similar mark on the seventh and eighth segments. It is of a rather slender cylindrical form, and carries a few colourless hairs.

Pupation takes place in a compact cocoon composed of pellets of the excreta of the caterpillar, which vary in colour with that of the fungus upon which it had been feeding. The cocoon is usually attached to the under surface of the fungus. It may be suspended by a short cord at one extremity, or may be attached at both extremities.

The caterpillars were feeding during January and February. The moths emerged during February and March.

E. ERNEST GREEN.

CEYLON CRUSTACEA.

Part 1.—Notes on the Alpheidæ.

By JOSEPH PEARSON.

(With three Plates.)

THE present report deals with a small collection of Alpheids from the Colombo Museum. The members of the genera *Alpheus* and *Synalpheus*, though numerous in individuals and species, are but little known to any but the specialist in marine carcinology. This is partly owing to their small size, but mainly due to the fact that they generally take up their abode in the deep recesses of some sponge or in the crevices of a fleshy alcyonarian, and even, for want of more favourable shelter, in some friendly hole in a coral. Thus the casual collector may be in the midst of a rich Alpheid fauna without being aware of the fact. Often, however, when sponges are brought up in the dredge and are emptied on deck, the Alpheids will emerge from their retreat.

These tiny creatures are characterized by having an asymmetrical pair of chelæ, one of them being extremely large, perhaps half as big as the body of the animal, while the other is of normal size. The large chela does not appear to be restricted to one side of the body in any particular species. It may be either on the left or on the right side. It is hard to say along what lines this single large chela has been evolved, and the exact meaning of its abnormal development. The Alpheids live in holes, and it is conceivable that, like the hermit crab, the single large claw may be used to block the entrance to the shrimp's retreat. But this does not afford a satisfactory explanation, especially in view of the fact that an Alpheid is much more independent of its place of shelter than is the hermit crab. Moreover, many active Macrurans, such as some of the *Palæmonidæ*, often have asymmetrical chelæ.

These small crustaceans are sometimes known as "snapping shrimps," on account of an interesting habit they have of snapping the fingers of their huge claw. When emptied on deck out of the dredge, or when put into a dish of water, they frequently betray their presence in this way, making a noise which may readily be heard at a distance of fifteen or twenty feet.

I give here an interesting note on the habit of Alpheids, contributed by my assistant, Mr. George Henry. He says :—

"On one occasion I watched two Alpheids, male and female, courting. They were in a pie-dish, full of sea water, with several other creatures, among which were some other Alpheids. The larger specimen, which I took to be a male, was following the smaller (female) slowly round the pie-dish, and evidently "showing off," feeling her with his antennæ, &c. The pair slowly crawled round and round the pie-dish, the female first, followed by the male. After a while a third Alpheid, presumably another male, became interested in the proceedings and approached the pair. When he was within a few inches of them, the first male discovered his presence and smartly whisked round, at the same time vigorously snapping his large chela. He did not attempt to attack the interloper, but merely snapped a number of times in succession, and this appeared to have the desired effect, because the intruder promptly fled. I was unable to make any further observation as a large cuttle-fish came scrambling round and crawled over the pair, much to the indignation of the male, who snapped his disapproval of this treatment."

The knowledge of colour characters that one is able to derive from specimens of Alpheids preserved in spirit is naturally not very reliable. When living these tiny crustaceans are very daintily and even brightly coloured, and the large chela is always most conspicuous by reason of its well-defined colour, generally of a uniform scarlet. Perhaps nowhere else in Nature are the colours so vivid and so varied as those possessed by the coral fishes and other creatures which frequent the brightly coloured sponge masses and branching corals of tropical seas. The Alpheids form no exception to this rule. Owing to the small size the colours are not very noticeable, but their brilliancy harmonizes with the general colour scheme of the coral reefs and sponge banks where the Alpheids abound.

Our present knowledge of Ceylon Alpheids cannot be regarded as being by any means extensive, as it is based upon two small collections—one made by Professor Herdman in 1902, and the other lying in the Colombo Museum and forming the subject of the present paper. As marine biological research in Ceylon has been mainly concerned with the Pearl Banks, most of the Alpheids hitherto described, and the majority of those dealt with in the present report, have come from that locality. It is true that Professor Herdman made collections all around the Ceylon coast, but those made on the Pearl Banks were much more intensive than those taken elsewhere. Consequently it is not surprising to find that of the eighteen species of Alpheids collected by him fourteen were obtained between Chilaw and Adam's Bridge.

In January last I made a very careful examination of the fauna of Trincomalee Harbour and I found it surprisingly rich in Alpheids. Only six species were represented, but the number of individuals was very large. The presence of so many Alpheids may be accounted for by the abundant sponge fauna of Trincomalee Bay.

The following is a list of the species described in the present report :—

Synalpheus neomeris, var. *streptodactylus*, Coutière.
Synalpheus gravieri, Coutière.
Synalpheus biunguiculatus, var. *exilipes*, Coutière.
Synalpheus tumido-manus, Paulson.
Alpheus ventrosus, H. M.-Edwards.
Alpheus phrygianus, Coutière.
Alpheus bucephalus, Coutière.
Alpheus aculeipes, Coutière.
Alpheus frontalis, H. M.-Edwards.
Alpheus rapax, Spence Bate.
Alpheus bis-incisus, de Haan.
Alpheus audouini, Coutière.
Alpheus strenuus, Dana.

The following table gives a list of Alpheids which have been described from Ceylon up to the present :—

	Herdman's Collection.	Colombo Museum.	General Distribution.
Synalpheus neomeris	×		Indo-Pacific, Australia
—— var. *streptodactylus*		×	Maldives, Ceylon
Syn. gravieri	×	×	Maldives, Ceylon
Syn. biunguiculatus	×		Indo-Pacific
—— var. *exilipes*		×	Maldives, Ceylon
Syn. laticeps	×		Maldives, Ceylon
Syn. tumido-manus		×	Red Sea, Indian Ocean
Syn. comatulorum	×		Indo-Pacific, Australia
Syn. carinatus	×		Indian Ocean
Alpheus ventrosus	×	×	Indo-Pacific, Australia
A. idiocheles	×		Maldives, Ceylon
A. phrygianus	×	×	Maldives, Ceylon
A. bucephalus		×	Indian Ocean
A. aculeipes		×	Maldives, Ceylon
A. paraculeipes	×		Maldives, Ceylon
A. paralcyone	×		Maldives, Ceylon
A. frontalis		×	Indian Ocean
A. miersi	×		Indo-Pacific
A. rapax		×	Indo-Pacific
A. pareuchirus	×		Maldives, Ceylon
A. bis-incisus	×	×	Indo-Pacific
A. audouini	×	×	Indo-Pacific
A. strenuus		×	Indo-Pacific
A. macrodactylus	×		Australia, Ceylon
A. spongiarum	×		Maldives, Ceylon

It is not surprising to find that of the twenty-five species and varieties of the Alpheidæ obtained from Ceylon, only three species have not also been found in the Maldives, as one naturally expects the Maldivian crustacean fauna to be similar to that of Ceylon. Coutière has described sixty-six species and varieties of Alpheids from the Maldives, and there is every reason to believe that when the Ceylon fauna has been thoroughly investigated a large number of species will be added to the present list of Ceylon Alpheids.

In giving the sizes of the various species I have used the following symbols :—

a = Total length of carapace along the mid-dorsal line, commencing at the base of the rostrum.

b^1 to b^6 = Lengths along the mid-dorsal line of abdominal segments 1 to 6 respectively.

b^7 = Total length of telson.

e = Greatest length of propodite of large claw.

e^1 = Greatest height of propodite of large claw.

e^2 = Greatest length of dactylopodite of large claw.

I shall not follow Coutière's terms for the parts of the antennules and antennæ.

For "stylocerite" I shall use *antennular scale;* for "carpocerite," *antennal peduncle;* instead of "scaphocerite," *antennal scale;* and I shall use *basal scale* instead of Coutière's "basicérite."

The following is the literature which has been chiefly consulted in the compilation of the present lists :—

1. *Pearson.*—Herdman's Ceylon Pearl Oyster Report. Supplementary Report No. XXIV. The Macrura. 1905.
2. *Coutière.*—Gardiner's Fauna and Geography of the Maldive and Laccadive Archipelagoes. Les Alpheidæ. 1906.

Genus **Synalpheus**, Spence Bate, 1888.

Cephalothorax laterally compressed. Abdomen well developed. Rostrum small and extremely variable in shape and length. Eyes covered by carapace. The orbital arches well defined and separated from rostrum and antennal sulcus by more or less well-defined grooves. Orbital spines in front of orbital arch always present and well developed, often equal in length to rostrum. First antennular article longer than the others. The antennular scale well developed. Basal antennal scale well developed. Pereiopods without epipodites. First two pairs chelate. First pair extremely large and asymmetrical; the propodite without upper and lower notches; the dactylopodite short. Carpopodite of second pair subdivided into five parts; the first part at least equal in length to the sum of the three following parts. Dactylopodite of last three pairs either bifid or trifid.

SYNALPHEUS NEOMERIS, var. STREPTODACTYLUS, Coutière.

Synalpheus neomeris, var. *streptodactylus*, Coutière. Fauna of Mald. and Lacc., 1906.

Two specimens, from Trincomalee ; January, 1911.

The rostrum and orbital spines are equal in length and about two-thirds the length of the first antennular article.

The first antennular article is twice as long as the third and one and a half times as long as the second. The antennular scale extends to the middle of the median article.

The antennal peduncle extends beyond the antennular peduncle by a distance equal to the third antennular article. The antennal scale is slightly longer than the antennular peduncle, but the leaf-like portion is considerably shorter. The basal scale bears two spines: a larger ventral one which nearly reaches the middle of the median antennular article, and a smaller dorsal spine which extends as far forward as the orbital spine.

This variety only differs from de Man's species *neomeris* in the form of the dactylopodites of the third and following pereiopods, The main spine of the dactylos is narrower than in de Man's species, and not so curved. The dorsal spine is longer than in *neomeris*, and is about two-thirds as long as the main spine.

The two specimens are very small, and are, moreover, in a very bad state of preservation, so that satisfactory measurements of the body cannot be given. Measurements of the first three pereiopods are appended, but I cannot say with any certainty that they all belong to the same individual. The only value of these measurements, therefore, is that they give the proportions of the parts of the legs.

Large chela.

$e = 5{\cdot}0$ mm.	$e^2 = 1{\cdot}1$ mm.
$e^1 = 1{\cdot}5$ mm.	

*Second pereiopod.**

$i = 1683$; 370†	$c^4 = 165$; 287
$m = 2112$; 363	$c^5 = 429$; 330
$c^1 = 1501$; 280	$p = 1056$; 363
$c^2 = 231$; 280	$d = 676$; 148
$c^3 = 181$; 277	

Third pereiopod.

$m = 2310$; 594	$p = 2046$; 363
$c = 1122$; 429	$d = 660$; 214

General Distribution.—Maldives, Ceylon.

Synalpheus gravieri, Coutière.

Synalpheus gravieri, Coutière. Fauna of Mald. and Lacc., 1906.

Ten specimens, from the Pearl Banks; February, 1911.

This form is closely allied to *Synalpheus neomeris*, but differs from it in having a longer antennal scale and a slightly shorter basal scale.

* i = ischiopodite; m = meropodite; c^1 to c^5 = segments 1–5 of the carpopodite; p = propodite; d = dactylopodite.

† The first of these numbers refers to the length, and the second to the width, of the segment in terms of μ.

The dactylos of the third and following pereiopods is also different, the dorsal spine being extremely small. The propodite is proportionately shorter in this species than in *Syn. neomeris*.

Dimensions of the body.

$a = 12 \cdot 6$ mm.	$b^6 = 2 \cdot 4$ mm.
$b^1 = 2 \cdot 4$ mm.	$b^7 = 5 \cdot 2$ mm.
$b^2 = 4 \cdot 5$ mm.	$e = 11 \cdot 5$ mm.
$b^3 = 3 \cdot 2$ mm.	$e^1 = 4 \cdot 9$ mm.
$b^4 = 3 \cdot 2$ mm.	$e^2 = 3 \cdot 65$ mm.
$b^5 = 2 \cdot 4$ mm.	

Second pereiopod.

$i = 4356 ; 825$	$c^4 = 627 ; 627$
$m = 5181 ; 825$	$c^5 = 1254 ; 660$
$c^1 = 3762 ; 594$	$p = 2145 ; 693$
$c^2 = 792 ; 594$	$d = 1287 ; 244$
$c^3 = 627 ; 594$	

Third pereiopod.

$m = 4785 ; 1617$	$p = 3729 ; 825$
$c = 2310 ; 957$	$b = 1056$

General Distribution.—Maldives, Ceylon.

SYNALPHEUS BIUNGUICULATUS, var. EXILIPES, Coutière.

Synalpheus biunguiculatus, var. *exilipes*, Coutière. Fauna of Mald. and Lacc., 1906.

Twelve specimens, from the Pearl Banks ; November, 1910.

The rostrum and the two orbital spines are about equal in length, and the rostrum is much narrower than the orbital spines. The rostrum extends beyond the middle of the first antennular article.

The first antennular article is one and a half times as long as the median article and two and a half times as long as the third. The scale reaches nearly to the middle of the median article.

The antennal peduncle is one-third longer than the antennular peduncle ; its scale is only slightly longer than the latter, and the leaf-like portion of the scale is poorly developed. The basal scale consists of two parts : a longer ventral portion which extends to the middle of the median antennular article, and a smaller dorsal piece which extends as far forward as the tip of the orbital spine.

The following are the dimensions of a typical specimen :—

$a = 7 \cdot 0$ mm.	$b^6 = 1 \cdot 5$ mm.
$b^1 = 1 \cdot 8$ mm.	$b^7 = 2 \cdot 5$ mm.
$b^2 = 1 \cdot 8$ mm.	$e = 9 \cdot 5$ mm.
$b^3 = 1 \cdot 6$ mm.	$e^1 = 4 \; 0$ mm.
$b^4 = 1 \cdot 6$ mm.	$e^2 = 3 \cdot 0$ mm.
$b^5 = 1 \cdot 25$ mm.	

The large claw differs somewhat from that of *S. biunguiculatus* in having the spine at the distal end of upper palmar surface upturned so as to resemble the claw of *Synalpheus apioceros*.

The second pereiopod is richly clothed with setæ near its distal end. Its dimensions are as follows :—

$i = 2046 ; 561$	$c^4 = 297 ; 379$
$m = 2706 ; 561$	$c^5 = 627 ; 412$
$c^1 = 1617 ; 396$	$p = 1254 ; 429$
$c^2 = 363 ; 396$	$d = 759 ; 198$
$c^3 = 297 ; 379$	

The third pereiopod has a single spine at the distal end of the posterior border of the carpopodite, and eight spines on the posterior border of the propodite. The dactylopodite is biunguiculate, the two parts being almost equal. The dimensions are as follows :—

$i = 1089 ; 825$	$p = 2079 ; 528$
$m = 3399 ; 1056$	$d = 396 ; 214$
$c = 1551 ; 627$	

General Distribution.—Maldives and Ceylon.

SYNALPHEUS TUMIDO-MANUS, Paulson.

Synalpheus tumido-manus, Paulson. Red Sea Crustacea, 1875.

Synalpheus neptunus, Coutière. Bull. Soc. Ent., France, 1898.

Synalpheus tumido-manus, Coutière. Fauna of Mald. and Lacc., 1906.

One specimen, from the Pearl Banks ; November, 1910.

Six specimens, from bottom of ss. "Violet," Colombo ; October, 1910.

Twelve specimens, from Colombo Harbour ; September, 1907.

This species resembles *Synalpheus biunguiculatus*, but differs from it in the antennal peduncle being comparatively shorter. There is also a slight difference in the dactylopodite of the third pereiopod. The chela is also slightly longer in proportion to the height.

The rostrum and orbital spines resemble those of *Synalpheus buinguiculatus*, var. *exilipes*, except that the rostrum is slightly longer.

The first antennular article is twice as long as the distal article and slightly longer than the median. The scale extends past the middle of the median article.

The antennal peduncle is only slightly longer than the antennal and about the same length as the antennal scale. The ventral part of the basal scale extends beyond the basal antennular article, and the dorsal part is but feebly developed.

The dimensions of the body are as follows :—

$a = 8 \cdot 0$ mm.	$b^6 = 2 \cdot 0$ mm.
$b^1 = 2 \cdot 6$ mm.	$b^7 = 3 \cdot 2$ mm.
$b^2 = 3 \cdot 4$ mm.	$e = 10 \cdot 6$ mm.
$b^3 = 2 \cdot 56$ mm.	$e^1 = 4 \cdot 5$ mm.
$b^4 = 2 \cdot 25$ mm.	$e^2 = 3 \cdot 2$ mm.
$b^5 = 1 \cdot 9$ mm.	

