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By John C. Phillips.

CAMBRIDGE, MASS., U. S. A.:

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December, 1913.

REPORTS ON THE SCIENTIFIC RESULTS OF THE EXPEDITION TO THE EASTERN TROPICAL PACIFIC, IN CHARGE OF ALEXANDER AGASSIZ, BY THE U. S. FISH COMMISSION STEAMER "ALBATROSS," FROM OCTOBER, 1904, TO MARCH, 1905, LIEUTENANT COMMANDER L. M. GARRETT, U. S. N., COMMANDING, PUBLISHED OR IN PREPARATION:—

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[1] Bull. M. C. Z., Vol. XLVI., No. 4, April, 1905, 22 pp.
[2] Bull. M. C. Z., Vol. XLVI., No. 6, July, 1905, 4 pp., 1 pl.
[3] Bull. M. C. Z , Vol. XLVI., No. 9, September, 1905, 5 pp., 1 pl.
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[14] Bull. M. C. Z., Vol. XLIII., No. 6, October, 1908, 285 pp., 22 pls.
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[16] Mem. M. C. Z., Vol. XXXVII., February, 1909, 243 pp., 48 pls.
[17] Mem. M. C. Z., Vol. XXXVIII., No. 1, June, 1909, 172 pp., 5 pls., 3 maps.
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[27] Mem M. C. Z., Vol. XXXV, No. 4, July, 1912, 124 pp., 12 pls.

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NOTES ON A COLLECTION OF BIRDS FROM THE SUDAN.

By John C. Phillips.

CAMBRIDGE, MASS., U. S. A.:

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December, 1913.

No. 1.— *Notes on a collection of birds from the Sudan.*

By John C. Phillips.

The following collection was obtained by Dr. G. M. Allen and the writer on the Blue-Nile and Dinder Rivers, in Sennar, Sudan, from December 25, 1912 to February 25, 1913. A few birds were also collected at Luxor and Cairo on the way up and down the Nile. A visit was made to the mountain at Fazogli, a place which Mr. A. L. Butler tells me he found very rich in birds in May. Our visit in January yielded very little indeed, and this suggests considerable local seasonal movements of resident species, which is borne out by the various excellent papers of Butler on Sudan birds (Ibis, 1905, 1908, and 1909). Since the Sudanese birds have been rather carefully studied in recent years, by Reichenow, Erlanger, Butler, Ogilvie-Grant, and others, it is not worth while to append many notes. I have therefore confined myself mostly to the status of some of the species as we found them in the winter months.

Many of the winter birds of this region are European migrants, some are visitors from Egypt, while a large number are resident species and referable mostly to Abyssinian types. Thus the avifauna of the upper Blue-Nile is quite different from that of the White-Nile on account of this Abyssinian element. There is no true desert near the Blue-Nile and Dinder Rivers, the soil being a deep loess deposit, the so-called "cotton-soil," which in the dry season becomes baked and cracked into great cakes. These contraction-cracks make travel very unconfortable. The entire region is wooded with a widely scattered thorn-forest, nearly leafless by mid-winter. The ground is covered by high grass which is largely burnt off in December and January. Along the banks of the river the scenery is a little more diversified. Palms, fig trees, Adansonias, and vines form thickets in which many species hide while going to water. A few isolated rocky hills or gebels protrude abruptly from the plain. From Gebel Fazogli eastward they begin to form the foothills of Abyssinia.

The larger birds we did not have time to collect or preserve to any extent. Among the more striking may be mentioned the enormous numbers of European cranes present on the lower Blue-Nile, and also the Crowned cranes in much smaller numbers. Anatidae are scarce on the Blue-Nile, on account of its sandy character, the Egyptian goose and the Comb duck being the commonest species. We saw the Secretary bird once only. It is rare in the Sudan.

The most abundant scavenger is the Egyptian kite which is bold past all belief, while there are several species of vultures. The Bateleur eagle and the Great river eagle, *Haliaëtus vociferus* are often seen.

We saw the Sacred ibis on the Blue-Nile in great flocks, the Glossy ibis much less often, while pelicans of probably two species were noted occasionally.

The huge Scavenger stork, *Leptoptilus crumeniferus* was nearly everywhere a constant camp attendant. The Common stork and the Saddle-back stork were seen here and there.

Little egrets, *Bubulcus ibis* followed the game, especially Buffalo, in large flocks, while a large White heron *Herodias alba*, or *Mesophoyx brachyrhyncha* was seen only once.

Much remains to be worked out concerning the seasonal movements of resident birds. The sharply contrasted wet and dry season is very marked in this part of the Sudan. On the Abyssinian border showers occasionally occur in winter, but this never happens farther westward.

Our route was from Sennar to Fazogli on the north bank of the Blue-Nile, then back to Abu Tiga by the same road and across to the Dinder River which is only two days journey from the Blue-Nile at this point.

On the Dinder we travelled S. E. to Um Orug Isle and then back to Sennar by forced marches. We did little bird collecting on the Dinder as our time there was short. We used camel transport for the entire journey.

To Dr. Allen belongs the credit of most of the actual collecting and I have to thank Mr. Outram Bangs for most valuable aid with identifications.

PHASIANIDAE.

FRANCOLINUS CLAPPERTONI Children.

5 specimens; 3 ♂'s, Bados, Blue-Nile, 7 Jan.; El Garef, 8 Jan.; Magangani, 1 Feb.

Very plentiful in tall grass near the river.

PTILOPACHYS FUSCUS FUSCUS (Vieillot).

One ♂, Fazogli, Blue-Nile, 18 Jan.

Only seen on Gebel Fazogli.

Numididae.

Numida ptilorhyncha ptilorhyncha (Lichtenstein).

2 ♀'s, Gabardi, Blue-Nile, 31 Dec.; El Garef, 9 Jan.
Seen in enormous numbers along our whole route.

Pteroclididae.

Pteroclis quadricinctus Temminck.

Pair, Fazogli, Blue-Nile, 18 Jan. and 20 Jan.
Common along Blue-Nile.

Treronidae.

Vinago waalia waalia (Gmelin).

3 specimens; 1 ♂, Gebel Fazogli, Blue-Nile, 18 Jan.; Um Orug, Dinder, 16 Feb.
As has often been remarked, this bird is almost confined to the fig tree. We did not find it in large numbers.

Columbidae.

Columba guinea phaeonota (G. R. Gray).

1 ♀, Roseires, Blue-Nile, 13 Jan.
Not a common bird. Seen in pairs here and there in rocky places.

Peristeridae.

Turtur isabellinus Bonaparte.

1 ♂, Sennar, Blue-Nile, 25 Dec.
This can not be a common bird for our region, although we may have seen it and mistaken it for *Streptopelia vinacea schoanus.*

Streptopelia decipiens (Finsch & Hartlaub).

1 ♂, El Serifa, Blue-Nile, 15 Jan.
Very common.

Streptopelia vinacea schoanus (Neumann).

3 ♂'s, Karkoj, Blue-Nile, 30 Dec.
A very abundant bird.

Stigmatopelia senegalensis aequatorialis (Erlanger).

1 ♂, Karkoj, 30 Dec.
Not so common as some other doves.

Oena capensis (Linné).

Pair, Sennar, Blue-Nile, 25 Dec.; Aradeiba, 22 Jan.
Very abundant, very tame and perfectly noiseless; in flocks.

Chalcopelia afra Linné.

3 specimens; 2 ♂'s, Bados, Blue-Nile, 2 Feb.; Singa, 28 Dec.; Magangani, 28 Jan.
Abundant; in pairs or singly.

Charadriidae.

Hoplopterus spinosus (Linné).

1 ♀, Roseires, Blue-Nile, 13 Jan.
A very common species.

Stephanibyx melanopterus (Cretzschmar).

1 ♀, Sennar, Blue-Nile, 27 Dec.

Aegialitis dubia (Scopoli).

Pair, Luxor, Egypt, 3 March; Roseires, Blue-Nile, 13 Jan.
Common migrant.

Himantopus himantopus (Linné).

1 ♀, Roseires, 11 Jan.
Common in suitable spots along Blue-Nile.

Actitis hypoleucus (Linné).

3 specimens; 2 ♂'s, Roseires, Blue-Nile, 24 Jan.; Magangani, 27 Jan.

Common.

Tringa nebularia (Gunnerus).

1 ♂, Roseires, Blue-Nile, 24 Jan.

Common migrant.

Pisobia minuta (Leisler).

1 ♀, Galegu, Dinder, 19 Feb.

We found it rare, but Butler states that it is common.

Rostratula bengalensis (Linné).

Pair, Abiad, Dinder, 14 Feb.

Not common.

Cursoriidae.

Pluvianus aegypticus (Linné).

1 ♂, Singa, Blue-Nile, 28 Dec.

Very abundant.

Oedicnemidae.

Burhinus senegalensis Swainson.

1 ♀, Magangani, 30 Jan.

Very common on Blue-Nile and Dinder.

Otididae.

Eupodotis arabs (Linné).

1 adult ♀, Gabardi, Blue-Nile, 30 Dec.

Uncommon.

Ardeidae.

Ardea melanocephala Vigors & Children.

1 ♀, Abu Zor, Blue-Nile, 5 Jan.

Common.

Bubulcus ibis (Linné).

1? sex, Aradeiba, Blue-Nile, 15 Jan.
Common. The stomach of this specimen contained two lizards, two locusts, and a butterfly.

Falconidae.

Circus macrurus (S. G. Gmelin).

Pair, Magangani, Blue-Nile, 28 Jan.; Ereifa el Dik, Dinder, 10 Feb.
Common about marshy spots.

Melierax metabates (Heuglin).

2 ♀'s, Ereifa el Dik, Dinder, 11 Feb.; Singa, Blue-Nile, 29 Dec.
Very common everywhere. The commonest hawk.

Micronisus gabar (Daudin).

3 ♀'s, Galegu, Dinder, 20 Feb.; Magangani, Blue-Nile, 28 Jan.
Not common.

Micronisus niger (Vieillot).

Pair, Roseires, Blue-Nile, 24 Jan.; Gabardi, 31 Dec.
Uncommon.

Astur sphenurus (Rüppell).

1 ♂, Roseires, Blue-Nile, 23 Jan.
Only one seen.

Lophoaëtus occipitalis (Daudin).

1 ♀, Roseires, Blue-Nile, 11 Jan.
Seen only in a few places, uncommon.

Kaupifalco monogrammicus monogrammicus (Temminck).

1 ♂, Fazogli, Blue-Nile, 16 Jan.
Uncommon. Shot with a grass-rat (Arvicanthis) in the claws.

Falco biarmicus tanypterus (Schlegel).

1 ♂, Singa, Blue-Nile, 28 Dec.
Not common.

Falco ruficollis Swainson.

Pair, El Garef, Blue-Nile, 8 Jan.; Magangani, 25 Jan.
Not common.

Cerchneis tinnunculus tinnunculus (Linné).

1 ♂ and 3 ♀'s; Lakandi, Blue-Nile, 6 Feb.; Karkoj, 30 Dec.; Roseires, 25 Jan.; Sennar, 25 Dec.
Common everywhere as a migrant.

Stridgidae.

Bubo maculosus cinerascens Guérin.

2 ♂'s, Magangani, Blue-Nile, 27 Jan.; Abu Tiga, 6 Feb.
Seen and heard in several places where trees were large.

Otus capensis capensis (Smith).

3 ♂'s, Abu Zor, Blue-Nile, 21 Jan.; El Mesharat, 5 Feb.; El Serifa, 4 Jan.
Common everywhere in thorn forest.

Athene noctua glaux (Savigny).

1 ♂, Cairo, Egypt, 14 Dec.

Psittacidae.

Poicephalus meyeri meyeri (Cretzschmar).

Pair, El Serifa, Blue-Nile, 14 Jan.; Abu Zor, 6 Jan.
Common on the Nile about Roseires but not seen north of El Mesharat.

Palaeornis torquatus docilis (Vieillot).

2 ♂'s, Singa, Blue-Nile, 28 Dec.; El Garef, 9 Jan.

Very common over the region covered. Breeding freely in Jan. and Feb. in holes high up in trees.

Coraciidae.

Coracias abyssinicus Boddaert.

3 specimens, 2 ♂'s and 1 ♀, El Garef, Blue-Nile, 9 Jan.; El Sabonabi, 2 Jan.; El Serifa, 22 Jan.

Very common. The showiest bird of this region during the winter.

Coracius naevius naevius Daudin.

1 ♂, Aradeiba, Blue-Nile, 21 Jan.

Rare. Only two seen.

Alcedinidae.

Ceryle rudis rudis (Linné).

1 ♂, Roseires, Blue-Nile, 13 Jan.

Common along the river.

Corythornis cyanostigma (Rüppell).

2 specimens, 1 ♂, Abiad, Dinder, 14 Feb.; 1, Roseires, Blue-Nile, 13 Jan.

Not common. In pairs along the river and the pools of the Dinder.

Halcyon chelicuti (Stanley).

1 ♀, El Mesharat, Blue-Nile, 2 Jan.

Uncommon and found in the thorn forest at some distance from water.

Bucerotidae.

Lophoceros hemprichi Ehrenberg.

1 ♀, El Mesharat, Blue-Nile, 2 Jan.

Very common all through the thorn bush in flocks of three or four.

Very tame. Sits low in the trees and the extraordinarily soft "Weet, weet," grows louder and louder until reaching a crescendo which is accompanied by an upright position and flapping of wings. This is almost the only bird sound heard at the heat of the day.

Lophoceros nasutus nasutus (Linné).

1 ♂, Magangani, Blue-Nile, 29 Jan.
Common in certain places only. Usually singly and in the tops of high trees. Very wild. A loud, clear, double note with opening and closing of wings.

Upupidae.

Upupa epops epops Linné.

Pair, El Serifa, Blue-Nile, 14 Jan.; El Garef, 1 Feb.
Note. *Upupa butleri* of Madarász (Ann. Mus. nat. Hung., **9**, p. 339) appears to be based on a small example of the European Hoopoe, which is a common winter resident in the Sudan.

Upupa epops major Brehm.

1 ♂, Galegu, Dinder, 20 Feb.
Probably common. This specimen certainly belongs to the large-billed form.

Irrisoridae.

Irrisor erythrorhynchus niloticus Neumann.

1 ♂, Fazogli, Blue-Nile, 16 Jan.
Common in certain areas in large flocks.

Rhinopomastus minor (Rüppell).

2 ♂'s and 1 ♀, Singa, Blue-Nile, 28 Dec.; Bados, 6 Jan.
Fairly common, usually seen singly.

Meropidae.

Melittophagus pusillus ocularis Reichenow.

1 ♂ and 2 ♀'s, Roseires, Blue-Nile, 13 Jan.; El Mesharat, 2 Jan.
Common in pairs or broods.

Melettophagus frenatus Hartlaub.

3 ♂'s and 2 ♀'s, El Mesharat, Blue-Nile, 4 Jan.; El Sabonabi, 1 Jan.

Common, roosting in holes in banks.

Merops orientalis cleopatra Nicoll.

1 ♂ and 3 ♀'s, Luxor, Egypt, 3 March; Fazogli, Blue-Nile, 19 Jan.; Magangani, 26 Jan.; Abu Zor, 5 Feb.

None of these show any variation; therefore the Blue-Nile birds are probably migrants from Egypt; seen only three times on the Blue-Nile would indicate this as its southern limit.

Merops nubicus Gmelin.

3 ♂'s and 2 ♀'s, Galegu, Dinder, 12 Feb.; Abiad, 14 Feb.

Very common on the Dinder but rather rare on the Blue-Nile. Roosted in flocks in thick trees. Flies very high with habits of a swallow.

Caprimulgidae.

Scotornis climacurus (Vieillot).

6 ♂'s and 4 ♀'s, Magangani, Blue-Nile, 31 Jan., 26 Jan., 27 Jan., 28 Jan.; Singa, 27 Dec.; Roseires, 13 Jan., 23 Jan.; Ereifa el Dik, Dinder, 10 Feb.

Very common about the high grass of both rivers. Sprung often in the woods during the day. When flying it makes a single clucking noise. These birds often eat their prey on the ground.

Macrodipteryx macrodipteryx (Afzelius).

1 ♂ and 2 ♀'s, Magangani, Blue-Nile, 30 Jan., 27 Jan.; El Serifa, 19 Jan.

We found this remarkable bird rare and local. We did not see more than three or four males. They fed over high elephant grass and never crossed open spots. They were about early in the evening and each male seemed to have a separate and distinct range.

Caprimulgas aegyptius Lichtenstein.

3 ♂'s and 3 ♀'s, Magangani, Blue-Nile, 25 Jan., 26 Jan., 27 Jan., 29 Jan., 31 Jan.; Roseires, 13 Jan.

This may be *C. a. saharae* Erlanger, the paler resident African race, but no material is at hand for comparison.

Common over the high grass at dusk. In large areas of elephant grass they were very numerous. Dr. Allen found ground crickets and cockroaches in the stomach of one of these birds which was shot early in the evening.

Caprimulgus eleanorae Phillips.

Proc. Biol. soc. Washington, 1913, **26**, p. 167.

Type, adult ♀ M. C. Z. No. 63,436, taken at Fazogli, Blue-Nile, Sudan, 15 Jan., 1913.

Description.— Most nearly like *C. monticola* of India, of which it appears to be the African representative. In general color very much like the gray examples of *C. monticola*, but at once distinguished by the spots on the three outer primaries, being small and round and confined wholly to the inner web, instead of being large and extending across both webs of 2d, 3d, and 4th primaries. In the new species the spot on the first primary is only 7 mm. in diameter, while on the third primary it is about 12 mm. Wing, 185 mm.; culmen to base of forehead, 28 mm.; exposed culmen, 11 mm.; tarsus, 20 mm. The characters of the male are unknown.

Remarks.— This species differs from all African species of somewhat similar general coloration by its much larger size, equal in fact to *C. monticola.*

Only one specimen was taken.

Micropodidae.

Tachornis parvus parvus (Lichtenstein).

1 ♂, Roseires, Blue-Nile, 13 Jan.

Common along rivers, especially about deleb palm trees.

Coliidae.

Colius leucotis leucotis Rüppell.

3 specimens, 2 ♂'s and 1 ♀, Magangani, Blue-Nile, 26 Jan.; El Mesharat, 4 Jan.

Common. In small flocks.

Colius macrurus (Linné).

1 ♀, Gabardi, Blue-Nile, 31 Dec.

We found it rare, but Butler gives it as common.

Musophagidae.

Chizaerhis zonura Rüppell.

1 ♂, Fazogli, Blue-Nile, 19 Jan.

Only seen near Fazogli.

Cuculidae.

Chrysococcyx klaasi (Stephen).

3 specimens, 2 ♂'s and 1 ♀, Roseires, Blue-Nile, 25 Jan.

Rare: only seen once in a large fig tree in the village.

Centropus superciliosus Hemprich & Ehrenberg.

2 ♀'s, Singa, Blue-Nile, 28 Dec.; El Garef, 9 Jan.

Uncommon.

Indicatoridae.

Indicator indicator (Gmelin).

3 specimens, 1 ♂ and 2 ♀'s, Um Orug, Dinder, 17 Feb., 18 Feb.

Seen mostly on the upper Dinder where honey was plentiful.

Indicator minor diademata (Rüppell).

1 ♀, Um Orug, Dinder, 17 Feb.

Probably not so common as *I. indicator*.

Capitonidae.

Lybius tridactylus (Gmelin).

Pair, Roseires, Blue-Nile, 25 Jan., 13 Jan.
Uncommon; only seen once or twice.

Lybius vieilloti (Leach).

2 ♂'s and 1 ♀, Magangani, Blue-Nile, 30 Jan.; El Mesharat, 4 Jan.
More common than *L. tridactylus* but only seen here and there.

Barbatula chrysocoma chrysocoma (Temminck).

2 ♂'s and 1 ♀, El Garef, Blue-Nile, 9 Jan.; Magangani, 30 Jan.
This may be *zedletzi* of Neumann on geographic grounds, but does not seem to agree with his description. Ours is more like true *chrysocoma.*
This bird was very common on the Dinder. Nest in the dead limb of a tree, with full grown young on Jan. 8; food of berries was being brought to the young, and was ejected after being eaten.

Picidae.

Dendromus nubicus nubicus (Gmelin).

3 specimens, 2 ♂'s and 1 ♀, El Garef, Blue-Nile, 8 Jan., 10 Jan.; Fazogli, 20 Jan.
Common. Has a cackling note which is heard commonly through the thorn forest. In pairs.

Mesopicus goertan abessinicus (Reichenow).

Pair, Galegu, Dinder, 20 Feb.; Magangani, Blue-Nile, 28 Jan.
Rare, only seen two or three times.

Dendropicus obsoletus obsoletus (Wagler).

4 ♂'s and 1 ♀, Mesharat Kuka, Dinder, 9 Feb.; Bados, Blue-Nile, 2 Feb.; Wad Shara Shara, 8 Feb.; Abu Tiga, 7 Feb.
Rather uncommon.

Hirundinidae.

Riparia minor (Cabanis).

2 ♂'s and 1 ♀, Fazogli, Blue-Nile, 20 Jan.; Serifa, 21 Jan.
Breeding in holes in bank near Fazogli and Roseires towards the end of January. Numerous.

Chelidon aethiopica Blanford.

2 ♂'s, Abiad, Dinder, 14 Feb.
Fairly common, the common resident swallow according to Butler.

Chelidon griseopyga Sundeval.

Pair, Fazogli, Blue-Nile, 20 Jan.
We found a colony of these birds near Fazogli breeding in burrows dug in the hard clay on open, level ground; the burrows ran parallel to the surface. One that we dug out was ten feet long and had a depth of from six to ten inches. The nest was three feet from the end. The young were partly fledged on Jan. 25.

Chelidon daurica rufula (Temminck).

1 ♂, Abiad, Dinder, 14 Feb.
Rare.

Muscicapidae.

Melaenornis pammelaena Stanley.

1 ♂, Roseires, Blue-Nile, 23 Jan.
Probably a rare bird.

Bradyornis pallidus granti Bannerman.

Pair, Galegu, Dinder, 19 Feb.; Sabonabi, Blue-Nile, 6 Feb.
Our bird is small and with underparts more strongly suffused with rufous, like *B. granti* of Bannerman, Bull. B. O. C., 1911, **27**, p. 84. The differences do not seem to be more than subspecific.

wing 85, tail feathers 71, tarsus 21, culmen 13.
wing 80, tail feathers 69.5, tarsus 20, culmen 11.5.

The records from the Dinder River extend the range of this small form into the eastern Sudan.

Uncommon.

Batis orientalis orientalis (Heuglin).

1 ♂ and 2 ♀'s, Magangani, Blue-Nile, 26 Jan., 27 Jan.

Fairly common.

Tchitrea viridis (Müller).

1 ♂, Um Orug, Dinder, 18 Feb.

Rare, only seen twice; in dense thickets.

Pycnonotidae.

Pycnonotus arsinoë (Hemprich & Ehrenberg).

2 ♂'s, El Mesharat, Blue-Nile, 4 Jan.; El Garef, 8 Jan.

One of the commonest birds in thickets along the river.

Timeliidae.

Crateropus leucocephalus (Cretzschmar).

3 ♂'s, Abu Zor, Blue-Nile, 5 Jan; El Mesharat, 4 Jan.

Fairly common in small flocks.

Turdidae.

Planesticus pelios pelios (Bonaparte).

1 ♂ and 2 ♀'s, El Garef, Blue-Nile, 8 Jan.; 18 Jan.; Fazogli, 8 Jan.

Not common; seen singly in the southern part of our region.

Phoenicurus phoenicurus phoenicurus Linné.

1 ♂ and 2 ♀'s, Magangani, Blue-Nile, 29 Jan., 1 Feb.; El Serifa, 14 Jan.

Not common.

Cyanosylvia svecica volgae (Kleinschmidt).

1 ♂, Cairo, Egypt, 12 Dec.
This may be *C. svecica svecica* in winter plumage.

Saxicola torquata rubicola Linné.

Pair, Cairo, Egypt, 12 Dec.

Saxicola torquata maura (Pallas).

1 ♂, and 2 ♀'s, Abiad, Dinder, 14 Feb.; Um Orug, 16 Feb.; Galegu, 20 Feb.
Not common. In open places on grass.

Oenanthe oenanthe oenanthe (Linné).

1 ♂, Roseires, Blue-Nile, 25 Jan.
Said to be a common species but we did not find it so.

Oenanthe hispanica xanthomelaena Hemprich & Ehrenberg.

2 ♂'s and 1 ♀, Abu Tiga, Blue-Nile, 7 Feb.; Fazogli, 16 Jan.; Singa, 28 Dec.
Common in open woods. Shy and seen singly.

Oenanthe isabellina Cretzschmar.

1 ♂, Sennar, Blue-Nile, 25 Dec.
Common in durrah fields round Sennar, not seen far south.

Oenanthe melanoleuca melanoleuca (Güldenstaedt).

1 ♂ and 2 ♀'s, Mesharat Kuka, Dinder, 9 Feb.; Singa, Blue-Nile, 28 Dec.; Sabonabi, 6 Feb.
Fairly common.

Sylviidae.

Agrabates galactotes galactotes Temminck.

1 ♂, Khamisa, Dinder, 23 Feb.

This specimen is apparently an extreme of the European species, (not *minor* of Cabanis) and has a wing of 85 mm. with a broad subterminal tail band. According to Hartert this bird migrates into the Sahara or to south of it.

Only seen once or twice.

Cisticola semitorques semitorques Heuglin.

Pair, Abiad, Dinder, 14 Feb.; Beit el Wahsh, Dinder, 13 Feb.
Rather common.

Cisticola ferruginea (Heuglin).

1 ♀, Fazogli, Blue-Nile, 20 Jan.
Uncommon, in thick grass.

Cisticola cisticola cisticola (Temminck).

Pair, Cairo, Egypt, 12 Dec.

Cisticola marginata (Heuglin).

2 ♀'s, Karkoj, Blue-Nile, 31 Dec.; Wad Shara Shara, 8 Feb.

Hypolais pallida pallida (Hemprich & Ehrenberg).

1 ♂, Singa, Blue-Nile, 27 Dec.

Phylascopus collybite collybite (Vieillot).

1 ♂ and 2 ♀'s, Cairo, Egypt, 12 Dec.; Luxor, 3 March.

Apalis pulchella (Cretzschm).

3 ♂'s, Magangani, Blue-Nile, 26 Jan., 27 Jan.; El Sabonabi, 1 Jan.
Fairly common.

Sylviella brachyura nilotica Neumann.

2 ♂'s, Ereifa el Dik, Dinder, 10 Feb.; Galegu, Dinder, 20 Feb. Wings 53 and 59 mm.
Rare.

Eremomela elegans (Heuglin.)

1 ♂ and 2 ♀'s, Magangani, Blue-Nile, 30 Jan.
These were the only ones seen.

Camaroptera griseiviridis griseiviridis v. Müller.

3 ♂'s and 1 ♀, Magangani, Blue-Nile, 28 Jan.; El Garef, 8 Jan.
Common in dense thickets and on the ground. Singly.

Prinia mystacea Rüppell.

4 ♂'s and 3 ♀'s, Magangani, Blue-Nile, 28 Jan., 30 Jan.; Singa, 27 Dec.; Fazogli, 20 Jan.; El Mesharat, 4 Jan.; El Sabonabi, 1 Jan.; Beit el Wahsh, Dinder, 13 Feb.
The common warbler of the country.

Prinia gracilis deltae Reichenow.

3 ♀'s, Cairo, Egypt, 12 Dec.

Prionopidae.

Prionops poliocephala (Stanley).

1 ♂, El Mesharat, Blue-Nile, 4 Jan.
Occasional, in small flocks.

Laniidae.

Lanius excubitor pallidirostris (Cassin).

1 ♀, Sennar, Blue-Nile, 25 Dec.
Only seen once.

Lanius nubicus (Lichtenstein).

1 ♂ and 2 ♀'s, Singa, Blue-Nile, 27 Dec.
Common on Blue-Nile.

Laniarius erythrogaster (Cretzschmar).

3 ♂'s and 3 ♀'s, Magangani, Blue-Nile, 27 Jan., 31 Jan.; Bados, 7 Jan.; Abu Zor, 5 Feb.; El Garef, 8 Jan.

Common, in pairs in thickets. Shy. These birds have responsive notes. Dr. Allen followed this up and shot the bird of a pair having the first note. It was the male. These birds fed much on the ground and we frequently caught them in our traps. One of the most beautiful of the Blue-Nile birds.

Dryascopus cinerascens Hartlaub.

2 ♂'s and 3 ♀'s, Magangani, Blue-Nile, 26 Jan., 30 Jan.; El Mesharat, 4 Jan.; El Sabonabi, 1 Jan.; El Garef, 8 Jan.

Fairly common; in trees.

Pomatorhynchus blanfordi (Sharpe).

1 ♂, Sennar, Blue-Nile, 25 Dec.
Not common; low in thickets, and on ground.

Pomatorhynchus remigialis (Finsch & Hartlaub).

Pair, Roseires, Blue-Nile, 12 Jan.; Magangani, 26 Jan.

Uncommon. Butler found it far from water and regards it as common.

Nilaus afer afer Latham.

1 ♂ and 2 ♀'s, Um Orug, Dinder, 17 Feb.; Singa, Blue-Nile, 28 Dec.; Fazogli, 19 Jan.

Not very common.

Paridae.

Melaniparus niger leucomelas Rüppell.

Pair, Gabardi, Blue-Nile, 31 Dec.; Mesharat Kuka, Dinder, 9 Feb.
Fairly common.

NECTERINIDAE.

HEDYDIPNA METALLICA (Lichtenstein).

Pair, Galegu, Dinder, 20 Feb.; Durraba, Dinder, 22 Feb.
Rare.

NECTERINIA PULCHELLA (Linné).

8 ♂'s, Magangani, Blue-Nile, 27 Jan.; Abu Zor, 5 Feb.; El Mesh-arat, 2 Jan.; Durraba, Dinder, 22 Feb.
Common among flowering thorn bushes.
These specimens are in all stages of immature plumage.

MOTACILLIDAE.

MOTACILLA ALBA Linné.

5 ♂'s and 1 ♀, Roseires, Blue-Nile, 13 Jan.; Cairo, Egypt, 12 Dec.
Confined almost entirely to village streets in the southern part of the Blue-Nile, but farther north it is everywhere. A very common migrant.

BUDYTES FLAVA (Linné).

3 ♂'s, El Garef, Blue-Nile, 1 Feb., 2 Feb.; Abiad, Dinder, 14 Feb.
In flocks along river. Occasional.

BUDYTES MOTACILLA FELDEGGI (Michah).

1 ♂, Wad Shara Shara, 8 Feb.
The only one seen.

ANTHUS CAMPESTRIS CAMPESTRIS (Linné).

1 ♂, Abiad, Dinder, 19 Feb.
Only seen at the above locality. Butler calls it fairly common.

ALAUDIDAE.

MELANOCORYPHA BIMACULATA (Ménétriés).

1 ♂, Beida, Dinder, 8 Feb.
One large flock seen.

Galerida cristata altirostris (Brehm).

1 ♂, Luxor, Egypt, 3 March.
Enormous numbers in Egypt.

Pyrrhulauda leucotis leucotis (Stanley).

Pair, Sennar, Blue-Nile, 25 Dec.; Abiad, Dinder, 25 Dec.
Not common. In pairs.

Fringillidae.

Petronia dentata (Sundeval).

4 ♂'s, Karkoj, Blue-Nile, 31 Dec.; El Sabonabi, 1 Jan.; Ereif el Dik, Dinder, 11 Feb.
The common sparrow of the thorn forest.

Passer domesticus arboreus Bonaparte.

2 ♂'s, Khartoum, 23 Dec., 24 Dec.
Seen only as far as Singa but not farther south.

Passer domesticus chephreni Phillips.

Proc. Biol. Soc. Washington, 1913, **26**, p. 167.

Type, Adult ♂ M. C. Z. No. 63,594 from Gizeh near Cairo, Egypt, 12 December, 1912.

Description.— Like *P. d. indicus* but cheeks and ear-coverts much darker (smoke gray, Ridgway, 1912) instead of whitish. Size similar to *P. indicus*. Adult female very similar to *P. indicus*, but cheeks darker and grayer.

Remarks.— Hartert (Vögel der Paläarktischen fauna, **1**, p. 151), did not name this lower Nile race, his material being insufficient, but in a footnote in the list of species to the first volume he refers the Egyptian bird to *niloticus* of Nicoll & Bonhote (Bull. B. O. C., **22**, p. 101).

P. d. niloticus is apparently a local desert race closely resembling *P. d. arboreus*, from Khartoum, and not the typical sparrow of lower Egypt, which Nicoll and Bonhote still refer to *P. d. indicus*.

Pair, Cairo, Egypt, 12 Dec.

Passer swainsoni (Rüppell).

Pair, Singa, Blue-Nile, 27 Dec.; Aradeiba, 21 Jan.
Common along Blue-Nile.

Serinus icterus icterus (Vieillot).

1 ♀, Fazogli, Blue-Nile, 16 Jan.
Uncommon.

Emberiza caesia Cretzschmar.

3 ♀'s, Roseires, Blue-Nile, 13 Jan.; Sennar, 25 Dec.
A fairly common migrant.

Ploceidae.

Steganura paradisea (Linné).

2 ♂'s, Roseires, Blue-Nile, 23 Jan.; Abu Zor, 6 Jan.
Common near Singa and Sennar but rare farther south; if in winter plumage we may not have noticed it.

Urobrachya phoenicea (Heuglin).

1 ♂, Abiad, Dinder, 14 Feb.
In flocks; with other weaver-finches.

Ploceipasser superciliosus (Rüppell).

1 ♂, Gebel Maba, Blue-Nile, 14 Jan.
Only one seen.

Quelea sanguinirostris aethiopica (Sundeval).

4 ♂'s and 1 ♀, Gabardi, Blue-Nile, 31 Dec.; Bados, 4 Feb.; Singa, 28 Dec.
Exists in unbelievable thousands and is a great menace to agriculture.

LAGONOSTICA SENEGALA (Linné).

3 ♂'s and 2 ♀'s, El Garef, Blue-Nile, 8 Jan.

These birds belong to some race of the above species, but on geographical grounds do not agree with Neumann's *L. s. erythreae* or *aboyensis*. It may be a new race. We did not obtain *brunneiceps*, though it appears to be the common bird of the region.

Common in little flocks.

PYTILIA CITERIOR Strickland.

2 ♀'s, Magangani, Blue-Nile, 27 Jan.; El Garef, 8 Jan.

These specimens are in very young plumage. It is not possible to place them under their proper subspecies from Zedlitz' review of the species, Ornith. monatsb., **18**, p. 171.

Uncommon.

HYPOCHAERA ULTRAMARINA (Gmelin).

3 ♂'s and 2 ♀'s, Singa, Blue-Nile, 27 Dec.; Regeba, 22 Jan.; Karkoj, 31 Dec.

A very common species; in small flocks.

AIDEMOSYNE CANTANS ORIENTALIS Lorenz & Hellmayr.

3 ♂'s, Durraba, Dinder, 22 Feb.; Sennar, Blue-Nile, 25 Dec.

Occasional.

ESTRILDA CINEREA (Vieillot).

Pair, El Garef, Blue-Nile, 10 Jan.

Fairly common.

URAEGINTHUS BENGALUS BENGALUS (Linné).

5 ♂'s and 2 ♀'s, El Mesharat, Blue-Nile, 2 Jan.; Singa, 27 Dec.; Magangani, 27 Jan.; Beit el Wahsh, Dinder, 13 Feb.

According to Reichenow, the above form ranges over the whole Sudan. The Sennar bird is therefore *M. b. bengalus* and not *M. b. shoenni* or *M. b. perpallidus* of Neumann, Journ. f. ornith., 1905, p. 350.

Very common, seen everywhere.

HYPHANTORNIS ABYSSINICUS ABYSSINICUS (Gmelin).

1 ♂, El Mesharat, Blue-Nile, 4 Jan.
Fairly common, in small flocks around durrah fields.

XANTHOPHILUS GALBULA Rüppell.

1 ♂ and 2 ♀'s, Singa, Blue-Nile, 27 Dec.; Magangani, 26 Jan.
Common. This is the species which Butler (Ibis, 1905) describes as the commonest weaver, but the great flocks seemed to us to be mostly Quelea, the Red-billed weaver.

EULABETIDAE.

LAMPROTORNIS PURPUROPTERUS AENEOCEPHALUS Heuglin.

1 ♂, Gabardi, Blue-Nile, 31 Dec.
Tail, 8 inches, tail feathers, 7.3 inches. This is maximum according to the Catalogue of the birds in the British Museum, but less than Butler's maximum for Kordofan birds (Ibis, 1905, p. 324).
Very common.

LAMPROCOLIUS CHALYBEUS CHALYBEUS (Hemprich & Ehrenberg).

1 ♂, Fazogli, Blue-Nile, 10 Jan.
Common in small flocks around villages.

LAMPROCOLIUS CHLOROPTERUS SCHRADERI Neumann.

1 ♀, Fazogli, Blue-Nile, 10 Jan.
An immature bird; w. 111, cul. 18, tail feathers, 69, tarsus, 24.

SPREO PULCHER (P. L. S. Müller).

1 ♂, Singa, Blue-Nile, 25 Feb.
Only seen a few times; apparently does not occur far south.

ORIOLUS CHRYSEOS (Heuglin).

1 ♀, Fazogli, Blue-Nile, 19 Jan.

The bill of this specimen is shorter and stouter culmen 26 mm. than that of a specimen of *O. auratus* from Gambia, in the M. C. Z.
Only seen at Fazogli.

DICRURIDAE.

DICRURUS AFER (Lichtenstein).