The dimensions of the second pereiopod are as follows :—

$i = 2442$; 660	$c^4 = 363$; 429
$m = 3217$; 660	$c^5 = 825$; 462
$c^1 = 1914$; 403	$p = 1485$; 495
$c^2 = 379$; 412	$d = 785$; 198
$c^3 = 396$; 429	

The dactylos of the third leg has the ventral part slightly shorter and broader than the dorsal part. There are eight spines on the propodite of the third leg. The distal end of the carpos bears a blunt process on the dorsal side and a sharp spine on the ventral. The dimensions are as follows :—

$i = 1369$; 891	$p = 3069$; 561
$m = 3679$; 1056	$d = 858$; 264
$c = 1914$; 693	

General Distribution.—Red Sea, Indian Ocean.

Genus **Alpheus,** *Fabricius*, 1798.

Cephalothorax laterally compressed. Abdomen well developed. Rostrum small, rarely extending beyond first antennular article. Eyes covered by carapace. The orbital arches well defined and separated from rostrum and antennal sulcus by more or less well-defined grooves. Orbital spines generally absent. First antennal article shorter than the second. Antennular scale much reduced. Basal antennal scale usually extremely small. Pereiopods with epipodites. First two pairs chelate. First pair of pereiopods extremely large and show well-marked asymmetry. Propodite with or without upper and lower notches. Carpus of second pair subdivided into five parts, the proximal part being less than the sum of the three following parts, the last three pairs of pereiopods ending in a simple dactylopodite.

ALPHEUS VENTROSUS, H. M.-Edwards.

(Plate V., Fig. 2.)

Alpheus ventrosus, H. M.-Edwards. H. Nat. Crust., t. 2, p. 352, 1837.

Alpheus lævis, Randall. J. Acad. Sci., Philadel., vol. VIII., 1839, and many others.

Alpheus ventrosus, Coutière. Fauna of Mald. and Lacc., 1906.

Six specimens, from Weligama.

Three specimens, from the Pearl Banks; February, 1911.

According to Coutière this is the commonest species of Alpheus, and the most widely distributed.

I have followed Coutière in including Randall's species along with that of Milne-Edwards.

This is one of the few examples of an Alpheus possessing orbital spines.

The rostrum, which extends almost to the extremity of the first antennular article, is well developed, and is separated from the orbits by well-defined grooves.

The first and second antennular articles are almost equal and nearly twice as long as the distal article. The antennular scale reaches nearly to the middle of the second article.

The antennal peduncle and scale are about equal in length, and extend beyond the antennular peduncle by a distance nearly equal to the third antennular article. There is a basal scale present which is nearly as long as the first antennular article.

This species is characterized by having the cephalothorax laterally compressed to a marked degree. The carapace is very deep, and its greatest depth is equal to its mid-dorsal length. Instead of the lower edge of the carapace being rounded as in most species, there are several sharp angles which give this form a very characteristic appearance.

The following are the dimensions of a typical specimen :—

a = 9·0 mm.	b^4 = 3·5 mm.	e = 14·9 mm.
b^1 = 1·7 mm.	b^5 = 2·8 mm.	e^1 = 6·0 mm.
b^2 = 4·25 mm.	b^6 = 3·0 mm.	e^2 = 5·0 mm.
b^3 = 3·6 mm.	b^7 = 5·0 mm.	

The large claw is laterally compressed, and possesses no upper and lower teeth on the palm. The hands of both the first pereiopods are coloured bright orange in the living specimen and have a mottled appearance. Some of the specimens have a setiferous ridge on the movable finger of the smaller hand. The presence of this setiferous ridge is doubtless a sexual difference, and is probably confined to males. I cannot, however, give any proof of this, as in every specimen the first pereiopods are detached and are lying loose at the bottom of the bottle.

The second pereiopod is not so slender as in most Alpheids. The hand is richly clothed with setæ.

The following are the measurements of the second pereiopod :—

i = 2112 ; 825	c^2 = 1023 ; 759	c^5 = 1221 ; 693
m = 4290 ; 990	c^3 = 858 ; 726	p = 1551 ; 693
c^1 = 2310 ; 792	c^4 = 825 ; 726	d = 359 ; 297

The third pereiopod is fairly strongly made. The dactylopodite is not nearly so slender as in most species of *Alpheus*. Dimensions of third pereiopod :—

m = 4290 ; 1551	p = 2706 ; 858
c = 2673 ; 1155	d = 1320 ; 660

Altogether this species is a very distinctive one, and in many ways is different from a typical member of the genus.

General Distribution.—Indo-Pacific.

Alpheus phrygianus, Coutière.

Alpheus phrygianus, Coutière. Fauna of Mald. and Lacc., 1906.

Three specimens, from the Pearl Banks ; February, 1911.

The rostrum is represented by an extremely small projection. It is continued back between the eyes as a well-defined ridge.

The antennular peduncle are comparatively long and slender. The proximal article is shorter than the distal and the median is twice as long as the distal. The antennular scale is rounded in front, and is half the length of the proximal article.

The antennary peduncle is short and only extends to the end of the median antennular article. Its scale is still shorter, and only reaches to the middle of the median article.

The following are the dimensions of the body :—

a = 7·6 mm.	b^6 = 2·1 mm.
b^1 = 1·9 mm.	b^7 = 2·69 mm.
b^2 = 2·0 mm.	e = 8·1 mm.
b^3 = 2·18 mm.	e^1 = 3·67 mm.
b^4 = 2·5 mm.	e^2 = 2·2 mm.
b^5 = 2·0 mm.	

The hand of the large claw is peculiar, and the dactylopodite has a process directed backward, which makes the dactylos hammer-shaped.

The second pereiopod is exceeding slender and has the following proportions :—

i = 5775 ; 693	c^4 = 792 ; 528
m = 7326 ; 5181	c^5 = 1221 ; 594
c^1 = 2772 ; 488	p = 2574 ; 693
c^2 = 2871 ; 528	d = 1154 ; 307
c^3 = 693 ; 528	

In the third and following legs the meros has a well-developed process near the distal end. At the distal end of the carpos there is a blunt process on the dorsal side and a spine on the ventral side, The propodite has six spines, and the dactylos is well curved and single. The dimensions of the third leg are as follows :—

i = 1386 ; 990	p = 2508 ; 581
m = 3993 ; 1221	d = 792 ; 198
c = 3300 ; 726	

This form undoubtedly belongs to the *obeso-manus* group.

General Distribution.—Maldives, Ceylon.

ALPHEUS BUCEPHALUS, Coutière.

Alpheus crinitus, Coutière. Bull. Soc. Entom., 1898.

Alpheus bucephalus, Coutière. Fauna of Mald. and Lacc., 1906.

One specimen, from Trincomalee; January, 1911.

The rostrum is short and is not half as long as the first antennular article. The rostrum is continued with a median ridge which extends backwards between the orbits.

The first and third antennular articles are equal, and both are slightly shorter than the median article. The scale is small, and only half the length of the first article. The peduncle is only five-sixths the length of the antennal peduncle, and equal in length to the antennal scale.

The single specimen is small, and is too mutilated for accurate measurement.

The dimensions of the chelæ are as follows :—

$$e = 7{\cdot}0 \text{ mm.} ; \ e^1 = 3{\cdot}15 \text{ mm.} ; \ e^2 = 2{\cdot}7 \text{ mm.}$$

The fingers are very short, and the palm is high in comparison to its length. Both upper and lower palmar borders are smooth.

The second pereiopod possesses a long second segment to the carpos. The dimensions are as follows :—

i = 2277 ; 462	c^4 = 462 ; 346
m = 2970 ; 330	c^5 = 660 ; 363
c^1 = 643 ; 297	p = 1221 ; 429
c^2 = 1840 ; 330	d = 627 ; 165
c^3 = 462 ; 330	

The third pereiopod is very broad. There is a well-developed spine on the ischium. The meros broadens out distally into a very prominent spine on the lower side. The carpos has a blunt spine at the distal end of its lower border. The propodus is short and has about eight spines irregularly arranged on the lower side. The upper side is richly clothed with setæ. The dactylos is strong and curved. Dimensions :—

m = 2310 ; 792	p = 990 ; 429
c = 1155 ; 495	d = 528 ; 165

General Distribution.—Indian Ocean.

ALPHEUS ACULEIPES, Coutière.

Alpheus aculeipes, Coutière. Fauna of Mald. and Lacc., 1906.

Two specimens, from the Pearl Banks ; February, 1911.

The rostrum is poorly developed.

The proximal antennular article is slightly shorter than the distal. The median article is nearly twice as long as the proximal. The scale is short, and does not reach to the end of the first article.

The antennal peduncle is one and a quarter times the length of the antennular peduncle. The spine of the scale is nearly as long as the antennal peduncle, but the leaf-like portion is shorter than the antennular peduncle.

The dimensions of the body are as follows :—

$a = 5 \cdot 0$ mm.	$b^4 = 1 \cdot 67$ mm.	$e = 7 \cdot 6$ mm.
$b^1 = 1 \cdot 0$ mm.	$b^5 = 1 \cdot 2$ mm.	$e = 3 \cdot 3$ mm.
$b^2 = 1 \cdot 2$ mm.	$b^6 = 1 \cdot 3$ mm.	$e^2 = 3 \cdot 0$ mm.
$b^3 = 1 \cdot 2$ mm.	$b^7 = 2 \cdot 0$ mm.	

The chela is exceedingly large in proportion to the body, and is probably about three-quarters as large as the rest of the body. The fingers are short.

The dimensions of the second pair of pereiopods are as follows :—

$i = 2277 ; 363$	$c^2 = 1534 ; 238$	$c^5 = 561 ; 264$
$m = 2442 ; 251$	$c^3 = 379 ; 247$	$p = 1105 ; 297$
$c^1 = 495 ; 231$	$c^4 = 379 ; 257$	$d = 627 ; 115$

The third pereiopod has a small spine on the ischium ; the meros has numerous short spines on its ventral border ; near this border is a longitudinal ridge which ends distally in a well-developed spine. The short carpos has a similar ridge and spine. The propodite has about a dozen spines more or less irregularly arranged. The dactylos is curved, and is characterized by the presence of a small process on its ventral surface. The carpos and propodos are richly clothed with setæ. Dimensions :—

$i = 792 ; 594$	$c = 1320 ; 462$	$d = 373 ; 99$
$m = 2475 ; 660$	$p = 1518 ; 363$	

General Distribution.—Maldives, Ceylon.

ALPHEUS FRONTALIS, H. M.-Edwards.

(Plate VI., Fig. 3.)

Alpheus frontalis, H. M.-Edwards. H. Nat. des Crust., 1834.

Alpheus latifrons, H. M.-Edwards. J. Mus., Godefroy, 1874.

proces—— de Man., Arch. f. Naturg., 1887.

a blunt *us frontalis*, Coutière. Fauna of Mald. and Lacc., 1906.

One specimen, from the Pearl Banks ; February, 1911.

The frontal region of carapace has a very characteristic appearance. There is no well-defined, sharply-pointed rostrum, but instead there is a broad lobe covering the bases of both antennules. This lobe is carinated in the mid-dorsal line. The region of the carapace covering the eyes is greatly arched and bulges out considerably. The proximal and distal antennular articles are subequal, and together are equal in length to the median article. From the anterior end of the proximal article there arises a well-defined bunch of long setæ which point anteriorly and extend beyond the end of the peduncle. The antennular scale is poorly developed and is merely a broad lobe about half as long as the proximal article.

The antennal peduncle is slightly longer than the antennular. The scale is short and does not reach much beyond the end of the median antennular article.

The dimensions of the specimen are as follows :—

a = 10·65 mm.	b^6 = 3·0 mm.
b^1 = 3·0 mm.	b^7 = 5·25 mm.
b^2 = 4·5 mm.	e = 10·5 mm.
b^3 = 3·6 mm.	e^1 = 4·4 mm.
b^4 = 3·95 mm.	e^2 = 3·5 mm.
b^5 = 3·0 mm.	

The first pereiopods have no teeth on the palmar borders.

Dimensions of second pereiopod :—

m = 3960 ; 561	c^4 = 528 ; 462
c^1 = 2409 ; 330	c^5 = 858 ; 495
c^2 = 759 ; 396	p = 1452 ; 528
c^3 = 561 ; 429	d = 639 ; 231

The third pereiopod has three spines on the posterior face of the carpopodite, and the distal end of this face also ends in a spine. There are seven spines on the propodite. The following are the dimensions :—

m = 5082 ; 1221	p = 3531 ; 359
c = 2640 ; 858	d = 990 ; 264

General Distribution.—Indian Ocean.

Alpheus rapax, Spence Bate.

(Plate VI., Fig. 4.)

Alpheus rapax, Spence Bate. "Challenger," Macrura, 1888.

One specimen, from Nachchikuda, Tamblegam.

The median antennular article is more than twice as long as the distal. The proximal and distal articles are equal. The scale is not so long as the first article.

The antennal peduncle and scale are about equal in length and slightly longer than the antennular peduncle. Spence Bate figures the antennal scale as being much longer than the peduncle, but this appearance is due to the long setæ on the front border of the scale.

The following are the dimensions of the body :—

$a = 10 \cdot 5$ mm.	$b^6 = 3 \cdot 5$ mm.
$b^1 = 2 \cdot 95$ mm.	$b^7 = 4 \cdot 4$ mm.
$b^2 = 4 \cdot 35$ mm.	$e = 11 \cdot 6$ mm.
$b^3 = 4 \cdot 0$ mm.	$e^1 = 3 \cdot 5$ mm.
$b^4 = 3 \cdot 7$ mm.	$e^2 = 4 \cdot 35$ mm.
$b^5 = 3 \cdot 25$ mm.	

The large claw is flattened laterally, and its length is two and a half times the height. Both upper and lower palmar surfaces are smooth.

There is nothing noteworthy about the second pereiopods. The measurements are as follows :—

$i = 4620 ; 462$	$c^4 = 792 ; 297$
$m = 3861 ; 429$	$c^5 = 924 ; 330$
$c^1 = 2310 ; 297$	$p = 1386 ; 396$
$c^2 = 1947 ; 280$	$d = 825 ; 165$
$c^3 = 792 ; 297$	

The third pair of pereiopods are characterized by having no regular row of spines on the propodite and by the lanceolate nature of the dactylopodite. The dimensions are as follows :—

$m = 5610 ; 1023$	$p = 3861 ; 594$
$c = 3135 ; 759$	$d = 2310 ; 363$

Distribution.—Indo-Pacific.

Alpheus bis-incisus, de Haan.

Alpheus bis-incisus, de Haan. Fauna Japonica, 1839.

Six specimens, from the Pearl Banks ; February, 1911.

Three specimens, from Trincomalee ; January, 1911.

One specimen, from Colombo Harbour ; September, 1910.

I have had considerable difficulty in deciding whether to place some of the above specimens in Coutière's varieties *malensis* and *stylirostris*. Minute investigation, however, has revealed the fact that there appears to be no constancy in the proportions of the hands of the first pereiopods and in the carpopodite of the second pereiopods upon which Coutière established his new varieties.

I have, in fact, several specimens which show intermediate conditions between de Haan's species and the variety *malensis*, both regarding the proportions of the hands of the first pereiopods and the relative lengths of the first and second articles of the carpos of the second pereiopods.

With regard to the rostrum, I have found that it shows considerable variation in this species, and consequently I do not consider that Coutière was justified in creating the new variety *stylirostris* upon the form of the rostrum of a single specimen. A careful consideration of the whole question makes me unwilling to separate any of these specimens from de Haan's species. Coutière's knowledge of the Alpheidæ is unsurpassed, and gives him an authority which one hesitates to question. But one cannot help feeling that many of the characters upon which he has established new species appear to be unimportant, and in some cases the material at his disposal does not appear to have been sufficiently abundant to enable him to say with any justification that these characters are constant.

In establishing his two new varieties, Coutière makes use of certain characters, the chief of which are, (1) the relation between the total length of the propodite of the first leg (*p*) and the length of the dactylopodite (*d*); (2) the relation between the height of the fingers (h^1) and the height of the palm of the first pereiopod (h^2); (3) the relation between the lengths of the first (c^1) and second parts (c^2) of the carpopodite of the second pereiopod; and (4) the relation between the length of the triangular rostrum (*l*) and the base of the triangle (*b*).

The following table gives Coutière's measurements for the three species :—

	$\frac{p}{d}$	$\frac{h^1}{h^2}$	$\frac{c^1}{c^2}$	$\frac{l}{b}$
Synalpheus bis-incisus ..	2·75 ..	1·6 ..	1·7 ..	about 1·5
S. bis-incisus, var. *malensis* ..	2·50 ..	1·34 ..	1·33 ..	about 1·5
S. bis-incisus, var. *stylirostris* ..	Not given		.. 1·53 ..	about 3·5

To illustrate how the Ceylon specimens differ from the above measurements I append the following table, giving the characters of six specimens belonging to the present collection :—

Specimen.		$\frac{p}{d}$		$\frac{h^2}{h^1}$		$\frac{c^1}{c^2}$		$\frac{l}{b}$
A	..	2·61	..	1·40	..	1·43	..	1·83
B	..	2·41	..	1·41	..	1·51	..	2·48
C	..	2·73	..	1·59	..	1·56	..	2·72
D	..	2·63	..	1·36	..	1·32	..	2·60
E	..	Chela absent			..	1·53	..	2·77
F	..	2·82	..	1·56	..	1·60	..	2·50

It will be seen that specimen C is the only one which approaches *A. bis-incisus* as diagnosed by Coutière, except that the rostrum is too long. Specimen E appears to be similar to *stylirostris*. None appear to correspond to the variety *malensis*.

I have no hesitation in identifying the specimens under discussion as *Alpheus bis-incisus*, and, as I have pointed out, my examination indicates a considerable amount of variation in all those characters upon which Coutière formed the new varieties.

The rostrum is triangular, and is separated from the orbits by deep depressions. The shape of the triangle is not constant, and varies between the type figured by Coutière as *malensis* and that of *stylirostris*. The rostrum does not reach the end of the first antennular article. The first antennular article is slightly longer than the second and twice as long as the third. The antennular scale reaches to the end of the first article. The antennal penduncle and scale are about equal, and are slightly longer than the antennular peduncle.

The dimensions of specimen A are as follows :—

a = 10·0 mm.	b^6 = 3·5 mm.
b^1 = 2·5 mm.	b^7 = 4·3 mm.
b^2 = 2·5 mm.	e = 17·0 mm.
b^3 = 3·2 mm.	e^1 = 7·0 mm.
b^4 = 3·25 mm.	e^2 = 6·5 mm.
b^5 = 2·6 mm.	

The large claw is of the "edwardsi" type, and this form undoubtedly belongs to that group of species.

The second pereiopod calls for no further comment. The following are the dimensions in specimen A :—

i = 4455 ; 643	c^4 = 693 ; 528
m = 4884 ; 561	c^5 = 1254 ; 544
c^1 = 2838 ; 528	p = 2376 ; 627
c^2 = 1848 ; 528	d = 1254 ; 247
c^3 = 726 ; 528	

The third pereiopod has about seven spines on the propodite. The propodite is richly clothed with setæ. The dactylopodite is long and curved. Dimensions :—

i = 1746 ; 653	p = 4092 ; 528
m = 5280 ; 726	d = 1518 ; 231
c = 3184 ; 627	

General Distribution.—Indo-Pacific.

ALPHEUS AUDOUINI, Coutière.

(Plate VII., Fig. 5.)

Alpheus edwardsi, Coutière (not *audouini*). Bull. Soc. Ent. France, 1898.

Alpheus audouini, Coutière. Fauna of Mald. and Lacc., 1906.

Five specimens, from the Pearl Banks ; February, 1911.

This form is very similar to *A. edwardsi* (*audouini*), but differs from it in the form of the palmar projections of the large claw. In *A. edwardsi* they are spinous and in the present species rounded.

This species, although related to *A. strenuus*, differs from it by well-marked characters. The second antennular article is only one and a half times as long as the third.

In *A. strenuus* a line joining the two palmar ridges of the large claw divides the hand into two equal parts. In *A. audouini* the distal portion of the hand is comparatively shorter, and such a line divides the hand in the proportions of 6 : 5.

The second pereiopod shows a difference in the proportions of the first and second parts of the carpos in the two forms. In *A. strenuus* the first segment is only slightly longer than the second (1·12 : 1). In *A. audouini* the proportion is 1·6 : 1.

The third pereiopod of the present species is not so robust as in *A. strenuus*, and the propodite does not bear so many spines.

The following are the dimensions of this form :—

$a = 6{\cdot}6$ mm.	$b^6 = 2{\cdot}0$ mm.
$b^1 = 1{\cdot}7$ mm.	$b^7 = 2{\cdot}62$ mm.
$b^2 = 2{\cdot}51$ mm.	$e = 9{\cdot}5$ mm.
$b^3 = 2{\cdot}3$ mm.	$e^1 = 4{\cdot}0$ mm.
$b^4 = 2{\cdot}62$ mm.	$e^2 = 3{\cdot}5$ mm.
$b^5 = 1{\cdot}6$ mm.	

Dimensions of second pereiopod :—

$i = 2541 ; 462$	$c^4 = 396 ; 363$
$m = 2640 ; 462$	$c^5 = 693 ; 396$
$c^1 = 1584 ; 363$	$p = 1452 ; 429$
$c^2 = 990 ; 363$	$d = 825 ; 198$
$c^3 = 495 ; 363$	

Dimensions of third pereiopod :—

$m = 3300 ; 627$	$p = 2442 ; 363$
$c = 1914 ; 396$	$d = 1023 ; 165$

General Distribution.—Indo-Pacific.

ALPHEUS STRENUUS, Dana.

(Plate VII., Fig. 6.)

A. strenuus, Dana. U. S. Expl. Exped., 1852.
A. strenuus, Coutière. Fauna of Mald. and Lacc., 1906.

Localities.—One specimen, from Weligama ; November, 1905.
One specimen, from the Pearl Banks ; February, 1911.
Five specimens, from Mandativu, Jaffna ; July, 1903.
One specimen, from Nachchikuda, Tamblegam ; September, 1908.
Six specimens, from Delft ; June, 1903.
Nine specimens, from Kapalturai, Tamblegam ; October, 1907.

This is a fairly common form, and is the largest of all the Ceylon Alpheids. It is closely related to *A. edwardsi* and *A. audouini*, but differs from them both in the relative lengths of the second and third antennular articles. The second article is twice as long as the third, and the first article is intermediate in size. The antennular scale reaches to the extremity of the first article. The antennal peduncle is longer than that of the antennule. The spine of the antennal scale does not reach the extremity of the peduncle, but is longer than the antennular peduncle. The rostrum does not reach to the extremity of the first antennular article.

The dimensions of the body are as follows :—

$a = 18 \cdot 25$ mm.	$b^4 = 6 \cdot 0$ mm.	$e = 24 \cdot 0$ mm.
$b^1 = 3 \cdot 6$ mm.	$b^5 = 4 \cdot 0$ mm.	$e^1 = 10 \cdot 5$ mm.
$b^2 = 5 \cdot 8$ mm.	$b^6 = 4 \cdot 8$ mm.	$e^2 = 10 \cdot 0$ mm.
$b^3 = 5 \cdot 2$ mm.	$b^7 = 6 \cdot 4$ mm.	

The large claw has been described and figured by Coutière.

The second pereiopod has the following proportions :—

$i = 7920$; 1089	$c^2 = 3531$; 825	$c^5 = 2145$; 858
$m = 8151$; 1056	$c^3 = 1386$; 825	$p = 3465$; 1023
$c^1 = 3960$; 858	$c^4 = 1320$; 825	$d = 1848$; 429

The third pereiopod has the propodite provided with seven or eight pairs of spines arranged more or less irregularly on the anterior side. The dactylos is a strong slightly curved hook. The following are the proportions of the parts :—

$i = 2970$; 1815	$c = 6006$; 1419	$d = 2475$; 495
$m = 8580$; 2442	$p = 6105$; 1320	

The above dimensions are taken from a typical form of this species.

The rostrum varies in length. In one specimen it passes well beyond the first antennular article, and in another it is as long as that article. Normally the rostrum is only about two-thirds as long as the first article.

General Distribution.—Pacific ; Maldives, Ceylon.

Explanation of the Plates.

Plate V.

Fig. 1.—*Synalpheus biunguiculatus*, var. *exilipes*.

Fig. 2.—*Alpheus ventrosus*. *2a*, frontal region of carapace, with antennæ and antennules × 8 ; *2b*, second pereiopod × 9 ; *2c*, third pereiopod × 9 ; *2d*, dactylopodite of third pereiopod × 21.

Plate VI.

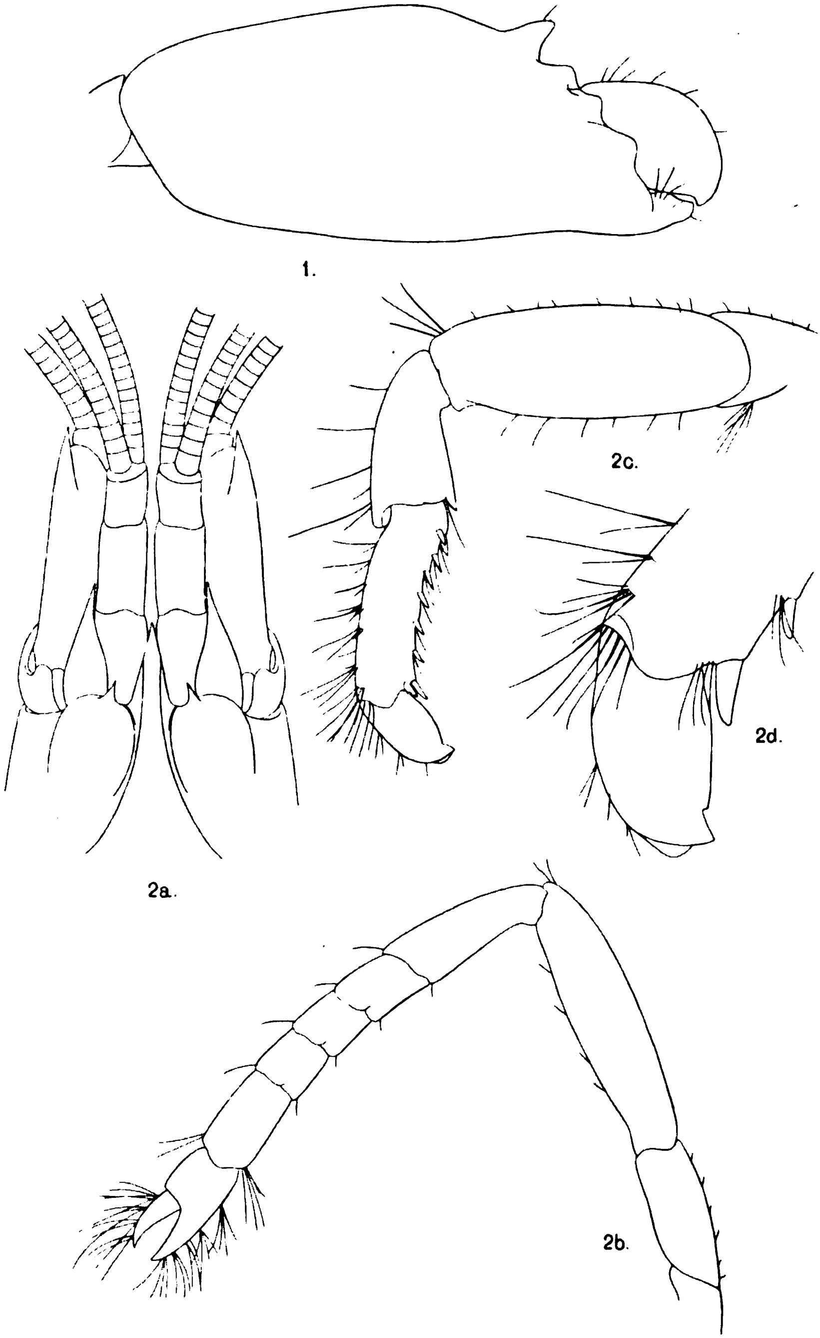
Fig. 3.—*Alpheus frontalis*. *3a*, frontal region of the carapace, the antennules, and antennæ × 6 ; *3b*, second pereiopod × 8 ; *3c*, third pereiopod × 8.

Fig. 4.—*Alpheus rapax*. *4a*, second pereiopod × 8 ; *4b*, third pereiopod × 8.

Plate VII.

Fig. 5.—*Alpheus audouini*. *5a*, frontal region of carapace, the antennules, and antennæ × 9 ; *5b*, second pereiopod × 10 ; *5c*, third pereiopod × 10.

Fig. 6.—*Alpheus strenuus*. *6a*, second pereiopod × 4 ; *6b*, third pereiopod × 4.



G. Henry, del. E. Wilson, Cambridge

FIG. 1. SYNALPHEUS BIUNGUICULATUS *var* EXILIPES
FIG. 2. ALPHEUS VENTROSUS

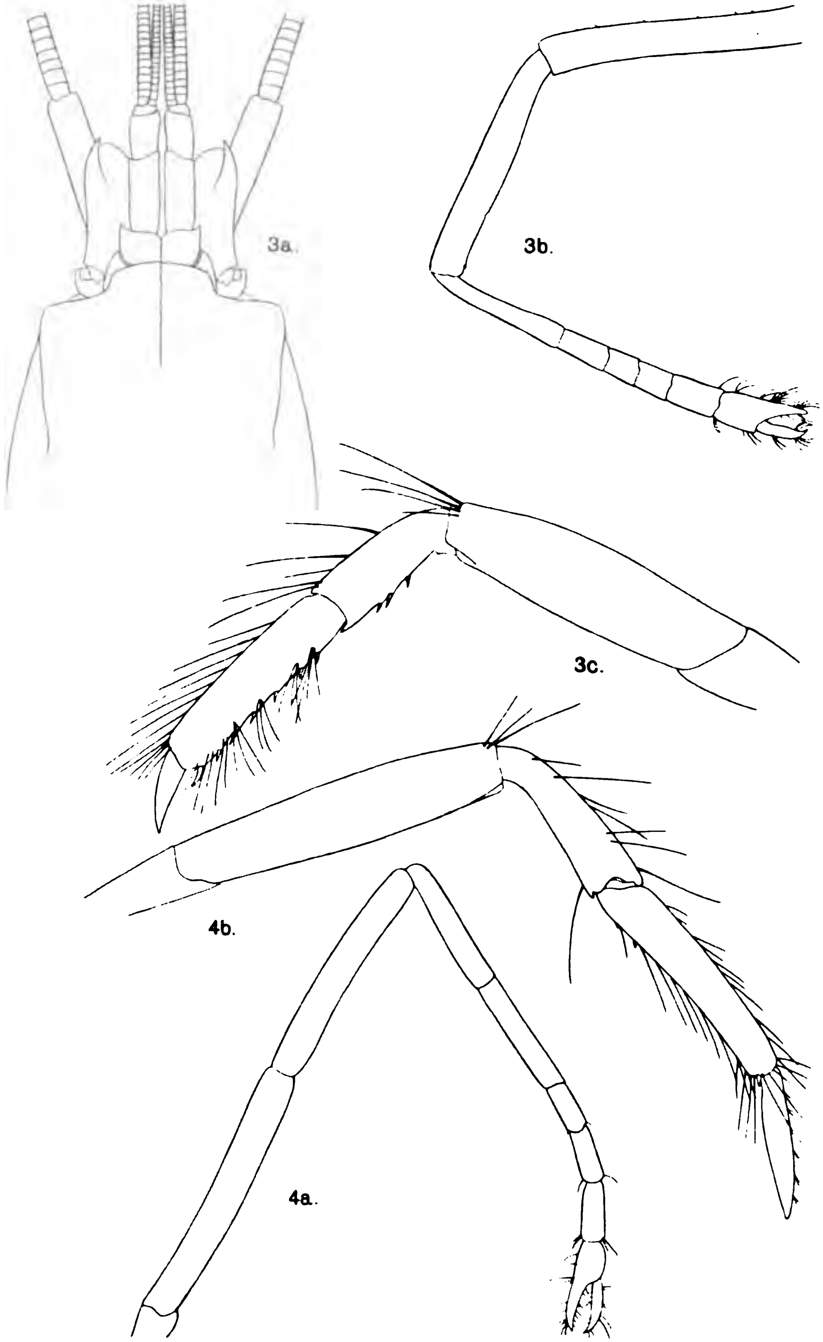


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FIG. 3 ALPHEUS FRONTALIS
FIG. 4 ALPHEUS RAPAX