1 ♂ and 3 ♀'s, Sennar, Blue-Nile, 25 Dec.; Singa, 27 Dec.; Gabardi, 31 Dec.; Magangani, 29 Jan.
Very common.

CORVIDAE.

CORVUS SCAPULATUS Daudin.

1 ♀, El Mesharat, Blue-Nile, 4 Jan.
Very common.

CORVUS CORNIX SHARPEI Oates.

1 ♀, Cairo, Egypt, 12 Dec.
Seen only as far up the Nile as Luxor.

RHINOCORAX AFFINIS (Rüppell).

1 ♂, Fazogli, Blue-Nile, 18 Jan.
Only seen around Fazogli.

The following Publications of the Museum of Comparative Zoölogy are in preparation: —

LOUIS CABOT. Immature State of the Odonata, Part IV.
E. L. MARK. Studies on Lepidosteus, continued.
" On Arachnactis.
A. AGASSIZ and C. O. WHITMAN. Pelagic Fishes. Part II., with 14 Plates
H. L. CLARK. The "Albatross" Hawaiian Echini.

Reports on the Results of Dredging Operations in 1877, 1878, 1879, and 1880, in charge of ALEXANDER AGASSIZ, by the U. S. Coast Survey Steamer "Blake," as follows:—

A. MILNE EDWARDS and E. L. BOUVIER. The Crustacea of the "Blake."
A. E. VERRILL. The Alcyonaria of the "Blake."

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieutenant Commander Z. L. TANNER, U. S. N., Commanding, in charge of ALEXANDER AGASSIZ, as follows:—

K. BRANDT. The Sagittae.
" The Thalassicolae.
O CARLGREN. The Actinarians.
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Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of ALEXANDER AGASSIZ, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding, as follows:—

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OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY

AT HARVARD COLLEGE.

There have been published of the BULLETIN Vols. I. to LIV.; of the MEMOIRS, Vols. I. to XXIV., and also Vols. XXVI. to XXIX., XXXI. to XXXIV., XXXVI. to XXXVIII., and XLI.

Vols. LV. to LVIII. of the BULLETIN, and Vols. XXV., XXX., XXXV., XXXIX., XL., XLII. to XLVIII. of the MEMOIRS, are now in course of publication.

The BULLETIN and MEMOIRS are devoted to the publication of original work by the Officers of the Museum, of investigations carried on by students and others in the different Laboratories of Natural History, and of work by specialists based upon the Museum Collections and Explorations.

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Reports on the Results of Dredging Operations from 1877 to 1880, in charge of Alexander Agassiz, by the U. S. Coast Survey Steamer "Blake," Lieut. Commander C. D. Sigsbee, U. S. N., and Commander J. R. Bartlett, U. S. N., Commanding.

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieut. Commander Z. L. Tanner, U. S. N., Commanding, in charge of Alexander Agassiz.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

Reports on the Scientific Results of the Expedition to the Eastern Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from October, 1904, to April, 1905, Lieut. Commander L. M. Garrett, U. S. N., Commanding.

Contributions from the Zoölogical Laboratory, Professor E. L. Mark, Director.

Contributions from the Geological Laboratory, Professor R. A. Daly, in charge.

These publications are issued in numbers at irregular intervals. Each number of the Bulletin and of the Memoirs is sold separately. A price list of the publications of the Museum will be sent on application to the Director of the Museum of Comparative Zoölogy, Cambridge, Mass.

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Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

VOL. LVIII. No. 2.

EXPLORATIONS IN THE GULF OF MAINE, JULY AND AUGUST, 1912, BY THE U. S. FISHERIES SCHOONER GRAMPUS. OCEANOGRAPHY AND NOTES ON THE PLANKTON.

BY HENRY B. BIGELOW.

WITH NINE PLATES

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CAMBRIDGE, MASS., U. S. A.:

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REPORTS ON THE SCIENTIFIC RESULTS OF THE EXPEDITION TO THE EASTERN TROPICAL PACIFIC, IN CHARGE OF ALEXANDER AGASSIZ, BY THE U. S. FISH COMMISSION STEAMER "ALBATROSS," FROM OCTOBER, 1904, TO MARCH, 1905, LIEUTENANT COMMANDER L. M. GARRETT, U. S. N. COMMANDING, PUBLISHED OR IN PREPARATION:—

A. AGASSIZ. V.[5] General Report on the Expedition.
A. AGASSIZ. I.[1] Three Letters to Geo. M. Bowers, U. S. Fish Com.
A. AGASSIZ and H. L. CLARK. The Echini.
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[1] Bull. M. C. Z., Vol. XLVI., No. 4, April, 1905, 22 pp.
[2] Bull. M. C. Z., Vol. XLVI., No. 6, July, 1905, 4 pp., 1 pl.
[3] Bull. M. C. Z , Vol. XLVI., No. 9, September, 1905, 5 pp., 1 pl.
[4] Bull. M. C. Z., Vol. XLVI., No. 13, January, 1906, 22 pp., 3 pls.
[5] Mem. M. C. Z., Vol. XXXIII., January, 1906, 90 pp., 96 pls.
[6] Bull. M. C. Z., Vol. L., No. 3, August, 1906, 14 pp., 10 pls.
[7] Bull. M. C. Z., Vol. L., No. 4, November, 1906, 26 pp., 4 pls.
[8] Mem. M. C. Z., Vol. XXXV., No. 1, February, 1907, 20 pp., 15 pls.
[9] Bull M. C. Z., Vol. L., No. 6. February, 1907, 48 pp., 18 pls.
[10] Mem. M. C. Z., Vol. XXXV, No. 2, August, 1907, 56 pp., 9 pls.
[11] Bull. M. C. Z., Vol. LI., No. 6, November, 1907, 22 pp., 1 pl.
[12] Bull. M. C. Z., Vol. LII., No. 1, June, 1908, 14 pp., 1 pl.
[13] Bull. M. C. Z., Vol. LII., No. 2, July, 1908, 8 pp., 5 pls.
[14] Bull. M. C. Z., Vol. XLIII., No. 6, October, 1908, 285 pp., 22 pls.
[15] Bull. M. C. Z., Vol. LII., No. 5, October, 1908, 11 pp., 2 pls.
[16] Mem. M. C. Z., Vol. XXXVII., February, 1909, 243 pp., 48 pls.
[17] Mem. M. C. Z., Vol. XXXVIII., No. 1, June, 1909, 172 pp., 5 pls., 3 maps.
[18] Bull. M. C. Z., Vol. LII., No. 9, June, 1909, 26 pp., 8 pls.
[19] Bull. M. C. Z., Vol. LII., No. 11, August, 1909, 10 pp., 3 pls.
[20] Bull. M. C. Z., Vol. LII., No. 13, September, 1909, 48 pp., 4 pls.
[21] Mem. M. C. Z., Vol. XLI., August, September, 1910, 323 pp., 56 pls.
[22] Bull. M. C. Z., Vol. LIV., No. 7, August, 1911, 38 pp.
[23] Mem. M. C. Z., Vol. XXXVIII., No. 2, December, 1911, 232 pp., 32 pls.
[24] Bull. M. C. Z., Vol. LIV., No. 10, February, 1912, 16 pp., 2 pls.
[25] Mem. M. C. Z., Vol. XXXV., No. 3, April, 1912, 98 pp., 8 pls.
[26] Bull. M. C. Z., Vol. LIV., No. 12, April, 1912, 38 pp., 2 pls.
[27] Mem. M. C. Z., Vol. XXXV, No. 4, July, 1912, 124 pp., 12 pls.

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EXPLORATIONS IN THE GULF OF MAINE, JULY AND AUGUST, 1912, BY THE U. S. FISHERIES SCHOONER GRAMPUS. OCEANOGRAPHY AND NOTES ON THE PLANKTON.

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No. 2.— *Explorations in the Gulf of Maine, July and August, 1912, by the U. S. Fisheries Schooner Grampus. Oceanography and Notes on the Plankton.*

By Henry B. Bigelow.

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The cruise.

During July and August 1912 the U. S. Fisheries Schooner Grampus was detailed for an oceanographic cruise in the Gulf of Maine, under my direction, the purpose being to make as nearly complete a survey of the temperatures, salinities, currents, and plankton, of the waters of the Gulf as the brief time at our disposal, and the limitations incident to the use of a sailing vessel would allow, (Bigelow, 1913). It was also planned to do some systematic trawling in the neighborhood of Casco Bay, in cooperation with the Harpswell Marine Laboratory. During the cruise I was accompanied by Messrs. W. W. Welsh and Herbert E. Metcalf as assistants. It is a pleasure to acknowledge the assistance which Dr. C. O. Esterly has afforded in the preparation of this report, by identifying the copepods in more than 60 samples of plankton, no small task. And the value of the discussion of the plankton (p. 98) is largely due to his efforts, for copepods were altogether its most important constituent. A like debt of thanks is due to Mr. E. L. Michael, who has identified many of the Sagittae (p. 121), and to Mr. W. W. Welsh, who supplied the lists of fish fry and adult fishes (p. 107). I am also indebted to Capt. John W. McFarland, of Gloucester, who made several "tows" from his Schooner Victor.

Up to the present time, very little attention has been paid to the oceanography of the Gulf of Maine. But the fact that waters of diametrically opposed origins, *i. e.* Gulf Stream water and cold coast water, have long been known to meet each other here, gives reason to expect that an examination by modern methods will be of general oceanographic interest, and may be expected to have a practical bearing on the extensive fisheries of which it is the seat.

It is obvious that observations restricted to two months in mid-summer can not afford a picture of the regular series of changes which its waters undergo during the year, or of the sporadic variations which may be expected from the geographic position of the region in question, and from its relation to the Gulf Stream. Consequently the following report is to be regarded only as the beginning of a survey which, it is hoped, will be continued at other seasons in ensuing years.

The preparations for the cruise were made in Gloucester, and our first station, some five miles off that harbor, was occupied on July 9th, when we made a trial of the winches, trawl, deep-sea thermometers, water-bottles, and of the current-meter. The current measurements must, of course, be made from a boat at anchor; and we found that time was economized by taking them, and the serial temperatures and water samples as well, from a dory, which we could easily anchor in any depth of water down to 150 fathoms.

Our first field of work was the northern part of Massachusetts Bay. We then ran out to the 100 fathom basin, some 35 miles east of Cape Ann, where we made Station 7; but unfortunately the sea was so rough that it was impossible to make a quantitative haul, although the other work, including the hydrographic observations from the dory, was successfully performed. The nature of the hauls and other observations made at this and the other stations is tabulated below (p. 135).

From the 100 fathom basin we ran in toward Ipswich Bay, where the plankton is proverbially rich, making a rich trawl-haul of fishes at Station 8, and taking observations in the deep trough between Jeffrey's Ledge and the coast. At Station 10, off Portsmouth, our trawl fouled in some obstruction, and the winch failed to pay out the wire rope, with the result that we lost the trawl with 150 fathoms of wire rope, broke the dredging boom, and did so much damage that we were forced to return to Gloucester to refit.

After the damage was repaired, heavy weather delayed us until July 22d, when we ran northerly to Casco Bay, touching at Portsmouth, and occupying Stations 12–14, to develop the hydrographic conditions along the coast and in the trough west of Jeffrey's Ledge.

According to previous agreement Casco Bay was made our headquarters until July 31st (Stations 15–20), the vessel being engaged in dredging and trawling in the Bay and off its mouth, in coöperation with the South Harpswell Marine Laboratory.

On the completion of this work, July 31st, the vessel proceeded along the coast as far as the mouth of Penobscot Bay, making one offshore Station (21), and numerous hauls in the coastal waters and among the islands, while I remained at the South Harpswell Laboratory and titrated all the water samples collected up to that date, a room being placed at my disposal by the Director, Dr. J. S. Kingsley. I rejoined the Grampus at Portland; but owing to heavy weather and thick fog, it was not until August 7th that we were able to resume work.

We now ran a triangle to Platt's Bank and Jeffrey's Bank, likewise making a station off Cape Elizabeth, one in the deep trough between Platt's and Cash's Ledge, and one between Jeffrey's and the mouth of Penobscot Bay; but on the evening of August 8th, we were driven to refuge in Boothbay by thick fog, and lay storm-bound there and in Portland Harbor for a week. Leaving the latter port on August 13th, we commenced a section toward Cape Sable, following the parallel of 48° 25′, making Stations 27 and 28 in the eastern part of the 100 fathom basin, and Stations 29 and 30 on German Bank off the Nova Scotia Coast on the evening of August 14th in thick fog. The following day Station 31 was occupied off Lurcher Shoal, the exact position doubtful because of the fog. That afternoon we spoke a fishing vessel lying at anchor on the Grand Manan Bank and making a good fare of cod; during the night the fog lifted, allowing us to pick up the light house on Petit Manan Island.

At daylight, August 16th, the weather having cleared, we occupied Station 32, some ten miles off Mt. Desert Rock, and then turned northeasterly along the coast, making a station off Moose Peak. That night we made Station 34 in the Grand Manan Channel, and anchored in Eastport the following morning. On our passage through the channel we had found almost no plankton, a result in very marked contrast to the hauls which we had made off shore and further to the west (p. 104); and our run homeward was planned to develop the limits of this barren area as well as to trace the breadth of the band of cold water which lies close to the coast of Maine. Consequently on leaving the Grand Manan Channel, August 20, we ran off shore once more to the 100 fathom basin (Station 36) where we found an abundant plankton, and then turned northward again, reaching the coast near

Mt. Desert, whence we followed the outer islands (Stations 37–39) to the mouth of Penobscot Bay. On August 21st heavy fog once more set in, and on the 22nd we were driven to refuge until the 24th, in the Kennebec River, whence we ran direct for Cape Ann. We had planned several stations for this run, but heavy sea so interfered with our work, that only surface and intermediate hauls, bottom temperature, and water sample were taken at one station.

Up to this time we had been covering fresh ground constantly, thus having little chance to trace the changes in hydrographic conditions consequent on the advance of the season. But we were now able to repeat in Massachusetts Bay some of the stations which we had occupied six weeks earlier. One Station (43) was likewise occupied off Cape Cod, and on August 31st the GRAMPUS returned to Gloucester.

EQUIPMENT AND METHODS.

The money available for fitting the GRAMPUS for the cruise was limited, and we were therefore unable to provide ourselves with various pieces of apparatus which would have been desirable. The GRAMPUS has no dredging engine, to remedy which deficiency a gasoline winch, built for her on a previous occasion (Bigelow, 1909), was installed on deck just forward of the mainmast. But as this machine has a cargo-drum only, it was necessary to wind the wire rope from it by hand on a second winch. The reeling drum carried 300 fathoms of plough-steel rope, $\frac{3}{8}$ in. in diameter, with which all the trawling, dredging, and towing with the large horizontal and vertical nets was done, the length of wire outboard being measured by a fathom recording sheave. A small hand winch with divided barrel carrying 300 fathoms of soft iron rope $\frac{1}{8}$ in. in diameter with breaking strain of 500 lbs., and 400 fathoms of malleable steel sounding wire was also used.

The little winch was used in the dory, for serial temperatures, serial water samples, and current measurements; and occasionally on the vessel for similar purposes.

'Soundings were usually made by hand with cod-line and 30 lb. lead, a method sufficiently accurate for depths of less than 150 fathoms; but occasionally with the $\frac{1}{8}$ in. wire, or with the sounding wire.

The surface thermometers were of two kinds; the ordinary "Bureau of Fisheries" type (Tanner, 1897) graduated to 1° F, and a set of six extremely accurate chemical thermometers provided by R. Goertze, Leipzig, graduated to .1°C. Most of the observations were made with the former, as the readings are sufficiently accurate for the purpose, and they are much more convenient in actual use. Two of them were used, their rating being so close that there was no appreciable difference between them.

We carried four Negretti and Zambra reversing deep-sea thermometers, unfortunately without auxiliary thermometers for taking the temperatures of the detached thread at the moment of reading, such as are provided in their latest pattern and in the Richter thermometer. Two of these were rated in the U. S. Bureau of Standards at Washington, two in the Chemical Laboratory at Harvard University, with the following results:—

Negretti and Zambra Thermometer, U. S. B. F., No. 7,277.

Reading, °F	Correction, °F when *T.* of detached thread is 32°	60°	90°
32°	−.3°	−.5°	− .6°
60°	−.6°	−.9°	−1.1°
90°	0	+.3°	+ .6°

Negretti and Zambra Thermometer, U. S. B. F., No. 7,259.

32°	−.5°	−.8°	−1.1°
60°	−.2°	−.5°	− .9°
90°	+.4°	0	− .5°

It is fortunate that the changes in reading consequent on change of temperature of the detached thread are so small, for without the use of a water-bath, which was not available, the temperature of the detached thread could be obtained only by allowing the instrument to come to the temperature of the air before reading.

The corrections for Nos. 84,036 and 49,648 were noted with the temperature of the detached thread the same as that of the readings; *i. e.*, the freezing point reading was taken at an air temperature of 32°, the 68.5° reading at an air temperature of 68.5°. They are as follows:—

84,036, 32°, correction −.2°; at 68.5°, −.55°; at 77.13°, −.82°.
49,648, 32°, correction −.5°; at 68.5°, −.16°; at 77.13°, −.37°.

With both these thermometers the requisite correction at readings between 40° and 50° is about −.3°: and though this is not exact, variations from it, within this range, are less than the probable error of the observations (p. 40). The thermometers were used in reversing cases of the Tanner type (Tanner, 1897, pl. 21) actuated by a propeller; and these worked very well.

Two water-bottles were taken for collecting samples, a "Sigsbee" (Tanner, 1897, pl. 24): and a stop-cock bottle; but as the first trial of the "Sigsbee" showed that it could not be relied upon, all subsequent samples were obtained with the stop-cock bottle. This apparatus is a modification of the stop-cock bottle used on the MICHAEL SARS and highly recommended by Helland-Hansen and Nansen, (1909) the chief difference being that it is single instead of double, and actuated by a messenger instead of by a propeller. In its essentials (fig. 1) it consists of a brass tube, tinned on the inside, with a stop-cock at either end, the openings of the latter being only slightly smaller than the inside diameter of the tube. The mouth of the lower one carries a large copper funnel, which hastens the flow through the tube as it is being lowered and prevents water being carried downward in the bottle. Each stop-cock is hinged by a rod to the brass plate which carries the tripping gear, in such a way that when the bottle is raised both stop-cocks are open. When the bottle is tripped, the tube falls of its own weight, the hinge-rods turning the cocks in their barrels, and closing them.

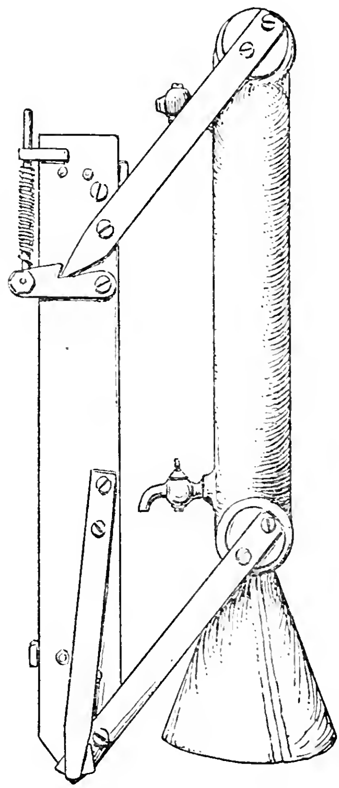
FIG. 1.— Stop-cock water bottle.

The tripping gear consists of a scear which engages the end of the upper hinge-rod when the tube is raised, and of a trigger which trips the scear when pushed downward against its spring by the messenger which is sent down along the wire rope. The dog, or ratchet engages the lower hinge-rod when the bottle falls and is closed, to prevent accidental opening. There is a small stop-cock near the upper end to admit air, and another near the lower end to discharge the water.

The apparatus proved entirely reliable, perfectly water tight, and it has the great advantage that it can be made by any skilled machinist at small expense. The most important precautions in its manufacture are to provide tight stop-cocks: and to make the diameter of the tube as nearly the same as that of the latter as possible.

The water samples were preserved in "citrate of magnesia" bottles, made of lead glass by the Whitall Tatum Co., with patent stoppers consisting of a porcelain disc forced by a spring against a rubber ring. The joint thus formed is so nearly air tight, that the danger of evaporation is negligible. As pointed out (p. 62) tests show no appreciable alteration of the samples after prolonged storage. The only drawback to these bottles is that they are fragile and occasionally break spontaneously as a result of sudden change of temperature.

Current measurements were taken with an Ekman current meter.

Salinity was determined by titration with nitrate of silver, the index being chromate of potassium. The burette and "Knudsen" 3-way pipette were supplied by Robert Goertze of Leipzig, the standard water by the International Committee for the exploration of the sea. This, of course, is the method almost universally employed; and the principle on which it depends has been explained by Murray and Hjort, (1912) as well as by various other writers.

The color of the sea is usually recorded by the "Forel" scale based on a combination of blue and yellow, the former being .5 gram copper-sulphate + 5 cc. ammonia in 95 cc. water, the latter .5 gram potassium chromate in 100 cc. water. The combinations used are: —

	1	2	3	4	5	6	7	8	9	10	11	12	13
blue	100	98	95	91	86	80	73	65	56	46	35	23	10
yellow	0	2	5	9	14	20	27	35	44	54	65	77	90

In practical use a scale consisting of a series of glass tubes is unsatisfactory because of surface reflections. But these are entirely avoided if the tubes be mounted in a frame above a white mirror of porcelain at 45°, being thus seen by transmitted light against a white background. The color of the sea water is observed by means of an ordinary plate-glass mirror mounted at 45° at the end of a pole and held a foot or two below the surface on the shady side of the ship. With this device, our home waters change from apparent blue to light bottle-green.

Transparency measurements were made with the ordinary white disc fourteen inches in diameter, and we likewise used a four candle-power electric light with storage battery, in a water-tight brass case with glass window at the top.

The following nets were used: —

1. Four foot open net for horizontal towing, of the ALBATROSS pattern; ten ft. long, the upper five ft. with $\frac{1}{8}$ in. mesh, the lower five ft. lined with silk, 38 meshes to an inch. A glass bucket was sometimes used with this net, and a 70 lb. weight attached to the wire rope.
2. Quantitative nets of the Hensen type, the opening of the net 36 cm. in diameter, with glass collecting-bucket, and a 70 lb. weight attached to the latter. Nets of two grades were used, the silk of one being 74 meshes to the inch, the other 144 to the inch.
3. Ordinary open net of no. 20 bolting silk, 18 inches in diameter.
4. Open net 12 inches in diameter, silk 38 meshes to the inch.
5. A scrim net 18 inches in diameter.
6. A closing net for horizontal towing.

This net, described in Int. rev. hydriob., 1913, **5**, p. 576, is a combination of the Chun-Petersen-Nansen principles, *i. e.*, it has a hinged ring which is sent down closed, to be opened by a spring released by

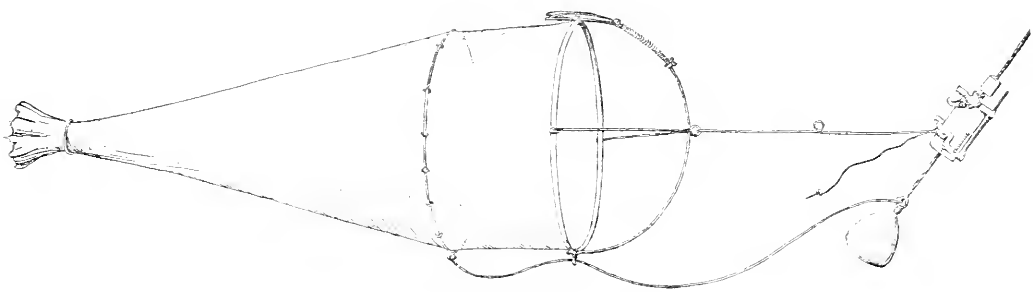

FIG. 2.— Closing net in operation.

a messenger; and it is closed by a draw-string about the net bag, likewise operated by messenger (fig. 2).

Trawling and dredging were a minor part of our program; for this work we carried ordinary dredges, and eight-ft. beam trawls.

The four-ft. and closing nets were towed horizontally, sometimes separately, sometimes simultaneously on the wire rope. In the latter case, the former was necessarily used at the deepest, the latter at the intermediate horizon. In the shallow waters in which we worked the catenary of the rope is so small as to be practically negligible;

and the depth can be calculated from the angle of the rope as observed by the dredging quadrant (Tanner, 1897) and the length outboard.

The need for a high degree of accuracy in oceanographic research has been emphasized by Helland-Hansen and Nansen, (1909) who have shown that in waters as comparatively well known as those of the North Sea and the Norwegian Sea, inaccurate salinity observations are worse than none, as they give a wholly misleading idea of the water-circulation. The same is true also of temperature readings, especially at great depths. But in a preliminary survey of a field, so little known as the Gulf of Maine, the same high degree of accuracy is not so essential, for any information which can be relied on as approximately correct is of value. Nevertheless, the more accurate the determinations the better, for the sake of future comparisons. In any case, it is essential that the probable limits of error of the observations for both salinity and temperature should be clearly stated, and constantly borne in mind in all discussions.

In the determinations for salinity we are provided with a perfectly satisfactory water-bottle; the storage of the samples is not open to any apparent criticism, and our burette and pipette are of the best. The instrumental error, therefore, must be very small indeed; and there remains only what we call the personal error of the observer. Unfortunately no trained chemist was available for the titrations; and I must confess that I have found the determination of the precise point at which the color changes from yellow to orange a difficult one. Nevertheless, as every sample was titrated twice, some of them three or four times, as the standard water could be relied upon, and as an actual test (p. 62) has shown that repeated tests of the same samples did not differ by more than .01 of salinity, I believe that the results arrived at are reliable considerably within the requirements of the International Committee for the exploration of the sea, *i. e.*, ±.05 of salinity, probably to ±.02 of salinity.

In the case of temperature, a very high standard of accuracy could not be expected from the instruments which we used. Our deep-sea thermometers were graduated only to 1.°F; and the graduations are so rough that we found it impossible to rely on estimation closer than .2°F, though the readings were taken with a reading lens, and estimation to .1°F was constantly attempted. We must also consider the possibility of error resulting from not knowing precisely the temperature of the detached mercury thread when read, though the table of correction shows that an error here of 5°F, at the usual air temperature of 55°–70°F would make a difference of only about .1°F in the reading, and this may be considered the extreme. There is one other source of error in any reversing thermometer actuated by a propeller; *i. e.*, uncertainty at what precise level the instrument reverses, with possibility of change in reading during its passage upward through the column of water necessary to reverse it. But we so often used two thermometers at each level, and so often repeated the entire series, that I do not believe this possible error is of any practical importance in the present case. On the whole, then, it is better not to claim accuracy closer than ±.3°F; *i. e.*, roughly, .15°C. And it is certainly much better to set these limits wide, rather than to claim a higher degree of accuracy than can be relied upon.

The surface thermometers were extremely reliable, and so far as the instruments themselves are concerned very little error is to be expected. But the readings were taken by various persons, often under difficult conditions, therefore accuracy is not claimed beyond ±.5°F.

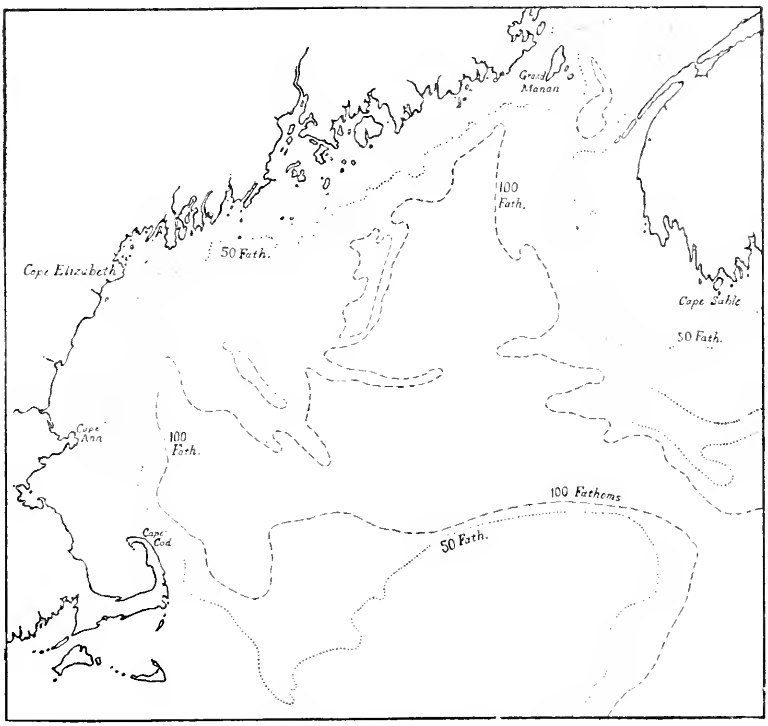

Fig. 3.— Bathymetic chart of the Gulf of Maine.

Oceanography.

Up to the present time no systematic studies of the oceanography of the Gulf of Maine have been undertaken. The surface temperatures have, of course, been known in a general way for many years, as has the existence of a cold band of water close to the coast of Maine and in the Bay of Fundy; and thanks to Dickson's, (1901) researches we have a fairly satisfactory idea of the seasonal range of surface temperature for two years, 1896 and 1897. But his records were far too few to delimit the distribution of slightly differing temperatures within the Gulf.

Almost all the knowledge we possess as to the bottom temperatures dates back to 1872, 1873, and 1874 when a series of dredgings was carried out by the U. S. Fish Commission and the U. S. Coast Survey on George's Bank, in the Bay of Fundy, off Cape Elizabeth, and at various other localities in the Gulf. The bottom temperature was recorded at each station, and the records have been published by Verrill, (1873–1875); but unfortunately, as he himself points out, the Miller-Casella thermometers which were used proved unreliable, two instruments often differing by several degrees when used simultaneously. Nevertheless the results were valuable as showing in a general way the low bottom temperature of the Gulf (p. 93). So far as I can learn, no intermediate temperatures have ever been taken in the Gulf, except a few which I obtained during the summer of 1911 between Cape Ann and Casco Bay.

The salinity records for the Gulf are even more scanty than those for temperature. A considerable number of hydrometer readings for the surface have been taken by the Bureau of Fisheries; but most of them were made with unstandardized instruments, and under circumstances precluding any approach to accuracy. The only reliable salinity records from the surface are three titrations by Dickson, (1901), of samples collected off Cape Cod, April, 1896; off Cape Sable, April, 1896; and northeast of George's Bank, April, 1896. And there are no records whatever of the salinity on the bottom, or at intermediate depths.

For George's Bank and the Eastern Channel, the data is rather more extensive, there being eighteen titrations (Dickson, 1901); and a considerable series of temperatures were taken by the Albatross in 1883 in the channel with Negretti and Zambra reversing thermometers. There is one titration from Brown's Bank and a considerable number southeast of Nova Scotia (Dickson, 1901) besides a series of surface and bottom temperatures by the ALBATROSS (Townsend, 1901).

Surface temperature, July–August, 1912.— The surface temperature was taken hourly, day and night, throughout the cruise; and the readings are plotted on the chart (Plate **1**). When I came to check up the results, one interesting anomaly became apparent, namely, that the surface temperature at each station is from .5° to 1° lower than the next reading on either side of it. This discrepancy is probably due to the method of observation, the readings at the stations being taken with the thermometer hanging a foot or so below the surface, whereas the instrument dragged on the actual surface when the vessel was under way.

The chart shows that so far as surface temperature is concerned the Gulf of Maine can be divided into two general regions, one with temperatures of 60° F or over, both day and night, in July and August, the other with temperatures below 60°. In a general way the first includes the whole of the southern and central parts of the Gulf, *i. e.*, Massachusetts Bay, and the off-shore waters south of 43° 21′ N. Lat., as far east as 66° 45′ W. Long., but it does not reach the Nova Scotia coast. Over all this area the daily average of the surface water was about 61° and the diurnal warming, touched on below, considerable. But though Massachusetts Bay as a whole belongs to the warm division, lower temperatures were observed along the northeast coast of the Bay, near Eastern Point, off Race Point (Station 44, 58°); off Baker's Island, and notably near Boston Light-ship (July 15, 58°) where two days before a temperature of 63° was observed. And on July 23 a band of water of only 56° was found extending from Gloucester around Cape Ann for some ten miles northeasterly, *i. e.*, covering a region where a few days before temperatures above 60° were found.

The temperature was above 60° in Ipswich Bay, north ofCap e Ann. But when we entered the passage between the Isles of Shoals and the mainland, the surface temperature dropped several degrees, the readings here being 55°–57°, and working northeastward, a continuous belt of this cold water was found lying next the coast. From the Isles of Shoals nearly to Cape Elizabeth this cold band was about 15 miles broad; south of the Isles of Shoals it narrowed suddenly, the 60° curve touching the coast somewhere between Station 10 and the mouth of the Piscataqua River. The cold water does not reach Cape Ann except sporadically, an instance, as noted above, being July 24th, when, strong northerly gales for the three preceding days had driven the warm surface water to the south. And even in this case it is probable that the cold water which took its place welled up from below, rather than that it was an extension of the cold zone normally encountered some 15 miles further north. At 43° 27′ N. Lat., *i. e.*, a few miles south of Cape Elizabeth, the cold band suddenly became broader, the 60° curve bending eastward almost at a right angle, and roughly following the parallel of 43° 27′, to within about 35 miles of Seal Island, Nova Scotia (*i. e.*, 66° 49′ W.) where it turned southward and passed out of the area covered by the cruise of 1912. The cold water thus expands from a narrow band to a triangular area which is about 45 miles broad opposite Grand Manan. It is continuous thence along the western coast of Nova Scotia, becoming narrower again (25 miles broad) off Yarmouth. Throughout this triangle the temperatures, day and night, were everywhere 59° or below, except for one sporadic reading of 60° off the Grand Manan Bank, probably explicable by diurnal warming on a very calm day; and the diurnal range very small. From Portland eastward to Mt. Desert the temperature range was from 56°–58°, a very small variation when we remember the strong tides of this region. Northeastward from Mt. Desert the temperature close to the coast dropped below 55°; and from Moose Peak to and through the Grand Manan Channel, as well as in Passamaquoddy Bay and Eastport Harbor the temperature on the surface was 50°–52°.

Unfortunately we did not enter the Bay of Fundy proper, and it is therefore impossible to draw the curve of 55° accurately. But so far as our observations show, it touched the outer islands at Mt. Desert; ran easterly for about 25 miles, and then turned southeasterly, enclosing the Bay of Fundy and a band along the west coast of Nova Scotia. On our run from Station 28 to Station 29, the drop in temperature was very sudden, from 60° at 60° 49′ W to 50.5° at Station 29, 20 miles further east. The area of water colder than 55°, is then roughly comparable in outline to that between 55° and 60°, though much smaller in extent. And this cold water was below 55°, usually below 53°, by day as well as by night. The lowest surface temperatures encountered were on German Bank (50.5°) off Grand Manan Bank (50°), and in the Grand Manan Channel (50°).

Our only example of seasonal change is in Massachusetts Bay, which we studied at the beginning and again at the end of our cruise. From July 9–15 the temperatures in the northern half of the Bay during the day time were usually 63°–65° (60°–65°) except for the occasional cold bands mentioned (p. 43) to which we will have occasion to return in our discussion of vertical circulation; and off Cape Ann the temperature during this same period ranged from 60°–66° (day and night); usually 63°–65° in the day time. On our return we crossed Massachusetts Bay twice (August 28th–31st). On the first passage the surface temperature ranged from 60°–62°, the mean being about 61°; on the second, two days later, from 59°–61°, the mean being nearly 61°; and on August 29th, off Cape Cod, the temperature range was from 60° to 62°, with a mean of 61°. These observations show that by the end of August an appreciable cooling of the surface water had taken place in and near Massachusetts Bay, from the annual maximum, which must be reached about the first of August.

Satisfactory data as to diurnal warming can be obtained only when the vessel lies at one spot for considerable periods, so our information on this point is not very extensive. But we made some observations which suggest an unusually great diurnal warming under certain con-

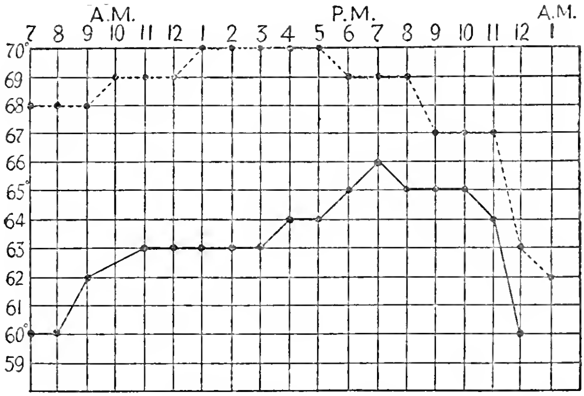

Fig. 4.— Air and surface temperatures, off Cape Ann, July 15, 1912.

ditions. On July 15th we ran eastward from Massachusetts Bay to Station 7, and then westward again in the evening, being continuously within an area of weak tides, with clear sky and moderate breezes. Surface and air temperatures for each hour from 7 A. M. to 12 midnight are shown (fig. 4). The surface temperature, which was 60°, near Boston Light-ship, rose rapidly to 63° at 10 A. M. It then remained constant until 2 P. M., when there was an irregular rise, culminating, at 7 P. M., with 66°. After this the temperature fell reaching 60° once more at midnight. Observations made during the rest of the night are not comparable with the foregoing, because we were then within a few miles of the coast; but they show that the temperature remained 60°–61° until 8 A. M., then rose gradually to 67° at 1 P. M., July 16, at which time we were in Ipswich Bay. In the afternoon we passed into the cold coast water off Portsmouth. The air temperature for July 15th shows a rise and fall roughly parallel to that of the water, the latter, however lagging far behind the former. On the 16th the air temperature rose from 64° at 6 A. M. to 76° at 11 A. M., *i. e.*, it was roughly parallel to the rise of the water.

On August 7th we had a second opportunity to observe diurnal warming of the surface. This day was flat calm, with a bright sun, but slightly hazy. We ran all day southeastward from Cape Elizabeth. Close to the coast, of course, we passed through the cold band; but at 9 A. M. we had run into the warm off-shore water, some fifteen miles from the Cape; and air and water temperatures for every hour from this point on until midnight are plotted (fig. 5). The surface

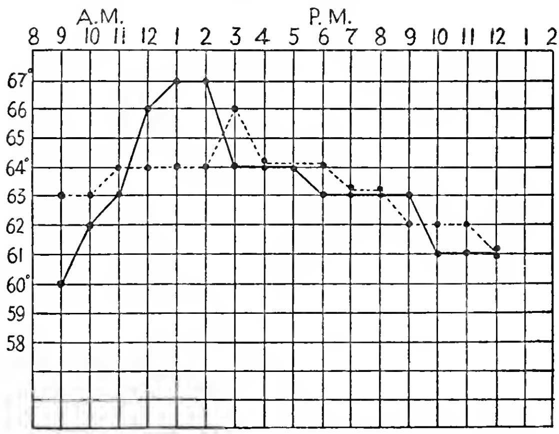

FIG. 5.— Air and surface temperatures, August 7, 1912.

temperature rose steadily from 60°, until at 1 P. M. the maximum, 67°, was reached. By this time the air temperature had risen only 1° (from 63°–64°); but by 3 P. M., when the water had fallen to 64°, the air reached its maximum for the day, 66°. From this time onward both air and water cooled, until at midnight both were 61°. This case is especially interesting, because the warming of the water preceded that of the air, and reached a higher degree. So far as they go, these observations show that diurnal warming in the region in question is very considerable in clear, calm weather, even as much as 6° or 7°, but it is usually much less, *i. e.*, 2° to 3°.

One day, August 21st, throws light on the diurnal warming of the cold coast water between Mt. Desert and the mouth of Penobscot Bay. The hourly diagram (fig. 6) shows that there was only about 2°

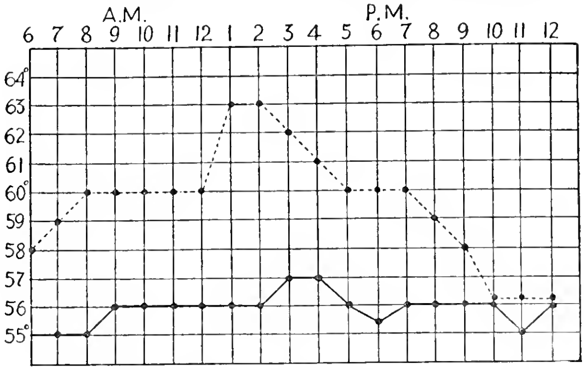

Fig. 6.— Air and surface temperatures, August 21, 1912.

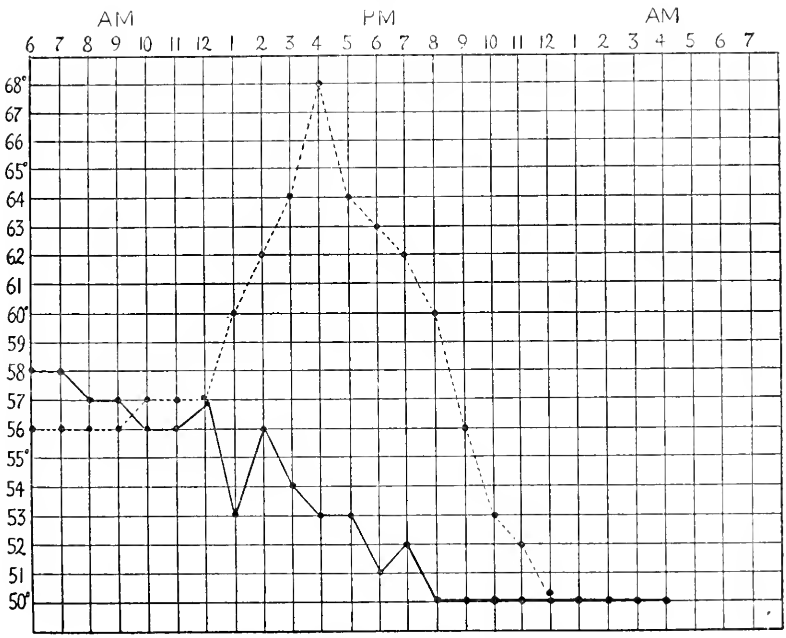

Fig. 7.— Air and surface temperatures, August 6, 1912.

rise in the surface temperature readings (55°–57°) although the air rose from 58°–63°, and the temperature readings taken on various days show that diurnal warming is very much less in this region than it is in the warmer off-shore waters. So far as our observations go, they suggest that in the cold coast water northeast of Mt. Desert diurnal warming is not usually observable; thus the diagram for August 6th (fig. 7) shows a slight fall (56°–57°) from 6 A. M. until

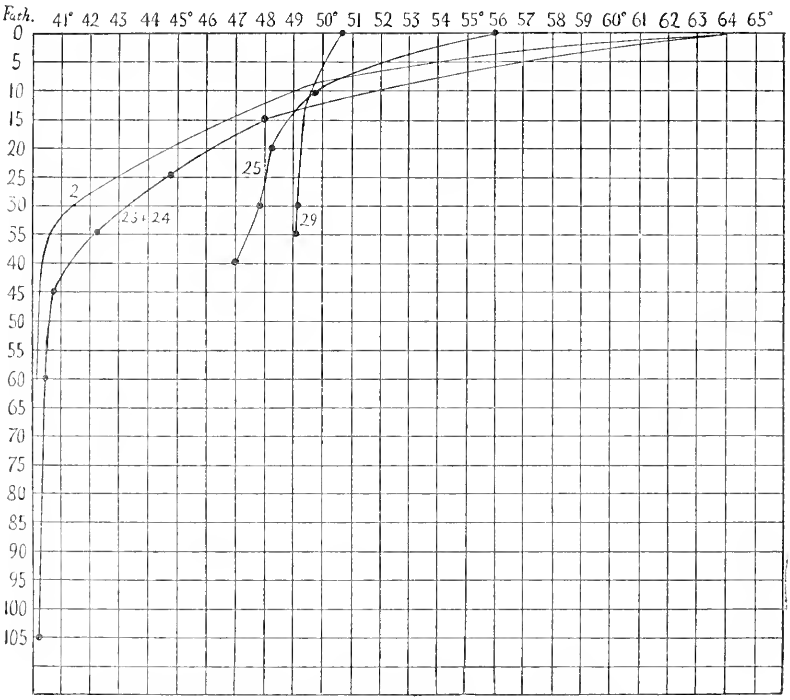

FIG. 8.— Temperature sections at Stations 2, 23, 24, 25, 29.

noon; although between 9 A. M. and 4 P. M. the air temperature rose from 56° to 68°.

To explain the distribution of the surface temperatures of the Gulf of Maine, just outlined, requires a knowledge of the temperatures in the underlying water layers at the same season, which is afforded for the first time by the Cruise of 1912.

Temperature sections.— The section made off the mouth of Massa-

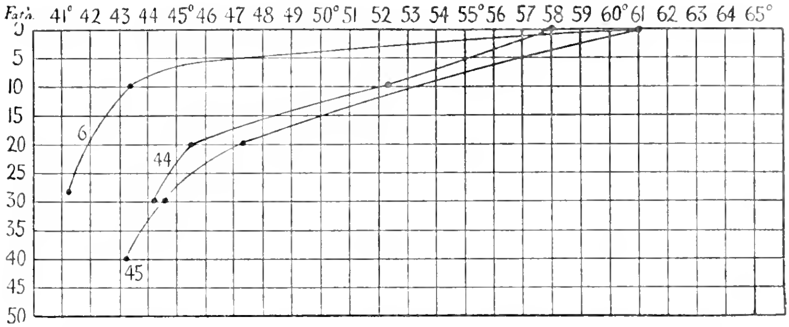

FIG. 9.— Temperature sections in Massachusetts Bay, Stations 6, 44, 45.

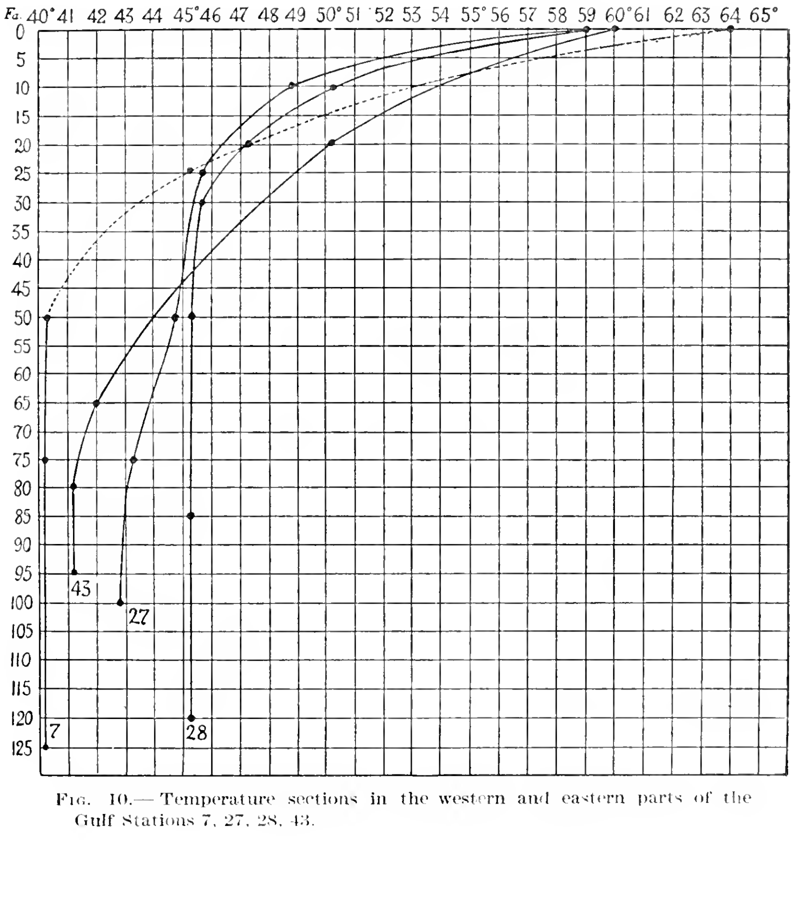

FIG. 10.— Temperature sections in the western and eastern parts of the Gulf Stations 7, 27, 28, 43.

chusetts Bay in the first half of July, (Station 2 [1]) shows (fig. 8, 11) that there is a very rapid decline in temperature from the surface where it is about 65°, to 49° at about ten fathoms, followed by a rather slower decrease to 40.3° at about thirty-five fathoms, from which point downward to the bottom there is no further change. In the shallower parts of Massachusetts Bay in July, Stations 5 and 6 (fig. 9) the cooling between the surface and ten fathoms is even more rapid, the drop being from 61° to 43.4°; and it then declines less rapidly just as at Station 2, to the bottom in twenty–thirty fathoms, at which point the lowest temperature, 41.3° is reached, the temperature at this level

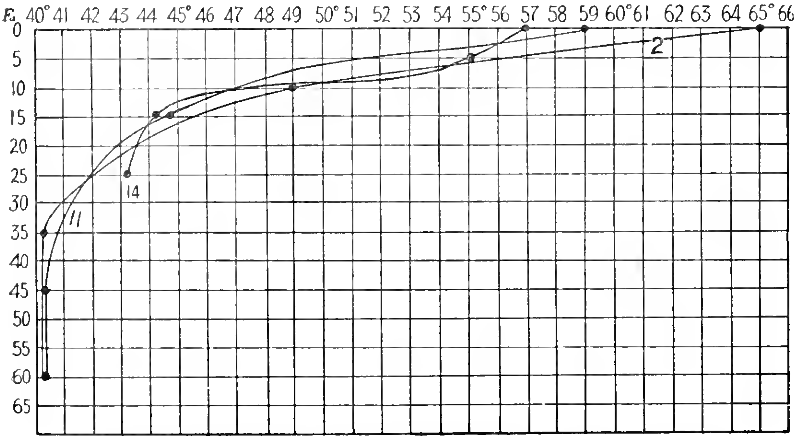

Fig. 11.— Temperature sections in the mouth of Massachusetts Bay (Station 2), and west of Jeffrey's Ledge (Stations 11, 14).

being the same as it was at Station 2. In the Bay at the end of August conditions are different, as pointed out below. At Station 1 the temperature curve is practically the same as at Stations 5 and 6, the temperature at the bottom in thirty-five fathoms being 40.6°, very nearly what it is at Station 2 at a corresponding depth.

The section in the 100 fathom basin off Cape Ann, Station 7, (fig. 10) shows that the surface layer of warm water was slightly thicker here, the drop from the surface to 10 fathoms being only from 64° to about 53°; and the rate of decrease diminishing slowly until the minimum of 40.3° is reached at fifty fathoms, instead of at thirty-

[1] To agree with the station numbers of the U. S. Bureau of Fisheries 10000 should be added to the numbers given in this report, *e. g.* 10002.

five as at Station 2. Below this level there was no further change of temperature to 125 fathoms.

At Stations 9, 11, and 14, (fig. 11) west of Jeffrey's Ledge, the curves agree very well with those for Massachusetts Bay, except that the surface temperature of the last two is several degrees lower, and that at one Station (12b) in the trench, a lower bottom temperature, 39.2°, was recorded. But as this was the only instance of a reading below 40.3°, it is possible that the thermometer recorded incorrectly. Off Cape Cod at Station 43, late in August, the bottom temperature was higher, in this case, 41.3° instead of 40.3°; and as at Staton 2, the uniform bottom water was met at 50 fathoms (fig. 10).

In all the western part of the Gulf, there was a bottom layer, of varying thickness, and reaching to within varying distances of the surface of the water, the temperature of which was practically uniform, 40.3°. In the western 100 fathom basin, it was seventy fathoms or more in thickness, and it filled the deep circumscribed basin at the mouth of Massachusetts Bay, as well as the bottom of the deep trough west of Jeffrey's Ledge. But the differences in the temperature in Massachusetts Bay in early July and late August (p. 58) show that it is only below fifty fathoms or so that the bottom temperature may be expected to remain fairly constant throughout the year. Above that level, the whole water mass is subject to summer warming and winter cooling.

If we compare the temperature sections at successive stations from Cape Ann toward Nova Scotia (Stations 2, 7, 23, 24, 27, 28, 29, figs. 8, 10) we find that the curves, which are nearly uniform from the Cape to Station 24, grow progressively straighter from that point eastward, the temperatures being higher and higher on the bottom, lower and lower on the surface. And while the curves for Stations 27 and 28 show that the lower seventy to eighty fathoms of the eastern arm of the 100 fathom basin, like that of the western one, was filled with a layer of water which shows very little decrease in temperature downward below thirty-five fathoms, the bottom water differed from that of the western basin in being decidedly warmer than in the latter, a difference which can not be laid to advance of the season, because on our return (Station 41) we once more encountered bottom water of 40.3°, west of Jeffrey's Ledge; and in being less uniform, for it was slightly warmer at all depths at Station 28 than at Station 27. And while at Station 28 the temperature of the whole mass below thirty fathoms was 45.3°, at Station 27 there was a slow, but constant decrease all the way to the bottom, where the temperature in 100 fathoms was about 43°. On reaching German Bank, we found that the surface temperature had dropped from 59° to 50.5°; the bottom water on the contrary, had risen to 49.2°, the entire drop taking place within ten fathoms of the surface.

Temperature sections from Cape Ann toward the Bay of Fundy, (Stations 11, 19, 39, and 35, fig. 12, and Stations 8, 14, 15, 21, fig. 13), exhibit a gradation similar to that seen on the line Cape Ann–Nova Scotia, the curves growing progressively straighter and straighter

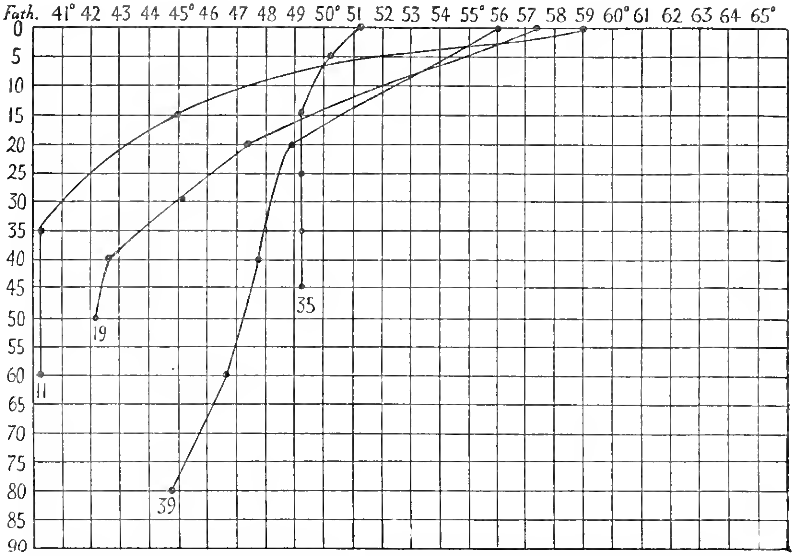

FIG. 12.— Temperature sections, Cape Ann to the Bay of Fundy, Stations 11, 19, 39, 35.

toward the northeast. Station 11 is practically identical with Stations 2, 23, and 24; Stations 33, and 35 with Station 29; Station 39 is intermediate.

It is interesting to compare the temperature conditions over the three off-shore banks which we visited, Platt's, Jeffrey's, and German, (fig. 14) with one another and with those of the deep basins. The first is about fifty miles northeast of Cape Ann. The surface temperature here was 64°, the bottom reading in 45 fathoms, 40.8°, and its temperature curve (fig. 14) is almost precisely identical with that of Stations 2 and 11. This, of course, shows that the bank had no disturbing effect on the water above it. On Jeffrey's Bank, some thirty-five miles south of the mouth of Penobscot Bay, the surface temperature was distinctly colder than we found it on Platt's the day before, *i. e.*, 57°; but the bottom, in 60 fathoms, was much warmer, 47.3°

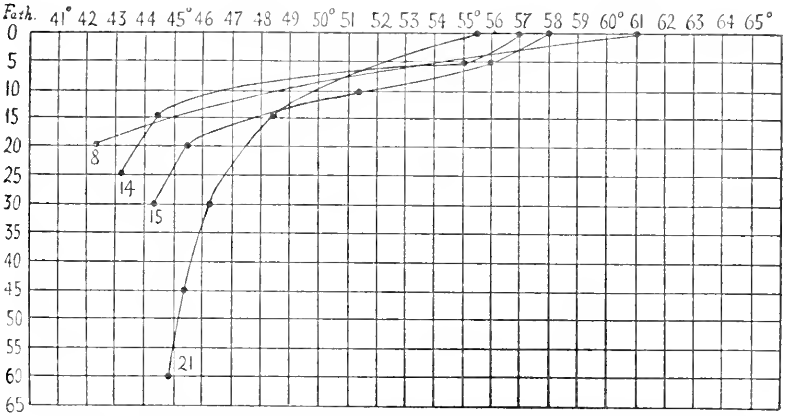

FIG. 13.—Temperature sections in Ipswich Bay (Station 8), off Cape Porpoise (Station 14), off the mouth of Casco Bay (Station 15), and off Monhegan (Station 21).

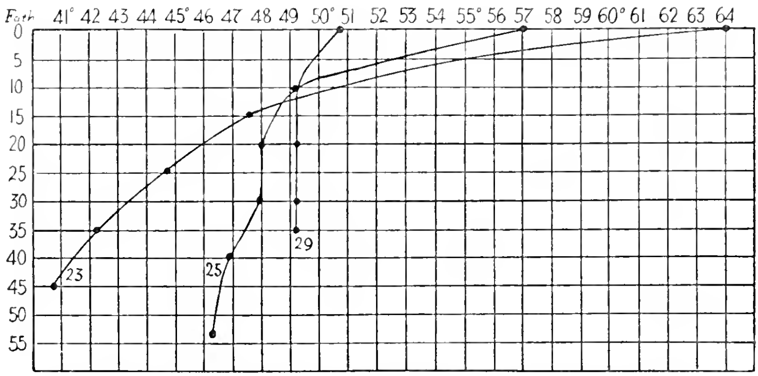

FIG. 14.—Temperature sections on Platt's Bank (Station 23), Jeffrey's Bank (Station 25) and German Bank (Station 29).

instead of 40.8°. The curve for Station 25 shows a rapid decline from the surface down to ten fathoms, in which distance there was a drop of nearly 8°, while from that point downward the decline was slow and irregular. On German Bank, some fifteen miles off Seal Island, Nova Scotia, the surface reading was 50.5°, the bottom 49.3°, the entire drop taking place in the upper ten fathoms, below which point the temperature was uniform to the bottom. These three banks, then, taken in a series, illustrate precisely the same kind of temperature relation as was exhibited by the coast waters passing eastward and northeastward from Cape Ann, but to a more pronounced degree.

The serial temperatures at Station 31 (Fig. 15) are especially in-

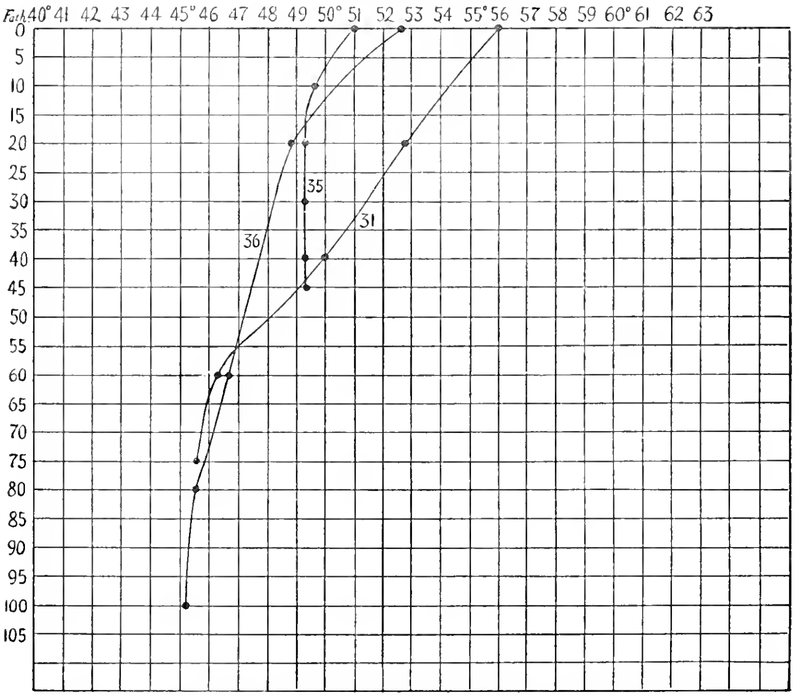

FIG. 15.— Temperature sections in the Grand Manan Channel (Station 35); in the northeast end of the Deep basin (Station 36), and near Lurcher Shoal (Station 31).

teresting because of nonconformity with those at neighboring stations, *i. e.* they are warmer at all depths above fifty fathoms, a phenomenon best discussed in connection with the temperature profiles.

Temperature at twenty-five fathoms.— The curves for temperature at twenty-five fathoms (Plate 1) reconstructed from the temperature sections, show that the relative distribution of temperatures at this depth was in a general way the opposite of what it was on the surface, the lowest temperatures being encountered in the west, in Massachusetts Bay, off Cape Ann, and in the trough west of Jeffrey's Ledge, the highest in the east, off the coast of Nova Scotia (Stations 29 and 31), and in the Grand Manan Channel. The extreme range, at this depth, was from about 42° to about 51°, the former characterizing the cold area delimited above, the latter encountered only at Station 31. In general the twenty-five fathom temperature in the northeastern part of the Gulf was between 48° and 49°. The curve for 48° runs southerly from the mouth of Penobscot Bay far enough to include Jeffrey's Bank, then turns northward again toward the coast, which it parallels at a distance of about twenty miles, until the meridian of 67° 25′ is reached, when it once more bends to the southward. Off the mouth of Casco Bay there was an isolated area where the twenty-five fathom temperature was 48° or higher. And off Cape Cod, Station 43, the temperature at twenty-five fathoms was likewise above 48°. The chart for this level is constructed only for July and early August, and our observations show that at least in the western part of the Gulf there is a decided rise in temperature at twenty-five fathoms from July 9 to August 31, the water shown on the chart as 42° warming to 45°–46°.

Bottom temperatures.— The curves for the temperatures at the bottom (Plate 1) show that, like those for twenty-five fathoms, there was a regular rise, both at corresponding depths and absolutely, passing northeastward from Cape Ann to Nova Scotia. Thus at Stations 2, 3, 5, 6, 7, 12b, and 24, the bottom temperatures in depths of from 40 to 120 fathoms were constantly below 42°, the minimum being 39.2 at Station 12b in the trench between Jeffrey's Ledge and the mainland. That is to say, in July, the bottom temperature over the western arm of the 100 fathom basin, in the deeper parts of Massachusetts Bay, below say forty-five fathoms in the trench west of Jeffrey's Ledge, and over Platt's Bank was extremely uniform, usually 40.3°. But as we ran eastward we found higher and higher bottom temperatures, irrespective of depth. Thus, at Station 27, on the western edge of the eastern arm of the 100 fathom basin, in 100 fathoms, the bottom reading was 43°; at Station 28, thirty-five miles further northeast, in 120 fathoms, it was 45.5°; at Station 29, on German Bank, in thirty-five fathoms, between 48° and 49°, *i. e.*, only about 1.5° below the surface reading; and some 7° or 8° warmer than the bottom temperature at a corresponding depth in Massachusetts Bay, 6° warmer than at thirty-five fathoms over Platt's Bank. Successive stations passing northeasterly along the coast from Cape Ann toward the Bay of Fundy show a similar rise of bottom temperature, irrespective of depth. Thus at Station 11, in sixty fathoms, abreast of Portsmouth, the bottom reading was about 40.3°; at Station 19, abreast of Cape Elizabeth, in fifty fathoms, 42.3°; Station 39, off the mouth of Penobscot Bay, eighty fathoms, 46°; Station 35, in the mouth of the Grand Manan Channel, forty-five fathoms, 49.3°; which was only about 1° lower than the surface temperature.

Temperature profiles.— The first profile (fig. 16) constructed from the temperature curves, shows the distribution of temperature for July and early August from Boston to Station 29, on German Bank, passing through Jeffrey's Bank, (Stations 6, 2, 7, 24, 25, 27, 28, 29). At the western end of the profile, there is a very thin surface layer of warm water with temperatures above 46° overlying the cold bottom water with a temperature of 40.3°–41°, which fills all the eastern basin below about forty fathoms. Passing eastward the lower limit of the warm layer, which may be established arbitrarily by the isothermobath of 46°, dips from about five fathoms at Station 6 to fifteen fathoms at Station 2; and in the trough west of Jeffrey's Ledge, it lies at about that same depth. From Station 2 to Station 7 it dips to about twenty fathoms, which level it follows to Stations 23 and 24.

At Station 25 a very interesting phenomenon is seen, for here the curves for temperatures above 48° rise nearly to the surface, while that of 46° touches the slope of Jeffrey's Bank at about seventy fathoms. East of the bank the reverse occurs, the curve of 48° rising to about fifteen fathoms at Stations 27 and 28, the curve of 46° to twenty – twenty-five fathoms at these same stations. At Station 29 there is a distortion of the curves parallel to that on Jeffrey's Bank (Station 25); the temperature of the entire water-mass being between 49.1° and 50.6°.

Over the eastern part of the profile, the bottom water is less uniform in temperature than it is in the western, the coldest water (about 43°) being met on the eastern face of the slope of Jeffrey's Bank, while the easterly part of the basin below thirty fathoms is filled with water of about 45.3°.

A profile from the basin (Station 28) to German Bank (Station 29) passing through Station 31 (fig. 17) reveals the presence of a mass of warm water on the surface at the latter. Over the first part of this line the curves for temperatures between 46° and 54° dip sharply, the former descending from about twenty-two fathoms at Station 28 to about sixty-five fathoms at Station 31. The curve for 50° dips from

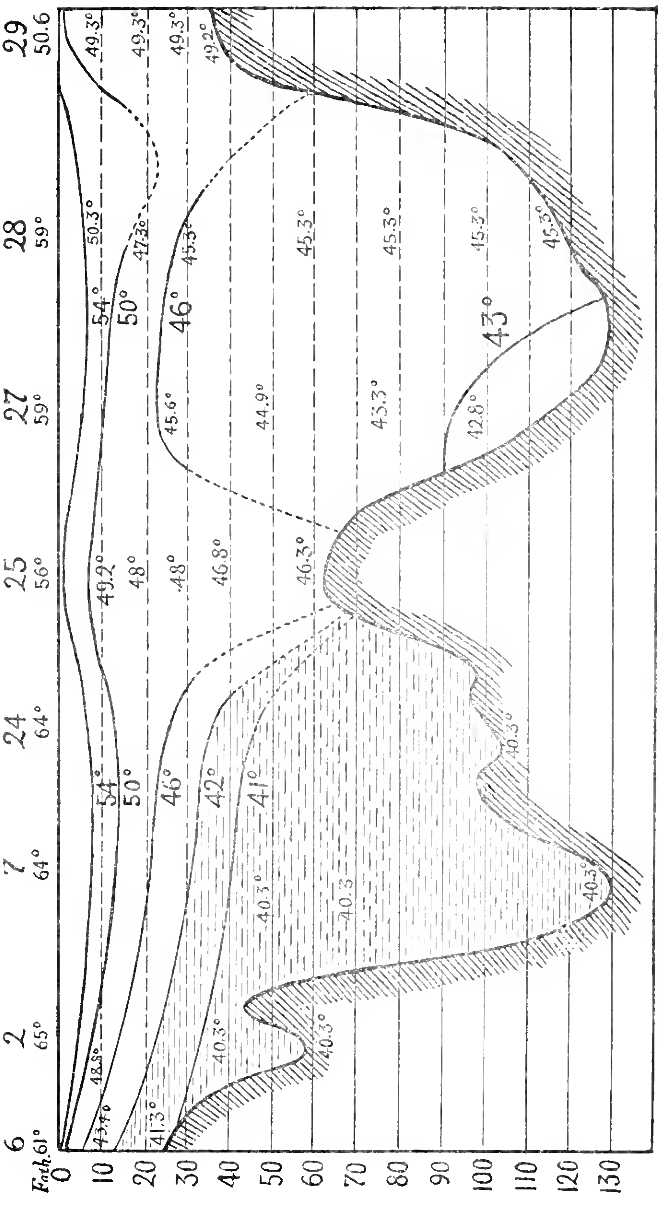

FIG. 16.— Temperature profile from Boston to German Bank, via Jeffrey Bank. Horizontal scale, 33 miles to the inch.

twelve to forty-two fathoms; that for 52° from about five to about twenty-five fathoms. The curve for 54°, however, runs parallel with the surface. But the course of the curves eastward from Station 31 shows that the warm water does not extend to the coast bank. On the contrary, the curve of 50° rises sharply until at Station 29 our serial observations locate it at a depth of only about three fathoms. The warm water at Station 31 can be further delimited by a profile across the mouth of the Bay of Fundy (Stations 33, 36, 31, 29, fig. 18) which shows that Station 31 is warmer at corresponding depths than either of the other three, Station 33 practically reproducing Station 29, except that the immediate surface was about .5° warmer. Evidently then there was a mass of water lenticular in section, several degrees warmer, at all depths, than the water either east, north, or west of it, at Station 31. Whether this warm area was circumscribed on the south also, or whether it was continuous with the warm off-shore water, possibly even with the Gulf Stream water, which washes the continental slope, is doubtful.

The profiles show that the temperature conditions over Jeffrey's Bank, on German Bank, and off the mouth of the Grand Manan Channel are closely related to one another, differing correspondingly from the deeper adjacent waters, in being colder at the surface, warmer at the bottom. The three differ from each other, it is true, in degree, but not in kind. But a profile running southeasterly from Mt. Desert for about fifty miles to Station 28 (Stations 37, 32, 28, fig. 19) shows that there is no spreading of the curves on the slope here, which is probably due to the fact that Station 37 lay in the shallow, partially enclosed waters of Frenchman's Bay, where local seasonal warming no doubt played a greater part than it does further off shore. But a profile running off shore from the mouth of Casco Bay (Station 15) to Station 24 shows a spreading of the curves at the shore end (fig. 20) and a profile from Swan Island (Station 38) to the deep basin near Platt's Bank roughly parallel in direction to the above, shows much the same temperature conditions, with the difference that at the northerly end, which lies just east of the main entrance to Penobscot Bay, the spreading of the curves is more extreme than it is further west.

Seasonal changes in Massachusetts Bay.— Our work over the central and northeastern parts of the Gulf did not last long enough to show anything about seasonal changes, further than that the bottom temperature at Station 41 (40.3°) compared with what we found off Cape Ann and in the trench west of Jeffrey's Ledge at the beginning of the trip,

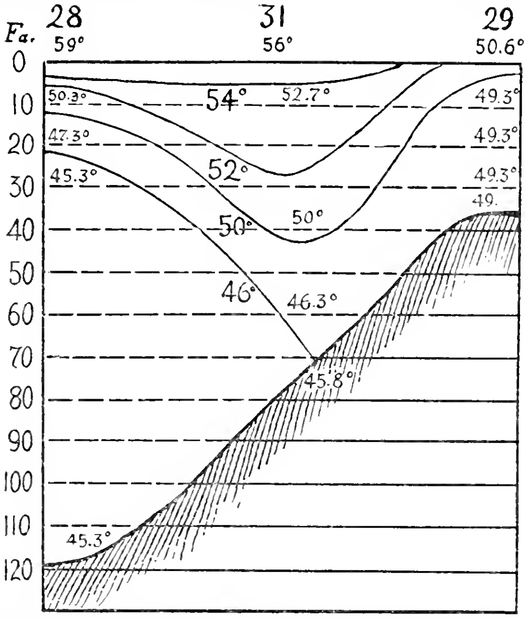

FIG. 17.— Temperature profile from the eastern basin (Station 28) to German Bank (Station 29) passing through Station 31.

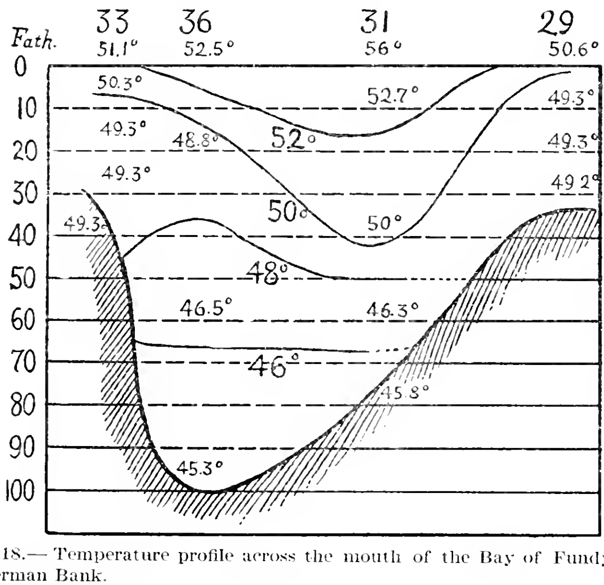

FIG. 18.— Temperature profile across the mouth of the Bay of Fundy to German Bank.

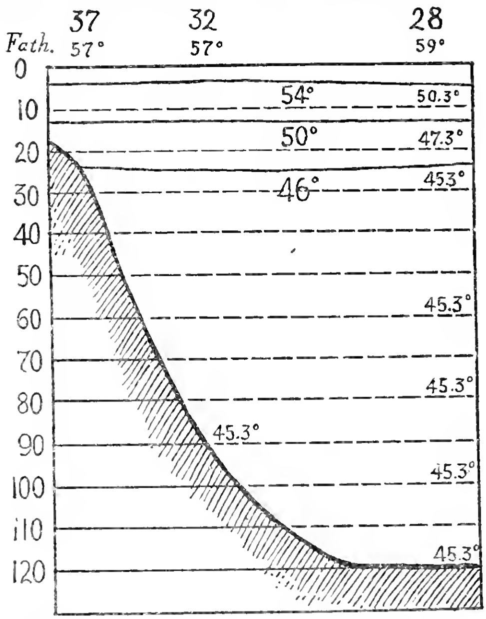

FIG. 19.— Temperature profile running southeasterly from Mt. Desert to Station 28.

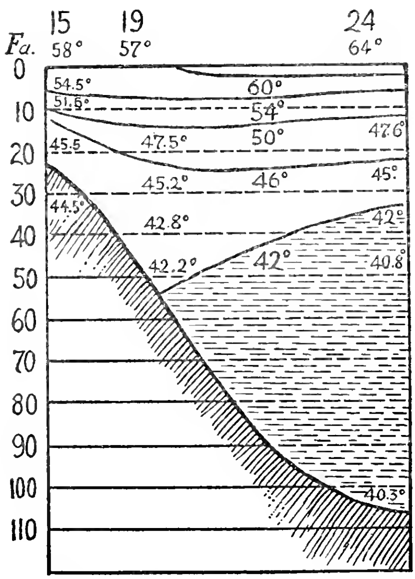

FIG. 20.— Temperature profile from the mouth of Casco Bay (Station 15) to Station 24.

revealed no appreciable change in temperature of the bottom water in that region from the middle of July to the 25th of August. But comparison between the serial temperatures in Massachusetts Bay July 9–13 (Stations 1, 5, 6) and those on August 31 (Stations 44, 45, 46) shows a marked warming of the bottom water down to forty fathoms, though, as pointed out above (p. 44), the surface water had cooled appreciably during the interval between our two visits. Stations 6 and 45 are especially instructive because made within a few miles of each other. The surface temperatures (fig. 9) were 61° at both; but whereas on July 14 the temperature was 43° at ten fathoms, and 41.3° at twenty-seven fathoms, on August 31 the ten fathom temperature had risen about 10°, *i. e.*, to nearly 53°. At thirty fathoms there was also a rise; but of only 3°, *i. e.*, to 44.7° the bottom temperature, in forty fathoms, being 43.1°. And the curves for Station 45, if continued downward, suggest that 40.3° would not have been met until a depth of about sixty-five fathoms was reached instead of at forty to forty-five fathoms as in early July. But as we were unable to make stations in the deep parts of the Bay on our second visit, it is impossible to state how far such a reconstruction would be correct, though we can safely say that the whole water-mass over the shallower parts of the Bay down to at least forty fathoms was several degrees warmer at the end of August, than it had been the beginning of July, except for the surface, which was slightly colder.