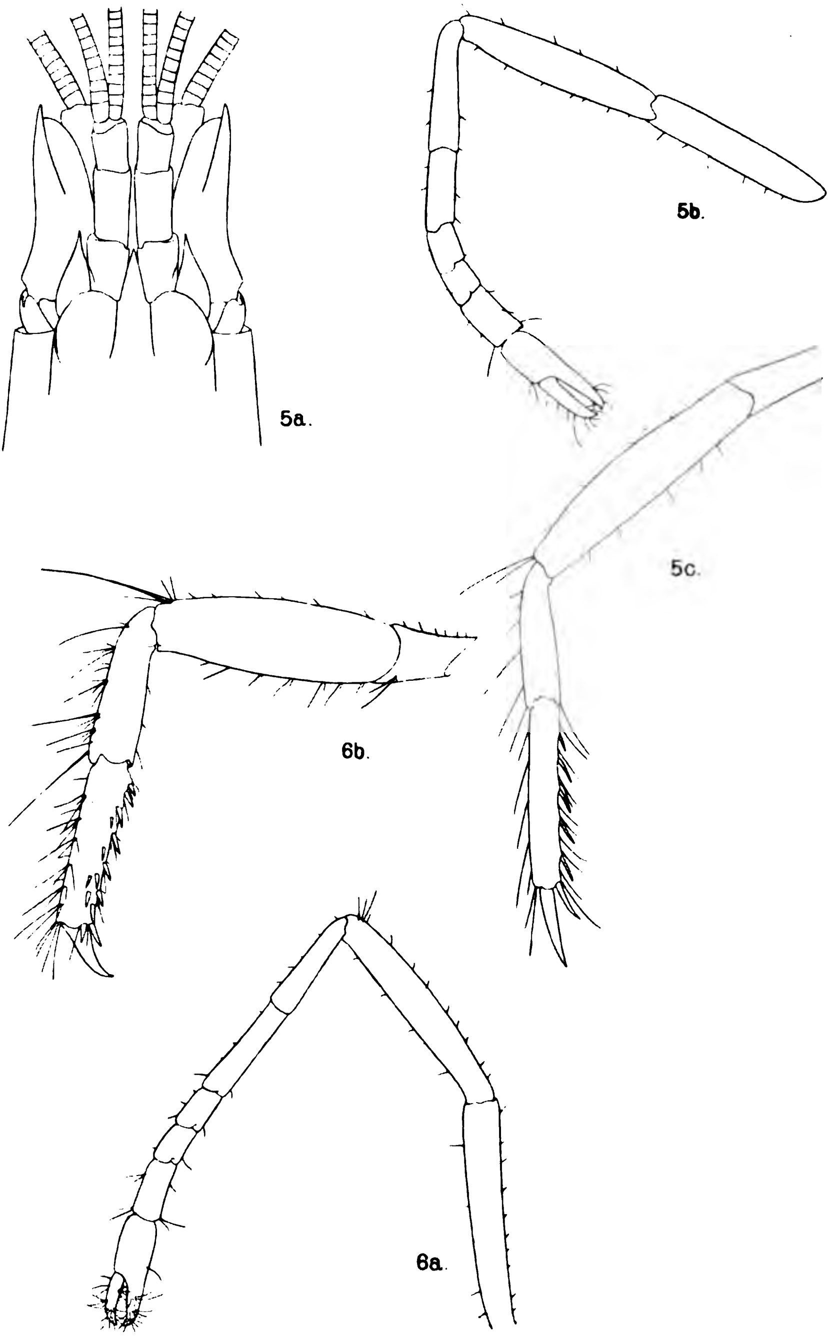

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FIG. 5. ALPHEUS AUDOUINI.
FIG. 6. ALPHEUS STRENUUS.

A NEW GENUS OF SHORT-BEAKED GNATS FROM CEYLON.

By N. Annandale, D.Sc., F.A.S.B., Indian Museum.

(With one Plate and one Text-figure.)

THROUGH the kind offices of Mr. E. E. Green I have been entrusted with the examination of microscopic preparations of the larva, pupa, and imago of a peculiar little gnat taken by Major MacDougall, R.A.M.C., in a swamp at Diyatalawa in Ceylon (alt. *ca.* 4,300 feet). The specimens are mounted in Canada balsam, and unfortunately include only one imago, a male; but the structure of the fly and its immature stages is of such interest from a systematic point of view that I have ventured to describe the genus and species as new. In so doing I have, I may say, found it very much easier to give a description of the structure than if the specimen had been mounted dry in the ordinary way.

It is a point worth considering whether more fixed and definite standards of entomological classification might not be reached if dried specimens were to be treated as of less account than those carefully mounted in some liquid medium, which would prevent their more delicate organs from becoming shrivelled out of all recognition. Colour would, in some cases, have to go, but, if the preservation be properly carried out, there is no reason why even the finest scales or hairs should be lost in specimens kept in spirit or Canada balsam.

The main interest of the new genus here described as *Ramcia* lies in the fact that it affords a complete link between the "Culicidæ" of Theobald* and other recent authors, and the genera which these authors, intent on finding new pretexts for rending asunder what Nature has joined together, would separate as the family "Corethridæ." In this particular instance the excuse for dividing families resides partly in the structure of the larva and partly in the short proboscis of the imago and the absence of scales on the head, body, legs, and veins of the wings. The larvæ of different "Corethridæ," however, differ considerably more one from another than certain of them do from those of the "Culicidæ"; there is far more difference in structure, to take parallel instances, between the proboscis of *Stomoxys* or even *Philæmatomyia* and that of *Musca* than there is between that of *Culex* and that of *Corethra*, although even the most recent writers place *Stomoxys* and *Philæmatomyia* in the same family as *Musca*, while *Phlebotomus*, although it undoubtedly belongs to a family (Psychodidæ) of which some species have densely scaled wings, has actually fewer scales on the wing than *Chaoborus*.† Nobody denies the affinity of *Corethra* and

* Mon. Culicidæ, iv., p. 15 (1907).

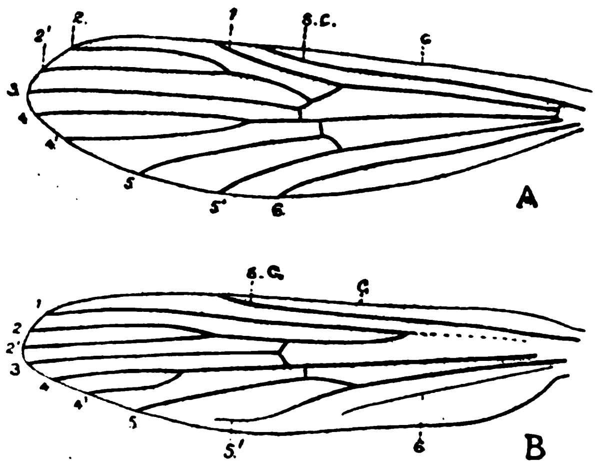
† As regards the synonymy of the genera allied to *Corethra*, see Brunetti, Rec. Ind. Mus., iv., p. 317 (1911).

Chaoborus, and even those authors who regard *Corethra* and its allies as constituting a separate family are forced to ignore the fact that *Pelorempis* has scales on its cross-veins, although they assign this genus also to the Corethridæ. *Ramcia* is eccentric enough to go further than *Pelorempis* in having at once a short proboscis, scales on the longitudinal veins (but not on the head or body), and a larva with several peculiar characters. I am not prepared to say whether those who have made a special study of the group would assign it to the Culicidæ (*sensu suo*) or the "Corethridæ." It differs from both groups in certain venation-characters, more especially as regards the position of the tip of the first longitudinal vein; but the larva on the whole resembles that of *Corethra*, and if the sub-family Corethrinæ is to be maintained, I would assign *Ramcia* to it.

I.—Description of the Adult Fly.

Ramcia,* gen. nov.

The venation is culiciform in general disposition, but is characterized by the fact that the first longitudinal vein, running almost parallel to the subcostal, reaches the costal border at some distance from the distal margin of the wing. The basal and marginal cells are elongate and narrow, and the cross-veins are situated near the centre of the wing.



Venation of the two Corethrinæ as yet known to occur in Ceylon:—A, *Ramcia inepta*, sp. nov. B, *Chaoborus asiaticus* (Giles), a species which occurs at Peradeniya.

c = costal border; $s.\ c.$ = subcosta; 1 = first longitudinal; 2 = anterior branch of second longitudinal; 2′ = posterior branch of the same vein; 3 = third longitudinal or median vein; 4 = anterior branch of fourth longitudinal; 4′ = posterior branch of the same vein; 5 = anterior branch of fifth longitudinal; 5′ = posterior branch of the same vein; 6 = sixth longitudinal.

* Named, by special request of Major MacDougall, after the Royal Army Medical Corps.

The wing-margin (except the anterior proximal part) and the distal half of all the longitudinal veins are clothed with true scales, the proximal half of some of the longitudinal as well as the whole of the cross-veins bearing flattened hairs.

There are no scales on the head, body, or legs.

The eyes of the male as seen from the side consist of a transverse basal and a narrow vertical portion. The proboscis is short and feeble, much shorter than the palpi, which consist of four joints. The antennæ have fifteen joints, of which the first is minute, the second large and globular, and the remaining thirteen (the flagellum) almost cylindrical, but tapering slightly at the distal end, verticillate, and clothed with fine hairs.

The legs are moderately slender. They are clothed with stiff hairs and have simple, smooth-edged claws. The first tarsal joint is longer than the two succeeding joints together. The claws are smooth-edged and simple.

The male claspers are of simple structure.

The venation of this genus approaches that of the Psychodidæ as regards the position of the tip of the first longitudinal vein, but is of a less simple character.

Ramcia inepta, sp. nov.

The abdomen is dark in colour, the thorax paler but probably reticulated or mottled with some dark shade. The wings are pale, except for an interrupted dark crossbar which embraces the extremities of the subcostal and first longitudinal veins, includes the petioles of the first submarginal and the second posterior cells, and appears in the form of spots on the costal and posterior wing-fringes, the anterior branch of the fifth and the distal end of the sixth longitudinal vein, completely omitting the third longitudinal and the main stem of the fifth. The spot on the posterior margin is considerably in advance both of that on the anterior margin and of that on the sixth vein. The tips of all the tibiæ and the three distal joints of the tarsi of the first and second legs are dark.

The subcostal reaches the costal margin a little in front of the middle of the wing, and the tip of the first longitudinal is not much in advance of it. The second longitudinal vein is angulate at its junction with the third, and its fork is a little in advance of that of the fourth. The anterior cross-vein is extremely short. The anterior branch of the fifth longitudinal arises only a short distance behind the posterior cross-vein. There are no longitudinal incrassations or false veins, and the seventh longitudinal is entirely absent.

The wing is moderately narrow, bluntly rounded at the tip, its anterior border being nearly straight and its posterior border regularly and not very strongly curved.

Each joint of the flagellum of the antenna (of the male) bears a circle of very long stiff hairs at its base, and is clothed for the greater part of its length with shorter and softer hairs. The first joint of the flagellum bears also several additional circles of long stiff hairs. The first joint of the antenna is very small and inconspicuous, the second nearly half as large as the head. The third (*i.e.*, the first of the flagellum) is of moderate length and practically cylindrical. Joints 3 to 10 are subequal, joints 11 to 13 also subequal, but distinctly shorter than 3 to 10.

The fourth joint of the palpi (of the male) is the longest, the second the shortest, the first and third being subequal. The basal joint is clavate, the others cylindrical; all are clothed somewhat sparsely with slender hairs.

The legs are not very long; they are densely clothed with long straight hairs, among which shorter hairs are dispersed. The hind tibiæ are slightly incrassated at the tip. The femur and tibia of each leg are subequal, and in the first two pairs either joint is distinctly longer than the first tarsal joint, which in its turn is longer than the next three joints together. In the hind leg, however, which is longer than either of the other two, the tibia is only slightly longer than the first tarsal joint, which is shorter than the next three joints together. The claws are slender and strongly curved.

There is a small bunch of stiff slender hairs on the vertex just behind the eyes and another just in front of them. The thorax is sparsely clad with longer and stouter hairs, most of which curve backwards. The scutellum bears a very prominent bunch. The hairs on the abdomen, which are also scattered somewhat sparsely, are finer, more slender, and apparently softer.

The basal joint of the male claspers is cylindrical, about three times as long as broad and of about the same length as the distal joint, which is slender, not very strongly curved, narrowly blunt, and a little irregular at the tip. This joint is naked, but the basal joint is clothed in long hairs.

Length 2 mm.; length of wing 1·3 mm.

II.—Description of the Larva and Pupa.

The larva differs considerably from any that has previously been described, but bears a certain purely superficial resemblance to that of *Stegomyia*. Its most conspicuous features are its broad triangular head, minute eyes, long jaw-like antennæ, which arise close together in front of the head, and the distinct segmentation of the thorax. There are no palmate chætæ on any part of the animal. When fully adult it measures about 2·5 mm. in total length, its head measuring 0·53 mm. by 0·72 mm.

The head is flattened as well as broad, triangular in outline, pointed in front, but with the posterior lateral angles broadly rounded. The antennæ arise close together at the anterior end, each on a small prominence. They are slender and somewhat depressed, each bearing at the tip three stout and rather lengthy chætæ. Pressed backwards in their natural attitude of repose their tips lie opposite the ocelli, which are dark, very minute, and circular in outline. They are situated on the dorsal surface near the lateral margin. There are no compound eyes. Fine sensory hairs are arranged as follows on the dorsal surface of the head: one on each side a short distance behind the base of each antenna, one just outside each eye, and a row of about five parallel to the lateral margin, a short distance in front of each eye. There is an S-shaped row of short, stout, simple chætæ on each side of the head, commencing on the dorsal surface a short distance behind the eye and curving down on to the ventral surface. Immediately posterior to the bases of the antennæ, on the middle line of the ventral surface, there is a bunch of slender pectinate chætæ which probably can be extended forwards, but in my specimens is folded backwards. The mandibles bear at the anterior end of their inner margin two stout rather blunt teeth, the outermost of which is the smaller of the two. Below these and on a different level six other teeth form an uninterrupted series, the first being the largest, the sixth the smallest, and the others subequal. Below the teeth there is a little T-shaped projection. The maxilla is rather slender and deeply notched on its free margin. The whole appendage is covered with minute chitinous projections. Two large chætæ are borne above the notch (the uppermost bearing a short subsidiary tooth on its upper margin) and two below it, the latter pair being very unequal in size. The lower lip is rather narrow, and the teeth on its anterior margin are slender, the central tooth being larger than any of the others, which are arranged approximately large and small alternately. There is a semi-circular row of stout simple bristles at the base of each maxilla, and at each side of the lower lip there are three sensory hairs, one situated near the end of the lip, the other two arising together some little distance posteriorly.

All the segments of the thorax are distinct and transverse. As seen from above, they have an irregularly hexagonal outline, and are produced to a point at each side, both the anterior and the posterior margins being sinuous, or (in the case of the posterior margin of the third segment) distinctly excavated in the middle. Each joint bears on the lateral point a bunch of long simple bristles.

The first segment of the abdomen, which consists of nine true segments, is broader than any of those of the thorax and more markedly produced at the sides, but otherwise resembles them. The succeeding joints are narrower and less distinctly hexagonal in dorsal profile. With the exception of the ninth, they bear a bunch of simple bristles at either side. The siphons are stout, of moderate length, and closely welded together; apparently they lie almost in the same line as the abdomen. They are provided round their free margin with several little organs, probably of a sensory nature and consisting of a minute chitinous structure shaped like a bird's mandible, from the base of which a slender chæta projects. A bunch of long simple bristles arises from the ventral surface of the tip of the abdomen below the base of the siphons. There are no "floats" or "fins."