One Station, (43), some twelve miles off Cape Cod, over the inner edge of the deep basin, in ninety-five fathoms, remains to complete our survey of the temperatures. With a surface reading of 60°, the intermediate temperatures at Station 43 below five fathoms were from 1°–3° warmer at all depths than they were in Massachusetts Bay two days later (Stations 45 and 46). The temperature curve (fig. 10) is a regular one, without sudden angles. Comparison with the curve at Station 7 (fig. 10) shows that the bottom water at Station 43 was 1° warmer, 41.3° instead of 40.3°; and that it was not encountered until a depth of eighty fathoms was reached, instead of at fifty fathoms, *i. e.*, it was only fifteen instead of seventy-five fathoms thick. Station 43 was colder at all depths above seven fathoms, warmer at all depths below that level.

In considering the differences between Station 43 on the one hand, and Stations 2 and 7 on the other, the advance of the season and consequent cooling of the surface must be borne in mind. And this no doubt accounts for the lower temperature down to seven fathoms at the former. But the fact that Station 43 was warmer at all depths than Stations 45 and 46, made almost simultaneously, shows that the discrepancy below seven fathoms between it, and Stations 2 and 7, can not be wholly the result of seasonal change, in the sense of solar warming. Hence it seems safe to say that at Station 43 we encountered a water mass distinctly warmer than the waters west, north, or northeast of it. But of course it is impossible to know whether this warm water would have been encountered off Cape Cod earlier in the season, or whether it had moved thither between the times of our two visits to Massachusetts Bay.

Salinity.

As pointed out above, titration is, on the whole, the most satisfactory method for determining salinity, (the term salinity meaning the number of grams of solids per kilogram of water); and the following account of the salinities of the Gulf of Maine is based entirely on the values arrived at by this method.

Every water sample was titrated twice, some of them three or four times, and to test the possibility that some evaporation or other alteration in the salinity of the samples might have taken place between collection and titration, the titrations for four samples, chosen at random, were repeated after an interval of two months, with the following results:—

Station		Trial A	Trial B
27,	surface	32.66	32.66
43	95 fathoms	33.69	33.70
22	45 "	32.74	32.75
2	60 "	32.92	32.91

The pairs of salinities agree so closely that there was evidently no appreciable change as a result of storage.

Surface salinity.— The chart of surface conditions in July and August, 1912 (Plate 2) shows that the salinity was lowest close to the coast, there being a band five to twenty miles broad reaching from Cape Ann northward nearly to Cape Elizabeth where the salinity was below 31.4, while it was highest along the western edge of the Gulf, over the Nova Scotia Coastal Bank (Station 31), where water of 32.84 was encountered. The curves clearly show two distinct masses of water of low salinity intruding into the comparatively salt waters of the central part of the Gulf. One of these was off Cape Ann, where the curves of 31.4, 31.8 and 32, swing far to the eastward. The curve of 31.8 divides Massachusetts Bay lengthwise, reaches eastward as far as longitude 69° 61′ W, thus including Station 7, then curves back abruptly to within fifteen miles of Cape Neddick, whence it runs northeasterly roughly parallel to the coast, as far as the mouth of Penobscot Bay, and the curves for values below 31.8 show a similar swing. In this region the lowest off-shore salinities observed were 31.08, at Station 14 abreast of Cape Porpoise, 31.2 off the mouth of Casco Bay, and 31.2 at Station 16, near Seguin. But even lower salinities were found at the mouths of the large rivers, *i. e.* 30.6 at Station 21a in Penobscot Bay. The second intrusion of comparatively fresh water was encountered off the mouth of Penobscot Bay, where the curve of 32.4 swings off shore southward for some twenty-five miles; but though relatively fresh, this mass of water was absolutely less so than the waters off Cape Ann, its salinity lying between 32 and 32.4, instead of below 32.

The conditions in Massachusetts Bay are complex. Both in July and in August the surface salinities of its central portion were between 31.8 and 32; but along the north shore from Nahant to Cape Ann, much higher salinities were occasionally noted, *i. e.*, 32.14 six miles southeast of Baker's Island on July 15th, while a few miles away (Station 6) the salinity was 31.9 two days previous. At Station 1, off Eastern Point, the salinity was 32.07, while at Station 2 it was only 31.7. At Station 44, the only one in the southern half of the Bay, it was likewise higher (32.03) than at the stations made on the same day in the central and northern part of the Bay, the salinity at Station 45 being 31.9, at Station 46 only 31.6. The curves show, furthermore, that while the comparatively saline water of the southern half of the Bay may have been directly continuous, on the surface, with the salt off-shore waters, the high salinities noted along the north shore were isolated patches enclosed by fresher water, *i. e.*, by the curve of 31.8. This phenomenon is important in connection with the fact that it was at just these same localities that abnormally low temperatures were recorded (p. 43). Its significance will be discussed later (p. 90). The salinity of the surface waters of the greater part of the Gulf, in July and August, was 32.4 or more. Off Cape Cod the curve for this value lies about twenty miles off shore; but abreast of Cape Ann it swings eastward toward Cashe's Ledge, corresponding to the intrusion of fresh water in that region. It then curves toward the coast once more, enclosing Platt's Bank, whence it runs northeastward almost to Monhegan Island, enclosing Stations 21 and 26. Off the mouth of Penobscot Bay, as already noted, it is forced far off shore (Plate **3**); but it then approaches the coast once more, water of this or higher salinity washing the outer islands from Mt. Desert to the Grand Manan Channel. The salinity of the whole of the Gulf to the south and east of this curve was probably above 32.4; but we have no data on the salinity in the head of the Bay of Fundy.

It is probable that the curve of 32.6 enclosed Cashe's Bank, where the violent tides must cause an active vertical mixing of water, and the GRAMPUS crossed it about half-way between Stations 25 and 27, whence it runs in a direct line northeastward, coming close to the coast at Moose Peak. But the water in the Grand Manan Channel was not so salt as this. Whether or not this curve entered the Bay of Fundy is not known; nor can we absolutely establish the occurrence of water with salinities between 32.4 and 32.6 along the west coast of Nova Scotia; but the facts that water only slightly more saline was found at Station 29 on German Bank, and that there is a considerable discharge of fresh water from the numerous small rivers along this coast suggest that the coast water was fresher than 32.6. Surface salinities above 32.6 were encountered generally over the eastern arm of the deep basin, the value at Station 27 being 32.6; Station 28, 32.75; Station 29, 32.7; and Station 31, 32.84. Unfortunately no sample was collected at Station 30.

Salinity at intermediate depths.— The table of salinities (p. 139) shows that in no case was the water saltest on the surface; while at most of the stations there was a rapid increase in salinity from the surface downward, though the rate varied in different localities, as shown by the sections (fig. 21–28). At five Stations, 2, 7, 11, 27, 43, samples were taken at three or more levels, thus allowing a satisfactory plotting of curves for the mouth of Massachusetts Bay, off Cape Cod, the western and eastern arms of the 100-fathom basin, and the trench west of Jeffrey's Ledge. At the other stations only surface and bottom salinities are known; consequently the curves are only approximate. But inasmuch as the known curves are all practically parallel down to fifty fathoms or so, they give a guide for reconstructing the others. The type of curve is strikingly different from the temperature curves, being regular and gradual, without the sudden dislocations which characterize the latter, though the increase in salinity is usually most rapid between the surface and fifty fathoms. They show, furthermore, that over the deeper parts of the Gulf the increase in salinity noted on the surface as we go eastward from Cape Ann, extended to the intermediate depths and to the bottom as well. Thus, taking successively Stations 7, 23, 27, 28, (figs. 21, 22) the curves show that each was salter than its predecessor at all depths. The bottom salinity at Station 24 is an apparent exception to this generalization; but this Station, like Station 2, lies in a circumscribed trough of the sea bottom, and it is probable that the salinity at the level of the enclosing sill, eighty fathoms, was almost as high as it was at the bottom, just as it was at Station 2. At Stations 8, 9 and 16 (fig. 23, 26) *i. e.*,

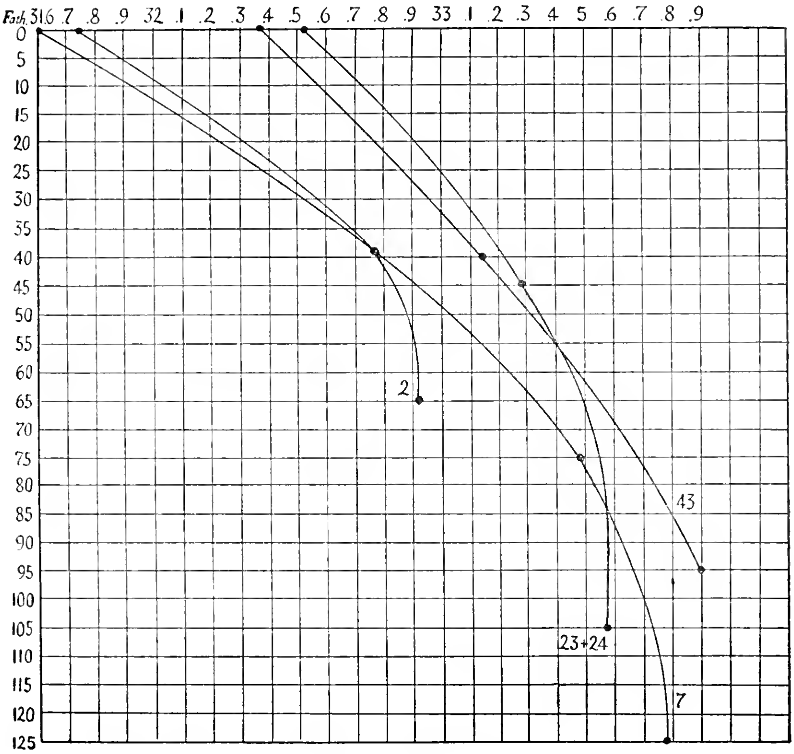

FIG. 21.— Salinity sections at Stations 2, 7, 23, 24, 43.

in the coastal band of low surface salinity, the rate of increase with depth was much more rapid than at the off-shore stations, which shows of course that the effect of the fresh drainage from the land is greatest at the surface; and the same is true of Stations 25 and 38 off the mouth of Penobscot Bay. The curves on the off-shore banks, Platt's, Jeffrey's and German, and in the Grand Manan Channel (fig. 24) are especially important, because of the peculiar temperature conditions which characterized the last two. German Bank and Platt's Bank bear the same relation to each other in salinity that they do in temperature, the former being colder and salter at the surface, warmer and fresher at the bottom, than the latter. But while Jeffrey's Bank was inter-

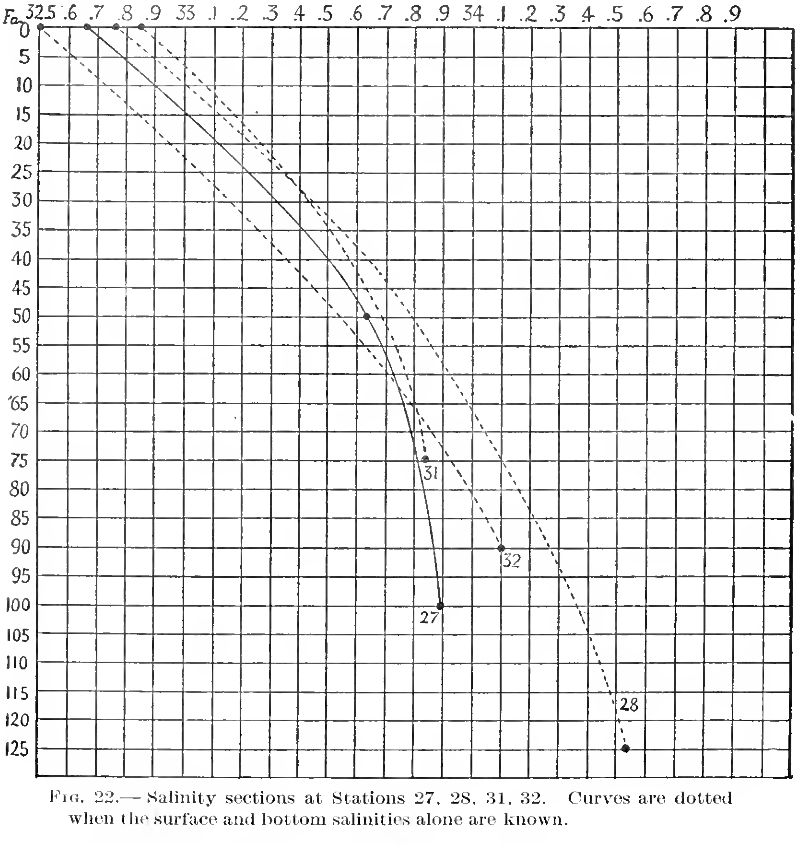

FIG. 22.— Salinity sections at Stations 27, 28, 31, 32. Curves are dotted when the surface and bottom salinities alone are known.

mediate between the two in temperature, it had a lower salinity at all depths than Platt's Bank and it was fresher down to about thirty fathoms than German Bank, showing the influence of fresh water from the Penobscot. The increase in salinity with depth was very slight on German Bank, the difference between surface and bottom

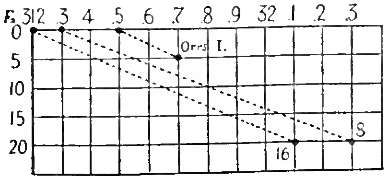

Fig. 23.

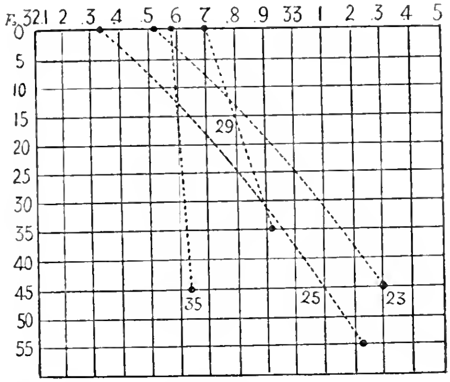

Fig. 24.

Fig. 23.— Salinity sections in the coast water, Stations 8, 16, and Orr's Island.

Fig. 24.— Salinity sections on Platt's Bank (Station 25), Jeffrey's Bank. (Station 23); German Bank (Station 29), and in the Grand Manan Channel (Station 35).

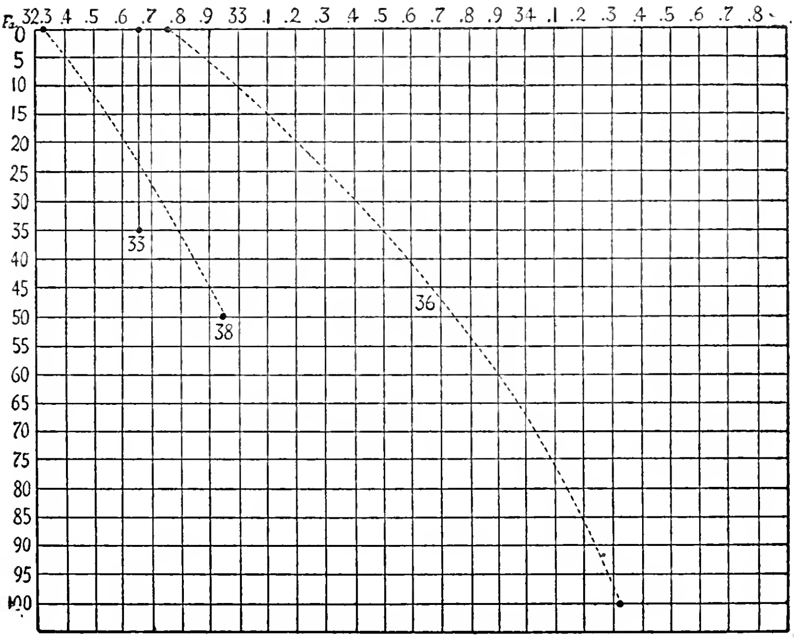

Fig. 25.— Salinity sections at Stations 33, 36, and 38.

being only .2‰; and in the Grand Manan Channel (Station 33) there was virtually no difference in salinity at different depths, *i. e.*, we find a reproduction of the temperature curve, though at all depths it was somewhat fresher than the water over German Bank.

Salinity at twenty-five fathoms (Plate **2**).— We have only a few samples at precisely this depth; but the salinity sections, and samples taken at several stations a little deeper or a little shallower than

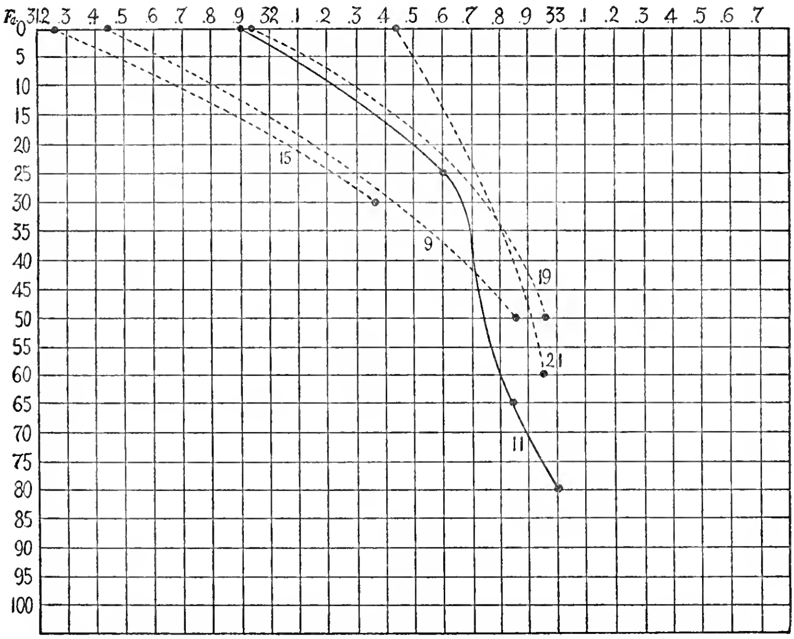

FIG. 26.— Salinity sections at Stations 9, 11, 15, 19, 21, from Ipswich Bay to Monhegan.

twenty-five fathoms, afford sufficient data for tentative mapping of the curves for the various values at this level. It must be remembered, however, that it, and the following charts, are not offered as final. At twenty-five fathoms the salinity for the whole of Massachusetts Bay, and for an area extending eastward some thirty miles over part of the deep basin was between 32.5 and 32.6. And comparison with the chart of surface salinity (Plate **1**) shows that the curve of 32.6 in this region reproduces the eastward swing of the curves of 31.8 and

32.4 on the surface. North of Cape Ann there was a band of comparatively fresh water, of 32.2 to 32.3, washing the coast along the twenty-five fathom curve, extending northeastward as far as Monhegan Island, some ten miles broad, *i. e.*, roughly corresponding to the fresh coast water noted on the surface in this same region. But it did not pass around Cape Ann into Massachusetts Bay. The band of water with salinities between 32.4 and 32.6, which was from thirty to fifty

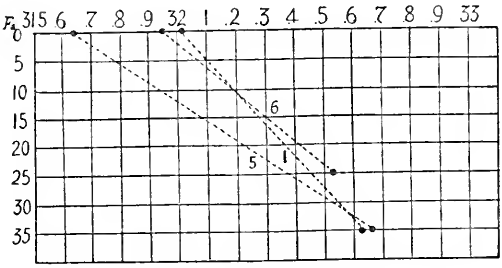

FIG. 27.— Salinity sections in Massachusetts Bay, Stations 1, 5, 6.

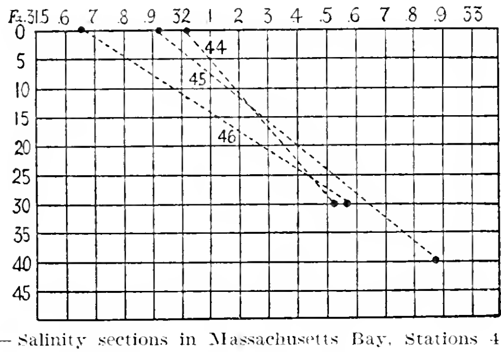

FIG. 28.— Salinity sections in Massachusetts Bay, Stations 44, 45, 46.

miles broad abreast of Massachusetts Bay, became very narrow north of Cape Ann, the two curves lying close together as far as Monhegan. Beyond this point, *i. e.*, in the mouth of Penobscot Bay, we have no data on the coast water from depths as great as twenty-five fathoms, or until Petit Manan is reached. But at Station 33 the twenty-five fathom salinity was 32.68, and judging from temperature and tidal currents, it is probable that the curve of 32.6 followed the twenty-five fathom curve from Mt. Desert Island to the southwestern end of the Grand Manan Channel.

Over the central part of the Gulf, including Platt's Bank as well as most of the 100-fathom basin, the salinity at twenty-five fathoms was above 33%. But the curve for that value runs off shore far enough to exclude the whole of Jeffrey's Bank, thus suggesting the southerly swing of the curve of 32.4 on the surface, though not exactly duplicating it. It then turns northward toward the coast, including in its sweep the whole of the eastern branch of the deep basin, as well as part of the coastal bank off Nova Scotia. The saltest water found at this depth was not at Station 31, as was the case on the surface, but at Station 28 (33.4). In spite of this discrepancy, however, the twenty-five fathom level corresponds to the surface in the presence of intrusions of comparatively fresh water off Cape Ann and off the mouth of the Penobscot, and in the fact that the saltest water was over the eastern edge of the 100-fathom basin.

Salinity at fifty fathoms.— The curves at fifty fathoms (Plate **3**) show the same influx of fresh water off Massachusetts Bay as do the charts for twenty-five fathoms and for the surface, though to a less degree. But I must point out that the charts for the different levels are not strictly comparable with one another in this region, because almost the whole of Massachusetts Bay, as well as the long ridge formed by Jeffrey's Ledge, running some forty-five miles northeasterly from Cape Ann, is shallower than fifty fathoms. The salinity over most of the Gulf at this level was above 33. But along the shore from Cape Ann northward, in the trough west of Jeffrey's Ledge and as far as Monhegan, the salinity was lower, between 32.8 and 33.; and in the isolated basin in the mouth of Massachusetts Bay (Station 2), the salinity at fifty fathoms was 32.8. The curves at this level hardly show the southerly swing off the mouth of Penobscot Bay so pronounced at higher levels, the curve for 33 running parallel to the coast, along the fifty fathom line, from Matinicus Rock eastward. This fact, of course, shows that the fresh water from the Penobscot had little or no influence at this depth, although its presence was evident nearer the surface. Over the eastern branch of the 100 fathom basin the fifty fathom salinity was above 33.6, the highest being 33.8 at Station 28, while at Station 31, so salt at the surface, the fifty fathom reading was only 33.5. The lowest salinity at this depth was in the Grand Manan Channel, 32.65, practically the same as at the surface.

Bottom salinity.— The bottom salinities of the Gulf of Maine (Plate **3**) are largely dependent on depth, for, as we have seen, there was a steady rise in salinity from the surface downward, at all our stations except in the Grand Manan Channel and on German Bank. The bottom salinity below the 100-fathom curve varied from 33.5 to 34.54. There is little if any evidence that the wedge of fresh water abreast of Massachusetts Bay, so noticeable from the surface down to fifty fathoms, influenced the bottom water, for the salinity curves at the bottom show very little easterly swing in this region, and that little is probably the result of the bottom contour. The same is true also of the influx from the Penobscot, because the southerly swing of the curve of 33.8 agrees with the bottom contour, following the slope at about the hundred fathom line. It likewise crosses the mouth of Massachusetts Bay at one hundred and twenty fathoms, rising to about eighty-five fathoms off the northern end of Cape Cod. But it does not enter the trough west of Jeffrey's Ledge, for here the salinity of the bottom water in sixty to eighty fathoms is only 33 to 33.2. Northeastward from Jeffrey's Bank the 33 curve rises higher and higher on the coastal slope until finally water of this salinity was found at about fifty-five fathoms off Petit Manan. The curve must then turn offshore, for the bottom water in the Grand Manan Channel was only about 32.5–32.6. No station was made on Grand Manan Bank; but judging from conditions on the other banks, it is not likely that the bottom water had a salinity as high as 33. The same is also true of Lurcher Shoal. On German Bank, also, the bottom water was fresher, only 32.9 in thirty-five fathoms; hence it is probable that the 32.6 curve came close to the surface along the west coast of Nova Scotia. The bottom salinity of Platt's Bank was above 32.5; and it is probable that this was the case on Cashe's Ledge likewise. On the other hand the circumscribed deep basin in the mouth of Massachusetts Bay (Station 2) had a considerably lower bottom salinity, 32.92, than the waters at corresponding depths further east. Over the eastern arm of the 100-fathom basin the bottom salinity was 34 or over, the highest values being at Station 28, 34.5; Station 32, 34.1; and Station 36, 34.3, in one hundred and twenty, ninety, and one hundred fathoms respectively. But at Station 27, only a few miles west of the saltest spot, the bottom salinity at 100 fathoms was only 33.9.

Salinity profiles. — The profiles (fig. 29–33) can not pretend to as great accuracy as those for temperature, because the number of observations is much smaller; and they are necessarily largely reconstructed from the salinity sections. But if regarded only as preliminary, they are useful as showing general distribution of salinity.

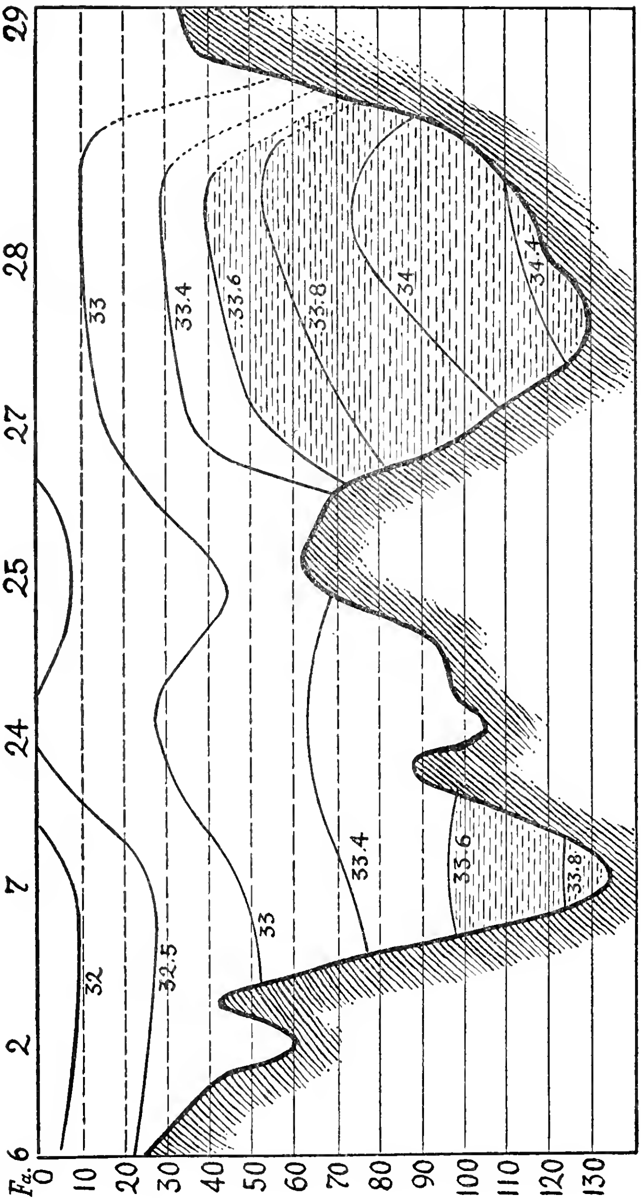

FIG. 29.— Salinity profile from Boston Light-ship (Station 6) to German Bank (Station 29), via Jeffrey Bank. Horizontal scale 33 miles per inch.

The profile from Boston Light-ship to German Bank (fig. 29) shows conditions in Massachusetts Bay, over both arms of the deep basin, on Jeffrey's Bank, and over the coast slope of Nova Scotia. From Station 6 to 7 salinities were very uniform at all depths, except for a slight upwelling of salt water above twenty fathoms at the westerly end, thus paralleling the temperature profile (fig. 16) and for the fact that there was no appreciable increase in salinity below forty fathoms in the isolated basin at Station 2, *i. e.* below the depth to which the enclosing sill rises. Passing easterly from Station 7, the entire mass of water above seventy fathoms becomes salter, all the curves approaching the surface, that for 32.5 rising from thirty fathoms to the surface, while the curve for 33 lies at about twenty-five fathoms at Station 24, instead of at fifty fathoms as at Station 7. Below seventy fathoms, however, there is very little difference between the two stations. Our profile thus shows that the wedge of comparatively fresh water off Massachusetts Bay was not traceable below about seventy fathoms.

Over Jeffrey's Bank the water was appreciably fresher at all depths than it was either west or east of it, the curve for 33 showing a pronounced downward swing from twenty-five fathoms at Stations 23 and 24 to fifty fathoms at Station 25. But its upper twenty fathoms, though fresher than at Station 24, had a higher salinity than in the region west of Station 7. The whole of the eastern basin was salter at all depths than the regions west of it, the curve of 33.6 rising to within about forty fathoms of the surface at Station 28, whereas in the western basin, water of this salinity was only found below ninety-five fathoms. At all depths down to about twenty-five fathoms salinities were highest at Station 31; but below that depth at Station 28; for example, the curve of 33.8 lies at sixty-five fathoms at Station 31, at fifty fathoms at Station 28; and the curve for 34 must show an even more pronounced rise, for water of that salinity or over was found at Station 28, from eighty fathoms down to 120 fathoms, whereas at Stations 27 and 31 the bottom water was only 33.9 and 33.8 respectively in 100 and in seventy-five fathoms.

Over German Bank, as already pointed out, the water was between 32.7 and 32.9 from surface to bottom.

The west to east extent of the fresh Penobscot water is shown by a profile running from Platt's Bank across Jeffrey's Bank to the neighborhood of Mt. Desert Rock (fig. 30) and the breadth of the coast-band of comparatively fresh water off the mouth of Casco Bay is illustrated by a profile from Station 15 to Station 24 (fig. 31). A similar profile

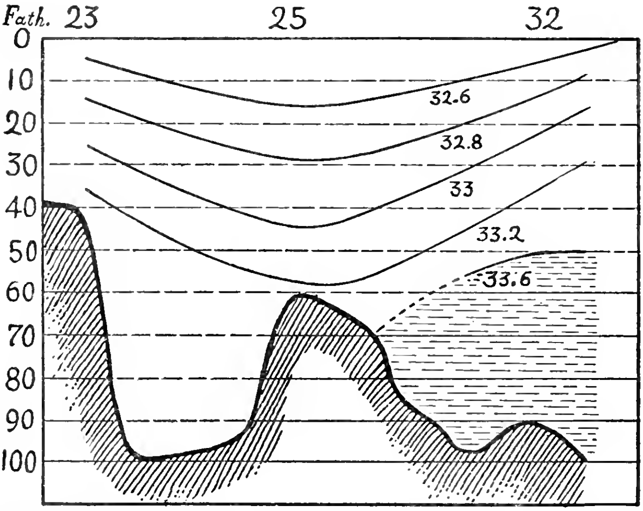

FIG. 30.— Salinity profile from Platt's Bank (Station 23) toward Mt. Desert Rock (Station 32) crossing Jeffrey's Bank (Station 25).

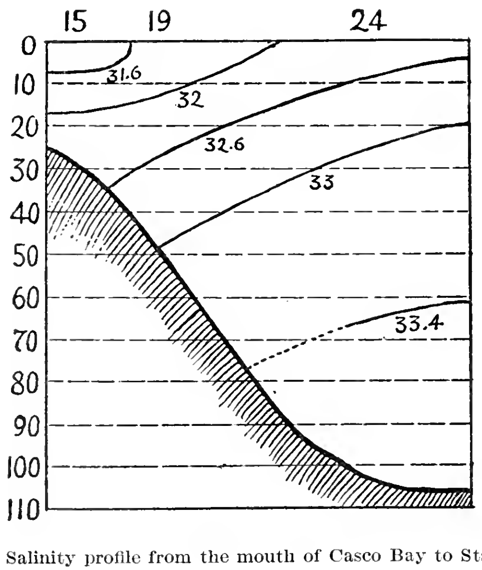

FIG. 31.— Salinity profile from the mouth of Casco Bay to Station 24.

running southeastward from Mt. Desert (Fig. 32) shows the increase in salinity passing off shore in that region.

In Massachusetts Bay two pairs of Stations, 6 and 45, and 5 and 46, (figs. 27, 28) were taken six weeks apart, purposely to show seasonal change, if any. But the sections show that at both 46 and 5 the salinity at the surface was 31.6, at 30 fathoms 32.5, and also that there was apparently nothing to separate Station 6 from Station 45, at both of which the surface salinity was 31.9; though as the depth at the former was twenty-five and at the latter forty fathoms, only two samples being taken at each, it is possible that there may be some slight divergence in the intermediate zone. In short, these four stations certainly do not suggest that there was any seasonal change in the salinity in Massachusetts Bay during our absence, although there was a very pronounced rise in temperature (p. 58) at all depths below five fathoms.

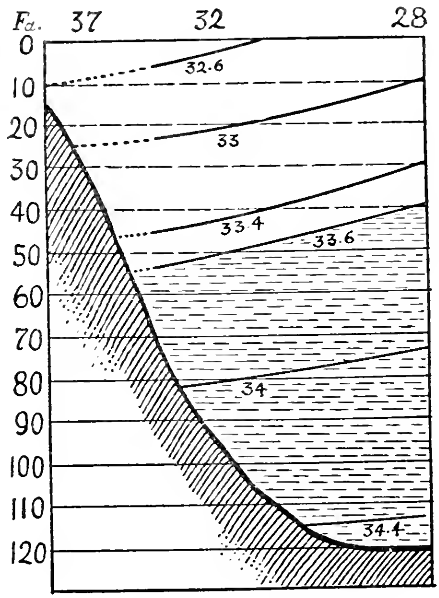

Fig. 32.— Salinity profile from near Mt. Desert (Station 37) to Station 28.

Stations 44, 45, 46, all taken on the same day, afford a profile across the Bay, from south to north (fig. 33). The curves show that the core of fresh surface water was thickest in the northern half of the Bay. And as Station 6 is, as we have just seen, interchangeable with 45, and 5 with 46, it is clear that this is the characteristic condition in midsummer. In the southern half of the Bay, the curve of 32.2, found at twenty fathoms at Station 46, rose to within eight fathoms of the surface; and the surface salinity was 32 instead of 31.9. But below twenty fathoms the salinities were slightly lower at Station 44 than in the centre of the Bay. Thus we find reproduced, but on a much smaller scale, the spreading of the salinity curves so pronounced on German Bank, and in the mouth of the Grand Manan Channel. And as pointed out (p. 56) the same thing was true of the temperatures.

In the northerly end of the profile Station 1 is introduced, to show how the cold salt bottom water wells up close to the shore. However, as pointed out in the discussion of temperatures, this phenomenon is

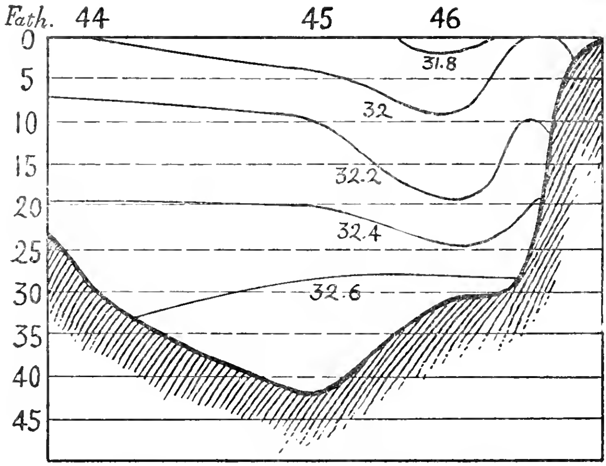

Fig. 33.— Salinity profile across Massachusetts Bay, August 13 (Stations 44, 45, 46).

sporadic, probably the result of offshore winds driving the surface water away from the coast, their place being taken by water from below. Conditions at Station 1 show that the effect may be felt to as great a depth as 20 fathoms.

Density.

The three features of sea water most interesting to the oceanographer are temperature, salinity, and density; the former because of its biological importance; the second because it is the only safe clue to the geographic origin of water-masses; and the third because of its importance as determining circulation, both vertical and horizontal. The last is a product of the first two and of a third factor, namely pressure. And we must never lose sight of the fact that as it is determined by temperature as well as by salinity, it is a temporary quality, changing as the water becomes colder or warmer. In the accompanying table (p. 141), the densities *in situ* are calculated from

Knudsen's (1901) tables and from Ekman's (1910) tables of sea water under pressure. Such calculations are approximately correct arithmatically, but notice must be called to the fact that the probable limits of error are the sum of the two observational errors, first for salinity, *i. e.*, ± .02 of salinity (p. 40), second for temperature, which is ± .3° F, approximately .15° C. Now the sum of these errors has a considerable effect on the calculated densities, and for this reason the fifth decimal point is disregarded in the table. Of course a much higher degree of accuracy could be, and is, obtained with improved instruments, for example, during the North Atlantic cruise of the Michael Sars in 1910 (Murray and Hjort, 1912). But it would be misleading to claim better results with our instruments.

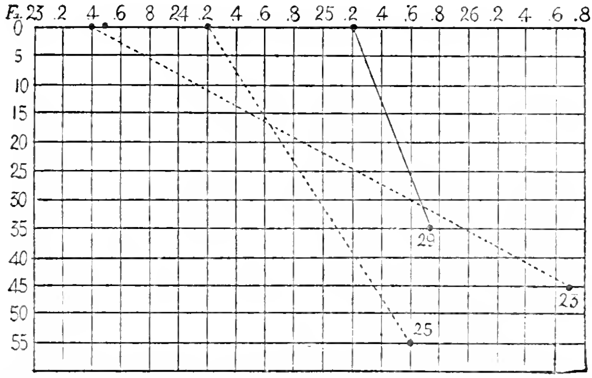

Fig. 34.—Curve of density *in situ* at Platt's Bank (Station 23); Jeffrey's Bank (Station 25) and German Bank (Station 29).

The correction for pressure has often been disregarded, especially in shallow water; but it can easily be applied from Ekman's tables. In depths less than fifty fathoms it is of little practical importance, but by the time 100 fathoms is reached it is by no means negligible. For example, at Station 28, 120 fathoms, the density at the temperature *in situ* without pressure correction, is 27.02; with pressure correction, 28.03. In the accompanying table the pressure correction for depths less than fifty fathoms is calculated by the use of Ekman's table IV alone, which is sufficiently accurate for our present purpose.

The most important thing which the table and curves (fig. 34–36) show is that there was a steady increase of density at every station from the surface down to the bottom, which, as we now know, is the normal condition in all ocean waters during the warm season, though there are temporal and local inversions due to temperature conditions in winter (Helland-Hansen and Nansen. 1909). But the rate of increase varies greatly in different regions, there being two very different types of vertical distribution in the Gulf. The first, exemplified over Jeffrey's and German Bank, and in the Grand Manan Channel. Station 25 (fig. 34), Station 29 (fig. 34), Station 35 (fig. 36), shows only a very slight increase from surface to bottom; but in the second, comprising practically all the other stations, there is a large rise, with slowly decreasing rate from the surface downward. The curves for

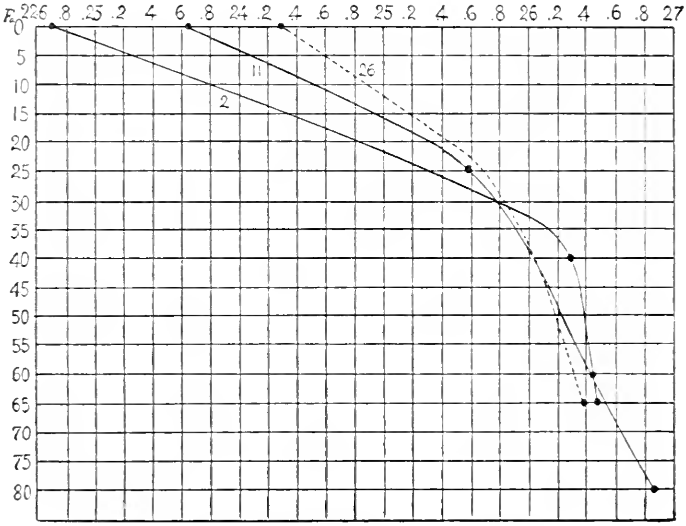

Fig. 35.— Curves of density *in situ* at Stations 2. 11. 26.

the last recall the salinity curves at corresponding stations; but the difference between surface and bottom was in every case considerably greater in the former than in the latter, at corresponding stations. The most important conclusion to be drawn from the density curves is that over the whole deep basin, in Massachusetts Bay, and along the coast from Cape Ann to the Penobscot, the water was in very stable vertical equilibrium during July and August; but that on Jeffrey's and German Banks and in the Grand Manan Channel the difference in density in different depths was so slight that it would offer very little resistance to vertical circulation. In comparing the densities for Stations 6 and 5 with those of 45 and 46 it is evident that vertical stability in Massachusetts Bay decreases with the advance of the season; pointing to the inversion which no doubt takes place there in winter.

A profile from Boston (Station 6) northeastward to German Bank, *via* Jeffrey's Bank (Station 25), and Station 31 (fig. 37) shows the

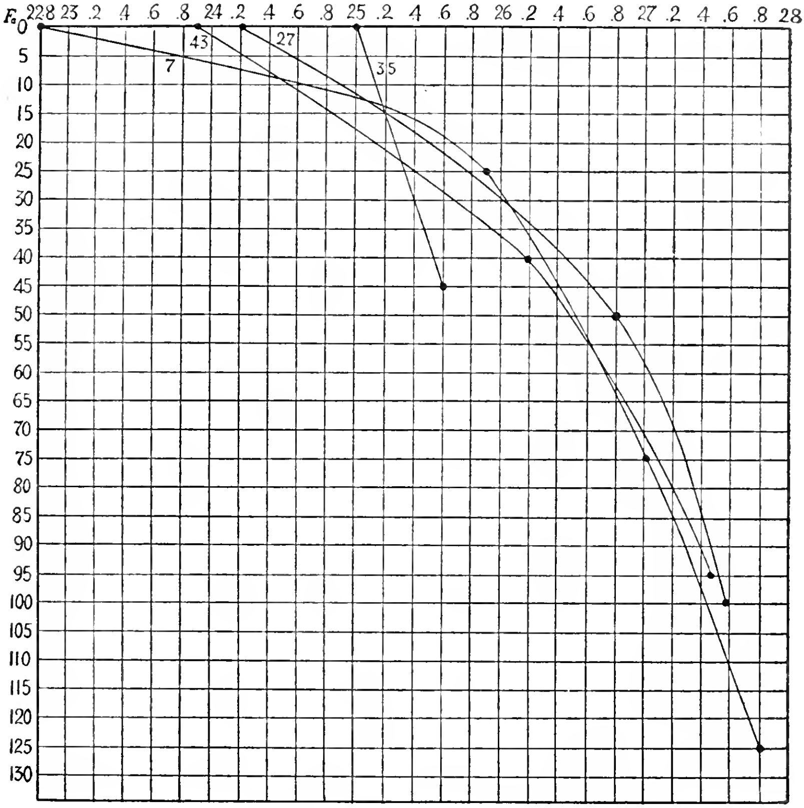

FIG. 36.— Curves of density *in situ* at Stations 7, 27, 35, 43.

relative distribution of lighter and heavier water over the northern part of the Gulf. Above the two deep basins heavy water, distinguished arbitrarily by the curve of .026, rose close to the surface, whereas over the two banks the whole column of water was of lower den-

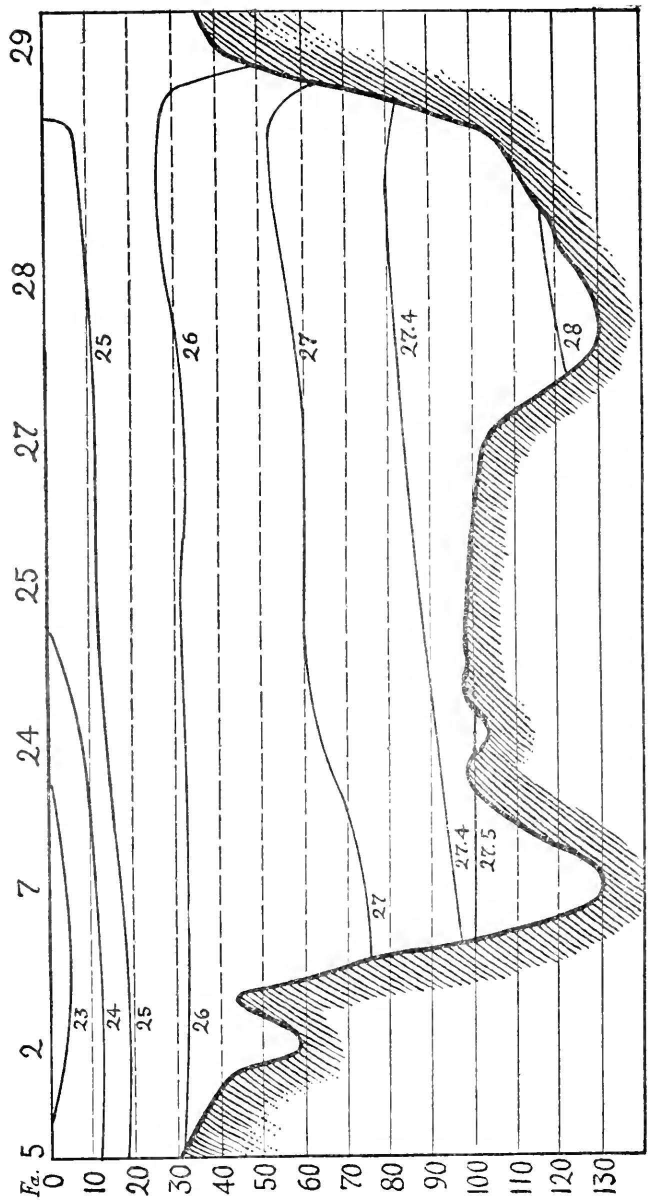

Fig. 37.—Profile from Massachusetts Bay to German Bank, passing between Platt's Bank and Cashe's Ledge, and south of Jeffrey's Bank, to show density *in situ*.

sity than this. But the water of the eastern basin was appreciably denser at all depths than that of the western, corresponding densities being about ten fathoms deeper in the latter than in the former. And corresponding densities were found twenty to thirty fathoms higher over German Bank than over Jeffrey's Bank. The profile shows also in a graphic way how much more rapid the downward increase was over the basins than over the banks, and consequently how much more stable, vertically, their waters must have been. At the western end of the profile there was again an increase in density as compared with the western half of the basin, a phenomenon consequent on the upwelling of cold, salt bottom water in this region, while at Stations 2 and 7 density near the surface was very low, corresponding to low surface salinity. In the trough between Jeffrey's Ledge and the coast the density agreed closely with that of the western basin, except that it was rather higher on the surface, corresponding to the low surface temperatures of this region. And passing northeastward along the coast we find the vertical range progressively less and less, until in the Grand Manan Channel the difference between surface and bottom was only .6 at 45 fathoms. The information our cruise afforded as to density is insufficient even for the northern half of the Gulf, but so far as it goes, it shows that two distinct water masses can be distinguished, a light over the western, a heavy over the eastern basin, partially separated by the disturbed conditions caused over Jeffrey's Bank by the influx of fresh water from the Penobscot.

Color.

The color of the sea is of minor importance in oceanography: but it can not be neglected, because it helps to form the physical complex, in which the plankton finds its biological environment. The color, described by percentages of yellow as indicated by the Forel scale, is given in the table (p. 82). At the off-shore stations it varied from 27% (Station 43) to 14% (Stations 7 and 23), usually being 20%: in Massachusetts Bay it was 20% at all stations at which a record was made (Stations 2, 4, 6, 44, 45). West of Jeffrey's Ledge the color was 14% at Station 9; but grew greener as we went north, being 20% at Station 11, 27% at Stations 13 and 14. Off the mouth of Casco Bay it was 27%, inside the Bay 27% and 35%. Over the northeastern part of the Gulf as a whole, the color was 20% yellow, except close to the shore (Stations 33, 37) where it was 35%. This distribution of waters of different colors does not correspond either to temperature or to salinity, for the bluest water was not the saltest, while the coldest water was neither bluest nor greenest. The plankton may give the necessary clue.

Color, in % of Yellow in the Forel scale.

Sta.	Color	Sta.		Sta.	Color	Sta.	Color	Sta.	Color
2	20	13	27	21[a]	27	29	20	39	20
4	20	14	27	22	27	31	20	40	20
6	20	15	27	23	14	32	27	41	20
7	14	16	27	25	20	33	35	43	27
8	20	17	35	26	20	35	20	44	20
9	14	Orr's I.	44	26[a]	20	36	20	45	20
10	20	19	20	27	20	37	35		
11	20	21	27	28	20	38	20		

The color of the Gulf of Maine agrees fairly well with that of the southern part of the North Sea, with the English Channel, and with the coast water of the Bay of Biscay (Schott, 1902, pl. 36). Up to the present time we have no records of the color of the water along the coast of the United States from Cape Cod south, or for the Gulf of St. Lawrence.

Transparency.

Measurements of transparency were taken with the disc (p. 00) at eighteen stations. In the clearest water (Station 23) it was visible at 8.2 fathoms; but it usually disappeared at from four to five fathoms. There was little, if any, correlation between color and transparency at these stations, for though the water was most transparent where bluest (Station 23), it was not least so where greenest, but where the percentage of yellow was only 20% (Station 38).

Transparency, in fathoms.

Sta.	Trans.	Sta.	Trans.
4	3.5	31	4
11	6	36	4
12b	6	37	4
14	6	38	3
15	4.5	39	4
16	3.5	40	6
22	7.2	41	5
23	8.2	43	5
25	6.5	44	5

Circulation in the Gulf of Maine.

Circulation in the Gulf may be expected to be of three types: — 1, tidal, which is proverbially violent in the northeastern part of this region; 2, the slower but more constant vertical or horizontal movement of water resulting from different density gradients at different regions, or from the presence of an actual ocean current, if there be one; and 3, sporadic movements of the water, due to prolonged or violent winds.

Tidal currents.— A considerable number of measurements of tidal movements have been made on the surface of the Gulf of Maine by the U. S. Coast and Geodetic Survey, by the British Admiralty, and by the Tidal Survey of Canada in charge of Dr. G. B. Dawson; but so far as I can learn, the only accurate records of bottom currents are the few taken on the Grampus last summer. The earlier surface records, for off shore stations, are limited to the east coast of Cape Cod, Stellwagen Bank and the channels north and south of it, George's Shoal, the Eastern Channel, Brown's Bank, the west coast of Nova Scotia, and the Bay of Fundy; these the 1912 cruise of the Grampus extends to the central part of the Gulf and to the coastal region between Cape Ann and the mouth of the Penobscot. Although our records are too few for a complete survey even at a given station, we always attempted to take them as close to the mid-period of flood or ebb as possible, so as to obtain the mean direction and velocity of the current for a given tide; but of course, this result could be expected only in regions where the current was fairly constant for the major part of each tide.

The sum of all available observations suggests that the violent surface currents of the Gulf, noticed by every navigator, are purely tidal, the mean flow of ebb and flood being in general about equally strong at a given locality; but the mean directions of the two are not always precisely opposite. The general rule is that "along the whole line between Nantucket shoal and Cape Sable Bank the ebb current runs southwardly. . . . the flood current northwardly. . . . " (U. S. Coast Pilot), and along this whole line the currents are swift (1.1 to 1.6 knots at their height). The tidal wave divides over the basin south of Jeffrey's Bank and Cashe's Ledge, the flood currents west of here turning westward toward Massachusetts Bay, and toward the coast between Cape Ann and Portland. Abreast of Casco Bay (Stations 14, 40) the flood flows nearly due north; but east of Jeffrey's Bank the general direction of the flood near shore, is N. N. E. toward the Grand Manan Channel and the Bay of Fundy, and along this coast the velocity increases steadily from west to east, the rate in the channel being two knots. Along the west coast of Nova Scotia the mean direction of the flood-current is nearly north. The flood is weakest in the northern part of Massachusetts Bay, and along shore from Cape Ann to Portland, as shown in the Table (p. 143), though there are strong tidal currents off the mouths of large rivers, and tide rips off Portsmouth (Station 11). In the central part of the Gulf (Stations 7, 27) the current is about .5 knot; but along the Nova Scotian Coast and off the mouth of the Bay of Fundy it occasionally attains velocities of more than two knots, with extensive and dangerous tide-rips on the various shoals, for example the Grand Manan Bank.

In a general way the ebb is the reverse of the flood, flowing out of the Bay of Fundy in a generally S. W. to S. S. W. direction, and around the coast of Nova Scotia to the S. and S. E. Along the coast of Maine from the Grand Manan Channel to Mt. Desert the ebb flows about S. W. But the current in the central part of the Gulf is about S. by E. Off Casco Bay the ebb is southerly; along the coast from Portland to Cape Ann it sets in general toward the E. S. E. but there are various local currents here, yet to be explained. The strength of the ebb current is proportional to that of the flood, strongest off the mouth of the Bay of Fundy and along the coast of Nova Scotia; progressively weaker to the westward.

The data is insufficient to show whether the tidal currents result in any definite eddy movement of the waters of the Gulf, nor have I been able to find in them any evidence of an inflow, or alongshore flow within the Gulf, such as might be credited to a branch of any constant ocean current. This question was thoroughly studied by Dawson (1910) for the Bay of Fundy and for the Nova Scotian Coast, between the mouth of the St. John and Cape Sable, in 1904 and 1907. And his general conclusion is that ebb and flood are almost opposite, veering at slack water only, if at all; and that there is little indication of any movement of water in a dominant direction. The mean compass-bearings and strengths of the currents on Brown's and George's Banks as given on the U. S. Coast Survey charts suggest a drift from northeast to southwest. But the data on the tidal currents of George's Bank given by Mitchell (Rept. U. S. Coast and Geodetic Survey, 1881, p. 175) show that there is a slight easterly drift, and it is so represented on the current chart in the coast pilot. (U. S. Coast Pilot, part 3, 1912, chart facing p. 9). And although most of the current charts which have appeared show a southwest flow along the outer edge of George's Bank, next the Gulf Stream, it is a question whether this flow is a contant, or even a dominant one.

Surface and bottom currents.— To obtain a satisfactory knowledge of the tidal currents at any locality, it is necessary to make observations at intervals throughout a twelve-hour period, to insure readings for both flood and ebb, because the time of turning of the tide at the bottom often differs by a considerable period from the time of slack water on the surface. Nevertheless, our few isolated observations are worth passing notice because they are the first attempts to measure the bottom currents of the Gulf of Maine with modern instruments. The diagrams (fig. 38) illustrate the considerable strength of the bottom currents even in the western side of the Gulf; and in the northeastern part, for example over German Bank, they are even stronger.

The only region where enough observations were taken to allow a tentative statement of the relations of bottom to surface currents is the northern half of Massachusetts Bay (Stations 1, 2, 4, 5, 6). The surface current flows into this part of the Bay toward northwest and west at the height of the flood (Station 5) turning at least one half hour before the time of high water at Gloucester, and flowing easterly during the first half of the ebb (Stations 1 and 4). We made no records for the last three hours of the ebb. A few miles further off shore the direction at mid-ebb was southeast (Station 2); and in the centre of the Bay (Station 6) N. N. E. (all bearings being magnetic). In the southern half of the Bay the flood current ran toward the southwest, the ebb toward the northeast. These observations are not sufficiently extensive to show whether or not there is any dominant drift alongshore. But tidal records taken by the U. S. Coast Survey at the mouth of the Bay suggest that it may be occupied by an eddy-like circulation flowing slowly from north to south, there being a decided drift to the northwest near Cape Ann, with an easterly movement on Stellwagen bank and near Race Point (U. S. Coast Pilot, part 1 and 2, 1911, p. 151). The bottom currents in Massachusetts Bay differ very noticeably from the surface ones (fig. 38) not only in being as a rule weaker, but in flowing in a different direction. At all the stations in the central and northern part of the Bay, the bottom flow was easterly, the records being made a few minutes before high water (Station 1), two-hour ebb (Station 4), mid-ebb (Station 6), and early flood (Station 5). This data, so far as it goes, suggests that if there be any tidal flow to the west on the bottom it must be restricted to the last two hours of the flood, veering again to the eastward shortly before high water.

There was no bottom current at Station 2, and inasmuch as that station was occupied at the mid-ebb, when the bottom current further

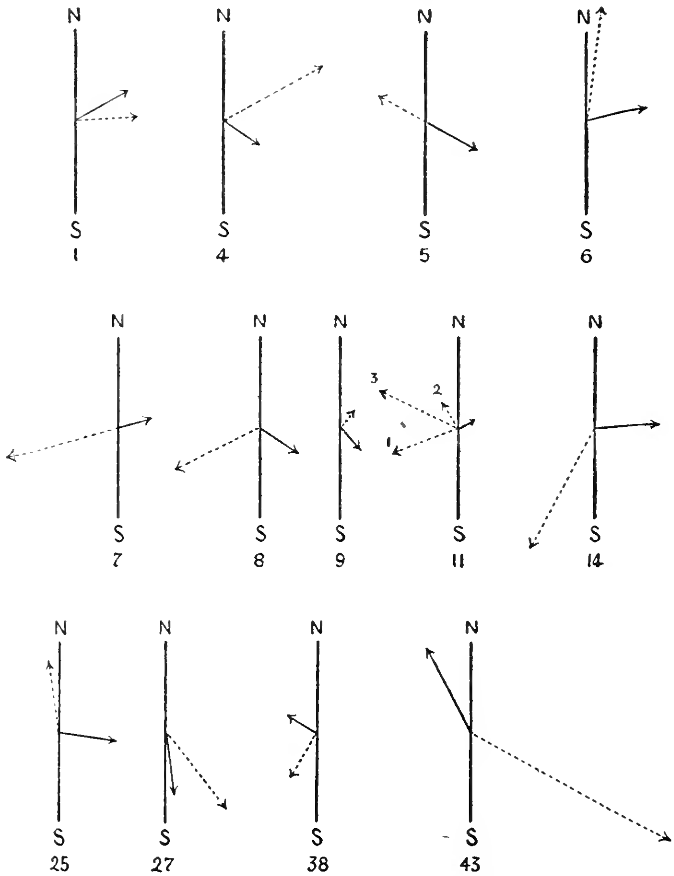

FIG. 38.— Currents, Stations 1, 4, 5, 6, 7, 8, 9, 11, 14, 25, 27, 38, 43. Surface current··········>; bottom current ———>. The strength of the current is represented by the length of the arrows, 3 cm. = 1 knot per hour.

within the Bay attains considerable velocity, its absence is no doubt to be explained by the fact that the bottom here is an isolated pocket some twenty fathoms deeper than its enclosing sill, with a consequent separation from the general bottom circulation. The highest bottom velocity recorded in Massachusetts Bay was .25 knots per hour. The observations at Station 7 show that over the western basin opposite Cape Ann the surface current begins to flow westerly with the considerable velocity of .5 knot, at least two hours before it is low water at Cape Ann; but not the bottom current, for the latter, a few minutes later, was still flowing to the east, though slowly.

There are four stations between Jeffrey's Ledge and the mainland in depths from twenty-five to eighty fathoms, at which bottom as well as surface readings were taken, Stations 8, 11a, on the flood; Stations 9, 11b and c, 14, on the ebb. On the surface the flood current runs to the west (Station 8), or W. by S. (11a), velocity .3 to .4 knots per hour, and the three sets of observations at Station 11 show that the current was still running to the westward two hours after high water at Cape Ann and Cape Porpoise, though it had veered from west to north by west. But there were several active tide-rips in the vicinity, which were probably responsible for this apparent on-shore flow during the ebb. At Station 14, there was a strong current flowing southwest (.6 knot) two hours before low water at Cape Porpoise, only eight miles distant. But at Station 9 it had started to run slowly to the N. E. by E. one hour after high water. On the bottom the current was easterly in every case (Station 8, 9, 14, 11c) except at 11b, where there was a very slow movement to the N. N. W. One of these records (Station 8) is at four-hour flood, the others are at various stages of the ebb. At Station 11b, two-hour ebb, the bottom flow was toward the N. N. W.; but one half hour later it had veered to the E. by N., *i. e.*, toward the extremity of Jeffrey's Ledge. At Station 14 there was a .3 knot current on the bottom toward the E. by S. the surface flow being S. W.

On Jeffrey's Bank (Station 25) the bottom current was to the E. S. E. almost at right angles to the surface flow (N. by W.), three hours after high water at Portland and Rockland.

Our one bottom reading in the eastern basin (Station 27) revealed a quarter-knot current, running southerly, like the surface flow, on the early ebb.

Off Cape Cod, our single reading (Station 43) showed that the bottom flow was still toward the northwest, on the early ebb, although the surface current was already flowing to the southeast.

Circulation as shown by temperature and salinity.— Since we have seen that the surface currents of the Gulf, though often violent, do not demonstrate the existence of any circulation on broader lines than that caused by the tides, we must turn to salinities, temperatures, and densities in the attempt to reconstruct the movements of its waters the most important subject on which the cruise may throw light. Perhaps the most striking oceanographic feature of the Gulf of Maine in summer, certainly the one which has aroused the most speculation, is the existence of a cold band of surface water which bathes the coast from Portsmouth as far as the Penobscot, and extends thence across the mouth of the Bay of Fundy and along the western coast of Nova Scotia, gradually growing broader and broader to the eastward. If we were to judge from surface temperatures alone we would naturally assume that this cold water was evidence of a cold current following the coast; and it has often been referred to as an Arctic current solely on this ground. But, as we have seen, the surface currents, at least in summer, afford no support to such a view, while serial temperatures and salinities show that the phenomenon can be explained on very different grounds.

The coldest surface water was found over German Bank and in the Grand Manan Channel; but serial temperatures show that this low temperature, at these stations, was solely a surface phenomenon, the bottom waters being much warmer there than at corresponding depths in the basin or on the west coast of the Gulf. Furthermore the mean temperatures for the upper forty fathoms, *i. e.*, for the whole depth at Stations 29, 33, and 35, are no lower than they are in the western part of the Gulf: (Station 29, 49.8°; Station 33, 49.5°; Stations 27 and 28, 49°; Station 11, 45.7°; Station 7, 49.1°; Station 2, 46.4°; Station 43, 51.1°.) We find, too, that in the northeast part of the Gulf, there is much less change in salinity from surface to bottom than in the western half. And when we take into consideration the extraordinary violence of the tide, both on German Bank and in Grand Manan Channel, and the numerous tide-rips, with which everyone who has sailed these waters is familiar, it can hardly be doubted that the low surface and high bottom temperatures are merely the evidence of thorough mixing of surface and bottom waters, caused by the active vertical circulation which necessarily results from the strong currents. Verrill (1873, p. 438) explained the phenomenon correctly when he wrote "the constant mixture of the cold bottom water with the warmer surface waters by means of the strong tides and local wind currents, causes the remarkably low temperatures observed in the shallow waters of these shores." The temperature conditions on Jeffrey's Bank result from a similar phenomenon, though as tidal currents are less strong here than they are further to the eastward, the equalization of temperature from surface to bottom is less complete; and the diminishing range of temperature from surface to bottom at successive stations along the coast from the Penobscot to Grand Manan, the surface growing warmer, and the bottom colder at least at corresponding depths, is evidently due to the fact that the diminishing force of the tidal currents is less and less effective in causing vertical circulation, so that the waters retain more and more nearly their normal temperature gradient. Exactly the opposite takes place in passing off shore from the mouth of Grand Manan Channel, the temperature and salinity range growing progressively greater.

The mouth of Casco Bay, *i. e.*, the region where the general trend of the coast changes from northerly to northeasterly, is the dividing line between temperature sections of two types; for whereas the coast waters east of this point were about as much warmer than the off-shore stations on the bottom as they were colder on the surface, the coast water south and west of Portland was no warmer on the bottom than it was off Cape Ann or near Platt's Bank, though it was constantly several degrees colder on the surface. On the contrary, Station 11, close to the coast, was colder at all depths down to about sixty fathoms than the water east of Jeffrey's Ledge, and the curve at Station 14, off Cape Porpoise, was almost precisely like it, the same temperatures being found from five to ten fathoms nearer the surface at Station 11 than at Stations 23 and 24. Below fifty fathoms the temperatures were about equal. If temperature were the only clue to oceanic circulation, we would naturally assume that such a profile indicated an upwelling of cold bottom water. But the salinities of this region, forbid this explanation, because, as the salinity sections show, the in-shore stations were fresher at all depths, whereas, if the surface were cooled by water rising from below, the salinity would necessarily be raised by the same process, and we would expect to find the surface salter than, or at least as salt as it was at the stations further off shore. But although the temperature readings at Station 11 were lower at all depths down to fifty fathoms, than they were east of Jeffrey's Ledge, the curve for the former was almost precisely the same as it was at Station 2, in the mouth of Massachusetts Bay a few days earlier, except that the upper ten fathoms were cooler at Station 11; while the salinity curves (fig. 11) show that the latter was slightly salter than Station 2 at the surface, slightly fresher below thirty fathoms. It is evident that while vertical movements of such a column of water as was met at Station 24 could not reproduce the temperature and salinity conditions found at Station 11, a vertical mixing of the upper fifteen or twenty fathoms of the waters at Station 2 would cause results very similar to the conditions observed over the trench west of Jeffrey's Ledge. And this is probably the correct explanation. Further evidence in its favor is afforded by the fact that diurnal changes of surface temperature are not so great in this region as they are further off shore.

The profiles show that this mass of coast water is fairly sharply defined from the off shore water east of Jeffrey's Ledge in July and August, by low temperature and low salinity, in which it agrees with the water off the mouth of Massachusetts Bay. And no doubt the contour of the bottom is largely responsible for this fact by hindering free circulation of the water below thirty-five fathoms; because although the northern end of the trench is open, and the water there (Station 22) was salter than it was at Station 11, yet it was so much warmer at all depths that the density, depth for depth, was about the same at the two stations. Consequently there is no dynamic cause for an active flow of water of high salinity into the deep parts of the trench, and the latter retains more nearly the conditions of early summer than does the coast water further north and east.

Temperatures and salinities show that the cold bands of water so often observed along the north shore of Massachusetts Bay are evidence of upwelling of bottom water, probably due to off-shore winds. But in the southern half of Massachusetts Bay, the curves of both these factors, taken with the strong tides of this region, show that the cool surface water is the result of mixing, rather than of upwelling, two forms of vertical circulation which may be perfectly distinct, though they are often combined.

The existence of a band of coast water of very much lower salinity than the off-shore water is no doubt the direct result of the vast volume of fresh water poured into the Gulf by the large rivers which empty into it, chief of which are the Merrimac, Saco, Androscoggin, Kennebec, Penobscot, St. Croix and St. Johns, with a combined water-shed of about 45,550 square miles. Unfortunately we have very little data on the salinities of the Gulf at any season of the year except in midsummer, but the salinity curves for July and August show that at that season, at least, the fresh river water is localized along the coast, swinging off shore opposite the Penobscot and off Cape Ann. It is true that at that season there is little or no evidence afforded by the surface salinities of an influx of river water in the northeast corner of the Gulf, although it is there that the greatest volume enters, *i. e.*, from the St. Johns and St. Croix. And although this can be partly explained as due to the active vertical circulation in this region, which raises the surface salinity by mixing, virtually equalizing the physical properties of the water from surface to bottom, the mean salinities for the upper thirty fathoms show that the water off the Grand Manan Channel is absolutely, as well as apparently, salter than it is at Station 11, or off Massachusetts Bay; and that Jeffrey's Bank, off the Penobscot, is intermediate between the two extremes (the figures are:—Stations 33 and 35, 32.5‰; Station 25, 32.6‰; Station 11, 32.3‰; Station 19, 32.4‰; Station 2, 32.2‰). These facts must be amplified by records from other times of year; but so far as they go they point to the conclusion that the coast water flows southwesterly alongshore, with a branch turning southward off the mouth of the Penobscot; and that it swings eastward as a whole off Cape Ann. The fact that the St. Johns water is less evident, though much greater in amount, than the water from the Penobscot, Kennebec, and Merrimac, can be explained only on the assumption that it is more constantly mixed with salt off-shore water than are the latter; an assumption supported by our observation that oceanic salinities are most closely approximated both on the surface and in deeper layers in the eastern part of the Gulf. All this, of course, indicates an in-shore movement of water in this region in August, which mixes with the St. Johns water off the mouth of the Bay of Fundy, with consequent changes of salinity; while the occurrence of Salpae over the Eastern Basin is as good evidence, as is the high salinity, that at the time of our visit this oceanic water was an offshoot from the northern edge of the Gulf Stream, not of northern origin. Off the mouth of the Penobscot the salinity curves show that the flow is the reverse, *i. e.*, to the south; but off Casco Bay we once more find a tongue of comparatively salt water approaching the coast, and separating the Penobscot from the Cape Ann fresh wedge. Thus, although the actual movements of tidal currents do not reveal the existence of any general circulation in the Gulf (p. 84), salinity conditions show very clearly that there is an influx of ocean water on the east side of the Gulf; and a longshore movement of the fresh coast water, sending out a southerly tongue off the Penobscot, and swinging eastward off Cape Cod. In other words, the surface of the Gulf as a whole, at the time of our cruise, was probably occupied by two separate eddies, which are reconstructed here from the salinities (Plate **4**). The fact that the salinity is lower over the western than over the eastern side of the eastern basin, is due to the eddy, part of the fresh wedge off the Penobscot being drawn into its circulation on the west side. And the comparatively low salinity of the western basin, and the gradual rise of salinity from west to east is similarly explained by the indraught into the eddy of the comparatively fresh water off Cape Ann. Off Cape Cod (Station 43) the water was considerably salter than off Cape Ann, the mean for the upper fifty fathoms being about 32.7, instead of 32.4 as it was at Stations 2 and 7; *i. e.*, in this region the influence of the coast water was felt but little.

Unfortunately we yet have so little data for the salinities of the region south of a line from Cape Ann to Cape Sable, that an attempt to extend the chart of circulation over the southern half of the Gulf would be little better than guess work.

COMPARISON WITH PREVIOUS RECORDS OF TEMPERATURE AND SALINITY.

In July and August, 1873, Verrill found nearly the same surface temperature fifteen to twenty miles southeast of Cape Elizabeth as we did last summer, 62°–65°. Near Seguin Island, August 20, he records 59°; this is very close to our Station 40, where on August 22 our reading was 58°. But by September, 1873, the surface temperature had fallen several degrees below our August records, the surface temperature east of Jeffrey's Ledge, and generally over the western basin opposite Cape Ann being given by Verrill as 57°–58°, *i. e.*, autumn cooling had probably set in by that time. And his records near Monhegan and Matinicus Rock are from 2°–3° lower than ours a month earlier. But in Massachusetts Bay his records are 59°–64°, suggesting that seasonal cooling in that region was more rapid in 1912 than in 1873.

The temperature data obtained by the U. S. Coast Survey in 1874 is of slight value, because the surface readings are not reliable (Verrill, 1875, p. 413, footnote); and there is no way of estimating the probable error, which *may* be several degrees. But so far as they go they suggest that the surface of the Gulf was several degrees warmer in that year than in 1912, with surface temperatures of 60–65° in its southwestern part. On Cashe's Ledge, and on the northern part of Jeffrey's Ledge readings of 55–58° were obtained, probably an index of active vertical tidal circulation.

Dickson's (1901) charts for July and August, 1896, and July and August, 1897, show a very different distribution of surface temperatures in the Gulf from what we encountered: for they do not show the cold coast-band east and north of Cape Ann, while in July, 1897, the surface temperature of the whole of the Gulf east of about 69° W. Long. is given as below 59°; the smaller area west of 69° Long., 60°

or warmer: and in August of that year, he shows all of the Gulf, including the Bay of Fundy, 59° to 68°, Massachusetts Bay above 68°.

But without access to the vessels' logs, and other unpublished data from which these charts were compiled, it is useless to discuss them critically further than to point out that the distribution of temperatures within the Gulf represented on them does not accord with conditions in 1912, with Verrill's observations, or with the occasional surface readings which I have made in other years. The surface temperatures taken by the GRAMPUS in July, 1908, while crossing the mouth of Massachusetts Bay on her way to the Gulf Stream, (Bigelow, 1909) were 66° to 68°, *i. e.*, appreciably higher than they were in 1912. This fragmentary data suggests that the surface waters in the Bay and over the Gulf as a whole, were colder than usual during the summer of 1912; the result of abnormally low air temperatures during the preceding winter, the coldest in eastern Massachusetts for many years.

Unfortunately the only previous records of bottom temperatures within the Gulf, those recorded by Verrill, (1873–1875) are not reliable, as shown by the fact that when two thermometers were used simultaneously their readings occasionally differed by as much as 4.5°, frequently by 1° or 2°; indeed it was the exception that they registered alike, and as Verrill himself pointed out, they rated differently at successive standardizations. His records, taken at their face value, would indicate that the bottom temperatures were distinctly lower in the northeastern part of the Gulf in 1873 than they were in 1912; *i. e.*, the reading, with both thermometers, in 107 fathoms, in September, 1873, twenty-three miles southeast of Matinicus Rock, was 39.5°; in 105 fathoms just east of Jeffrey's Bank it was 40°, whereas it was 42.8° at Station 27, in 1912. Fifteen to twenty miles southeast of Cape Elizabeth, the discrepancy is still greater, for Verrill records bottom temperatures of from 36° to 39.5°. But these differ so much from those of the GRAMPUS (41° to about 45°) and are so much lower than he himself records from any other part of the Gulf, that it seems that the instrumental readings were too low. In the deep basin off Grand Manan, Verrill found the bottom temperature 37.5° in 106 fathoms in 1872, but we have no data to compare with his; and this basin is isolated from the exterior by a sill over which there is only about eighty fathoms of water.