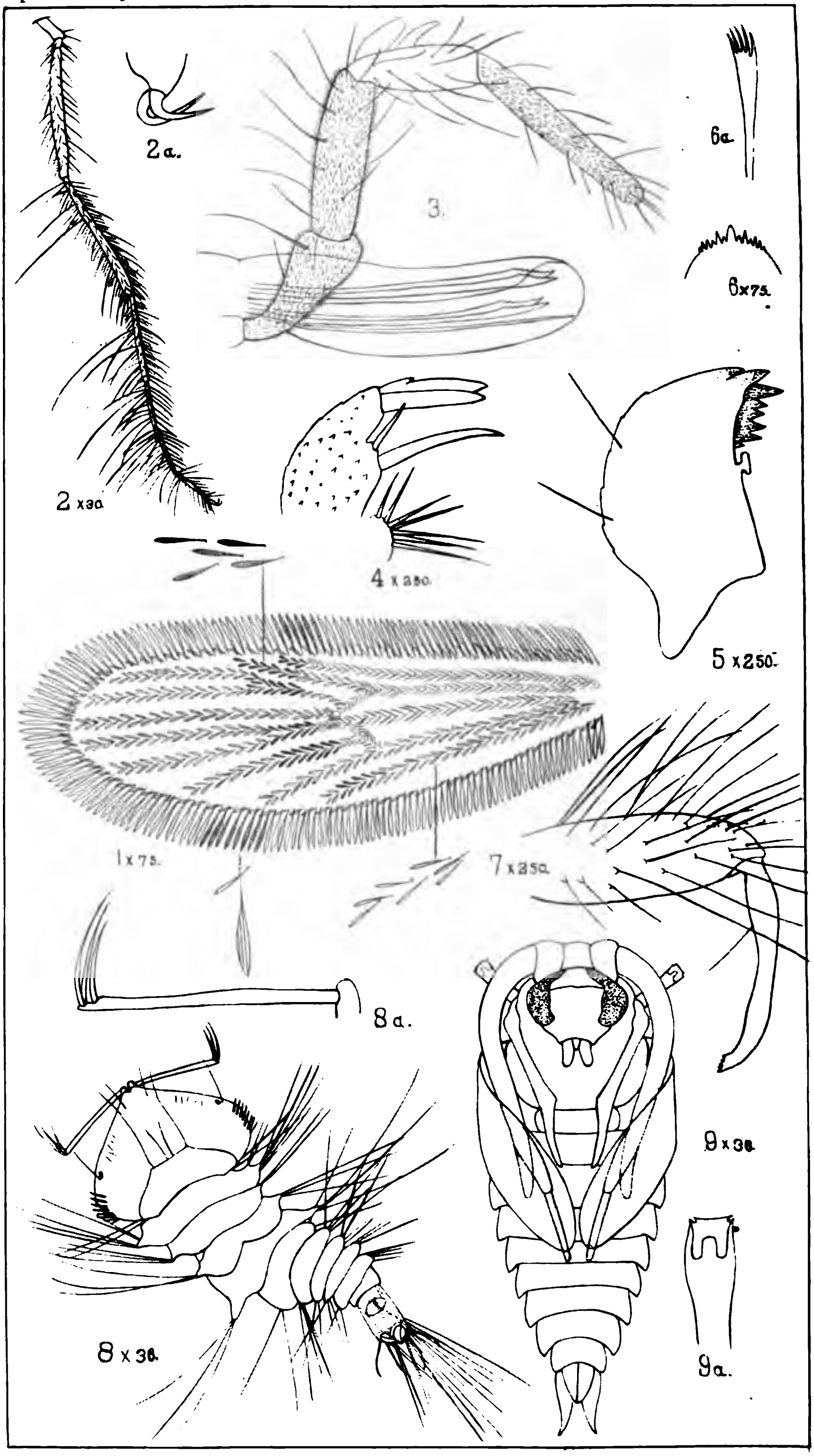
In general structure the larva is not unlike that of *Corethra* (*Mochlonyx*) *velutina*, but the position of the antennæ is different, the head is much broader, the thoracic segments are not welded together, the abdomen is shorter and broader, the siphons are much stouter, and there are other differences.

The pupa of *Ramcia* is not so peculiar as the larva. The general shape is an elongate ovoid, and there is no very clear distinction in the outline between the thorax and the abdomen. The length is about 2 mm. and the greatest breadth about 0·7 mm. The breathing trumpets are long and slender. Their distal margin is distinctly emarginate dorsally, and there is a minute projection in the centre of the emargination. The antennæ curve round entirely outside the eyes. The wings extend to the ventral surface of the abdomen and nearly meet in the mid-ventral line. The abdominal segments decrease gradually in width from before backwards. The tergites are produced laterally in a triangular form, and their free margins are minutely denticulated. The anal lamellæ are slender and pointed; they also are minutely denticulated round the edge.

This pupa differs from that of most Culicidæ in not having the cephalo-thoracic mass distinctly separated from the abdomen. The respiratory trumpets differ from those both of *Culex* and of *Corethra*, but resemble the latter more nearly.

Unfortunately direct information as to the habits of the larva is not forthcoming, but light on this subject may be obtained by a study of the structure. The structure of the thorax indicates great freedom of movement, while that of the antennæ suggests that these organs are employed in seizing prey. There can, I think, be little doubt, therefore, that the larva is actively predacious. The points in which it differs anatomically from the larva of *Corethra* (*Mochlonyx*) *velutina* are not so great as those which distinguish the latter from the larvæ of *Chaoborus plumicornis* and *Ch. pallida*, and it is not too much to assume that in each genus the larval peculiarities are adaptive and due to differences in habits and environment rather than genetic divergence.

The swamp in which the original larvæ were taken has been drained, and neither Mr. Green nor Major MacDougall, both of whom have been kind enough to search for further specimens, have been able to obtain more. It is, however, desirable that dry specimens of the imago should be examined, if only to satisfy those entomologists who regard the superficial character of colour as the most important.



D. Bagchi, del. et lith.

Explanation of Plate.

Ramcia inepta, nov. gen., nov. sp.

1. Wing ($\times$ 75), with scales from different parts further enlarged.
2. Hind leg ($\times$ 30): 2a, claws further enlarged.
3. Proboscis and right palp of male (enlarged).
4. Right maxilla and bunch of bristles at its base ($\times$ 250).
5. Right mandible ($\times$ 250).
6. Lower lip ($\times$ 75): 6a, pectinate chæta from bunch in front of lower lip.
7. Clasper of male ($\times$ 250).
8. Larva from dorsal surface ($\times$ 36): 8a, antenna further enlarged.
9. Pupa from ventral surface ($\times$ 36): 9a, dorsal view of breathing trumpet further enlarged.

SOME REMARKS ON THE OCCURRENCE OF CESTODES IN CEYLON.*

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THERE are few groups of animals in Ceylon concerning which so little is known as the Cestoda. As far as I have been able to ascertain, prior to 1902 only the following Cestodes were recorded :—

Tænia solium, Rud., from man.

Tænia saginata (?), Goeze = *Tænia mediocancellata*, Kuch., from man.

Dipylidium caninum, L. = *Tænia elliptica*, Batsch. = *Tænia cucumerina*, Bloch., from dog.

Tænia saginata has since been definitely identified.

In consequence of the visit of Professor Herdman to the Pearl Banks in 1902, fifty-two new species were described by Shipley and Hornell in Herdman's "Ceylon Reports." Since that time nine other new species, also from marine fish, have been described in Part V., "Ceylon Marine Biological Reports," and a further seventeen new species from the same source are now being described by the writer.

Castellani and Chalmers ("Manual of Tropical Medicine," 1910) report the occurrence of a single case of *Echinococcus granulosus*, Batsch., but this was probably imported from South Africa.

Twelve other species (eleven new) were recorded by Von Linstow (*Spolia Zeylanica*, Vol. III., Part XI., 1906), and seven species (including one *Cysticercus*) were recorded by Shipley (*Spolia Zeylanica*, Vol. I., Part III., 1903).

The total number of Cestodes reported from Ceylon up to the present is therefore 100, described as under :—

Seventy-eight species from marine fish ("Ceylon Reports" and "Ceylon Marine Biological Reports"); two species from man; one species from dog; and the following list :—

Hymenolepis septarai, v. Lins., from *Upupa ceylonensis*.

——— *clausa*, v. Lins., from *Dendrocygna javanica*.

——— *spinosa*, v. Lins., from *Rostratula capensis*.

* From the Ceylon Marine Biological Laboratory (Ceylon Company of Pearl Fishers, Limited).

Tænia spec. (?), from *Haliastur indus*.
Diorchis occlusa, v. Lins., from *Phœnicopterus roseus*.
Davainea polycolcaria, v. Lins., from *Corvus macrorhynchus*.
Diplochetes volvulus, v. Lins., from *Lobipluvia malabarica*.
Ophryocotyle ceylonica, v. Lins., from *Lophoceros gingalensis*.
Brochocephalus paradoxus, v. Lins., from *Ægialitis mongolica*.
Cittotænia bursaria, v. Lins., from *Lepus nigricollis*.
Ichthyotænia cryptobothrium, v. Lins., from *Chrysopelea ornata*.
Aphanobothrium catenatum, v. Lins., from *Phœnicopterus roseus*.
Cysticercus, from *Cervus axis*.
Duthiersia fimbriata, Dies., from *Varanus salvator* and *V. bengalensis*.
Bothridum pythonis, Blainv., from *Python molurus*.
Tetrabothrius erostris, Lonnbg., from *Sterna bergii*.
Tænia polycalcaria, v. Lins., from *Felis pardus*.
Tænia meander, v. Lins., from *Hipposideris speoris*.
Acanthotænia shipleyi, v. Lins., from *Varanus salvator*.

Of these 100 species, the life-history of four only is definitely known, viz. :—

Tænia solium, Rud.
Tænia saginata, Goeze.
Dipylidium caninum, L.
Tetrarhynchus unionifactor, Shipley and Hornell (the pearl-inducing worm).*

Through the kindness of Drs. Castellani and Chalmers I have had the opportunity of examining some parasites from the pathological laboratory of the Ceylon Medical College. The collection contained the following :—

(*a*) Two fragmented specimens of *Tænia solium*, Rud., from man. Heads and a considerable portion of the "anterior" end of the worms absent.

(*b*) Four specimens of *Tænia serrata* (?), Goeze, from dog. All without heads.

(*c*) Eight specimens of *Cysticercus cellulosæ*, Rud. (= *Cysticercus acanthotrias*, Wienl.) from man (described by Chalmers in *Spolia Zeylanica*, Vol. II., Part VIII., 1905).

(*d*) One part specimen without head of *Tænia saginata*, Goeze, from man. Only about the terminal half of the worm was obtained, and this comprised 170 proglottides and measured 250 cms. (over 8 feet). Each segment was approximately 12 mm. broad and from 18 mm. to 19 mm. long. The worm was markedly gelatinous in consistency, opalescent, and milky white in the fresh state.

* In addition to the foregoing, numerous Cysticercoids have been obtained from marine fishes, the adults of which are undetermined.

(*e*) Seven specimens of *Dipylidium caninum*, L., from a dog.

Average length of worm, 85 mm.
Length of largest segment, 6 mm.
Breadth of largest segment, 3 mm.
Total number of segments, 22.

(*f*) One specimen of *Ascaris lumbricoides*, Linn., from man. The specimen was a female of a grayish-brown colour.

Length 230 cm., greatest breadth 7 mm.

In addition to the foregoing, there were several fragments of a Cestode of the genus *Tænia*, said to have been obtained from a rat. No heads were present, and it was found impossible to identify the fragments further.

It will be obvious from the foregoing that our knowledge of the Cestodes found in the common Ceylon animals is very limited.

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Do. Vol. III., Part XI., January, 1906.

AN EXPLORATION OF THE BELIGAL-GE, NEAR BALANGODA.

By C. Hartley.

IN August, 1910, I undertook a partial exploration of the Beligal-ge, or Snail Cave, which is situated about twelve miles north of Balangoda and close to the tea estate of Dikmukalana, belonging to Mr. W. D. Holland.

On a preliminary survey I found the cave placed in a most advantageous position, scooped out of a solid and almost perpendicular cliff of gneiss and some 30 feet above a small rivulet, to which there slopes steeply a bank or talus of earth overgrown with trees. The front of the cave faces nearly due west; and at its southern extremity it plunges almost at right angles 79 feet into the rock. From this point it shallows rapidly, until after a considerable inward bend, forming a second recess in the rock, it grows even narrower, and finally tapers to nothing. The rock roof is lofty in the deeper parts, and the floor of dust strewn with boulders slopes gently downward to the northern end. Although no drip-ledge has been cut, the cave seems absolutely dry within; a small wall of rough stones and earth has been built from the southern end some little distance northward; and the drip from the cliff face falls entirely clear of the interior. In fact no more comfortable cave for inhabitation can well be imagined.

A considerable amount of water finds its way down the cliff face, since a small patch of paddy land is situated immediately over the cave; and the constant drip cutting on the loose soil of the slope at the mouth of the cave has laid bare and collected in pools an immense quantity of quartz chips once embedded in the soil. I carefully examined these fragments, and selected one or two which appeared to be implements. They are immediately distinguishable by their smooth waterworn faces from the sharply angular remains recovered beneath the soil.

I found that the floor of earth inside the cave had been greatly disturbed. Not only had the late Mr. Parsons carried out a small excavation near the southern end, in the course of which he found some human bones and other remains now in the Museum, but it has also been the custom among the neighbouring peasants to dig in the soil for the water-snail shells, from which the cave takes its name, and which they burn for chunam to accompany their betel.

During the whole time that I was engaged in digging a number of women and children were hard at work sifting the earth for shells. These consist principally of *Paludomus gardneri*, and more rarely of *Paludomus dilatata*, *Acavus phœnix*, *Bulimus albizonatus*, *Aulopoma hoffmeisteri*, and *Philopotamis globulosa*, which latter, my workers assured me, were not to be found within fifteen miles. I engaged six men, and started work on August 11 by digging a trench leading from Mr. Parsons's excavation northwards, and incidentally clearing out the hole which he had dug and which had become partially choked. Near the surface we found traces of recent civilization: fragments of pottery, at first stout and well made, later thin and fragile, quantities of charred wood and bones mingled with archaic chips of quartz and chert, buttons, and a short length of cheap brass chain. Under similar circumstances in Europe one might have reckoned confidently on unearthing a few coins; but it is certain that none reached my hands. Between 2 and 3 feet below the surface modern traces disappeared, and nothing came to light but fragments of quartz, chert, bone, and shells. At four o'clock we knocked off for the day, at a depth of 4 feet 6 inches.

As the earth was dug out, it was loaded into baskets, carried outside, and passed through a 1-inch sieve. I selected whatever struck my eye; but it is likely that better work would have been done with a smaller sieve. One or two well-shaped bone implements were recovered by the women sifting the earth for snail shells.

Next day, August 12, we resumed digging at the same place, but in less than an hour we found large boulders which barred our way, and were forced to abandon the hole at a depth of 5 feet.

I thereupon selected a spot at the southern end of the recess in the rock wall already mentioned, and started a trench 8 feet long by 5 feet in breadth. The digging, I may say, is extremely easy work, the earth being light and dry, grayish-brown in colour, and largely composed of sand, ashes, and bats' droppings. We found pottery down to 3 feet, with rare quartz chips; below 3 feet the latter became more numerous. Chert was comparatively scarce, which is all the more surprising, as a boulder occurs in a stream within half a mile of the cave. I examined this later, and found it much splintered, having no doubt been drawn upon for gun-flints and strike-a-lights. In this second excavation some bones were recovered showing knife-cuts and, at a considerable depth, a small waterworn fragment of plumbago. At a depth of 7 feet 6 inches we were again stopped by boulders; but snail shells and quartz chips were withdrawn by hand from under these.

A thickness of 7 feet of cave-earth would in Europe lead us to assign a very remote antiquity to the bottom layer. Unless a cave is exposed to floods, such earth can only be composed of wind-borne dust and of particles adhering to the feet of beasts or men who made the cave their home; and it is unlikely that such fine matter could be deposited at a rate of more than 1 foot in a thousand years. In the tropics, however, another agent of accumulation must be reckoned with. All caves in Ceylon swarm with bats; and their droppings even in a single year would add appreciably to the earth, while in a century they might, if undisturbed, perhaps amount to over a foot in thickness.

On the morning of August 13 I opened a trench outside the cave in the sloping bank, heading at first uphill towards my second excavation. The soil here, being exposed to the action of rain, differed totally from the cave-earth from which it was derived. I excavated a considerable area, and found a uniform surface layer of black humus mixed with ashes, pottery, bones, shells, and chips to a depth of 2 feet. Below this we found stiff reddish-brown soil without ashes, but with quantities of quartz and chert chips, which grew ever rarer; until at a depth of 3 feet in the brown earth, or 5 feet from the surface, all traces of human work came to an end. In the brown earth I found neither pottery nor shells nor bones nor any sign of fire. Yet it was in the soil immediately below the layer of ashes that I found chips of quartz and chert most abundant. After carrying my trench 12 feet towards the cave, and meeting with more boulders, I dug another at right angles to the first for a distance of 6 feet and found precisely similar conditions.

The Doctors Sarasin in their "Ergebnisse naturwissenschaftlicher Forschungen auf Ceylon," published in 1908, describe on page 14 the excavation of a similar "talus" in the Bintenna; but they appear not to have found the same sharp dividing line between the black humus (which they do not record as containing ashes) and the brown earth rich in quartz fragments. It seems to me however that the brown deposit, which was evidently blown, kicked, or swept out of the cave above, must have required a lengthy period, perhaps some thousands of years, for its formation; that the underlying layer free from chips was accumulated previously to man's appearance; that the layer with chips and without ashes points to a period when man lived without fire; and that only the uppermost layer proves his acquaintance therewith. Too much stress must not be laid upon the results of a single excavation; but I look forward with interest to further researches.