Fifteen miles southeast of Boon Island, in the trench west of Jeffrey's Ledge, the older record is about 39° (37.5° and 40.5°) in ninety-five fathoms, instead of 40.3° which we found to be the general temperature at that level (Stations 11, 41), though at one Station near by (12b) we got a bottom reading of 39.2°. In the deep basin off Cape Ann, Verrill's readings, in ninety, one hundred and eighteen and one hundred and fourteen fathoms, are 40°, 43°, 39° and 39°, at three stations near together. But the fact that we found a thick layer of bottom water very uniform in temperature in this region, suggests that the discrepancy in his readings was due to the faulty instruments. And it is at least suggestive that the average of his four readings in the basin is 40.2°, *i. e.*, within .1° of our observations. Off Cape Cod, too, in 142 fathoms, close to Station 43, the bottom temperature in 1874 was 39° or 42°, agreeing fairly well with our record of 41.3° at Station 43. And the difference in depth is not significant in this case, because we encountered the uniform bottom water at 50 fathoms. On the other hand Verrill records a bottom temperature of 52° in 100 fathoms southwest of Jeffrey's Bank, where in 1912 the bottom reading, to judge from neighboring stations, must have been little, if any above 40.3°. And our entire experience makes it so improbable that the 100 fathom temperature is as high as 50° anywhere in the Gulf, that such a reading is best credited to the unreliability of the instrument with which it was taken. On the whole the bottom temperatures in Massachusetts Bay, in the western basin, and in the trough west of Jeffrey's Ledge were practically the same in 1873 as they were in 1912. But Verrill's readings for the northeast corner of the Gulf are so consistently lower than ours, that it is probable that the bottom water in that region actually was from 1° to 3° colder in 1873 and 1874 than it was in 1912. His records for 1874, (1875, p. 413) agree in a general way with our work in 1912, but as the same unreliable thermometers were used, and only one reading taken at each station, it is unwise to lay stress on them.

Dickson's, (1901) charts show the salinity of the eastern half of the Gulf as below 32‰ the Bay of Fundy 31‰ or lower, and Massachusetts Bay as below 32 for August, 1897 (no salinities are given for the remainder of the Gulf for these months). But on examining his tables, which give the tests of the water samples on which the charts are based, I did not find a single record from within the Gulf for either month, which suggests that the salinity credited in his charts to the eastern half of the Gulf was deduced from the low salinities revealed by several water samples taken in that month off the Nova Scotian Coast. But our own records show that his reconstruction of this region was probably incorrect, because it is certain that in August, 1912, there was an indraught of Atlantic water with salinities of 32.8 or more into the eastern part of the Gulf, and we have no actual data to disprove the supposition that this is an annual, if not a constant phenomenon. A similar indraught is shown by Schott, (1902) on his chart of the Atlantic.

Unfortunately salinities at other times of year do not aid as to whether or not the 1912 conditions were normal, for there are only two titration records from within the Gulf, north of George's Bank in Dickson's tables, one of 32.9 off Cape Cod, April, 1896, the other of 32.3 off Cape Sable in the same month. There are several records in his table from George's Bank, and I have received two samples from its northern edge, collected November, 1911, with salinities of 32.7 and 32.9 respectively.

General considerations.

Various explanations have been proposed to account for the band of cold water of low salinity which bathes the coastal slope from Newfoundland to Cape Hatteras, one of the earliest being that it is a branch of the Labrador Current flowing southerly along the shore. And although there is little actual evidence, other than low temperature, in its support, this is the one which has found its way most generally into literature, scientific as well as popular. Thus Libbey (1891), in his discussions of ocean temperatures south of Nantucket, constantly refers to the cold wall as the "Labrador Current." Of late years, however, practical oceanographers have found less to recommend it, and Verrill, (1874) long ago questioned whether the low bottom temperatures which he observed off Portland in 1873 were not really a part of the cold bottom water of the North Atlantic rather than evidence of Arctic water. The facts, according to Verrill, do not warrant the assumption that an Arctic Current, properly so called, as distinguished from tidal currents, enters the Gulf of Maine; but he qualifies this generalization by adding that the Gulf gets constant accessions by the tides of cold water which has primarily come from the north.

According to Schott, (1897) and Hautreux, (1910) the source of the cold water, as far south as New York, is not the Labrador Current, but the St. Lawrence. But Pettersson, (1907) discarding the idea of an Arctic Current, definitely classes the cold wall along the North American coast as "an updrift of the cold bottom water of the ocean when pushed against the coast banks," the motive force for this push being the "sinking cold water at Newfoundland," though, as he points out, "we know too little of the hydrography of the Gulf Stream and of the cold wall on the American side of the Atlantic to be able to trace with security the origin of its waters." Quite a different explanation for the cold wall is proposed by Tizard, (1907, p. 343) who believes that the chief factor in forming the cold coast water is the discharge of fresh water from the rivers along the American coast, by which means large quantities of cold fresh water and fresh ice are emptied over the coastal slope. And he argues that neither upwelling of oceanic bottom water, nor the Labrador Current, has anything to do with the formation of the cold wall.

The partial isolation of the Gulf of Maine from oceanic waters by the sill formed by George's and Brown's Banks, makes it possible that its cold waters need a different explanation from those of the "cold wall" west of Cape Cod; and the discussion of the latter is best postponed until we have a better knowledge of their salinity. But so far as the Gulf is concerned, we can safely say that the low salinities in July and August certainly show that its waters are not predominantly Atlantic abyssal water welling up over the continental slope, because the salinity of the bottom water over most of the North Atlantic is about 34.9 (Murray and Hjort, 1912).

The same index, salinity, shows that Tizard has suggested a factor of real importance, for besides the fresh water emptied into the Gulf of Maine annually by its rivers (p. 90) there is also the annual rainfall of about 40 inches, a total annual increment of fresh water, which would make a layer more than a fathom thick over the entire Gulf. To offset this, there is the annual evaporation; and while this is not exactly known for any off-shore station in the Gulf, conditions on the neighboring coasts indicate that it is probably less than the rainfall. Rainfall and inflow from rivers combined are likewise considerably in excess of the annual evaporation all along the coast of Nova Scotia where the salinity, according to both Dickson, (1901) and Schott, (1902) is 32‰ or less.

The Gulf of St. Lawrence, has, of course, been mentioned by previous authors as a source of fresh water, but its importance must be greater than has been usually recognized, because of the enormous extent of its watershed, including the St. Maurice, Saguenay, Humber, and other large rivers, besides the St. Lawrence itself. Its rainfall, too, exceeds evaporation. The little that is known about the currents in its two mouths (Dawson, 1910) shows that its main outlet must be through Cabot Straits, as Schott represents it in his chart of ocean currents, (1902, pl. 39) not through the Straits of Belle Isle. The comparatively fresh St. Lawrence water is continuous with the water with salinities of 32 or less, along the east coast of Nova Scotia. And if the Gulf of Maine receives any regular accessions of northern water of low salinity, it is probably from the Gulf of St. Lawrence, not from the Labrador Current.

The temperatures of the Gulf of Maine are, of course, very low in comparison with the Gulf Stream off shore; and its surface temperature, at least, is considerably lower than the average for its latitude, about 57°, as calculated by Krümmel, (1904) as against a probable yearly mean of about 48° for the Gulf. But we must remember in this connection that on the east coast of North America cyclonic atmospheric disturbances move as a whole from the land out over the sea, not from sea to land, as they do over Western Europe, and consequently, that the coastal waters may be expected to take their temperatures from the land climate instead of the latter being governed by oceanic temperatures, as is the case in Europe.

If the Gulf of Maine were an enclosed basin, we would expect its bottom temperature to be about the same as the mean annual temperature of the surrounding land-mass, just as Nordgaard, (1903) has found it for the Norwegian fjords. And as a matter of fact, the lowest temperatures which we encountered in the Gulf are practically the same as the mean annual for northern New England, *i. e.*, that portion of the land mass from which the chilling winds of autumn and winter blow. The considerable snowfall must likewise be an active factor in chilling the surface water in winter, while the inrush of fresh snow-water, only a few degrees above freezing point, in spring, may be expected to show its effect in retarding the warming of the coast water as the season advances. Furthermore, the considerable thickness of the bottom water of uniform temperature in the western part of the Gulf, is good evidence of winter cooling, while our observations show that the temperature was lowest in the western half, just where cooling land winds and snow are most active, instead of in the eastern, where a northern current might be expected to show itself most clearly. Thus Verrill was probably correct in his contention that the waters of the Gulf are not abnormally cold, considering their geographic location, and the climate of the neighboring land mass.

The possibility that cold northern water enters our Gulf in small amounts is not forbidden by the conclusion that the low temperature of the latter is chiefly due to winter cooling. On the contrary, the fact that the bottom temperatures on the coastal banks along the coast of Nova Scotia are much lower than at corresponding depths in the Gulf or further west, and that they decrease from southwest to northeast, as found by the ALBATROSS in 1883 and 1885, together with the salinities, as pointed out above (p. 97) is good evidence that there is a flow of St. Lawrence water along the coast of Nova Scotia toward the southwest. And, finally, at least two wreck courses (Hautreux, 1910) have been recorded with a southerly drift near Nova Scotia. But there are no wreck tracks nor iceberg tracks leading from the grand banks of Newfoundland toward Nova Scotia, such as might be expected were there any pronounced westerly drift of the Labrador current. The occasional occurrence of Arctic pelagic organisms in Massachusetts Bay and the Bay of Fundy, such as the medusa Ptychogena and the ctenophore Mertensia, neither of which has been able to establish itself in the Gulf, shows that there are occasional indraughts of the St. Lawrence water into the latter. But the fact that last summer the indrift was of Atlantic not St. Lawrence origin (p. 94), and the occasional record of tropical organisms, *e. g.*, the siphonophore Physalia at Grand Manan, show that its influence is either sporadic, or seasonal, not constant.

If any general conclusion can be drawn from the scanty oceanographic data yet available, it is that the Gulf of Maine owes its low temperature and salinity largely to local causes; *i. e.*, to its geographic position and partial isolation by the sill formed by George's Bank; and that though there was an influx of ocean water in the summer of 1912 from the edge of the Gulf Stream, in other years, or at other seasons, there are more or less sporadic indraughts of cold water flowing from the northeast. This water, however, probably has no connection with the Labrador Current, but comes from the St. Lawrence.

PRELIMINARY NOTES ON THE PLANKTON.

The following notes on the macroplankton, preliminary to the special reports on the various groups, are offered because no attempt seems to have been made to study the pelagic fauna of the Gulf as a whole; and because the collections and oceanographic data of the GRAMPUS allow a correlation between its plankton at a given time and the physical factors of the water, at the same time and place. With these ends in view, our main efforts were directed toward qualitative, rather than quantitative results, though we devoted as much attention to the latter as was practicable. The usual program of plankton work during the day time, was to use the no. 20 (bolting silk) net at or near the surface, and to tow the coarse four-foot net horizontal for half an hour at some intermediate depth. When stations were occupied after dark, we usually used the four-foot net within a fathom or so of the surface, in this way getting very rich tows. The data of the hauls is listed in the table of stations (p. 135). The hauls with the quantitative (Hensen) net are discussed separately (p. 127).

By far the most important member of the animal plankton over most of the Gulf, numerically at least, was the small copepod *Calanus finmarchicus*, which was taken at every Station (p. 115). This species plays much the same rôle in the vital economy of the Gulf as it does in Norwegian waters on the other side of the Atlantic, being the chief food for pelagic fishes, particularly the mackerel. It is well known to fishermen under the name of "red feed," from the reddish color of a mass of these little crustaceans. At times it occurs in almost unbelieveable numbers; for example our four-foot net hauls in Massachusetts Bay near Cape Ann in July often yielded two or three quarts of this Calanus. At this time the plankton of the Bay was almost exclusively composed of *C. finmarchicus*, with very few other copepods; *e. g.* Pseudocalanus, Eurytemora, and Metridia; an insignificant number of Sagittae (chiefly *S. elegans*); a few larval schizopods; an occasional full-grown schizopod (*Meganyctiphanes norvegica*), and a few medusae, *e. g.*, Aurelia, Cyanea, Melicertum, and the northern ctenophore, *Bolinopsis infundibulum*. We also obtained one specimen of the large pteropod *Clione limacina* in the Bay, and others off Cape Ann (p. 119). In the northeastern corner of the Bay, this general type of plankton was varied by the presence of great numbers of fish eggs (Station 1), and our several stations in the northeast corner of the Bay yielded many pelagic larvae of the cunner (Tautogolabrus), cod (*Gadus collarius*), witch flounder (*Glyptocephalus cynoglossus*), and sanddab (*Hippoglossoides platessoides*), with a few silver hake (Merluccius), redfish (*Sebastes marinus*), haddock (*Melanogrammus aeglifinus*), rockling (Enchelyopus) and other species (p. 107).

Twelve miles or so off Cape Ann (Station 2) there were very few fish eggs; and no fry; and over the western arm of the deep basin (Station 7) there were no eggs at all, but a considerable number of fish larvae, mostly cod, of which twenty-nine specimens were taken. The Calanus swarm, however, was nearly as dense as in the Bay; and we noted here, for the first time, the large boreal copepod *Euchaeta norvegica*, between seventy-five fathoms and the surface. There were no other copepod species in the haul. At this station we likewise captured two large *Meganyctiphanes norvegica*, and one specimen of the pelagic boreal amphipod, Euthemisto, which was taken frequently from this point on, while a swarm of *Sagitta elegans* gave a new aspect to the tow. Clione, too, was represented by several large specimens. There were neither Aurelia nor Cyanea so far off shore; but the four-foot net yielded several large *Beroe cucumis*, a cosmopolitan form already often recorded from the Gulf. Perhaps associated with the abundance of Calanus, were the numerous Wilson's petrels which surrounded the ship as soon as we hove her to at this station. From Station 7 we ran in shore again, and worked for two days in Ipswich Bay, a region where I had previously found an abundant plankton, and which is proverbial for whales, sharks, etc., and the seat of an important winter fishery. *Calanus finmarchicus* was still the prevalent organism, the nets bringing back a swarm of juveniles, besides several *Euchaeta norvegica*, great numbers of *Sagitta elegans* (Stations 8, 9, 10, 11, 12b), *Tomopteris helgolandica*, represented by a very large specimen in the quantitative haul at Station 11, and, among Medusae, Aurelia and Cyanea in large numbers, with a few *Melicertum campanula*, and *Phialidium languidum*. The latter species we found very widely distributed in the coastal waters of the Gulf.

But the most important feature of Ipswich Bay, to us, was the immense number of pelagic fish eggs, largely *Urophycis chus:* and a haul of the eight-foot beam trawl for thirty minutes at Station 8 yielded the following large haul of fishes; twelve skates (*Raja radiata*) two *Aspidophoroides monopterygius*, four *Zoarces anguillaris;* twenty silver hake (*Merluccius bilinearis*,) two hake (*Urophycis regius*), thirty-four squirrel hake; (*Urophycis chus*), two rocklings (*Enchelyopsis cimbrius*), forty-one sanddabs (*Hippoglossoides platessoides*), six rusty flounders, (*Limanda ferruginea*), forty-eight witch flounders (*Glyptocephalus cynoglossus*), and seven large goosefish (*Lophius piscatorius*). The squirrel hake (*Urophycis chus*) were full of ripe eggs and milt; and comparison of their eggs, fertilized on board, with the pelagic eggs taken in the tow, established the identity of the most abundant of the latter as belonging to this species. This discovery is of great interest, because very little is known of the early stages of any members of this genus, and nothing of this particular species. It, and the other fishes will be described by Mr. W. W. Welsh. Meantime it may be noted here that the fish were spawning in twenty-two fathoms, temperature 42.4°, salinity 32.39‰. In spite of the great numbers of pelagic eggs, Ipswich Bay and the waters immediately to the north yielded but few fry, except for the sanddab (Hippoglossoides), of which twenty-four specimens of 10–22 mm. were taken at

Station 11. In Kittery Harbor, however, we obtained great numbers of Tautogolabrus and Merluccius.

Our enforced return to Gloucester for repairs on July 18 gave us an opportunity to compare the plankton off the Harbor mouth (Station 12) with what we had found a week or two previous, with the result that there had been no appreciable change, the waters still being filled with the Calanus swarm besides an occasional Euchaeta, and a few fish eggs, and many fry, as noted above.

Our run from Cape Ann to Casco Bay showed that the spawning area of the squirrel-hake, admitting our identification of the pelagic eggs to be correct, extended over the whole coast band, large hauls of fish eggs, including this species, being made at Stations 14 and 20. At the latter many cunner eggs (Tautogolabrus) were also taken; and a few eggs probably belonging to the mackerel, which were schooling in small numbers in this neighborhood at the time. Mackerel eggs were likewise taken in our surface tows at our anchorage at Orr's Island, on August 1. Only two species of fish fry were taken in numbers in the northwest corner of the Gulf and in Casco Bay. Most important of these, because of its purely boreal habitat, is the redfish (*Sebastes marinus*), no less than 320 larvæ of which were taken in the closing net and in the intermediate haul at Station 19 (p. 108). At Station 22, likewise, it was represented by fifty-three specimens, in the open net haul. In Casco Bay, larval cunners (Tautogolabrus) were numerous.

Along this stretch of coast we continued to find *Calanus finmarchicus* in large numbers, with a few *Euchaeta norvegica;* and at Station 13 we captured a few of the large blue copepod *Anomalocera patersoni* on the surface, a species frequently taken after this, occasionally in large numbers (p. 118); and several other copepods in lesser numbers, as shown in the table (p. 115). Off Cape Porpoise we first encountered the amphipod Euthemisto in large numbers. Here, too, our tows revealed many specimens of the pteropod *Limacina balea;* while Stations 19 and 22 added a fresh Chaetognath, *Sagitta serratodentata* in small numbers. Another addition to the plankton, in this region, was the large hydromedusa *Staurophora mertensii*, which we first met at Station 14, where three large specimens were taken in a haul of the four foot net from twenty fathoms. *Meganyctiphanes norvegica*, too, occasionally occurred in our hauls off Casco Bay, (Station 19). In the coast region Aurelia and Cyanea were taken in most of the hauls, but usually not on the surface; though several large specimens were seen floating at Station 22. Our most notable find in this region was four fragmentary specimens of the hydromedusa *Halopsis ocellata*, taken at Stations 15, 22, and 23. This species, first discovered in Massachusetts Bay (A. Agassiz, 1865, p. 102) has since been recorded only once, by Fewkes, (1888), who found it in considerable numbers "near the wharves at Grand Manan." The chief point of interest about this species is its otocysts, for though Agassiz figured them (1865) it has remained questionable whether they are open or closed, and consequently Browne, (1910) found it impossible to refer the genus definitely either to the Mitrocomidae or to the Eucopidae. Fortunately our specimens, though much battered, show these organs well, and it is easy to demonstrate that they are open pits. The opening is evident on surface views of the oral side of the velum, and large enough to admit a fine bristle. Consequently Halopsis is a mitrocomid. The specimens agree with Fewkes's statement as to the independent origin of the radial canals from the stomach (in the original account they are described as arising in four groups).

Our run out to Platt's Bank showed that very few fish were spawning except close to the shore, for the tows at Station 23, on the bank, contained no eggs at all, nor did we meet any over the deep trench a few miles further south (Station 24), while very few were found over Jeffrey's Bank (Station 25) except for a Lophius veil, with the eggs nearly ready to hatch, which we picked up from the surface at this station. And to complete the brief survey of fish eggs I may add that very few were taken at any of our stations further north or east; none at all at the off-shore stations over the Eastern Basin (Stations 27, 28) on German Bank (Stations 29, 30), off Lurcher Shoal (Station 31), off Mt. Desert Rock (Station 32) or in the Grand Manan Channel.

On the other hand we captured 190 larval red fish (Sebastes) on Platt's Bank (Station 23); 18 at Station 27, 61 at Station 28; and 27 at Station 32; but it was not taken on Jeffrey's Bank (Station 25); nor along the coast from Grand Manan to Penobscot Bay (Stations 33 to 39).

At our off-shore hauls the plankton repeated, in a general way, the conditions met nearer land, *Calanus* with a few other copepods, notably *Euchaeta norvegica* and *Anomalocera patersoni*, still forming the bulk of the hauls (Stations 23, 24, 27, 28). But the haul from twenty fathoms at Station 23 yielded an important addition to the list of copepods, in the Arctic Calanus, *C. hyperboreus*, represented by six specimens among the thousands of *C. finmarchicus*. We now met Meganyctiphanes more regularly, considerable numbers of this schizopod being taken at Station 27, 80–0 fathoms. And at Station

23 we found a single specimen of the medusa *Tiaropsis diademata*, which is abundant in Massachusetts Bay in June.

At Station 23 we first met *Pleurobrachia pileus*, and we frequently took it later, further north and east; we saw *Beroe cucumis* on the surface, and captured sticklebacks, and a large isopod (Idotea) from floating Fucus. In these off-shore waters *Sagitta serratodentata* was more plentiful than we had found it before,— a case treated at length elsewhere (p. 121) and an occasional fragmentary agalmid was likewise taken (p. 121) besides considerable numbers of fish fry.

At Station 27 *Calanus finmarchicus* was taken in swarms at the surface, the only time we found it abundant at that level, in the day time, though it often was at night. Euthemisto was plentiful at the off-shore Stations 29 and 31, and at the former we took one *Tiara pileata*, and two Aglantha (40–0 fathoms), this being the first time the latter was encountered during the cruise. On the other hand, we found none of the typical shore forms, *e. g.*, Aurelia, Cyanea, Melicertum; and over the Eastern Basin not even Staurophora, Phialidium, Beroe, Bolinopsis, or Pleurobrachia, though the last three, of course, are not dependent upon shallow water at any stage in development.

German Bank proved interesting, for though the surface temperature was low (52°, Station 30) and the bulk of the tow consisted of *Calanus finmarchicus*, with a few Euchaeta, Anomalocera, a large number of the schizopod Euphausia, the amphipods *Hyperia galba* and Euthemisto, *Tomopteris helgolandica*, *Sagitta elegans*, and *S. serratodentata*, forming a typical boreal assemblage, the surface haul also yielded two large *Salpa fusiformis* and two specimens of the siphonophore *Physophora hydrostatica*. During the next day Salpae were occasionally seen on the surface; and at Station 31 several were taken in the tow, all *S. fusiformis* (p. 121). But here, as on German Bank, the plankton as a whole was the same as we had found over the Gulf as a whole, *Calanus finmarchicus* composing far the chief bulk of the haul. This proved to be an interesting station, because the open net from fifty-five fathoms brought back several specimens of the cold water Chaetognath *Eukrohnia hamata*, a species found on the surface in Arctic and Antarctic regions, but limited to the mesoplankton in temperate and tropical latitudes. This same haul also yielded two specimens of the large *Sagitta lyra;* and neither of these species was taken again during the voyage. The list of copepods also received an addition, *Euchirella rostrata*. After leaving this station we saw no more Salpae.

Twelve miles off Mt. Desert Rock, August 16, 3 A. M., we made a rich surface haul of *Calanus finmarchicus,* with a few other copepods, *e. g.* Centropages, Metridia, Anamalocera, and Euchaeta, besides *Meganyctiphanes norvegica,* Hyppolyte, Euthemisto, *Limacina balea, Sagitta elegans* and *S. serratodentata, Tomopteris helgolandica, Clione limacina,* Pleurobrachia, Phialidium, and agalmid fragments, *i. e.,* the plankton was of the same type as off shore and further west; and rich quantitatively. But when we approached shore, off Moose Peak, our hauls were extremely barren, by far the poorest yet made. The four-foot net, hauled for three quarters of an hour, at Station 33, with an electric light in its mouth, contained only a few Calanus, four medium sized Staurophora, and a few Sagittae, the whole, aside from the large Medusae, being less than 20 cc. in bulk. This was quite the contrary to what we expected, as the northeastern corner of the Gulf and the Bay of Fundy have always been credited with a rich pelagic life. But in the Grand Manan Channel (Station 34), the plankton was even poorer than at Station 33, the four foot net, hauled from 50–0 fathoms, containing almost nothing except a very few Calanus and other small copepods, while a few Staurophora were seen on the surface. And much the same condition was encountered in the mouth of the St. Croix River, where surface tows were made on August 18, very little being taken, or seen, except Staurophora. In Eastport Harbor, however, many Meganyctiphanes, probably attracted by refuse from the sardine factories, were taken on the surface.

When we returned through Grand Manan Channel, we made a haul off the north end of Campobello Island, where the four-foot net did not bring back even a single copepod; but it yielded large numbers of Balanus eggs in segmentation stages; and a few Staurophora were seen on the surface. Near the entrance of the Channel (Station 35) the water was hardly more productive, the whole catch of the four-foot net (35–0 fathoms), chiefly Calanus and Sagittae, being contained in an ordinary table spoon; while no Medusae or ctenophores were seen on the surface. That night, however, in Cutler Harbor, we found a fairly rich neritic plankton, chiefly copepods, gammarid amphipods, and the hydromedusid Sarsia. When we once more ran off shore to the edge of the deep basin, August 20 (Station 36), the water was occupied by the Calanus swarm, with a few Euthemisto, a few Euchaeta, many Sagitta, chiefly *S. elegans, Aglantha digitale, Beroe cucumis,* Meganyctiphanes, and Staurophora, *i. e.,* a typical Gulf of Maine plankton in considerable quantity. And the richness of this station and that of Station 32, showed that the edge of the dense Calanus swarm followed the 100 fathom curve, the barren zone being only a narrow coast belt.

At Station 38 and 39, the nets yielded comparatively little except diatoms (p. 133), though more than in Grand Manan Channel. In fact it was not until Penobscot Bay was passed that we once more ran into copepods in abundance near the coast. The poverty of the macroplankton in general was shared by the fish fry, for our nets did not yield a single young fish along this whole stretch of coast, *i. e.* Stations 33 to 39. At Station 40 we once more met a rich copepod plankton, chiefly *Calanus finmarchicus* on the surface as well as in the intermediate haul. *Calanus hyperboreus* was likewise represented by one specimen (20–0 fathoms). Considerable numbers of larval Sebastes were taken at this Station; and swarms of *Pleurobrachia pileus* and *Phialidium languidum* gave the tow a distinctive character different from any previously taken. Between Station 40 and Cape Ann (Station 41), the Calanus swarm was once more met, but at this Station there were about as many Centropages as Calanus on the surface; and a surface haul at night off the Cape (Station 42) yielded large masses of Calanus. The tow at this Station was notable for containing large numbers of the copepod *Anomalocera patersoni*, besides Euthemisto, *Tomopteris helgolandica*, *Sagitta elegans*, Cyanea, Staurophora, Phialidium, and many fish larvae. The plankton off Cape Cod at the end of August (Station 43) proved to be of the same type that we had found generally over the Gulf, the prevailing animal being *Calanus finmarchicus*, with *Eucheata norvegica* in less abundance; Euthemisto, Pleurobrachia, Beroe, Staurophora, and a few larval fishes were also taken. Our lines do not afford any information as to how far south the Calanus swarm extended; but some tows made by Capt. John McFarland of the fishing schooner VICTOR revealed this copepod in great numbers five miles east of Chatham, on September 20. However, twelve miles S. E. of Chatham, a day or two later, his tow shows that it was outnumbered by Pseudocalanus, five hundred to one. And, as pointed out (p. 121) he collected a pure Salpa plankton on the surface twenty-five miles off the same port on September 30, which is good evidence that Gulf Stream water was making its influence felt in that region.

Off Cape Ann (Station 42) fish fry of several species, notably cunner (Tautogolabrus), redfish (Sebastes), rockling (Enchelyopus) and witch flounder (Glyptocephalus) were taken; and in the southern half of Massachusetts Bay (Station 44) the hauls yielded many larval sanddabs (Hippoglossoides) and witch flounders (Glyptocephalus), with a few redfish (Sebastes), silver hake (Merluccius), and rockling (Enchelyopus). The hauls off Cape Cod (Station 43) contained only nine fish fry, five Sebastes, and four Enchelyopus.

Of the three components, Arctic, Boreal, and Temperate Atlantic, into which the northern pelagic communities can be divided according to Hjort (Murray and Hjort, 1912, p. 637), the plankton of the Gulf belongs distinctively to the Boreal, for only a single species distinctively characteristic of polar waters, *Calanus hyperboreus*, was detected in 1912. Thus the ctenophore *Mertensia ovum*, was conspicuously absent, though it is known from Massachusetts Bay (A. Agassiz, 1865) and is recorded from the Bay of Fundy by Fewkes, (1888). The polar pteropod *Limacina helicina* was likewise wanting, whereas its boreal relative *L. balea* was taken at several stations, in some abundance. Nor did we detect the Arctic prawn, *Hymenodora glacialis*, a species lacking in boreal as well as in tropical waters. On the other hand *Calanus finmarchicus*, the most characteristic animal of all in the Gulf, is the most important member of the Boreal, as opposed to the polar plankton, in the Norwegian Sea and in the North Sea; and it is the commonest copepod off San Diego, California (Esterly, 1905, p. 126). Euthemisto, *Meganyctiphanes norvegica*, and *Euchaeta norvegica* are all characteristic of the Norwegian Sea, and of the southern edge of the Newfoundland Banks (Murray and Hjort, 1912, p. 108). *Clione limacina*, too, is by no means a sure indication of polar water, for though it is abundant in the Labrador Current off the east coast of Newfoundland, and has been taken off the west coast of Greenland, near Spitzbergen, and at other Arctic stations, it is not associated with polar water in the Norwegian Sea, (Murray and Hjort, 1912, p. 107) but, on the contrary, is found in Atlantic water there, and south of Iceland. To judge, however, from its great abundance in high latitudes and comparative scarcity in our Gulf, it appears to reach its maximum development in a lower temperature than that of the Gulf of Maine in summer. And neither is *Eukrohnia hamata* purely Arctic, for it occurs in the mesoplankton at lower latitudes; as for example in the Bay of Biscay, where Fowler, (1905) found it in one haul from fifty fathoms, *i. e.*, at about the same depth as our one record, and in many hauls from greater depths. And there is no more reason to assume a polar origin for the Gulf of Maine specimens than there is for the Biscayan ones.

Most of the important Medusae and ctenophores, for example Aurelia, Cyanea, Melicertum, *Bolinopsis septentrionalis*, are regular inhabitants of the Norwegian Sea, and of the northern part of the North Sea. Staurophora is known from Helgoland; while *Pleurobrachia pileus* and *Beroe cucumis* are apparently cosmopolitan. *Tomopteris helgolandica* is known from the North Sea, the coast of

Norway, the English Channel, the northeast coast of Scotland, and from the Grand Banks of Newfoundland; and *Sagitta elegans* is a characteristic member of the North Sea plankton.

Most oceanic species so far detected in the collections, *e. g.*, *Salpa mucronata*, and *S. fusiformis*, *Sagitta serratodentata*, *Agalma elegans*, *Physophora hydrostatica*, are dwellers in warm or in temperate waters, the only far northern records of any of them being obviously the result of warm currents (for northern records of Salpa, see Apstein, 1909: of *Sagitta serratodentata*, see Ritter Zahony, 1911; Agalma and Physophora, see Bigelow, 1911. And the resemblance which the Gulf bears in a small way, to the Norwegian Sea in the more important constituents of its zoöplankton, is heightened by the fact that Salpa, Agalma, and Physophora are regular summer visitors to the latter with the northward movement of Atlantic water (Helland Hansen and Nansen, 1909, Murray and Hjort, 1912), while their presence in our Gulf is positive evidence of an influx of water from the northern edge of the Gulf Stream.

List of fishes.

(Identified by W. W. Welsh, U. S. Bureau of Fisheries).

1. *Larval and postlarval stages taken in the plankton hauls.*

Argentinidae.

Smelt. *Osmerus mordax* (Mitchill).

Portland Harbor	July 31	Surface	1 specimen	19.5 mm.

Herring Smelt. *Argentina silus* Ascanius.

Station 27	August 14	35 fathoms	1 specimen	49 mm.

Gasterosteidae.

Three-spined Stickleback. *Gasterosteus aculeatus* Linné.

Station 11	30–0 fathoms	1 specimen	2.3 cm.
Station 23	surface	4 specimens	3.9–3 cm.
Station 25	surface	8 specimens	3.9–2.8 cm.
August 13	surface	4 specimens	4.4–3.7 cm.
Station 29	surface	1 specimen	4.6 cm.
Station 30	surface	11 specimens	4.2–2.8 cm.
August 16	surface	1 specimen	4.2 cm.
Station 43	surface	2 specimens	3.3–2.8 cm.

Two-spined Stickleback. *Gasterosteus bispinosus* Walbaum.

Station 23	surface	9 specimens	3–2.6 cm.
August 13	surface	10 specimens	3.4–2.7 cm.
Station 29	surface	1 specimen	4.5 cm.

Syngnathidae.

Pipefish. *Siphostoma fuscum* (Storer).

Portland Harbor	July 31	surface	1 specimen	14.5 mm.

Labridae.

Cunner. *Tautogolabrus adspersus* (Walbaum) (?).

Station 5	July 12	surface	25 specimens	4.5–2.5 mm.
Gloucester Harbor	July 19	surface	7 specimens	6.5–5 mm.
Station 12	July 22	5–0 fathoms	6 specimens	6.5–5 mm.
Kittery Harbor	July 27	surface	102 specimens	6.5–3.5 mm.
Orr's Island, Me.	July 30	surface	35 specimens	6.5–3 mm.
Casco Bay	August 4	surface	80 specimens	5–2 mm.
Station 42	August 24	20–0 fathoms	3 specimens	9–6.75 mm.
Station 44	August 31	20–0 fathoms	1 specimen	8.5 mm.

Scorpaenidae.

Redfish. *Sebastes marinus* (Linné).

Station 12	July 22	5–0 fathoms	1 specimen	12 mm.
Station 14	July 24	20–0 fathoms	6 specimens	11–6.5 mm.
Station 19	July 29	20 fathoms	150 specimens	9–6.5 mm.
Station 19	July 29	25–0 fathoms	170 specimens	9.5–6.5 mm.
Station 22	August 7	30–0 fathoms	53 specimens	8.5–6.5 mm.
Station 23	August 7	20–0 fathoms	190 specimens	13.5–7 mm.
Station 27	August 14	35 fathoms	5 specimens	20.5–13 mm.
Station 27	August 14	80–0 fathoms	13 specimens	21–13 mm.
Station 28	August 14	30–0 fathoms	61 specimens	16–7.5 mm.
Station 31	August 15	55–0 fathoms	2 specimens	8–7 mm.
Station 31	August 15	25–0 fathoms	13 specimens	12.5–9 mm.
Station 32	August 16	surface	27 specimens	15–7 mm.
Station 40	August 22	20–0 fathoms	20 specimens	13–7.5 mm.
Station 42	August 24	20–0 fathoms	5 specimens	12–8.5 mm.
Station 43	August 29	35–0 fathoms	5 specimens	12.5–9 mm.
Station 44	August 31	25–0 fathoms	6 specimens	11.5–7 mm.

Cottidae.

Artediellus atlanticus Jordan and Evermann.

Station 19	40–0 fathoms	2 specimens	6.3–4.3 cm.
Station 21	60–0 fathoms	4 specimens	5.1–4.2 cm.

Cyclopteridae.

Lumpfish. *Cyclopterus lumpus* Linné.

Station 25	August 8	surface	16 specimens	91–13 mm.
Station 26b	August 13	surface	53 specimens	57–10.5 mm.
Station 27	August 14	surface	1 specimen	44 mm.
Station 30	August 14	surface	9 specimens	70–21 mm.
Between Petit Manan and Libbey Island	August 16	surface	39 specimens	34–14 mm.
Station 40	August 22	surface	1 specimen	10.5 mm.

Liparididae.

Liparis liparis (Linné) (?).

Station 12	July 22	5–0 fathoms	9 specimens	9–5.5 mm.
Station 44	August 31	25–0 fathoms	2 specimens	7–5.5 mm.

Blenniidae.

Pholis gunnellus (Linné).

Station 25	August 8	surface	1 specimen	39 mm.
	August 13	surface	1 specimen	29 mm.

Ulvaria subbifurcata (Storer) (?).

Station 5	July 12	surface	2 specimens	8 mm.
Station 12	July 22	5–0 fathoms	8 specimens	14–8 mm.
Station 14	July 24	20–0 fathoms	3 specimens	12–10 mm.
Station 20	July 31	7–0 fathoms	1 specimen	14 mm.
Station 42	August 24	20–0 fathoms	1 specimen	15.5 mm.

Zoarcidae.

Lycenchelys verrillii (Goode and Bean).

Station 21	60–0 fathoms	1 example	10 cm.

Merlucciidae.

Silver Hake. *Merluccius bilinearis* (Mitchill) (?).

Station 5	July 12	surface	8 specimens	4–2.5 mm.
Kittery Harbor, Me.	July 27	surface	22 specimens	4–2.5 mm.
Orr's Island, Me.	July 30	surface	2 specimens	3 mm.
Station 44	August 31	20–0 fathoms	9 specimens	10–6 mm.

Gadidae.

Cod. *Gadus callarias* Linné.

Station 7	July 16	18–0 fathoms	29 specimens	15–4.5 mm.
Station 11	July 17	25–0 fathoms	1 specimen	8.5 mm.
Station 12	July 22	5–0 fathoms	61 specimens	19.5–8 mm.

Haddock. *Melanogrammus aeglifinus* (Linné) (?).

Station 12	July 22	5–0 fathoms	6 specimens	21–10 mm.

Hake. *Urophycis sp.*

Station 16	July 26	surface	1 specimen	84 mm.
Station 25	August 8	surface	1 specimen	70 mm.
Station 27	August 14	surface	1 specimen	67 mm.
Station 30	August 14	surface	1 specimen	41 mm.
Station 31	August 15	surface	1 specimen	102 mm.

Rockling. *Enchelyopus cimbrius* (Linné).

Station 5	July 12	surface	5 specimens	5–3 mm.
Station 11	July 17	30–0 fathoms	6 specimens	38–12 mm.
Orr's Island	July 30	surface	1 specimen	2 mm.
Casco Bay	August 4	surface	1 specimen	5.5 mm.
Station 25	August 8	surface	1 specimen	42 mm.
Station 29	August 14	surface	1 specimen	20 mm.
Station 30	August 14	surface	1 specimen	31.5 mm.
Station 41	August 24	surface	1 specimen	23 mm.
Station 42	August 24	surface	2 specimens	16.5–13.5 mm.
Station 43	August 29	35–0 fathoms	4 specimens	44–39 mm.