This concluded my labours in the cave. I explored a few hill-tops in the neighbourhood, found a moderate number of quartz chips, and noted a large outcrop of good white quartz close to the cave. There is a considerable deposit of hard and heavy titanic iron ore within a few yards of the quartz; but I could not find that any use had been made of it by the cave-dwellers.

The harvest of implements which I reaped was a modest one. I brought away over five hundred specimens, of which a little over fifty have found their way into my collection. The best were a few bone needles or borers, two good hammers, and a certain number of blades, points, and scrapers. One waterworn pebble of micaceous gneiss has plainly been used as a rubber, both ends being much worn. But the conclusion is forced upon one, either that the cave-dwellers were very indifferent workmen, or that they were lacking in that quality so valuable to archæologists, of leaving their tools about.

On comparing the results of my digging with those achieved by the Doctors Sarasin, I find a general similarity, except in the case of the talus already mentioned. The identifiable animal remains were more numerous in their excavations in the Bintenna. It appeared to me that bones were surprisingly scarce in the Beligal-ge, those of the larger animals, such as deer and pig, being entirely wanting, while the enormous number of water-snail shells proved that my cave-dwellers were satisfied with the humblest fare. The implements of quartz, crystal, and chert were neither more nor less rude in the one case than in the other. A distinguished archæologist in England has favoured me with the following remarks: "The Veddas—if it be they who made them—must have been a very degraded people, worse than the most degraded we find about here of any period, except perhaps one lot who seem to have come for a short time in a short interglacial period." These scathing sentences are absolutely justified by the roughness of the specimens—good palæolithic work is as far superior to them as it is inferior to good neolithic work. The immense numbers of chips, cores, and refuse prove that the makers had abundant practice. The Doctors Sarasin note with justice the intractability of quartz as compared with flint. But the same plea cannot be admitted in the case of chert, and the chert implements recovered so far from caves are as rude as those of quartz and crystal. It is notable that a far higher level of workmanship and design is attained by implements found on hill-tops, and on the evidence before us I am inclined to believe that the cave-dwellers represent the oldest and rudest type, while their descendants, armed with improved weapons and disdaining the wretched fare of their ancestors, forsook the caves and led an ampler and freer life on the hills, following the game in their seasonal migrations.

Of animal remains discovered, the most important were the snails already mentioned, which seem to have formed their principal food supply. In addition, a fair number was found of the non-edible *Helia* (*Acavus*) *phœnix*, described by the Doctors Sarasin as the "Hobelschnecke," or Plane-snail, used for smoothing wood, of which specimens are to be seen in the Museum. Bones of the following animals have been identified by Dr. Pearson: Madras langur (*Semnopithecus priamus*) and mouse deer (*Tragulus meminna*).

On the other hand, the list of things which one would have liked to find, but did not, would fill several pages.

REVIEW.

The Veddas: by C. G. Seligmann, M.D., and Brenda Z. Seligmann. Cambridge University Press. 1911.

THIS handsome volume of over four hundred pages, with seventy-one plates, thirty-four musical records, numerous songs, and a vocabulary, may be taken as summing up all that we know or are likely to discover of the history, the traditions, and the usages of the fast vanishing race whose purest representatives are estimated by Mr. Parker at less than one hundred persons. An average of over four pages to each individual of a semi-savage tribe may seem excessive to those who do not reflect that the lower the type, the greater the interest; and that, if a race could be discovered living under palæolithic conditions, an allowance of pages twice as generous as we have here would be eagerly demanded.

Dr. and Mrs. Seligmann have gone to the root of the matter. They forsook civilization for a time to live intimately with the Veddas. They have shared their meals and their primitive accommodation; they have been near them in sickness and in health, in festivity and in mourning; and we may well believe the handsome acknowledgment made in the preface to Mrs. Seligmann; "I feel convinced that the measure of success attained in gaining the confidence of these shy and extremely jealous people was entirely due to her presence and assistance."

A full but discriminating use has been made of previous writers on this subject. The works of Knox, Tennent, and Parker are widely known; but those of Virchow, Rutimeyer, and the Sarasins are mostly in German; while much important information is contained in stray articles by Bailey, Nevill, Hartshorne, and others, which is here conveniently summarized. The question of prehistoric stone implements is dismissed with one plate and five pages. We cannot but think that more use might have been made of the researches of the Sarasins and of the collections of Messrs. Pole and Green. For the matter as a whole we have nothing but praise. The authors expressly state that "this volume will scarcely touch on physical anthropology"; but a careful examination has been made of the Veddas' social and family life, religion, magic, ceremonies, music, language, and senses. There is very little in the book which will not be understood by any intelligent reader; but we think that the mode of testing for sight might have been explained at greater length for the benefit of the uninitiated.

Of the numerous illustrations, a few are partial failures owing to the forest gloom, but have been skilfully doctored, or, as Dr. Seligmann terms it, "faked." The greater part, however, are vivid presentments of wild life, and one, No. LV., "Nila holding bow while reciting invocation," rises to the level of fine art.

The "Conclusions" form the shortest chapter, and the authors agree in the main with Mr. Parker's theory that the upper ranks of the Veddas were absorbed by the conquering Sinhalese, who in their turn were influenced by the customs of the vanquished; while the Veddas represent the untamed remnant who by accident or choice resisted or escaped absorption.

A useful warning is given to tourists not to accept the Danigala Veddas as the children of nature they pretend to be.

"These folk, who when we saw them wore their Vedda loin cloths and were smeared with ashes, are reported to wear ordinary Sinhalese cloths when not in their professional pose, and Mr. Bibile, who has himself seen one or more of them in sarongs, points out that the imposture is kept up for two main reasons: firstly, they fear that their cultivation might be stopped, or that they might be taxed if they did not appear to be poor fellows living on hardly-won jungle produce; secondly, their pose of poverty interests strangers and procures them visitors, whose generosity is the greater, the more primitive their mode of life appears to be."

These gentlemen, under a more extended franchise, will vote solidly for converting Ceylon into a great winter resort for passengers.

C. HARTLEY.

NOTES.

17. *Further Note on Flies of the Genus "Phlebotomus."*—Recent additions to the collection in the India Museum, including a number of specimens received from Mr. E. E. Green, enable me to supplement, and in one or two points to correct, my former notes issued in Vol. VII. (pp. 57–62) of *Spolia Zeylanica*, while the publication of detailed descriptions of the species found in the Maltese islands by Mr. R. Newstead has made it possible to come to a decision as regards the identity of *P. minutus*, Rondani, and my own *P. babu*. In the first place, I may note that the examination of a large series of specimens of *P. argentipes* from different parts of India and from Peradeniya in Ceylon shows that the peculiarities in venation exhibited by the form I described as *P. marginatus*, great as they appeared to be, are not beyond the limitations of variation found in the former species. I have, moreover, taken specimens in Calcutta the colouration of which agrees closely with that of the form *marginatus*. I am therefore forced to the conclusion that this form must be regarded merely as a variety of *P. argentipes*. It should also be noted that the figure of *P. zeylanicus* printed in my former paper (p. 60, fig. 4) gives, because of the angle at which the wing was drawn, a somewhat incorrect idea of the venation in that species; fig. 5 on the same page is more exact in this respect.

As I suggested would prove to be the case, my *P. babu* is clearly identical with Rondani's *P. minutus*. Mr. Newstead's careful description and figures (Bull. Ent. Research, II., pp. 62, 69–70, 1911) leave no doubt as to this, differences in proportions noted by him being evidently due to nothing but the method of preparation and examination of specimens. I can confirm his statements in every particular from specimens of *P. babu* examined in a fresh condition or preserved in spirit without further treatment.

The changes proposed in this note therefore are—

(1) that *Phlebotomus marginatus* should be known as *P. argentipes*, var. *marginatus*; and

(2) that the name *Phlebotomus babu* should be sunk in favour of *P. minutus*.

As regards the former point, it is interesting to note that several, perhaps all, species of the genus exhibit a curious colour-dimorphism which is apparently not due to season or locality, and certainly is not sexual. Thus, *P. papatasi* exists in Malta, according to

Newstead, both in a "typical pale form" and in a "dark form," and the same is the case with *P. minutus* in Northern Bengal and with *P. major* in the outer Himalayas (see Rec. Ind. Mus., IV., p. 340, 1911).

N. ANNANDALE.

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18. *Contest between a Mynah ("Acridotheres tristis") and a Locust ("Acridium violascens").*—I was a witness a short time ago of a very good instance of the method of defence in a locust when attacked by a bird. The mynah in question was quite tame, and had the run of the house and garden; the locust flew on to the verandah, and in its usual blundering flight hit against the wall and came to the ground. It was immediately pounced on by the mynah, but at the moment of seizure the insect rolled slowly on to its side, drawing up the long hind leg and exposing to view the gray and black ocellated spots surrounding the spiracles. They certainly gave the insect a bizarre appearance, which was not without effect, as the bird immediately drew back obviously disconcerted. After a moment of hesitation it cautiously approached its beak within two inches of the locust, when again the leg was slowly drawn back, evidently also with the intention as a last resource of striking the bird a smart blow with the sharply serrated ridge of the tarsus. This had the effect of again postponing an attack, and two or three times the same manœuvre was repeated on the approach of the bird's bill. It was very remarkable how the insect seemed to know that the startling effect was more pronounced the more slowly it moved over on to its side, and its apparent intelligence to be aware that it had, so to speak, only one shot in its locker which was to be used as a final resource. It was clear that once it had struck out, and possibly missed its object, the bird would have been immediately inside its guard, with disastrous consequences. Whether the above comes under the heading pseudaposematic defence (false warning colouration), *i.e.*, the assumption by a defenceless insect of a terrifying attitude, or aposematic, or warning character of an insect able to protect itself, is not quite certain, but probably the latter; which ever it was, it was quite clear to my mind that the insect derived distinct advantage from its terrifying attitude, and displayed an almost human intelligence in its use.

I may add that the bird eventually gave up the contest, and the locust made good its escape.

N. MANDERS.

Note.—Since writing the above, it has occurred to me that an objection may be made to this interpretation; the argument being that the bird's natural food was locusts and grasshoppers, which it caught in large numbers in the garden, and therefore it must have been well aware of these terrifying marks, and knew that as a practical defence they were useless, and further, that as it was acquainted with the formidable hind leg, it purposely put its beak within striking distance in order to draw its opponent's fire and render it for the moment harmless.

It is somewhat doubtful in my judgment that the above objections are correct; in the first place, the bird quite likely may never have seen these startling spiracles, as they are normally hidden by the legs and wing covers and would not be visible under normal circumstances; and again, if the insect had not by some means been aware that a certain amount of protection was obtained by them it would not have rolled slowly on to its side, by which means a greater effect was produced, but as quickly as possible in order to draw up the hind leg, its only means of defence.

I mention these objections in order to show how two trained observers might well draw different conclusions from the same facts.

N. M.

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19. *The Effects of the Bite of "Ancistrodon hypnale."*—The other day I was bitten on the ball of the thumb by one of my *Ancistrodons* (I have been keeping a few in captivity). Although I had been previously bitten without any effect, I washed my thumb in a strong solution of permanganate of potash and applied a ligature of string above the bite, as the latter was a bad one, the fang having been broken off and left sticking in my thumb almost up to its base. My thumb then turned blue (due I think to the ligature, and not to the poison), and not wishing to take any chances I visited a native "Vedarala," who put on what he called a "caustic," though it did not burn at all, and only caused a slight smarting. Upon removal of the ligature my thumb returned to its normal colour and became very stiff and swollen, as if it was going to burst; there was also a slight local tenderness and aching. About five hours afterwards the swelling began to subside and the stiffness to go, and the thumb became quite well in about twelve hours. Personally, I think that the effect of the poison on the blood was practically nil, and that all the symptoms were entirely local, resulting from the ligature, which I drew extremely tight. There was no sign of mortification about the place bitten.

A. F. ABERCROMBY.

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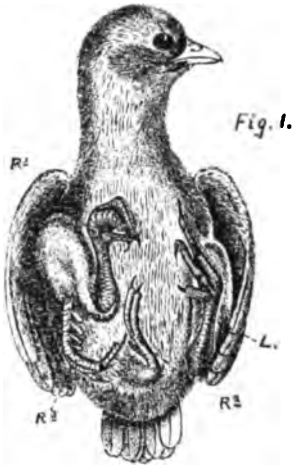
20. *Notes on Ceylon Snakes.*—The commonest of Ceylon snakes are perhaps the following: *Zamenis mucosus*, *Dryophis mycterizans*, *Naia tripudians*, *Lycodon aulicus*, *Dipsas ceylonensis*, *Dendrophis*

bifrenalis, *Oligodon sublineatus*, *Vipera russellii*, *Tropidonotus stolatus*, *Tropidonotus asperrimus*, and *Helicops schistosus*, though the list may vary greatly in different localities, *Ancistrodon hypnale* and *Python molurus* being both common in the northern jungles, while *Trimeresurus trigonocephalus*, so often met with in the Central Province, is rare in the north. I once encountered a young python at Yala, in the Southern Province, during the dry season, a most unlikely place to expect one, owing to the dry sandy condition of the district. It had probably worked its way down the river from the jungles further north.

Among the less common varieties I have found several specimens of *Dipsas forstenii* and *Dipsas barnesii* round Anuradhapura, though I have never come across these in the Central Province or round Kurunegala, though at the latter place are some colonies of *Tropidonotus plumbicolor*.

Snakes usually choose the type of country that suits their colouration, which country also suits their habits. Of all Ceylon snakes, the colour of *Python molurus* is the most inexplicable. It certainly blends with the sun and shadow effects of the jungle in a way which a uniform colouration would not do; but what is the reason for this protection. It is not hunted sufficiently to render protection from man necessary, and there are no other enemies to prey on it. When young, a python might be attacked by a mongoose, but when as small as all that a uniform colouration would not be conspicuous and would serve as a protection. Allowing that the python is "aggressively" coloured, it must be remembered that the latter is usually nocturnal in its habits, waylaying its prey after or about sunset, when its "sun and shadow" colour would be of no avail. The only conclusion is that the python is not as nocturnal as is commonly supposed, and probably waylays its prey at about six o'clock in the evening, when in the remote jungles the deer and small game go down to the tanks and water-holes to drink, though in more civilized and open country the game confine their drinking to after dusk.

Another common Ceylon snake, *Lycodon aulicus*, causes much needless alarm by its resemblance to *Bungarus ceylonicus*, and is much feared by the natives on that account, who mistake it for the deadly "krait," as the *Bungarus* is called in India. *Lycodon*, however, is very common, while *Bungarus* is rare in Ceylon; the former being distinguished by its pear-shaped head and regular scaling, and the latter by its enlarged hexagonal vertebræ. If the snake is over 26 inches long it is probably a *Bungarus*. Of the two species of *Bungarus* found in Ceylon, *Bungarus ceylonicus* is rare, while *B. cæruleus* is very rare indeed, and even of the former I have only obtained two specimens, both from Rangalla, in the Kandy District. Owing to their snake-eating propensities they probably keep to the mountainous districts, where there are many



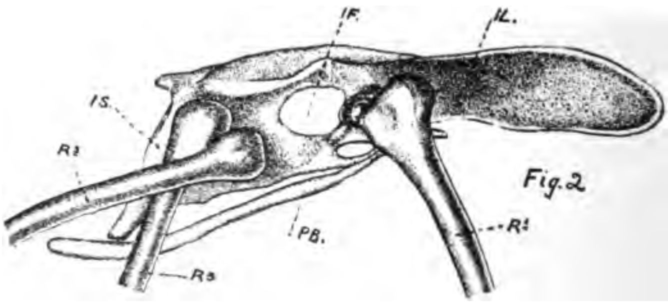


FIG. 1.—Abnormal chicken, ventral view. × ½.

R¹ Normal right leg.
R² and R³ Abnormal right legs.
L. Left leg.

FIG. 2.—Skeleton of pelvic girdle, showing attachment of the three right legs.

R¹ Femur of normal right leg.
R² and R³ Femurs of abnormal legs.
IL. Ilium.
IS. Ischium
PB. Pubis.
IF. Ilio-sciatic foramen.

earth-snakes. In fact, at the Zoological Gardens in Regents park it has been found impossible to make them eat anything but other snakes.

The pretty whip-snake, *Dryophis mycterizans*, has a peculiar habit, if caught and placed somewhere where it cannot escape, of raising itself up, opening its mouth, and expanding the lower jaw into the form of an oblong, which gives it a most ferocious appearance. Although I have repeatedly noticed this habit in low-country specimens, yet I have never seen one of the up-country snakes do it, though I have kept many of them.