Enchelyopus cimbrius (Linné). (?).

Station 11	July 17	25–0 fathoms	4 specimens	11–5 mm.
Station 12	July 22	5–0 fathoms	2 specimens	5.5 mm.
Station 20	July 31	7–0 fathoms	1 specimen	5 mm.
Station 42	August 24	surface	6 specimens	10–5 mm.
Station 44	August 31	25–0 fathoms	2 specimens	8.5–5 mm.

Cusk. *Brosme brosme* (Müller) (?).

Station 12	July 22	5–0 fathoms	1 specimen	13.8 mm.

Pleuronectidae.

Sanddab. *Hippoglossoides platessoides* (Fabricius).

Station 11	July 17	25–0 fathoms	24 specimens	22.5–10 mm.
Gloucester Harbor	July 18	surface	1 specimen	23.5 mm.
Station 21	August 2	60 fathoms	1 specimen	89 mm.

Hippoglossoides platessoides (Fabricius) (?).

Station 44	August 31	25–0 fathoms	24 specimens	9.5–6 mm.

Winter Flounder. *Pseudopleuronectes americanus* (Walbaum) (?).

Station 7	July 16	18 fathoms	1 specimen	10.5 mm.
Station 11	July 17	25–0 fathoms	1 specimen	13 mm.
Station 20	July 31	7–0 fathoms	1 specimen	6.5 mm.

Witch Flounder. *Glyptocephalus cynoglossus* (Linné).

No label			2 specimens	16.5–8.5 mm.
Station 12	July 22	5–0 fathoms	1 specimen	9.5 mm.
Station 14	July 24	20 fathoms	2 specimens	16.5–8 mm.
Station 21	August 2	60 fathoms	8 specimens	108 –65 mm.
Station 30	August 14	surface	1 specimen	18.5 mm.
Station 42	August 24	20–0 fathoms	6 specimens	18–10 mm.
Station 44	August 31	25–0 fathoms	20 specimens	16.5–9 mm.

Pleuronectids unplaced.

Station 7	July 16	18 fathoms	1 specimen	7 mm.
Station 12	July 22	5–0 fathoms	15 specimens	10–6 mm.

Lophiidae.

Goosefish. *Lophius piscatorius* Linné.

Station 5	July 12	Surface	1 specimen	6.5 mm.

Adult stages taken in the trawl.

Rajidae.

Little Skate. *Raja erinacea* Mitchill.

Station 16	25 fathoms	1 specimen

Prickly Skate. *Raja radiata* Donovan.

Station 6	27 fathoms	1 specimen
Station 8	22 fathoms	12 specimens

Scorpaenidae.

Redfish. *Sebastes marinus* (Linné).

Station 1	33 fathoms	1 specimen
Station 6	27 fathoms	14 specimens
Station 13	30 fathoms	1 specimen
Station 15	30 fathoms	2 specimens
Station 16	25 fathoms	6 specimens
Station 19	50 fathoms	1 specimen
Station 21	60 fathoms	7 specimens
Station 23	47 fathoms	5 specimens

Cottidae.

Triglops pingelii Reinhardt.

Station 1	33 fathoms	1 specimen
Station 6	27 fathoms	1 specimen

Sculpin. *Myoxocephalus octodecimspinosus* (Mitchill).

Station 1	33 fathoms	1 specimen
Station 6	27 fathoms	5 specimens
Station 17	16 fathoms	1 specimen
Station 19	50 fathoms	2 specimens

Sea Sculpin. *Hemitripterus americanus* (Gmelin).

Station 15	30 fathoms	1 specimen
Station 21	60 fathoms	1 specimen

Agonidae.

Alligator Fish. *Aspidophoroides monopterygius* (Bloch).

Station 1	33 fathoms	8 specimens
Station 6	27 fathoms	9 specimens
Station 8	22 fathoms	2 specimens
Station 15	30 fathoms	1 specimen

Blenniidae.

Ulvaria subbifurcata (Storer).

Station 6	27 fathoms	1 specimen
Station 16	25 fathoms	1 specimen

ZOARCIDAE.

Eelpout. *Zoarces anguillaris* (Peck).

Station 6	27 fathoms	3 specimens
Station 8	22 fathoms	4 specimens
Station 15	30 fathoms	7 specimens

MERLUCCIIDAE.

Silver Hake. *Merluccius bilinearis* (Mitchill).

Station 1	33 fathoms	1 specimen
Station 8	22 fathoms	20 specimens
Station 15	30 fathoms	2 specimens
Station 16	25 fathoms	1 specimen
Station 21	60 fathoms	9 specimens

GADIDAE.

Cod. *Gadus callarius* Linné.

Station 1	33 fathoms	1 specimen
Station 6	27 fathoms	2 specimens

Haddock. *Melanogrammus aeglifinus* (Linné).

Station 15	30 fathoms	1 specimen
Station 16	25 fathoms	1 specimen

Spotted Hake. *Urophycis regius* (Walbaum).

Station 8	22 fathoms	2 specimens
Station 17	11 fathoms	3 specimens
Station 21	60 fathoms	1 specimen

Squirrel Hake. *Urophycis chus* (Walbaum).

Station 8	22 fathoms	34 specimens
Station 13	30 fathoms	2 specimens
Station 15	30 fathoms	4 specimens
Station 16	25 fathoms	1 specimen
Station 21	60 fathoms	2 specimens

Rockling. *Enchelyopus cimbrius* (Linné).

Station 1	33 fathoms	1 specimen
Station 8	22 fathoms	2 specimens
Station 15	30 fathoms	1 specimen
Station 16	25 fathoms	2 specimens

Pleuronectidae.

Sanddab. *Hippoglossoides platessoides* (Fabricius).

Station 6	27 fathoms	7 specimens
Station 8	22 fathoms	41 specimens
Station 13	30 fathoms	2 specimens
Station 15	30 fathoms	3 specimens
Station 16	25 fathoms	2 specimens
Station 21	60 fathoms	3 specimens

Rusty Flounder. *Limanda ferruginea* (Storer).

Station 6	27 fathoms	3 specimens
Station 8	22 fathoms	6 specimens
Station 15	30 fathoms	1 specimen

Winter Flounder. *Pseudopleuronectes americanus* (Walbaum)

Station 17	11 fathoms	6 specimens

Witch Flounder. *Glyptocephalus cynoglossus* (Linné).

Station 1	33 fathoms	1 specimen
Station 6	27 fathoms	1 specimen
Station 8	22 fathoms	48 specimens
Station 16	25 fathoms	1 specimen
Station 21	60 fathoms	1 specimen

Lophiidae.

Goosefish. *Lophius piscatorius* Linné.

Station 8	22 fathoms	7 specimens
Station 15	30 fathoms	2 specimens
Station 21	60 fathoms	3 specimens

List of copepods.

(Identified by C. O. Esterly).

Stations →	2	4	5	6	7	11	12	14	15	16	19	19	20
Depths →	60-0	15-0	0	27-0	75-0	25-0	40-0	20-0	15-0	15-0	25	25-0	7-0
Calanus finmarchicus	×	×	×	×	1000	1000	×	×	×	50	100	50	40
Calanus hyperboreus	....	....	....	....	....	....	....	....	....	....	....	....	....
Pseudocalanus elongatus	....	....	....	×	....	1	....	....	....	1	3	3	3
Paracalanus parvus	....	....	....	....	....	....	....	....	....	....	....	....	....
Euchirella rostrata	....	....	....	....	....	....	....	....	....	....	....	....	....
Euchaeta norvegica	....	....	....	....	1	....	×	....	....	....	....	....	....
Centropages hamatus	....	....	....	....	....	....	....	....	....	1	....	....	....
Centropages typicus	....	....	....	....	....	....	....	....	....	....	1	....	1
Temora longicornis	....	....	....	....	....	....	....	....	....	1	....	....	1
Eurytemora herdmani	....	....	....	×	....	....	....	....	....	1	....	....	....
Metridia lucens	....	....	....	×	....	100	....	....	....	....	....	....	....
Anomalocera patersoni	....	....	....	....	....	....	×	....	....	....	....	....	....
Acartia clausi	....	....	....	....	....	....	....	....	....	....	....	....	....
Acartia longiremis	....	....	....	....	....	....	....	....	....	....	....	....	2
Tortanus discaudatus	....	....	....	....	....	....	....	....	....	....	....	....	....
Corynura discaudatus	....	....	....	....	....	....	....	....	....	....	....	....	1

Stations →	21	22	23	24	25	25	26	26b	27	27	27	28	29
Depths →	10-0	30-0	20-0	0	30-0	20-0	0	0	0	80-0	35-0	25-0	20-0
Calanus finmarchicus	×	×	1000	×	100	20	×	×	×	500	500	×	×
Calanus hyperboreus	....	....	6	....	....	....	....	....	....	....	....	....	....
Pseudocalanus elongatus	....	....	....	....	....	1	....	....	....	....	....	....	....
Paracalanus parvus	....	....	....	....	....	....	....	....	....	....	....	....	....
Euchirella rostrata	....	....	....	....	....	....	....	....	....	....	....	....	....
Euchaeta norvegica	....	....	4	....	....	..	....	....	....	2	10	....	....
Centropages hamatus	....	....	....	....	....	....	....	....	....	....	....	....	....
Centropages typicus	....	....	....	....	....	....	....	×	....	....	....	....	....
Temora longicornis	....	....	....	....	....	....	....	×	....	....	....	....	....
Eurytemora herdmani	....	....	....	....	....	....	....	....	....	....	....	....	....
Metridia lucens	....	....	....	....	5	1	....	....	....	2	....	....	....
Anomalocera patersoni	....	....	....	×	....	....	....	×	....	....	1	....	....
Acartia clausi	....	....	....	....	....	....	....	....	....	....	....	....	....
Acartia longiremis	....	....	....	....	....	....	....	....	....	....	....	....	....
Tortanus discaudatus	....	....	....	....	....	....	....	....	....	....	....	....	....
Corynura discaudatus	....	....	....	....	....	....	....	....	....	....	....	....	....

STATIONS →	30	31	32	35	36	37	38	39	40	40	41	41	42
DEPTHS →	0	55-0	0	40-0	75-0	15-0	40-0	75-0	0	25-0	0	20-0	0
Calanus finmarchicus	×	50	×	×	×	×	100	×	×	50	40	50	100
Calanus hyperboreus	....	....	....	....	....	....	....	....	....	1	....	....	....
Pseudocalanus elongatus	....	....	....	....	....	....	1	....	....	1	....	....	....
Paracalanus parvus	....	....	....	....	....	....	....	....	....	....	....	....	....
Euchirella rostrata	....	1	....	....	....	....	....	....	....	2	....	....	....
Euchaeta norvegica	....	×	×	....	×	....	....	....	....	....	....	....	....
Centropages hamatus	....	....	....	....	....	....	....	....	....	....	....	....	....
Centropages typicus	....	....	×	....	....	....	....	....	....	1	30	1	60
Temora longicornis	....	....	....	....	....	....	....	....	....	....	....	....	....
Eurytemora herdmani	....	....	....	....	....	....	....	....	....	....	....	....	....
Metridia lucens	×	4	×	....	....	....	1	....	....	....	....	....	....
Anomalocera patersoni	×	....	×	....	....	×	....	....	×	....	×	....	12
Acartia clausi	....	....	....	....	....	....	....	....	....	....	....	....	....
Acartia longiremis	....	....	....	....	....	....	....	....	....	....	....	....	....
Tortanus discaudatus	....	....	....	....	....	....	....	....	....	....	....	....	....
Corynura discaudatus	....	....	....	....	....	....	....	....	....	....	....	....	....

STATIONS →	42	43	43	44	44	Gloucester	Rockport	Kittery	Portland	A.	B.	C.
DEPTHS →	15-0	35-0	85-60	0	20-0					8	0	10
Calanus finmarchicus	×	2000	1	1	50	×	20	×	×	50	300	5
Calanus hyperboreus	....	....	....	....	....	....	....	....	....	....	....	....
Pseudocalanus elongatus	....	....	....	....	....	×	20	×	....	1	10	500
Paracalanus parvus	....	....	....	....	....	×	....	....	....	..	....	....
Euchirella rostrata	....	....	....	....	....	....	....	....	....	....	....	....
Euchaeta norvegica	....	1	1	....	....	....	....	....	....	....	....	....
Centropages hamatus	....	....	....	....	....	....	....	....	....	1	....	....
Centropages typicus	....	....	....	1	....	....	....	....	....	3	1	10
Temora longicornis	....	....	....	....	....	....	....	....	×	1	....	1
Eurytemora herdmani	....	....	....	....	....	×	1	×	....	....	....	....
Metridia lucens	....	....	....	....	1	....	....	....	....	....	....	1
Anomalocera patersoni	....	....	....	....	....	....	....	....	....	....	....	....
Acartia clausi	....	....	....	....	....	×	....	....	....	....	....	....
Acartia longiremis	....	....	....	....	....	×	....	....	....	1	....	....
Tortanus discaudatus	....	....	....	....	....	....	....	....	×	....	....	....
Corynura discaudatus	....	....	....	....	....	....	....	....	×	....	....	....

The numbers indicate the proportional abundance of species in a haul, not numerical occurrence. × indicates that the species occurred: —

Station A	6 miles off Cape Porpoise	August 18	8 fathoms.
Capt. John McFarland.			
Station B	8 miles E. of Chatham	September	surface.
Capt. John McFarland.			
Station C	12 miles S. E. of Chatham	September	10 fathoms.
Capt. John McFarland.			

Distribution of the more important plankton species.

Among the objects of the exploration of the Gulf is the correlation of the distribution, seasonal and geographic, of the more important members of the plankton with the physical characters of the waters in which they live; and the determination of the factors which govern their times of reproduction, movement, and abundance. Obviously the summer work in 1912 is only the first attack on the problem; but the data acquired is valuable because salinity and temperature are known for the various captures, and can be used as the basin of future work. In the following notes, the occurrence of some of the more important animals is summarized, without any reference to earlier records for the region.

Calanus finmarchicus.— As pointed out, (p. 99) this copepod was taken at every station, including the harbors of Gloucester, Kittery, and Portland; and it greatly predominated over all others at most of the off-shore stations. The exceptions, as noted above (p. 105), and in the table (p. 115), were the surface hauls at Stations 41 and 44, which yielded nearly equal numbers of Calanus and of Centropages; the closing net haul at Station 43, in which there were about as many Euchaeta as Calanus, and Capt. McFarland's haul twelve miles S. E. of Chatham, late in September, in which Pseudocalanus outnumbered Calanus one hundred to one.

In twelve hauls the copepod constituent of the plankton was exclusively Calanus, *e. g.* in the northeastern part of Massachusetts Bay and off Cape Ann in July; and at the off-shore stations as a whole very few other copepods were found. Thus at Station 7, there were about 1,000 Calanus to one Euchaeta; at Station 23, about 1,000 *Calanus finmarchicus* to six *C. hyperboreus* to four Euchaeta; at Station 27, 500 Calanus to two Euchaeta to two Metridia; at Station 28, pure Calanus; and at Station 43, in the open net, 2,000 Calanus to one Euchaeta; *cf.* table (p. 116).

Calanus hyperboreus. This Arctic species was taken twice, at Station 23, 20–0 fathoms, six specimens, and Station 40, 20–0 fathoms, one specimen. The importance of these captures has been noted (p. 106).

Euchaeta norvegica.— This species has been detected at Stations 7, 8, 12, 23, 27, 31, 32, 36, 43, and from two miles off the Isles of Shoals, *i. e.*, Massachusetts Bay, Ipswich Bay, both arms of the deep basin, off Cape Cod, on Platts' Bank, off the Nova Scotian Coast and the coast of Maine. Thus *Euchaeta norvegica* was generally distributed over the Gulf, though of irregular occurrence. The only localities where it was abundant were at Station 36, in a haul with the open net at seventy-five fathoms, and at Station 43, where many were taken in the closing net at eighty-five to sixty fathoms, forming the bulk of the haul. As most of the hauls were taken from intermediate depths, neither the horizon from which the specimens came, nor, consequently, the precise salinity and temperature can be determined. The known salinities and temperatures are:—

Station 32	surface	temperature 57°	salinity 32.51‰.
Station 43	85–60 fathoms	temperature 42°	salinity about 33.5‰.

Euchaeta was only once taken in a surface haul (Station 32), and the fact that it was most abundant in deep hauls agrees with its occurrence in the Norwegian Sea.

Anomalocera patersoni. — This copepod was taken at Stations 13, 24, 26b, 27, 30, 37, 40, 41, 42, being thus generally distributed over the western side of the Gulf, in Frenchman's Bay, and on German Bank. But it was not taken in Massachusetts Bay, nor over the off-shore portion of the Gulf as a whole, its only occurrence far from land being at Station 24. It was taken in surface hauls, never in the closing net, only once (Station 37) in the open net from intermediate depths. The temperatures at which it occurred ranged from 52°–61°, the salinity from 31‰ to 32.7‰. The fact that it was a purely surface form makes it probable that it was more widely distributed than our records show, for comparatively few hauls were made at the surface with the large net. But it was conspicuously absent from the surface hauls made at Stations 27, 28, 29, 31, 32, a fact showing that it is not brought to the Gulf by the indraught of oceanic water which is noticeable over the region covered by these stations.

Meganyctiphanes norvegica.— The following notes are based only on the occurrence of large adults of unmistakable identity; probably the list of localities will be largely augmented by identification of the large series of young schizopods. Thus restricted, Meganyctiphanes was taken at Stations 3, 7, 19, 25, 26a, 27, 32, in Eastport Harbor, and two miles southeast of Duck Island, Mt. Desert: *i. e.*, Massachusetts Bay, the coast of Maine, Jeffrey's Bank, the region off Casco Bay, and both sides of the deep basin. The oceanographic data of the captures is as follows:—

Station 25	surface	temperature 56°	salinity 32.34‰
Eastport Harbor	surface	temperature 50°	salinity about 32.5‰
Station 27	closing net 40 fathoms	temperature 45°	salinity about 33.6‰
Station 32	surface	temperature 57°	salinity 32.51‰
Station 26a	surface	temperature 57°	salinity about 31.4‰
Off Duck Island	surface	temperature 56°	salinity about 32.3‰

Euthemisto compressa (Plate 5).— This common boreal amphipod occurred at twelve stations, so distributed as to show that it occurs generally over the Gulf. In Massachusetts Bay it was taken once (Station 44), and the records cover Platt's Bank (Station 23), Jeffrey's Bank (Station 25), off Cape Cod (Station 43), off Cape Elizabeth (Stations 19, 22, 26b), off Seguin Island (Station 40), off Mt. Desert Rock (Station 32), the Eastern Deep Basin, both off shore and near shore (Stations 27, 36), and the neighborhood of Lurcher Shoal (Station 31). It was not taken in the closing net, and the only two captures for which the horizon is known give the following data:—

Station 27	surface	temperature 59°	salinity 32.6‰
Station 32	surface	temperature 57°	salinity 32.5‰

The other captures are from open hauls from intermediate depths. The largest number were taken at Station 32, surface; Station 31, at 55–0 fathoms; and Station 43, 35–0 fathoms. It was not found on German Bank (Stations 29, 30).

Clione limacina (Plate 5).— Apparently this large and striking species is not abundant anywhere in the Gulf, at least in summer, though it occurs in dense swarms in the Labrador Current and between Norway and Spitzbergen. Although it was taken at nine stations, Nos. 2, 6, 7, 11, 14, 19, 22, 25, 32, *i. e.*, in Massachusetts Bay, off Cape Ann, between Jeffrey's Ledge and the coast, off Casco Bay, over Jeffrey's Bank and off Mt. Desert Rock, the total number of specimens was only sixteen, the most at any station, three; and it is such a conspicuous object in the tow, that it is not likely that any were overlooked. These stations are all near shore, the furthest out being only some twenty miles from land; and so many off-shore hauls were made (*e. g.*, Stations 23, 24, 27, 28, 29, 30, 31) that its absence from the more nearly oceanic part of the Gulf can hardly be laid to an accidental failure to capture specimens. It was not found in the northeastern part of the Gulf, nor in the Grand Manan Channel (Stations 33, 34, 35, 36, 37); but its absence from the latter is probably associated with the general poverty of the zoöplankton in that region. It was taken three times in the closing net, at 30 fathoms (Stations 22, 25), and 20 fathoms (Station 19), and once on the surface (Station 32). Probably it would have been found oftener at the latter horizon had we made more surface hauls near shore, especially at night. But as it happened, most of the night hauls were made far off shore, where Clione was not found. The hauls afford the following data on temperature and salinity:—

Station 2	30 fathoms	temperature 41.5°	salinity 32.6‰.
Station 19	20 fathoms	temperature about 47°	salinity about 32.5‰.
Station 22	30 fathoms	temperature about 46.5°	salinity about 32.6‰.
Station 25	30 fathoms	temperature about 48.5°	salinity about 32.9‰.
Station 32	surface	temperature 57°	salinity 32.5‰.

The salinity ranges from 32.5–32.9‰, the temperature from 41.5° to 57°; and at all other stations where Clione was taken, the nets, in their course, passed through waters with physical characters lying within these limits. In the Gulf, adult Clione occurs over a wide range of salinity and temperature, in water fully 10° warmer than the Labrador Current. But our collections throw no light on the conditions under which it reproduces.

Limacina balea (Plate 5).— The occurrence of this pteropod was even more circumscribed than that of *Clione limacina*. It was taken at Stations 19, 22, 23, 24, 25, 30, 40, *i. e.*, in two general regions, first in the northwest corner of the Gulf, off Casco Bay and over the deep trench beyond Platt's Bank and Jeffrey's Bank, and second, on German Bank. The known salinities and temperatures of the captures are:—

Station 19	25 fathoms	closing-net	temperature 47°	salinity 32.5‰
Station 25	30 fathoms	closing net	temperature about 48°	salinity 32.9‰
Station 30	surface		temperature about 52°	salinity 32.7‰

Thus it was inhabiting rather warmer water than Clione (47°–52° as against 41°–57°), but of about the same salinity; and the capture at Station 30, on the surface, is particularly interesting, because *Salpa fusiformis* was likewise taken at that Station. The other captures of Limacina were in open nets from 20–30 fathoms. Unlike Clione, the specimens were of various ages; a swarm of small ones being taken at Station 19, the largest at the last Station at which it occurred, *i. e.*, 40. This suggests that its chief period of growth is July and August in the Gulf.

Salpae (Plate 5).— Salpae were observed over only a small area, from Station 30 to Station 31; several *S. fusiformis* being taken at each Station, and others seen floating on the surface. But a large haul of *S. mucronata* was made twenty-five miles off Chatham, on the surface, September 30, by Capt. John McFarland of the fishing schooner VICTOR. The geographic importance of these hauls has been noted (p. 107).

Tomopteris helgolandiea. This is the only species of the genus encountered, and was taken at Stations 11, 14, 30, 32, 40, 42, and 44, *i. e.*, in Massachusetts Bay, north of Cape Ann, off Cape Porpoise, off Mt. Desert, on German Bank, off Seguin, and once in the Kennebec River. It was not taken in any of the off-shore hauls. The known salinities and temperatures are:—

Station 30	surface	temperature 52°	salinity 32.7‰
Station 32	surface	temperature 57°	salinity 32.5‰

The other captures were in open nets from considerable depths (20–60 fathoms).

Chaetognaths.— Sagittae were taken in greater or less numbers at almost every station. But the determination of most of the species of this genus is so difficult that only four, *Sagitta serratodentata*, *S. elegans*, *S. lyra*, and *Eukrohnia hamata* have been selected, as being so easily recognized that the records can be depended upon. And the identifications of these have been verified by Mr. E. L. Michael. *Sagitta serratodentata*, especially, is a useful index-species, because the serrate margins of its jaws separate it from all its allies. Among the Sagittae in the GRAMPUS collection it is likewise readily identified by its stiff, slender body, and very large spermaries.

Sagitta serratodentata (Plate 5) was taken at Stations 19, 21, 22, 23, 25, 27, 28, 30, 31, 32, 33, 36, 38, 40, 41, 44, but not in any of the bays or harbors, or in the Grand Manan Channel. The list of stations shows that it occurred very generally over the Gulf, *i. e.*, in Massachusetts Bay, off Portland, on Platt's and Jeffrey's Banks, over the Eastern Basin, on German Bank, and off the coast of Maine. But the table of specimens taken at each station shows that the only ones at which more than five were taken were no. 25, 28, 30, 31, 32, and 36. Only one specimen was taken in Massachusetts Bay, one off Boon Island (Station 41), one off Monhegan (Station 21), and two each at Stations 19, 22, and 40. Evidently, then, its centre of abundance was off shore. It was not common anywhere near shore. The known salinities and temperatures of the captures are:—

Station 25	30 fathoms	closing net	temperature about 48°	salinity 32.9‰
Station 27	30 fathoms	closing net	temperature 46°	salinity 33.3‰
Station 30	surface		temperature 52°	salinity 32.7‰
Station 32	surface		temperature 57°	salinity 32.5‰

The other captures were in open nets. The largest hauls were at Stations 31 and 32, where swarms were taken.

Comparison between the occurrence of *S. serratodentata* and *S. elegans* shows an interesting difference in quantitative distribution. The latter was taken at even more stations than the former, very generally over the whole area, including bays and harbors. It occurred in great numbers at Stations 2 and 7, where no *serratodentata* were taken, and also at Station 44, where we captured only one *serratodentata*. Swarms of *S. elegans* were also encountered at Stations 12 and 14, where *serratodentata* was absent. At Stations 19, 20, 25, 27, 33, 38, 40, 44, it was numerous, from 10 to 30 or more specimens being taken at each, where *serratodentata* was represented by only a few specimens; and at Station 30 we encountered a swarm. On the other hand, at Stations 28, 31, 32, where we met swarms of *serratodentata*, they far outnumbered the *elegans*, as shown in the accompanying table.

	Number of specimens	
Station	*S. elegans*	*S. serratodentata*
2	25	0
6	2	0
7	swarm	0
11	4	0
12	swarm	0
14	20	0
19	15	2
20	30	0

	Number of specimens	
Station	*S. elegans*	*S. serratodentata*
21	0	1
22	2	2
23	1	2
25	23	8
27	15	5
28	6	25
30	swarm	12
31	2	64
32	20	swarm
33	50	4
35	3	0
36	30	15
38	swarm	2
40	10	2
41	0	1
43	3	0
44	25	1

The stations at which *S. elegans* was most abundant (Plate 5) were 2, 7, 12, 14, 19, 20, 25, 27, 30, 32, 33, 36, 38, 44. Most of these stations are near shore; the only one which is not, Station 7, is within the influence of coast water, as described above (p. 91), and the same is true of Station 25. At Station 43, however, but few were taken, and salinity shows that this is not coast water. So far as last summer's work shows, *elegans* is neritic in the Gulf; *serratodentata* oceanic. But there is, of course, no sharp line between the two.

Two other chaetognaths may be mentioned here, because of their geographic importance: — *Sagitta lyra*, taken once, two specimens, Station 31, 55–0 fathoms, and *Eukrohnia hamata*, likewise taken only once, in the same haul, about twenty specimens. This species is discussed (p. 106).

Medusae.— There are several Medusae of importance in the present connection. Chief among them, because so often called an Arctic form, is *Staurophora mertensii;* but as pointed out (p. 106) this species is not an index of polar water, for it is known from Helgoland. Large Staurophora (Plate 6) were seen, and taken, at Stations 14, 15, 19, 22, 23, 25, 26, 26b, 31, 33, 34, 36, 40, 41, 42, 43, in the Grand Manan Channel, and at Eastport; showing that it was very generally distributed over the Gulf, with the notable exceptions that it was not met with in Massachusetts Bay, at the off-shore Stations (27, 28), in the Eastern Basin nor on German Bank (Stations 29, 30). Its absence off shore is not surprising, because it is undoubtedly neritic; but its absence from Massachusetts Bay is less easily explained, because it is often very abundant there in May and June. The known salinity at which it was taken ranges from 32.5‰ to 32.7‰, the known temperature from 50°–64°, all being surface records. But most of the actual specimens taken came from intermediate hauls with open nets; and this was notably so at Stations 14, 15, 19, 25, 36, 41, and 43, where none were taken or seen on the surface. And the Staurophorae seen floating were usually from $\frac{1}{2}$ to 2 fathoms down, seldom on the actual surface as Aurelia so often is. None were taken in closing nets. Our records do not suggest that Staurophora is restricted to cold waters; but probably the young stages are more sensitive to temperature.

Aurelia and Cyanea (Plate 6) can be considered together, as the Gulf of Maine, unlike the Norwegian Sea, has only one species, or variety, of Cyanea, which is not a migrant from elsewhere, but a permanent inhabitant, breeding and going through its young stages here. As might have been expected, both these Medusae were most numerous near shore, Aurelia particularly so in the bays and harbors; and they are so large and conspicuous that they are easily seen on the surface, even if not taken in the net.

In Massachusetts Bay, early in July, we saw many Aurelia, though, as it chanced, no Cyanea; but on our return thither at the end of August, both genera were seen floating on the surface at various spots between Gloucester and Provincetown. During our work along the coast between Cape Ann and Portland, the two genera were frequently recorded, both in the nets and on the surface, both of them being generally distributed in the coast waters in this region. But on the run to Platt's Bank we left them behind at about Lat. 43° 15′, long. 69° 50′, and saw and took neither of them on the course thence to Jeffrey's Bank (Station 25) or until approaching the mouth of Penobscot Bay, where (Station 26) both species once more appeared on the surface. Similarly on the run from Cape Elizabeth toward Nova Scotia the last Aurelia was seen at about 69° long. 43° 30′ lat., and neither genus was found until we approached the coast again between Mt. Desert and Grand Manan. In the Grand Manan Channel, at Eastport, and during the run westward along the coast, both were seen frequently, except at Stations 38 and 39. But neither species was encountered anywhere in as great abundance as they are often seen, except off Cape Cod, on August 29, when Aurelias were passed in swarms. The greatest number of Cyaneas were at Station 14 and in Penobscot Bay (Station 21a).

As Damas has pointed out (Helland Hansen and Nansen; 1909, pt. 1, p. 101) Cyanea is one of the most important index-species of the larger plankton, because its attached stage lives in shallow water; consequently wherever Cyaneas are found off shore, it shows that there is a considerable admixture of coast water, and the same is true of Aurelia. Our data is important as showing that neither of them is general over the Gulf; both seem, if not absolutely, at least chiefly limited to a rather narrow coast-band all around the Gulf, even more so than Staurophora. And this fact suggests that there is comparatively little mixing of offshore and coast water in August. In early July as pointed out (p. 62), there is a pronounced fresh tongue off Cape Ann; but this flow of coast water probably reaches its maximum in June, when the Aurelias and Cyaneas are still very small, or perhaps even before they are set free.

Phialidium languidum affords another example of the distribution of a neritic species. It was taken at Stations 22, 24, 25, 31, 32, 38, 40, 41, 42, 43, and in all the harbors and bays, especially Kittery, Winter Harbor and the Kennebec River; and also near Gloucester. These records show that it was found further off shore than either Aurelia or Cyanea, *i. e.*, near Platt's Bank (Station 24) and on Jeffrey's Bank (Station 25). But we did not find it on our run across the Eastern Basin toward Nova Scotia, nor on German Bank; meeting it again at Station 31 and 32, but not at Station 36. It swarmed at Station 32 and Station 40, on the surface, the salinity and temperature being:—

Station 32	surface	temperature 57°	salinity 32.5‰
Station 40	surface	temperature 58°	salinity about 32‰

It was abundant in the harbors with lower salinity.

Much more strictly confined to the coast water is the medusa *Melicertum campanula*, which attains sexual maturity at just the time of our cruise. Great swarms were met with in Kittery Harbor, July 12 and 23, many in Gloucester and in Rockport Harbor, July 9–12; but the only outside stations at which it was taken were Nos. 4, 8, 12, 14, 22, none of them over ten miles from land. In past years, likewise, I found it very common in Penobscot Bay and at Grand Manan: but all its records in the Gulf are close to shore.

Siphonophores.— Only two species of siphonophores, *Agalma elegans* and *Physophora hydrostatica*, were taken on the cruise; but their few occurrences are worth special notice because they are typical oceanic organisms, and both belong to the warm waters of the North Atlantic, though both are carried to Norwegian waters by the Gulf Stream.

Physophora was taken at Station 30, on the surface, two specimens. Agalma was more generally distributed, being captured at Stations 7, 27, 28, 32, 39, a total of eight very fragmentary specimens. Unfortunately, most of them have all the organs stripped off the stem, not a tentillum being intact; and as the latter organs are the chief generic character, identification is not beyond dispute. But the general form of the few bracts which remain attached, and of the bells taken in the same hauls, suggests identity with *Agalma elegans* rather than with its close ally, Stephanomia. The records are all from the off-shore part of the Gulf.

Ctenophores.— Two ctenophores were taken and seen frequently, *Pleurobrachia pileus* and *Bolinopsis septentrionalis*, neither of which was generally distributed over the Gulf, though both were taken at many localities.

Pleurobrachia (Plate 6) was found at Stations 23, 27, 29, 30, 31, 32, 40, 43: in the Kennebec River and off the Grand Manan Bank: several times, notably at Station 40, in great abundance. That is to say, during July and August it was wholly absent from Massachusetts Bay, and from the coast waters between Cape Ann and Casco Bay; but was of general occurrence in the northeastern part of the Gulf, over German Bank, and the Eastern Basin, as well as off Cape Cod (Station 43). Swarms were encountered at Stations 30, 31, and 40; the salinities and temperatures being:—

Station 30	surface	temperature 52°	salinity about 32.7‰
Station 31	surface	temperature 56°	salinity about 32.8‰
Station 40	surface	temperature 58°	salinity about 32‰

The salinity was not taken at Station 40, but is estimated from the records of neighboring stations. At Station 40, the swarm consisted of small individuals; at Stations 30 and 31, of large and small; and it is interesting to observe that the swarm at Station 40 was in water with very little microplankton (p. 133) while a few miles to the east, where there was an abundant microplankton, we found no Pleurobrachia.

Bolinopsis infundibulum (Plate 6) was taken (or seen floating on the surface) at Stations 4, 6, 9, 11, 22, 25, 34, and 43, *i. e.*, in Massachusetts Bay, the coastal waters north of Cape Ann, Jeffrey's Bank, the Grand Manan Channel, and off Cape Cod; but it was apparently absent at all the off-shore stations, at Platt's Bank and on German Bank: nor was it abundant anywhere. A third genus, Beroe, was likewise seen often; and all the specimens taken belong to the cosmopolitan species *B. cucumis*, often recorded before from the Gulf.

Results of the quantitative hauls.

(Plate 7).

In using the Hensen net for quantitative hauls we were most seriously handicapped by working from a sailing vessel, because hauls of this sort are significant only if the vessel is practically motionless when they are taken; and it was impossible to hold the vessel motionless with the auxiliary engine in a breeze. Consequently we could carry on this line of work only at the stations which were occupied in calm weather. Small nets might have been hauled by hand from the dory at anchor; but this was not practicable with the large apparatus with which we were provided. The qualitative composition of the catches made with the Hensen net shows that they did not afford a fair estimate of the plankton even under favorable circumstances, because they seldom yielded any Sagittae; organisms which are plentifully represented in the four-foot net hauls. The trouble was, probably, that the nets were hauled too slowly, our hoisting engine reeling in at a rate of only about ten fathoms (about eighteen meters) per minute, which allowed the more active animals to escape. But the copepods, which usually form the bulk of the plankton of the Gulf, are more fairly represented. These shortcomings make it out of the question to draw any exact conclusion from the hauls. But they serve to show, in a general way, the relative richness of the plankton over different parts of the region. The four-foot net hauls, too, help very materially, by supplementing the few quantitative hauls; and although I recognize that the various four-foot net hauls are not directly comparable with one another, because rate of towing, etc. is never exactly the same at any two stations, and because the level at which the major part of the haul was made, with the open nets, might, or might not coincide with the zone richest in plankton, yet they do show, in a general way, whether the water was very rich, barren, or intermediate. And the fact that the results agree fairly well with those of the Hensen nets gives them a greater value than they could be credited with if unsupported by this more exact, though less extensive evidence. The four-foot hauls were made as nearly comparable as possible, by being of the same duration (with few exceptions $\frac{1}{2}$ hour); and by being made with the vessel travelling at such a speed that the wire rope made an angle of about 60°, the same weight (seventy pounds) being invariably used. The catch was placed in jars, killed with formalin, and allowed to settle, usually over night, and then measured for bulk. The Hensen net hauls were preserved entire in formalin, and measured for bulk at Cambridge, being allowed to settle before measurement, until no further visible shrinkage took place. The data of the quantitative hauls are:—

Station	Vol. c. c.	Relative no. of copepods
2	25	239
4	5	104
7	6.5	471
8	5±	
11	2	30
15	1	11
21	1	
22	3	97
25	8	125
28	3	25
31	3	20
35	only a trace	trace
36	3	50
38	2	24
43	1.5	15

To obtain the number of copepods, the mass was diluted to 150 cc., well mixed, and while the plankton was in suspension, three cc. taken, by a pipette and counted: most of them were tried twice and the results averaged. The total number of copepods in each haul is not given, but can be easily obtained by a simple calculation. Most of them are *Calanus finmarchicus*.