Very much the same aggressive behaviour is to be seen in *Tropidonotus stolatus*, which puffs out its body in resemblance of a viper, while the rat-snake will often raise itself up and expand its neck with air, in emulation of the cobra.

Considering how closely allied *Trimeresurus trigonocephalus* is to the American *Crotali*, its custom of vibrating its tail rapidly when irritated is peculiar, but I do not think this habit is in any way due to its relationship to the rattle-snake, as I have noticed the same behaviour in *Dipsas ceylonensis*.

In view of the discussion which recently occurred as to the species of *Dendrophis* commonly found in Ceylon, it may be of interest to say that when last in England I asked Mr. G. Boulenger about it, and he gave it as his opinion that *D. bifrenalis* was the common variety, though there was very little distinction between it and *D. pictus*.

A. F. ABERCROMBY.

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21. *Abnormal Chicken with Four Legs.*—Some months ago a newly-hatched chick of the common domestic fowl was brought to me. The bird was peculiar in having two supernumerary legs—both on the right side of the body (see fig. 1). Such abnormalities in birds appear to be by no means uncommon. I was interested to see how the two additional legs were attached to the pelvic girdle, and for this purpose a skeleton of the specimen was prepared. Owing to the soft nature of the bones this process was by no means an easy one.

The heads of the two additional femurs did not appear to be fitted into sockets, but the two bones were plastered down flat on the side wall of the right ischium (see fig. 2). The heads of the two femurs lay quite close together, and the two bones crossed over each other. The interesting point about these two limbs was that there was no tibio-tarsus present. Each femur was directly connected with the tarso-metatarsus. The femur and tarso-metatarsus of each supernumerary leg was the same size as the similar parts in the normal legs. Each supernumerary leg had only three toes.

Measurements taken.

Total length of chick from beak to tip of tail 125 mm.

Lengths of normal legs (R^1 and L)—

Femur 21 mm.

Tibio-tarsus 33 mm.

Tarso-metatarsus 21 mm.

Foot with four toes, longest toe 24 mm.

Lengths of extra legs (R^2 and R^3)—

Femur 21 mm.

Tarso-metatarsus 21 mm.

JOSEPH PEARSON.

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22. *Sun-fish caught near Jaffna.*—In May last I received word from the Government Agent, Northern Province, of the capture of a peculiar fish in Kayts harbour, near Jaffna. A photograph of the fish was sent on to me, and is here reproduced. So far as I can make out it is a specimen of *Orthagoriscus truncatus*, a fish which has a very wide distribution throughout the Atlantic and Pacific. So far as I am able to determine this is the first time this species has been recorded from Ceylon waters. In 1885 a small sun-fish was caught off Colombo and created a small sensation. The fish was exhibited in the Pettah, and hundreds of natives paid a small fee to see it. It is unfortunate that the fish was not identified nor obtained for the Museum collections.

The present specimen agrees with *O. truncatus* in having small hexagonal markings on the skin. In the original photograph these markings were readily made out on the side of the body with the aid of a hand lens. The size of the specimen was—

Greatest length 26 inches.

Greatest height 13 inches.

Greatest thickness 4 inches.

The photograph which is reproduced was sent by the Government Agent, Northern Province.

JOSEPH PEARSON.

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23. *The Giant Tortoise at Galle.*—Rambling about the grounds of Hirimbura, Garstin Hill, Galle, at present occupied by Mr. J. Black, is a fine old giant tortoise belonging to the same species as the old Colombo tortoise, viz., *Testudo gigantea*. This is undoubtedly the "Matara tortoise" to which I have already referred in *Spolia Zeylanica*, Vol. VII., Part XXVI., p. 109. The history of this tortoise

Sun-fish caught near Jaffna.

is by no means clear, and previous to the year 1843 nothing seems to be known about it. Mr. Black writes from Galle as follows: "He has been at the Hill as long as the oldest inhabitant can remember. Though quite active he is blind in one eye, and I do not think sees very well with the other...... I wrote to America to Mrs. Garstin, an old lady of ninety, the widow of the Rev. Norman Garstin, D.D., who lived many years at Hirimbura as far back as 1843. She could not remember how the tortoise came to the Hill. Her son, also in America, writes that he remembers riding the tortoise when a boy. He left Ceylon about 1860." Mr. Paul Pieris, C.C.S., writes as follows: "The Galle tortoise is at Garstin Hill, about three miles from the fort, a spot which is very prominent as one sails past Galle. This tortoise is said to be one of two brought to the spot by Dr. Norman Garstin, Colonial Chaplain of Galle, certainly before 1846. The animal is about four feet across, and is still in fairly good health. It roams about the Hill, eating leaves and the very tender coconuts which drop from trees, and any food that the servants at the house throw to it. Garstin Hill was purchased by Dr. Garstin in part from a clergyman who lives in local recollection as William and in part from the neighbouring villagers. Garstin, I understand, built the bungalow. His administrators sold the land to my kinsman, the late Frederick Dias Abeysinha, Mudaliyar, who in a fit of spleen has left it to the church. I remember the Mudaliyar had some papers which he once showed to me, from which he proved to his own satisfaction that the tortoise was over 120 years old. Where those papers are I cannot say. Perhaps the Bishop may have them among the title deeds. The Mudaliyar was also not unwilling to give the animal to the Museum. Perhaps if the Bishop were informed of this he might carry out his desire. I am sorry that I cannot give you any further information, but you ought to have no trouble about securing a photo of the animal from Galle."

In April last I paid a visit to Galle and saw the tortoise for myself. He is a specimen of *Testudo gigantea*, and is slightly larger than the Colombo tortoise. He seemed perfectly happy, roaming at will through the delightful grounds of Mr. Black's residence, and was quite active.

In addition to the Colombo and Galle giant tortoises, there was still another specimen, which was the property of Mr. A. A. Hankey, of Arncliffe, Colombo. This beast was brought from the Seychelles twelve years ago, and has now been sent to the Trevandrum Zoological Gardens in India.

JOSEPH PEARSON.

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24. *The Gourami.*—In his Administration Reports for 1908 and 1909 Dr. Willey describes the introduction of the gourami into Ceylon. Eventually three were placed in the small tank at the

back of the Museum, and twenty were placed in the large pond in Peradeniya Gardens. In a footnote to Dr. Willey's paper on the Fresh-water Fisheries of Ceylon (*Spolia Zeylanica*, Vol. VII., Part XXVI., p. 96) I wrote as follows: "On November 5, 1910, Mr. Green and I made an examination of the pond at Peradeniya and found no signs of the gourami. Two native fishermen were employed, and they used a vertical net somewhat like a seive net. After an exhaustive search they declared that there were no fish in the pond. The pond overflows into the Mahaweli-ganga, and it is probable that the fish have escaped to the river, although the ledge which guards the overflow would render this difficult but not impossible." Since the above was written, Mr. Pertwee of Colombo has seen some of the gourami in the Peradeniya pond, so that it is not true that all the gourami have escaped to the river. I had the small Museum tank emptied on May 16, 1911, and found the three gourami in a flourishing condition.

No figures are available regarding the exact sizes of the fish when first placed in the tank, but Dr. Willey, speaking in general terms of all the fish imported, said that they measured from six to eight inches in length. Those measurements refer to September, 1909. The following are the measurements of the three fish in the Museum tank taken in May, 1911:—

	(1).	(2).	(3).
Weight of fish ..	1 lb. 2 oz. ..	1 lb. 10 oz. ..	1 lb.
Total length ..	12 in. ..	12½ in. ..	10¼ in.
Height of middle of body ..	6 in. ..	6 in. ..	5 in.

It is highly probable that a further stock of gourami will be imported, and after being suitably labelled they will be deposited in various tanks and ponds in different parts of the country. Here they will be protected to some extent from their natural enemies until they have become acclimatized and have fairly established themselves. If spawning is successful, as undoubtedly it ought to be, the young fry can be gradually transplanted either to other ponds where they will be preserved or directly to the rivers.

JOSEPH PEARSON.

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25. *Proposed further attempt to introduce the Gourami ("Osphromenus olfax") into Ceylon, with notes on a suitable locality.*—The gourami is so well known and so highly prized as an article of food throughout the Far East, that its absence from the rivers and tanks of Ceylon constitutes one of the many mysteries of our local domestic economy. True, several attempts to introduce gourami into Ceylon waters have been made in the past, the earliest of which

I have traced any authentic record being that by Mr. G. M. Fowler some ten or twelve years ago, but this, in common with other efforts since made by private individuals, came to nothing, chiefly for want of knowledge how to protect and propagate them and for lack of observation as to what actually happened after they were liberated in their new environment.

As many readers will remember, the most recent attempt to add this species to our meagre show of palatable fresh-water fish was made in September, 1909, when Mr. Kelway Bamber, at the instance of Dr. A. Willey, brought up a consignment of about forty from Java, most of which were landed in excellent condition. Unfortunately lack of experience on the part of their custodians, or want of time to give them adequate attention, has resulted in yet another failure. The writer had several opportunities of observing a few of the above specimens which were kept for a time in the cement tank at the rear of the Museum, and in spite of their cramped situation they appeared to be doing well, and certainly gained considerably in size and weight. After a few months, however, they developed a fungoid growth immediately above the eye, and this, although apparently no inconvenience to the fish, was thought by Dr. Willey to be a misfortune of sufficient gravity for special investigation. Whether or not the learned Doctor ever determined the cause I have been unable to learn. Probably the restricted space, high temperature of the water, or other local condition was accountable; anyway the appearance of fungoid growths on the eyes of fish is no new thing, particularly in the tropics, and need not be taken into account when considering the advisability or otherwise of introducing a new species.

Dr. Willey's successor at the Museum, Dr. Joseph Pearson, has recently looked into this question of introducing gourami into Ceylon waters, and at his suggestion the writer recently made an examination (or rather inspection) of the Kandy waterworks reservoir with a view to determine its suitability or otherwise as a permanent nursery for the propogation of *Osphromenus olfax*, and possibly other tropical fresh-water fishes which are not at present represented in our inland waters.

For reasons set forth below, I am of opinion that the water in question is suitable in every way, and I strongly advocate the introduction of gourami therein. This fish thrives best in still or gently flowing water, a condition which is admirably filled in the above situation. It is also largely herbiverous, and the water indicated is well provided with subaquatic vegetation of a suitable nature. Marginal feeding grounds, which is an exceedingly important factor where breeding operations are to take place, could easily be provided; at present the banks are kept strictly bare and free from vegetation of any sort. Essentially a tropical species, the temperature of this water is suitable in every way for the propagation of gourami, as I learn it seldom, if ever, drops below 70° F. At the date of my inspection (June 17, 1911), after an unusually long drought, there was 35 feet of water at the outlet, shelving up to a few inches at the intake—an admirable condition for breeding purposes.

There appear to be two natural enemies present, namely, the Indian otter and the fresh-water tortoise, but I do not consider either are sufficiently plentiful to constitute a serious menace, though unless checked they may become so.

I am further of opinion that gourami, if allowed to reach the age of 9 to 12 months, would thrive well in the large lake at Kandy, but the great number of tortoises there renders successful breeding problematical. At present the reservoir contains no fish beyond a few small carp, probably *Barbus mehecola* (black spot), *B. pinnauratus*, and *Rasbora daniconius*.

The fact that this water is close to Peradeniya is a further favourable circumstance, since any experiments that may be decided upon can be supervised by the Government Entomologist or other member of the Peradeniya staff. Further, the reservoir being enclosed and in charge of watchers night and day, the danger of poaching or other interference is reduced to a minimum.

A. H. PERTWEE.

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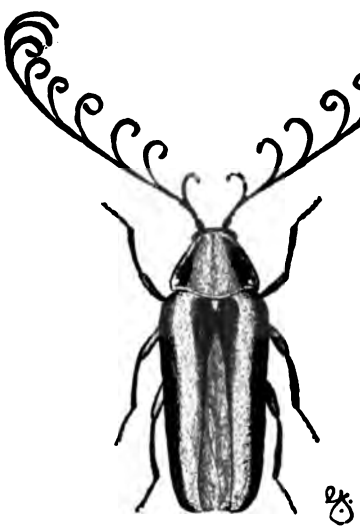
26. *On the Occasional Luminosity of the Beetle "Harmatelia bilinea."*—This small beetle (shown in the figure as magnified about 6 diameters) is extremely abundant, at certain times of the year, in many parts of Ceylon. It may be found resting upon the leaves of various shrubs in the jungle, and is often seen on the wing. It is noticeable on account of its remarkable pectinated antennæ, and may be further distinguished by two conspicuous longitudinal ochreous stripes (one on each elytron) on a black ground.

Although this beetle has been included by Olivier amongst the Lampyridæ (fireflies and glow worms), nothing appears to be known about its luminous properties. I have frequently examined living examples of *Harmatelia*, but have never observed the faintest trace of luminosity, nor does the abdomen show any conspicuous photogenic organ such as is noticeable on the under surface of all the typical fireflies. But that it can, on occasion, produce an appreciable light is proved by the following observation of Mr. John Pole, who, in sending me a specimen of the insect, asks if I am aware that it "gives light at night like a firefly." He reports that, one evening, at 7.30, in a mist and with a clouded moon, he "caught the animal, alight, on a tea bush, and boxed it as a small firefly." He adds that the light paled out before he reached home. The insect was kept



× 6

Harmatelia bilinea.

alive, and Mr. Pole tells me that on the following night the animal again became luminous, but that the light was rather more subdued, and that at no time was it as bright as that of the common firefly. Other examples of the same species, examined by Mr. Pole at the same time, did not exhibit this phenomenon.

Wishing to find out what had been recorded on the subject, I applied to Mr. C. J. Gahan, of the British Museum (Nat. Hist.), who replied as follows: "I believe nothing is known as to the luminous properties or otherwise of *Harmatelia*. The mere fact that Olivier included *Harmatelia* in Lampyridæ counts for little, as I believe the genus was unknown to him until he paid us a visit here a short time ago. Do you know the female of *Harmatelia ?* All our specimens seem to be males .... They (the females) might incidentally throw some light upon the position of the genus. I suspect that the female *Harmatelia* is like the male, except that it has simple instead of pectinated antennæ; my reason for thinking so being that we have one (apparently) female of a species (undetermined) which seems referable to *Harmatelia*. Have you ever heard anything of a glow worm in Ceylon which has a series of emerald green lights along each side of the body? It is just possible that the female of *Harmatelia* may be luminous after this fashion; that it may, in fact, be larviform like the female of the *Phengodini*, of which the males have fine plumose antennæ and are not very different in structure from *Harmatelia*."

An examination of the series in my collection shows that these also are apparently all males—having elaborately pectinated antennæ. So the problem of the female of this insect still remains to be solved. If any readers of *Spolia* should meet with a multi-illuminated glow worm, as described in Mr. Gahan's letter, I would ask them to preserve it and send it to me, dead or alive, but preferably the latter.

Though Mr. Gahan speaks of the single species *Harmatelia bilinea*, Olivier ("Genara Insectorum," fasc. 53) records two species—*bilinea* and *discalis*—from Ceylon, both described by Walker in 1858. A study of my series, comprising specimens from Maskeliya (4,000 to 5,000 ft.) and from Peradeniya (approximately 1,600 ft.), convinces me that we really have two distinct species; but which is which I am not at present in a position to determine. The montane form (from Maskeliya) is the darker of the two, and has the prothorax proportionately smaller; the head black and almost glabrous, with strongly raised frontal ridges above the insertion of the antennæ; the median area of the prothorax uniformly black; the costal margin of the elytra ochreous, and the whole under surface of the body of the same pale tint. The Peradeniya form has the head and prothorax ferruginous red, the latter with a black fascia on each side, which in some examples tends to spread over the central area; the head is sulcate between the antennæ and densely clothed with fulvous hair, and has no markedly prominent frontal ridges; costal margin of elytra black, and under surface of body distinctly fulvous. My figure represents the species (or form) common at Peradeniya. The luminous properties were observed in the up-country species; but the two, if really distinct, are so closely allied that they are unlikely to differ in this respect.

Mr. J. Bourgeois, in a paper on "Malacodermes et Lymexylonides de Ceylan" (Ann. Soc. Ent. France, Vol. LXXVIII., 1909), has described and figured our Peradeniya insect under the name of *Haplogeusis ceylanica*, gen. et sp. nov. This is almost certainly a synonym of either *Harmatelia bilinea* or *H. discalis*.

E. ERNEST GREEN.

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27. *On the probable occurrence of Field Mice in Ceylon.*—Blanford, in his volume on Mammalia ("Fauna of British India"), describes nine distinct species of voles from the Indian region, but not a single one of these is recorded from Ceylon. At present, so far as zoological records are concerned, we have no voles in Ceylon. I am convinced that this omission is not really justified.

During a recent visit to the Horton Plains I saw an animal in the resthouse garden that could have been nothing but a vole. And my companion (Mr. J. C. F. Fryer) observed another (probably of a different species) in a swampy piece of ground near the jungle. The latter individual appeared to be of the nature of a water rat, as when disturbed it took to the water.*

The voles (or field mice and water rats) may be distinguished superficially from the true rats and mice by their comparatively short tails and blunt muzzles. The tail of a vole is never more than one-third the length of its body, while rats and mice have tails that are seldom less than half and sometimes equal in length to the body of the animal.

Will any of our sporting friends help us to establish the occurrence of voles in Ceylon? The Horton Plains are the happy hunting grounds of sportsmen with rod, gun, and hounds, who must have unique opportunities of observing the wild life of the locality. A skin, accompanied by the skull, would settle the matter beyond dispute.

E. ERNEST GREEN.

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* Since sending in this note, I have had independent corroborative evidence of the existence of voles in the higher parts of Ceylon. Mr. W. Ormiston tells me that, while fishing at Ambawella, he has often seen small reddish mice on the banks of the streams. He describes them as having the appearance and attitudes of English field mice.—E. E. G.

28. *On some Butterflies of the Horton Plains.*—At the time of my visit (in the middle of May) butterflies were neither abundant in unmbers or variety. The commonest species in the jungle paths were *Lethe daretis*, *Cyaniris lanka*, and *C. singalensis*. I was somewhat surprised to find at this elevation (between 6,000 and 7,000 ft.) two species that are usually associated with the low-country and the lower montane regions. I caught a single example of *Nepheronia ceylanica* in the resthouse garden, and found *Ypthima ceylonica* frequenting the edges of the jungle. *Ypthima singala*, which usually replaces *ceylonica* in the higher hills, was conspicuous by its absence. Similarly, the typical up-country forms of *Terias*, *venata*, and *libythea* were not seen, though *hecabe* was on the wing.

E. ERNEST GREEN.

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29. *On an interesting aberration of "Vanessa (Pyrameis) indica."* *—A curious aberration of this usually very constant butterfly has occurred amongst examples bred at Peradeniya, presumably consequent upon a stimulus induced by a sudden change of temperature. This butterfly is a distinctly montane species, seldom, if ever, occurring spontaneously below 3,000 ft. in Ceylon, but more frequent at still higher elevations. In India the species is said to range from 2,000 ft. upwards, but to be found more commonly at and above 4,000 ft.

The food plant of *Vanessa indica* is *Girardinia heterophylla* var. *palmata*. According to Trimen, typical *heterophylla* is common on waste land in the low-country up to 3,000 ft., above which elevation it is replaced by its variety *palmata*, which differs from the type form principally in having the leaves hirsute beneath. From its distribution *V. indica* appears to be restricted to the higher montane variety of *Girardinia heterophylla*.

In May last I received from Major A. J. MacDougall some pupæ of *V. indica* collected at Diyatalawa (4,300 ft.), together with a single full-fed larva. The pupæ all disclosed butterflies of the typical pattern, but the single larva, after pupating in the warmer climate of Peradeniya (1,500 ft.), appeared in a strikingly different form.

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* Since the preparation of my note on an aberration of *Vanessa indica*, I have seen a description and coloured figure of what must be a closely similar aberration from Southern India. This account is in a paper by Mr. P. J. Lathy, "On some aberrations of Lepidoptera from the collection of Herbert J. Adams" (Trans. Ent. Soc. London, 1904, p. 65). The locality quoted is merely "Travancore, S. India." The circumstances of the capture are not given, nor the altitude at which it was taken. It would be interesting to know whether this specimen was caught on the wing, or whether (like my examples) it had been bred from larvæ taken at a higher elevation.—E. E. G.

The main characters of the aberration are as follows. On the upper side the red area on the fore-wing is more widely extended, obliterating the usual black patch in the middle of interspace 1, and the submarginal red band on the hind-wing does not include the black spots that are found in typical examples. On the under side the differences are still more marked; the red area on the fore-wing is even more widely extended, and the subapical white streaks and spots in the black area have disappeared; the hind-wing is almost entirely suffused with pale gray scales, leaving only a few nebulous patches of brown. If this specimen had been captured on the wing it might have suggested a natural hybrid between *indica* and *cardui*.

From a subsequent batch of larvæ that pupated under similar conditions I obtained two normal examples of the butterfly and one aberration precisely similar to the first.

E. ERNEST GREEN.

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30. *On "Megaderma lyra," its Habits and Parasites.*—In a previous number of this Journal I have called attention to the carnivorous habits of bats of the genus *Megaderma*. I have found frequent signs of its depredations in the remains of birds and small bats dropped in my verandah. I have since seen the fragments of a mouse (consisting of the feet and part of the head, mingled with the characteristic excreta of a bat) that had evidently been captured and devoured by the same animal. But, until quite recently, I had never come to close quarters with the bat itself. Examination of a loft above the Royal Botanic Gardens Laboratory has, however, revealed a stronghold of *Megaderma lyra*. They were found to be swarming with a minute dipterous parasite, allied to the "tick-flies" (*Hippobosca*). The common bat parasite (*Nycteribia*) belongs to the same family (*Pupipara*), but is apterous. The parasite of *Megaderma* has small but fully developed wings and is capable of flight.

The destruction of small birds, due to these vampire bats, must be enormous. Day after day, for weeks together, I have found my verandah strewn with the wings and feathers of small birds, principally of the dainty little honey-sucker (*Cinnyris zeylonicus*). It would be interesting to know how the bat effects its capture. Though extremely agile on the wing, a bat is but a clumsy animal when it has to rely upon progress by means of its feet and claws alone. When the bat is abroad, the bird is snugly roosting in the recesses of a bush. How does the bat discover the presence of its prey? Does it enter and explore bush after bush on the chance of happening upon a sleeping bird, or does it scent them from a distance and then hunt them down in their retreat?

E. ERNEST GREEN.

31. *Capture of a Mouse by a large Spider.*—The huge spiders of South America, of the family *Aviculariinæ*, are known to capture and devour small birds and mammals. Our so-called "Tarantula" of Ceylon (*Pœcilotheria*) is nearly allied to these bird-eating spiders, and may, perhaps, occasionally indulge in a similar diet, though no such instance has been actually recorded. They are certainly strong enough to overpower a small bird. Their principal food appears to be cockroaches, grasshoppers, and large beetles, with perhaps an occasional lizard; one has been observed with a gecko in its clutches. I am now able to record an instance of its capture of somewhat bigger game. Mr. G. Harbord, of the Cotton Experiment Station, found one of these spiders devouring a mouse on the wall of a room in his bungalow near Anuradhapura.

E. ERNEST GREEN.

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32. *On the Employment of a Snake-stone in a Case of Centipede-bite.*—Any first-hand records of the bites or stings of venomous insects are of interest. The following account was related by a friend who had recently been bitten on the naked foot by a large centipede (about 5 inches long). He describes the pain having been very severe at the time; but after borrowing a "snake-stone" and applying it to the place he obtained immediate and complete relief. The stone adhered tightly to the wound, and remained attached for about an hour. There was no subsequent inconvenience from the bite, though the spot was tender for a few days.

There is a very prevalent idea that the mere passage of a centipede over the bare flesh is followed by severe inflammation. I have always felt rather sceptical about this matter; but the following occurrence lends some support to the idea. My informant tells me that, while gardening a short time ago, a large centipede ran over his hand. He did not feel any bite and shook the animal off quickly; but shortly afterwards the whole back of his hand swelled up. There were no marks of punctures.

E. ERNEST GREEN.

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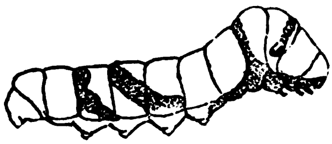
33. *Notes on the Larvæ of "Papilio polytes," "P. demoleus," "P. helenus" (race mooreanus), and "P. polymnestor" (race parinda).*—In an attempt to obtain statistics as to the relative abundance of the three forms of *Papilio polytes*, much trouble has been caused by a complete ignorance of any points of distinction between the larvæ of this species and those of *P. demoleus*. A search through the literature

available has yielded no satisfactory information, while, on the other hand, it has brought to light an apparent confusion between the larvæ of *P. parinda* and *P. mooreanus.* There appears to be, therefore, sufficient justification for a few notes on the four species, though it must be confessed that the material of *P. mooreanus* obtained up to the present has been very scanty.



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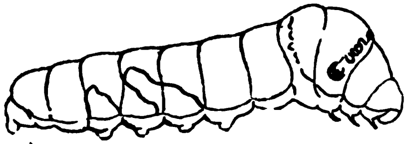

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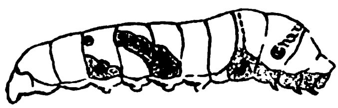

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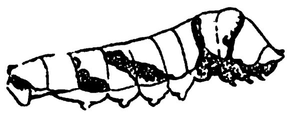

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FIG. 1.—Larva of *Papilio mooreanus* (?).
FIG. 2.—Larva of *Papilio parinda.*
FIG. 3.—Larva of *Papilio polytes.*
FIG. 4.—Larva of *Papilio demoleus.*

In habit the larvæ all feed on members of the natural order Rutaceæ, and are usually found on the cultivated species of *Citrus.* The adult larvæ, those in their fourth skin, may be easily distinguished by the following key :—

A. 4th and 5th segments markedly swollen ; much larger than succeeding segments .. .. *Section A.*

B. 4th and 5th segments not markedly swollen ; hardly larger than succeeding segments .. .. *Section B.*

Section A.	(i.)	Diagonal bands commencing on segments 8 and 10 mainly brown and meeting in the dorsal middle line..	*P. mooreanus* (fig. 1).
	(ii.)	Diagonal bands commencing on segments 8 and 10 mainly white; not meeting in dorsal middle line ..	*P. parinda* (fig. 2).
Section B.	(i.)	Caudal tubercles white, much reduced ..	*P. polytes* (fig. 3).
	(ii.)	Caudal tubercles brown; size moderate ..	*P. demoleus* (fig. 4).

By "caudal tubercles" are meant the projecting points found in most Papilio larvæ on each side of the posterior portion of the terminal segment. When young the larva usually has two pairs of caudal tubercles; as it grows older the anterior pair are often lost, and even the terminal pair may become much reduced, as in *polytes*.

Young larvæ of *polytes* and *demoleus* are extremely hard to separate, and the following distinctions must not be too implicitly relied upon. When newly hatched, *polytes* is usually yellowish-brown, with an irregular yellow dorsal line; *demoleus* is blackish-brown, with a yellow "saddle" limited to segments 7, 8, 9. These differences, however, only apply when both larvæ are in their first skin; they soon change, and *polytes* then resembles *demoleus* in the characters enumerated above.

After the first moult the caudal tubercles show good distinctive characters; during the second skin there are two pairs of tubercles, of which the terminal pair are grayish-white, or white in *polytes* and brown in *demoleus;* in the third skin the anterior pair of tubercles degenerates, but the posterior remain, and are always white in *polytes* and brown in *demoleus*. After the third change of skin the larvæ attain their final scheme of colouration, and may then be easily known by the characters given in the key; in addition it may be mentioned that in *demoleus* the "ocellus" mark on segment 4 is connected by a brown line with the dark area surrounding the legs; in *polytes* there is no such connection.

The young stages of *parinda* and *helenus* have not been sufficiently studied to give distinctive characters; after the second moult, however, *parinda* is easily known by the absence of dark markings and the presence of minute blue spots, especially on segments 4 and 5. At all stages both species are larger than either *polytes* or *demoleus*, if the comparison is made when the larvæ are in the same skin.

Pupal distinctions, as well as general descriptions, of the larvæ can be found in various papers by Davidson, Bell, and Aitken in the

"Journal of the Bombay Natural History Society"; to avoid the necessity of reference, it may be mentioned that the pupa of *helenus* resembles that of *polytes*, but is slightly larger, and is bent back at an angle of almost 90 per cent. *Demoleus* differs from *polytes* in being comparatively narrow across the hind part of the thorax; *polytes* is very wide in this region, and as a rule is bent back at a greater angle than *demoleus*. *Parinda* is, of course, easily recognized by its superior size, as compared with any of the other species.

In conclusion it should be noted that the above distinctions apply in Ceylon only; in India, where other orange-feeding Papilios occur, considerable modification would probably be necessary.

My thanks are due to Mr. E. E. Green, who has most kindly figured the full-fed larva of each species. To avoid confusion, only the salient characteristics of each are represented, small unimportant markings being neglected.

J. C. F. FRYER.

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34. "*Filodes mirificalis*," *a good species.*—This pyrale was first described by Lederer in 1863 under the name *Auxomitia mirificalis* (Led., Wien. Ent. Mon., 1868, p. 391); subsequently it was re-described by Moore* as *Filodes patruelis* (Moore, Lep. Atk., p. 218), but in the "Fauna of British India" (Moths, Vol. IV., p. 297) it is reduced to the status of a variety of *Filodes fulvidorsalis*, Hubn. Mr. E. E. Green has always expressed the opinion that the two forms should rank as good species, and this view has now proved to be correct. Both species have been bred at Peradeniya, marked differences being found in the larvæ, while in every case the imagoes proved true to the maternal type. For a general description of *F. fulvidorsalis* the "Fauna of British India" must be consulted; the following table presents the essential differences between the two species:—

	Filodes fulvidorsalis.	*Filodes mirificalis.*
Wings ..	No dark band or fascia crossing fore- and hind-wings. General colour, black with a steely reflection.	A conspicuous dark band always present. Colour black, usually without metallic reflection, and often with slight fuscous suffusion.
Thorax and base of fore-wings	Bright orange ..	Usually reddish fuscous, but occasionally orange.
Build ..	Somewhat stout ..	Slender.

* Moore also referred to it under its correct name in Lep. Ceylon, p. 331.

As a whole the two species show a different fascies, the sum of the distinguishing characters having a greater effect than their consideration separately would suggest. No adequate description of the larva of *fulvidorsalis* has been found, and therefore a detailed description is necessary to allow a comparison with that of *mirificalis*.

When full fed the general ground colour of the larva is apple-green, with the exception of the head (the 1st segment), which is yellowish-brown, and the 2nd segment, which is green tinged with brown. The markings are as follows: The 2nd segment with six black tubercular spots, a pair being situate on each side of the middle line and a single spot over each leg (fig. 3); the 3rd and 4th segments similar to the second, but with an additional spot below the dorsal pair; the 5th–12th segments with three black spots on each side of the middle line, one pair being situate towards the anterior margin of the segment and the third behind, forming a triangle, the interior

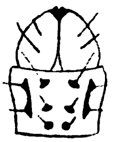

FIG. 1.

FIG. 2.

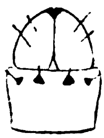

FIG. 3.

FIG. 4.

FIG. 1.—Head and second segment of the larva of *Filodes mirificalis*.
FIG. 2.—Seventh segment of the same.
FIG. 3.—Head and second segment of the larva of *Filodes fulvidorsalis*.
FIG. 4.—Seventh segment of the same.

of which is occupied by a shining white plate, while there is a small white spot behind the apex of the triangle (fig. 4); in addition, on these segments a subspiracular black spot and a spot over base of prolegs on segments 7, 8, 9, 10; segment 12 with a pair of black spots united in the middle line, the white plates obsolescent; segment 13 much reduced, with a single dorsal spot and a pair on each side; terminal segment with a black spot above anus and a spot on the hinder part of each clasper. From each of the tubercular spots arises a hair, those from the lateral spots being longest. The general shape of the larva is short and stout. Length 2·5 cm.

The larva of *F. mirificalis* resembles that just described in the general system of markings, but may be easily distinguished by the following points: It is more slender; the ground colour is a blue-green (sage-green) instead of apple-green. The 2nd segment has a larger number of spots, there being three on each side of the middle line, and in addition an irregular composite lateral spot (fig. 1).

The white "plates," which give such a characteristic appearance to the larva of *fulvidorsalis*, are much smaller, and are usually reduced to small lobes near the inner angles of the triangles of black spots (fig. 2). No differences have been observed between the pupæ. The food plant in each case is *Thurbergia fragrans*, but the larvæ will also eat *T. allata* and *T. coccinea*. Finally, it may be pointed out that there is a further Ceylon species, *Filodes bilinealis*, Hampsn., about the larva of which nothing as yet is known, though it must be widely distributed, having been taken both at Peradeniya and Wellawaya.

J. C. F. FRYER.

H. C. COTTLE, GOVERNMENT PRINTER, COLOMBO, CEYLON.

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