The volumes of the four-foot qualitative hauls (omitting the surface hauls made with this net), in hundreds of cubic centimetres, are: —

Station	Volume	Station	Volume
4	19	25	3
6	19	27	4.7
7	9.5	28	8
8	9.5	29	2.5
11	4.7	31	3
12	9.5	33	less than 1

Station	Volume	Station	Volume
14	20	34	trace
15	very small	35	trace
16	" "	36	7
19	4.7	38	2
20	4.7	40	3.5
21	(less than 2)	42	13
22	9.5	43	4.5
23	19	44	4.5

When analyzed, the foregoing tables, which in general bear each other out, show that we may separate the catches into three classes, rich, fair, and poor. The first, which I limit arbitrarily to stations where the volume of the quantitative catch was three or more cubic centimetres, and the number of copepods ninety or more in every three cc. when diluted to 150 cc. with water, includes Stations 2, 4, 7, 8, 22, and 25; the second, with quantitative hauls of one to three cc., and ten to ninety copepods, Stations 11, 15, 25, 28, 31, 36, 38, 43; the third, with quantitative haul less than one cc. in bulk, and less than fifteen copepods, Station 35. These classes agree fairly well with the volumes of the qualitative (four-foot net) hauls, as is shown by the following table, the stations in italics being the ones at which quantitative hauls were made.

1	2	3
Qualitative 800 cc. or more Quantitative 3 cc. or more with 90 or more copepods	Qualitative 200–800 Quantitative 1–3 copepods 10–90	Qualitative below 200 Quantitative less than 1 copepods, fewer than 10
2	*11*	16
4	*15*	*21* [1]
6	19	33
7	20	34
8	27	*35*
12	*28* [1]	
14	29	
22	*31*	
23	*36*	
25	*38*	
28	40	
32	*43*	
42		

[1] Station 28 is on the line between 1 and 2, 21 on the line between 2 and 3.

The richest zoöplankton (p. 99, 100) both in volume and in the number of copepods, was found in the northern part of Massachusetts Bay, off Cape Ann, in Ipswich Bay, over the western arm of the 100-fathom basin, off Cape Porpoise, and on Platt's Bank; the poorest, in the Grand Manan Channel, and along the northeast coast of Maine, where the water was almost barren (p. 104). In the cold fresh water along the southern coast of Maine, and in general over the northeastern part of the Gulf along the west coast of Nova Scotia the richness of the plankton was intermediate, column 2 in preceding table. Along shore from Casco Bay to Penobscot Bay it was poor on our first visit early in August, but with a rich diatom plankton; and on our return, this type of plankton was found from Petit Manan to Penobscot Bay; but off the Penobscot and the Kennebec Rivers there were more copepods, enough to bring the hauls into column 2.

Microplankton.

The microplankton will be the subject of a special report, consequently no attempt is made here to identify all the species. But its character varies so much at the different stations, and proves so characteristic of different regions, that the following notes are pertinent.

An examination of the hauls with the no. 20 net, made at Stations 1, 6, 7, 8, 9, 12, 12a, 13, 16, 17, 19, 21, 21a, 22, 23, 24, 25, 26, 26a, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, as well as at various localities in Casco Bay, shows that the microplankton was of two principal types, one consisting chiefly of the peridinian, *Ceratium tripos*, the other of various diatoms, mainly species of Chaetoceras and Rhizosolenia. The diatom plankton usually contains a few Ceratium; and at several localities the two types are mixed together. Quantitatively, too, as well as qualitatively, there is much variation between the hauls made in different parts of the Gulf (Plate 8) though our brief period of work throws no light on seasonal fluctuations.

At our first few stations, in the northern half of Massachusetts Bay and in the neighborhood of Cape Ann, the microplankton proved to be very scanty in amount, consisting of a few Ceratium, an occasional Peridinium, hardly any diatoms in spite of proximity to land; but a considerable number of eggs and larvae of various Metazoa, chiefly copepods. And when we returned to Massachusetts Bay in the latter half of August, no apparent change had taken place, the hauls at

Station 44 and off Marshfield consisting of a few *Ceratium tripos*, with no diatoms at all, but a large amount of dirt and débris, and copepod eggs. It appears, then, that the water of the northern half of Massachusetts Bay, throughout July and August, was occupied by a very scanty Ceratium plankton, with very few diatoms.

North of Cape Ann the same scanty Ceratium plankton was found occupying a belt some fifteen miles broad, as far north as Cape Porpoise, both in July (Stations 9, 11, 12b, 13) and on the return, late in August (Station 41). But in Ipswich Bay, just north of Cape Ann, close to land (Station 8), the plankton, though equally scanty, was mixed, containing a considerable number of diatoms, especially various species of Chaetoceras, and *Asterionella japonica*, which gives it a character quite distinct from that of Massachusetts Bay, or from the neighboring stations further off shore.

No station was occupied immediately abreast of Cape Ann on the voyage north; but on the return, August 24, we made a haul some four miles off the Cape (Station 42), finding an almost pure Ceratium plankton, with very few diatoms. But though qualitatively this agreed with Massachusetts Bay, it was considerably richer quantitatively, than at any of the stations immediately north or south of the Cape. This was likewise true of our hauls over the western arm of the deep basin in early July (Station 7), and off Cape Cod at the end of August (Station 43). At both of these, *Ceratium tripos* was the prevailing organism; and with it were large numbers of Peridinium, but no Chaetoceras or Asterionella. Inasmuch as the samples taken at the two stations are hardly distinguishable from each other, either qualitatively or quantitatively, it is fair to assume that they represent the characteristic facies of the summer microplankton for the general region which they cover; one distinctly richer in mass, as well as in species, than that found in Massachusetts Bay; but with the same organism, *Ceratium tripos*, occupying the leading position, and with equally few diatoms.

The Ceratium plankton reached its maximum density over a roughly oval area southwest of Cape Elizabeth (Plate 8), which we traversed twice, (Stations 19, 22, 23, 26b) with an interval of seven days between our two visits. On our second visit, when running our line to Nova Scotia we were struck by the "slick" oily appearance of the water, some thirty-five miles off Cape Elizabeth; and consequently stopped the vessel for a surface tow (Station 26b). The net, when brought aboard, was distinctly reddish, and its meshes clogged with what proved to be a mass of Ceratium, with a very few Peridinium, and an occasional diatom; and this phenomenon continued for several miles.

At Stations 19, 22, 23, Ceratium was not so phenomenally plentiful; but still far more abundant than at any station further to the south; and the microplankton was almost pure *Ceratium tripos*, with an occasional Peridinium, but few, if any, diatoms; though it contained a considerable amount of copepod eggs, fish eggs, nauplii, etc., corresponding to the rich macroplankton encountered there (p. 101). Further east, on Jeffrey's Bank, the microplankton was much less abundant, but still mostly *Ceratium tripos*, with a very few diatoms, among which I noted the genus Chaetoceras, and the characteristic needle-like chains of *Nitzschia seriata*.

Along the coast from Casco Bay to the mouth of Penobscot Bay (Stations 16, 21) there were, on the other hand, very few Ceratium, but the microplankton, which was fairly rich, in contrast with a very scanty macroplankton, consisted almost wholly of diatoms, the principal forms being various species of Chaetoceras, *Thalassiosira gravida*, *Nitzschia seriata*, and *Asterionella japonica*. Over the eastern arm of the deep basin (Stations 27, 28), the pure Ceratium plankton characteristic of the waters further west gave way to a mixed plankton, rather poor quantitatively, in which Ceratium was associated with a few Peridinium and various diatoms, among them several species of Chaetoceras, and *Thalassiosira gravida*. And a similar type, but quantitatively richer, was revealed by our hauls on German Bank (Stations 29, 30), where several species of Chaetoceras, *Rhizosolenia setigera* and other species of the genus, and Thalassiothrix were especially prominent in the hauls. These two stations were within a few miles of each other, and it is therefore interesting to note that at Station 29 the plankton was far richer, both quantitatively and in species, than at Station 30; and that Ceratium played, proportionately, a greater rôle. However, the microplankton at both these stations, and over the eastern basin (Stations 27, 28) can be classed as Ceratium with a large admixture of diatoms, the latter probably of neritic origin for the most part.

At Station 31, off Lurcher Shoal, the microplankton was very scanty, consisting chiefly of minute copepods and their eggs, and nauplii; but there were a few Ceratium and diatoms, especially Chaetoceras and Asterionella, *i. e.*, it was of the mixed type. And much the same thing was encountered off Mt. Desert Rock (Station 32), but quantitatively rather richer, the two most prominent organisms being *Ceratium tripos*, and the diatom Asterionella, with a few Chaetoceras and Peridinium. As we approached the mouth of the Grand Manan Channel (Station 33), Ceratium was no longer found and the microplankton became very scanty, just as the macroplankton did (p. 104), consisting of various diatoms, chiefly Chaetoceras and Asterionella: and it grew poorer and poorer as we sailed eastward. In the Channel the microplankton was very scanty indeed, purely diatom, several species of Chaetoceras, and Asterionella being the most important forms, with a few Thalassiothrix, etc.

The poverty of the microplankton in the Channel was paralleled, to an even more extreme degree, by the macroplankton, and is one of the most interesting observations made on the trip, as the fact that herring occasionally swarm here shows that at times the plankton must be much more abundant than we found it.

On the voyage homeward Ceratium was once more met in considerable numbers at Station 36, where the haul revealed a mixed plankton of the type general over the Eastern basin. (Plate 8).

On August 21, when passing Great Duck Island, one of the small islands off Mt. Desert, the appearance of the water was noticeably "soupy" and immediately the vessel was hove to, and a surface haul made with the no. 20 net. When brought on board, the net was filled with a brown slimy mass which, on examination, proved to consist almost wholly of countless numbers of chains of *Asterionella japonica*, with a few other diatoms, particularly Chaetoceras. This phenomenon was so striking that we took frequent samples as we sailed westward, finding that the Asterionella swarm continued for some miles, though nowhere else was the mass of diatoms so dense as it was off Duck Island. At Station 38 a surface haul revealed much the same type of microplankton, but less dense, with more Chaetoceras, and a few Peridinium, but no Ceratium. During the following night, while running from Station 38 to Station 39, a surface tow, abreast of the mouth of Penobscot Bay, was made to ascertain the extent of the Asterionella swarm; this tow revealed a diatom plankton, chiefly Asterionella, very much like Station 38, but rather less in amount. But at Station 39, we had evidently passed out of this belt, for though our hauls yielded many diatoms, there were also many *Ceratium tripos; i. e.* we were once more in the region of mixed microplankton; though the water was yet visibly cloudy. This phenomenon continued as we crossed the mouth of Penobscot Bay, until suddenly, when some six miles off Seguin Island, there was a visible change and the surface water grew perfectly clear. The vessel was at once hove to, and Station 40 occupied, making a series of tows. The no.

20 net brought in very little indeed; but the coarser nets yielded great numbers of the common cosmopolitan ctenophore *Pleurobrachia pileus*, which had been previously represented only by occasional individuals; thus showing that we had run out of the diatom swarm. And a pure diatom plankton was not met again on the run from the Kennebec to Cape Ann. A haul sixteen miles S. S. W. from Seguin yielded a rather barren plankton, chiefly Ceratium, with a very few Asterionella but no Chaetoceras; and, as noted above, the same type was found at Stations 41, and 42, which, with the data of stations made in July shows that a rather sparse Ceratium plankton is the normal summer type for a belt reaching from Cape Elizabeth to Cape Ann, just as it is for Massachusetts Bay.

There was a striking difference between the plankton in Casco Bay and in Penobscot Bay. In the latter, at our only Station (21a) the water was extremely barren, there being almost no microplankton, except a few Chaetoceras. In Casco Bay (Station 16, 17, 20) on the other hand, there was an extremely rich diatom plankton, consisting almost altogether of various species of Chaetoceras and Rhizosolenia with various metazoan larvae.

At Orr's Island, on July 28, the surface water was full of Chaetoceras and a large number of the diatom Navicula; but two days later, this type of plankton had entirely disappeared, its place being taken by hosts of ophiuran plutei, copepods, and small Medusae, *e. g.* Phialidium and Sarsia, without any apparent change in the physical nature of the water.

TABLE OF STATIONS.

The depths are by soundings, in fathoms.

A = 4 ft. open net.
C = horizontal closing net.
D = No. 20 silk net.
E = Scrim net.
H = Hensen quantitative net.
T = 8 ft. Beam trawl.
Dr = Dredge.
S = Silk net, mesh 38 per inch.

Note. To agree with the Station numbers of the U. S. Bureau of Fisheries 10,000 should be added to each Station number, e. g., 10,001.

Station	Date	Time	Lat. N.	Long. W.	Depth	Nets	Depths of hauls	Depth of temperatures	Depth Current	Depth H_2O sample
1	July 9	4 P. M.	42°30′	70°34′	33	T E	33, 0	0, 33	0, 33	0, 33
2	" 10	10 A. M.	42°32′	70°23′	65	A C H	0, 30, 65–0	0, 10, 35, 60	0, 60	0, 40, 65
3	" "	P. M.	42°37′	70°22′	31	T	31	0		
4	" 11	8 A. M.	42°33′	70°33′	27	A H	15–0, 31–0	0	0, 27	
5	" 12	3 P. M.	42°32′	70°36′	27	C.	0	0, 27	0, 27	0, 27
6	" 13	11 A. M.	42°22′	70°43′	27	T A H. C	27, 0, 27–0, 15–0	0, 10, 27	0, 27	0, 27
7	" 15	4 P. M.	42°44′	69°50′	145	D A H	0, 75–0, 145–0	0, 25, 50, 75, 125	0, 145	0, 75, 125
8	" 16	8 A. M.	42°45′	70°39′	22	H A D T	22–0, 20–0, 0, 22	0, 22	0, 22	0, 22
9	" 16	12 M.	42°49′	70°28′	65	D	0	0, 50	0, 65	0, 50
10	" 16	4 P. M.	42°53′	70°41′	25	T A	25, 0	0		
11	" 17	11 A. M.	43°4′	70°20′	60	D A H	0, 30–0, 60–0	0, 15, 30, 45, 60	0, 60	0, 25, 60, 80
12	" 22	2 P. M.	42°32′	70°33′	47	D A	47–0; 47–0	0		
12b	" 23	12 M.	42°53′	70°20′	80			0, 80	0, 80	0
13	" 24	12 M.	43°16′	70°20′	30	D T	0, 30	0		
14	" 24	1 P. M.	43°19′	70°13′	25	E A	0, 20–0	0, 5, 15, 25	0, 25	0, 25
15	" 25	10 A. M.	43°37′	70°	30	T Dr. E A H.	30, 17, 0, 15–0, 20–0	0, 5, 10, 20, 30		0, 30
16	" 26	11 A. M.	43°42′	69°42′	19	Dr T E A	19, 25, 0, 15–0	0, 5, 10, 15, 20		0, 20
17	" 27	10 A. M.	43°41′	70°8′	15	T E	15, 0	0		
18	" 27	12 M.	43°41′	70°3′	20	Dr	20	0		
19	" 29	11 A. M.	43°30′	69°48′	50	T E D A C.	50, 0, 0, 20–0, 25	0, 20, 30, 40, 50	0	0, 50
20	" 31	10 A. M.	43°39′	70°7′	10	D A	0, 7–0	0		0
21	Aug. 2	3 P. M.	43°38′	69°13′	60	T A D C H	60, 10–0, 0, 20, 60–0	0, 15, 30, 45, 60	0, 60	0, 60
21a	" 3	3 P. M.	44°5′	69°1′	8	A D	8–0, 0	0		0
22	" 7	10 A. M.	43°26′	70°4′	47	A D H C.	30–0, 0, 45–0, 30.	0, 45		45
23	" 7	4 P. M.	43°10′	69°40′	47	T A D	47, 20–0, 0	0 15, 25, 35, 45	0	0, 45
24	" 7	10 P. M.	43°2′	69°19′	106	E	0	0, 105		
25	" 8	9 A. M.	43°26′	68°49′	55	D A C H	0, 30–0, 30, 50–0	0, 10, 20, 30, 40, 55	0, 55	0, 55
26	" 8	3 P. M.	43°40′	69°2′	64	D	0	0 64	0, 64	0, 64
26a	" 8	9 P. M.	43°41′	69°38′		A	0	0		
26b	" 13	4 P. M.	43°28′	69°25′		D S	0, 0	0		0
27	" 14	1 A. M.	43°26′	68°06′	100	D E A C. H.	0, 0, 80–0, 30, 90–0	0, 25, 50, 75, 100	0, 100	0, 50, 100
28	" 14	9 A. M.	43°26′	67°20′	120	A D E S	25–0, 0, 0, 0	0, 10, 20, 30, 60, 80, 100, 120	0	0, 30, 120
29	" 14	6 P. M.	43°26′	66°25′	35	A E D	20–0, 0, 0	0, 10, 20, 30, 35		0, 35
30	" 14	9 P. M.	43°18′	66°28′		A E D	0, 0, 0	0		
31	" 15	8 A. M.	43°45′	66°55′	75	A C D E H	60–0, 25–0, 0, 0, 70–0	0, 20, 40, 60, 75		0, 75
32	" 16	3 A. M.	43°56′	67°58′	88	A D	0, 0	0, 88		0, 88
33	" 16	6 P. M.	44°25′	67°30′	35	A D	15–0, 0	0, 5, 15, 25, 35		0, 35
34	" 17	4 A. M.	44°50′	66°53′	55	A D	50–0, 0	0, 10, 25, 40, 55		0, 55
35	" 19	6 P. M.	44°36′	67°11′	45	A D S H	40–0, 0, 0, 40–0	0, 10, 20, 30, 40, 45		0, 45
36	" 20	11 A. M.	44°16′	67°23′	101	A D S E	75–0, 0 0 0	0, 20, 60, 80, 100		0, 100
37	" 21	7 A. M.	44°17′	68°5′	22	A A O	22, 15–0, 0	0, 10, 20		
38	" 21	6 P. M.	43°51′	68°33′	48	A. C. H. D E S	40–0, 10–0, 40–0, 0, 0, 0	0, 20, 30, 40, 48	0, 48	0, 48
39	" 22	9 A. M.	43°37′	69°1′	80	A D	75–0, 0	0, 20, 40, 60, 80		0, 80
40	" 22	3 P. M.	43°37′	69°36′		A D S	25–0, 0, 0	0		
41	" 24	11 A. M.	43°6′	70°12′		A D S	20–0, 0, 0	0, 80		0, 80
42	" 24	9 P. M.	42°51′	70°29′		A D S	15–0, 0, 0	0		
43	" 29	12 M.	42°11′	69°53′	95	A H C D S	35–0, 90–0, 85–60, 0, 0	0, 20, 40, 60, 80, 95	0, 95	0, 40, 95
44	" 31	9 A. M.	42°9′	70°22′	30	A D S	20–0, 0, 0	0, 10, 20, 30	0	0, 30
45	" 31	1 P. M.	42°20′	70°36′				0, 20, 30, 40		0, 40
46	" 31	3 P. M.	42°30′	70°39′	30			0, 30		0, 30

TABLE OF TEMPERATURES (degrees are Fahrenheit).

Stations	1	2	3	4	5	6	7	8	9	10	11	12	12b	13	14	15	16	17	18	19	20	21	21a	22	23	24	25	26	26a	26b	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
0	64	65	66	56	61.3	61	64	61	67.5	61	59	60	57	57	57	58	57	57	57	57	55	55.5	56.3	62	61	61	56	57	57	61	59	59	50.6	52	56	57	51.1	50	51	52.5	55	55.5	56	58	61	61	60	58	61	61
5															55.2	54.5	53.6																				50.7													
10		49.2				43.3										51.4	51.4										49.2					50.7	49.7					49.7	49.6		50.9							52.7		
15											44.9				44.4		47.7					48.6			[illegible]												49.7													
20								42.4								45.5	45.4			47.3							49.2					47.7	49.4		52.7				49.6	49.2	49.8	49.9	49				50.9	45.9	47.7	
25			41.1		41.3	41.3	45.3								43.3										45.2						46						49.4	49.7												
30											41.3					44.4				45.6		46.7					48.4					45.6	49.4						49.6			48.7						44.3	44.9	44.3
35	41	40.3																							42.1								49.3				49.3													
40																				42.6							46.8								50.4			49.3				48.3	48				46.5		43.1	
45											40.3											45.5		46.3	40.8														49.5											
50							40.3		40.											42.2											46											48.3								
55																											46.2					45.3						49.2												
60		40.3									40.3											45													46.7					46.8			47				42.			
65																												45.8																						
70																																																		
75							40.3																								43.3				45.8															
80													39.4																			45.3								45.7			44.8		40.3		41.3			
85																																																		
90																																																		
95																																															41.3			
100																															42.8	45.3								45.4										
105																										40.3																								
110																																																		
115																																																		
120																																45.3																		
125							40.3																																											
Depths																																																		

TABLE OF SALINITIES.

Depths / Stations	1	2	5	6	7	8	9	11	12b	14	15	16	19	20	21	21a
0	32.07	31.74	31.67	31.96	31.62		31.44	31 92	31 92	31 08	31 26	31 20	31 92	[1]	32 43	30.61
5																
10																
15																
20						32 39						32.14				
25				32.52				32 61								
30			32.57								32.38					
35	32.65															
40		32.77														
45																
50							32.84						32 97			
55																
60								32 85							32.94	
65		32.92														
70																
75					33.49											
80								33 04								
85																
90																
95																
100																
105																
110																
115																
120																
125					33.78											

Depths / Stations	22	23	24	25	26	27	28	29	31	32	33	34	35	36	38	39	41	43	44	45	46
0		32 52	32.50	32 34		32.66	32 75	32 70	32 84	32 51	32 68		32.57	32 75	32 32		32 07	32.39	32.03	31.92	31.67
5																					
10																					
15																					
20																					
25																					
30																			32.52		32.56
35								32 92			32 68										
40																		33.15		32.89	
45	32.74	33 30											32 65								
50						33 64									32.95						
55				33 22								32.56									
60																					
65					33 13																
70																					
75									33.82												
80																33.37					
85																					
90										34 13											
95																		33.69			
100						33 89								34.31							
105			33 57																		
110																					
115																					
120							34 54														
125																					

[1] Surface sample taken at this Station was lost.

Boothbay Harbor, 7 fathoms, August 4, 31.71. Gloucester, surface, July 12, 31.8. Orr's Island, July 28, 5 fathoms, 31.7. Orr's Island, surface, 31.5. Six miles S. E. Bakers Island, surface, July 15, 32.14. Gloucester, surface, July 22, 31.7.

TABLE OF DENSITIES.

Stations / Depth	1	2	5	6	7	8	9	11	12b	14	15	16	19	20	21	21a	22	23	24	25	26	27	28	29	31	32	33	34	35	36	38	39	41	43	44	45	46
0	23.05	22.68	23.23	23.45	22.71		22.22	23.64	23.85	23.19	23.23	23.29	23.89	[1]	23.21	22.93		23.41	23.86	24.26	24.30	24.21	24.28	25.19	24.65	24.30	25.09		25.00	24.98	24.35		23.54	23.89	23.84	23.42	23.22
5																																					
10																																					
15																																					
20						25.70						25.19																									
25				25.93	25.89			25.97																													
30			26.02								25.64																								25.72		25.81
35	26.18																							25.74			25.57										
40		26.28																																26.21		26.23	
45																	25.90	26.72											25.60								
50							26.48						26.44									26.77									25.95						
55																				25.58								25.59									
60								26.43							26.40																						
65		26.52																			26.43																
70																																					
75					27.09																				27.06												
80								26.89																								26.81					
85																																					
90																										27.18											
95																																		27.45			
100																						27.55								27.69							
105																			27.49																		
110																																					
115																																					
120																							28.03														
125					27.84																																

[1] Surface sample taken at this Station was lost.

TABLE OF CURRENT MEASUREMENTS.

All bearings are magnetic.

Surface.

STATIONS	1	2	4	5	6	7	8	9	11a	11b	11c	14	19
Flow toward	E by S	S S E	E by N	N W	N N E	W	W by S	N E by E	W	N by W	N W	S W	S
Vel; cm. per sec.	10.2	12.7	20.7	11.7	21.0	20.7	14.8	1.8	13.2	3.3	17.7	24	22.1
Knot per hour	.25	.30	.5	.25	.5	.5	.37	.05	.3	.12	.45	.62	.5

STATIONS	21	23	25	26	27	28	29	31–32	35 Flood	35 Ebb	36	37	38	41	43	44
Flow toward	N E	0	N by E	N N W	S S E	E S E	S	W by S	E	S W	N W by W	0	S W	W	S E	N E
Vel; cm. per sec.	10.4	0	13.2	Trace	17.4	12.7					33	0	8.4		39.4	
Knot per hour	.25	0	.3	Trace	.45	.3	.5–1	.2–.3	1±	1±	.85	0	.2		1	.75

Bottom.

STATIONS	1	2	4	5	6	7	8	9	11a	11b	14	21	25	27	38	43
Depth fath.	33	60	27	27	27	145	22	50	60	60	25	60	55	100.	48	95
Flow toward	E by N	0	S E	S E	E	E	S E	S S E	N N W	E by N	E by S	S E	E S E	S by W	N W	N by W
Vel. cm. per sec.	10.8	0	8.7	9.7	11	7.2	7.3	7.1	3	1.5	11.8	4.8	10.3	11.6	6.4	14.
Knots per hour	.25	0	.2	.25	.25	.18	.18	.18	Trace	Trace	.28	Trace	.25	.28	.13	.37

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1875. Results of dredging expeditions off the New England coast in 1874. Amer. journ. sci., ser. 3, **9**, p. 411–415.

———

1911. United States Coast Pilot. Atlantic coast, pts. 1–3.

EXPLANATION OF PLATES.

PLATE 1.

Temperatures at 25 fathoms, - - - - -, and at the bottom ———, July and August, 1912.

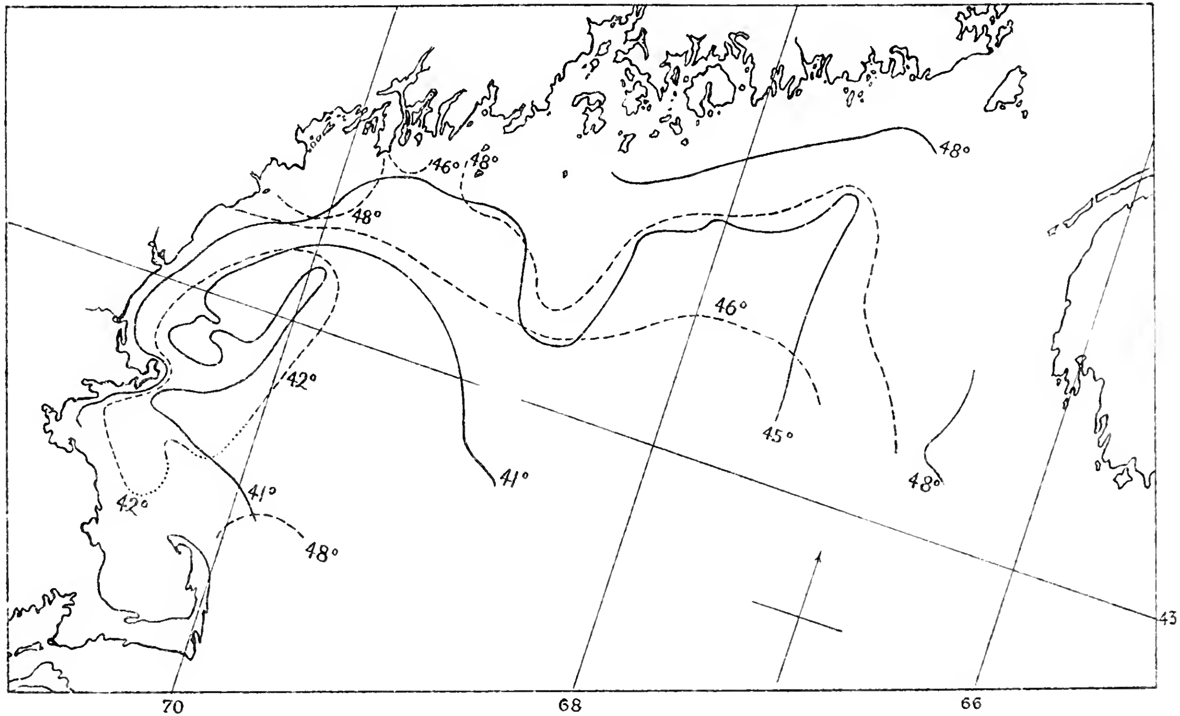

48°
46°
48°
48°
46°
45°
48°
42°
41°
41°
42°
48°
43
70
68
66

PLATE 2.

Salinities at the surface, ———, and at 25 fathoms - - - - -, July and August 1912.

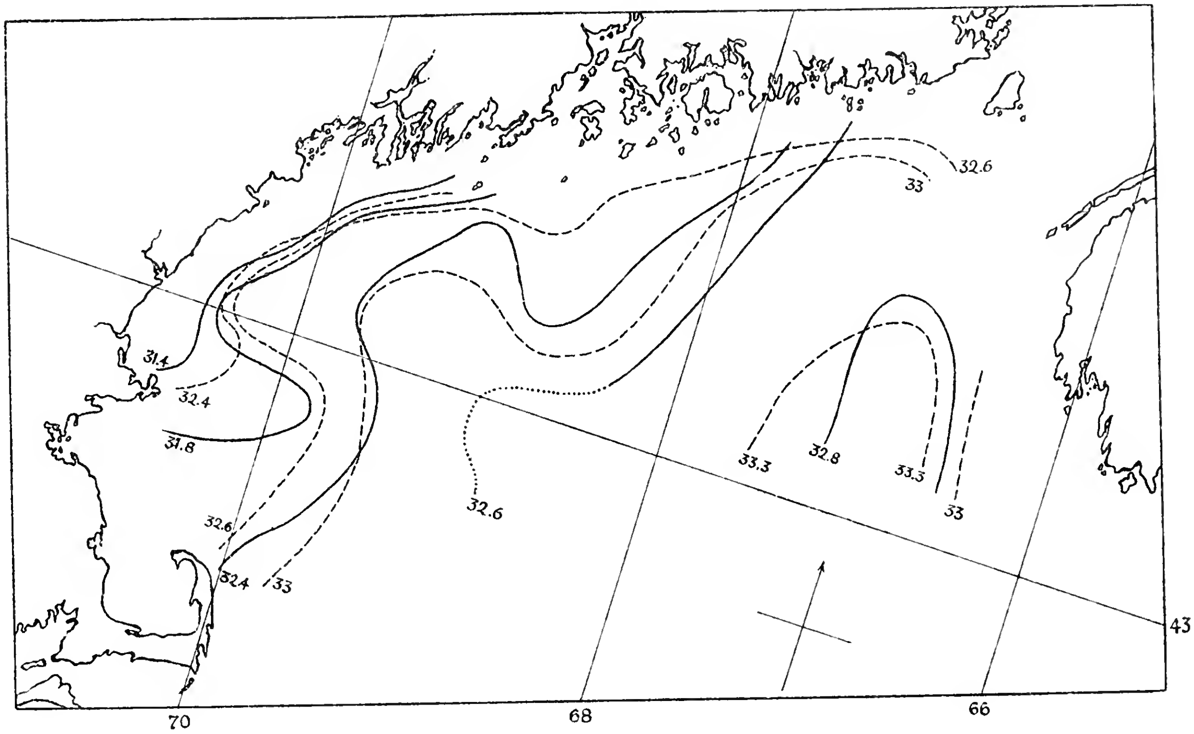

32.6
33
31.4
32.4
31.8
32.6
32.4
33
32.6
33.3
32.8
33.3
33
43
70
68
66

PLATE 3.

Salinities at 50 fathoms ———, and at the bottom - - - - -, July and August, 1912.

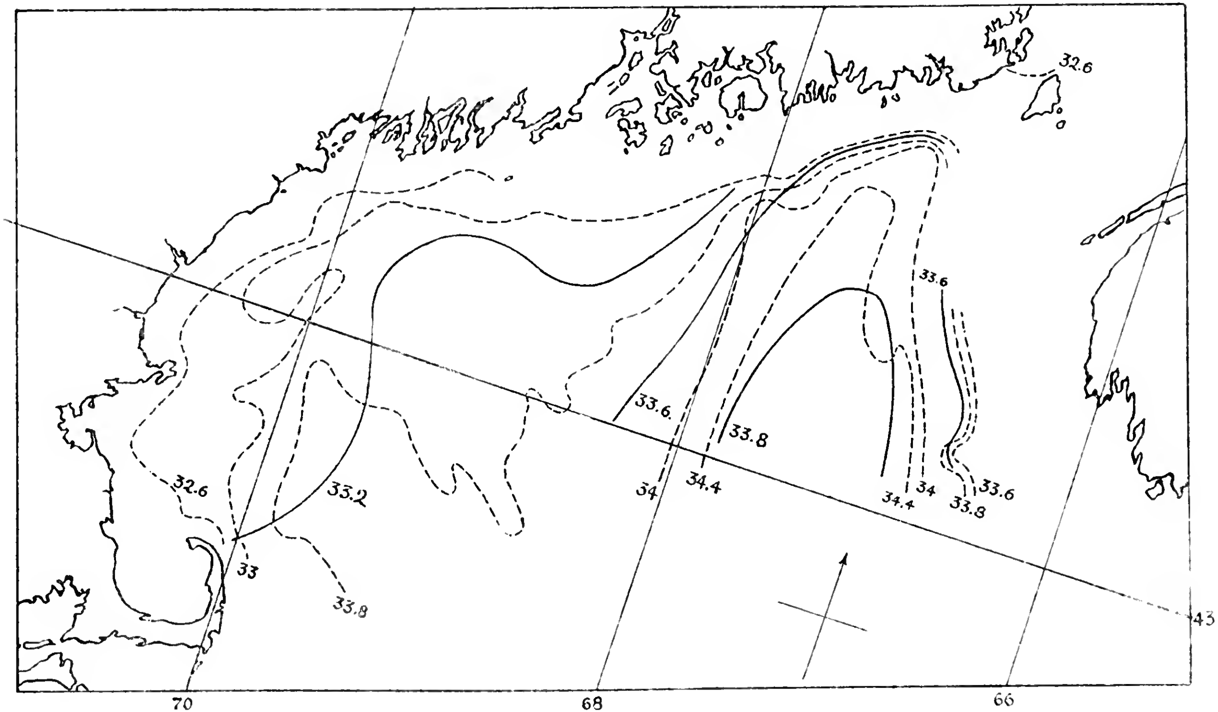

32.6
33.6
33.6
33.8
34.4
34
34.4
34
33.6
33.8
33.6.
34
34.4
33.8
32.6
33.2
33
33.8
70
68
66
43

PLATE 4.

Circulation of water in the Gulf, July and August, 1912, as shown by salinities and temperatures.

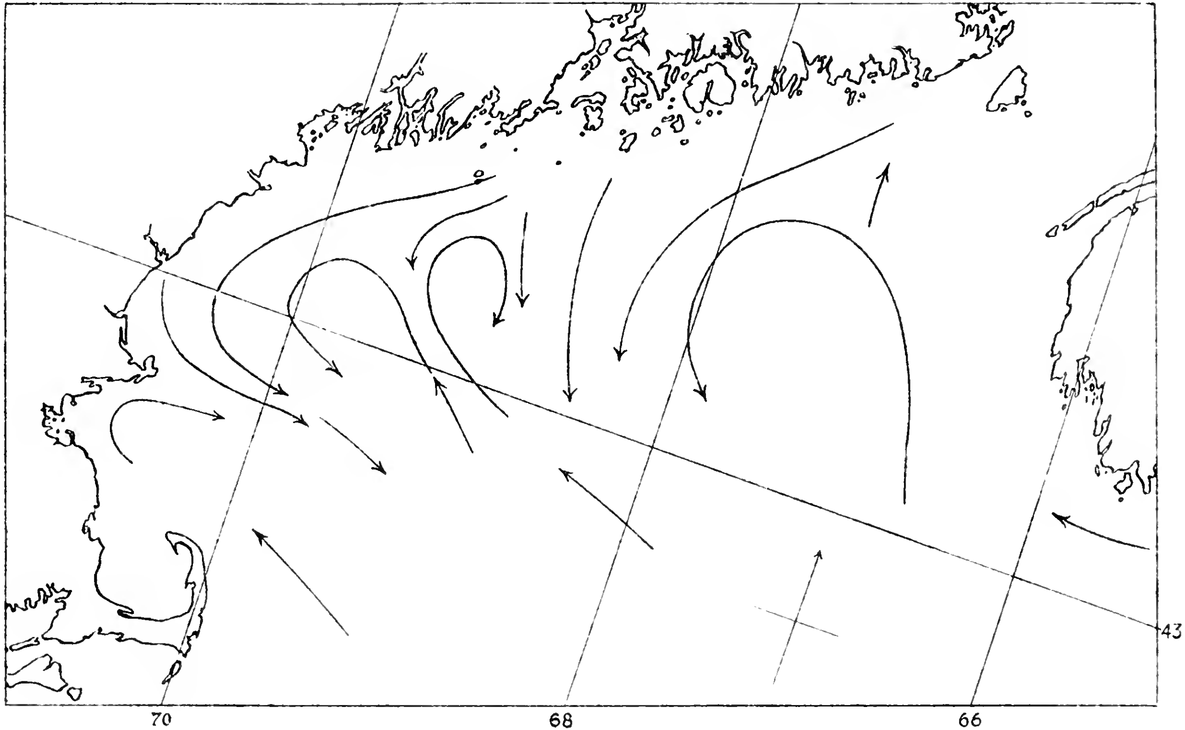

43
70
68
66

PLATE 5.

Occurrences of pelagic animals.

C. Clione limacina.
L. Limacina balea.
S. Sagitta serratodentata, abundant.
s. " " scarce.
H. Eukrohnia hamata.
F. Salpa fusiformis.
M. " mucronata.
E. Euthemisto compressa.

The curve ——— marks the off-shore limit to abundance of Sagitta elegans, the curve - - - - - the in-shore limit to abundant S. serratodentata.

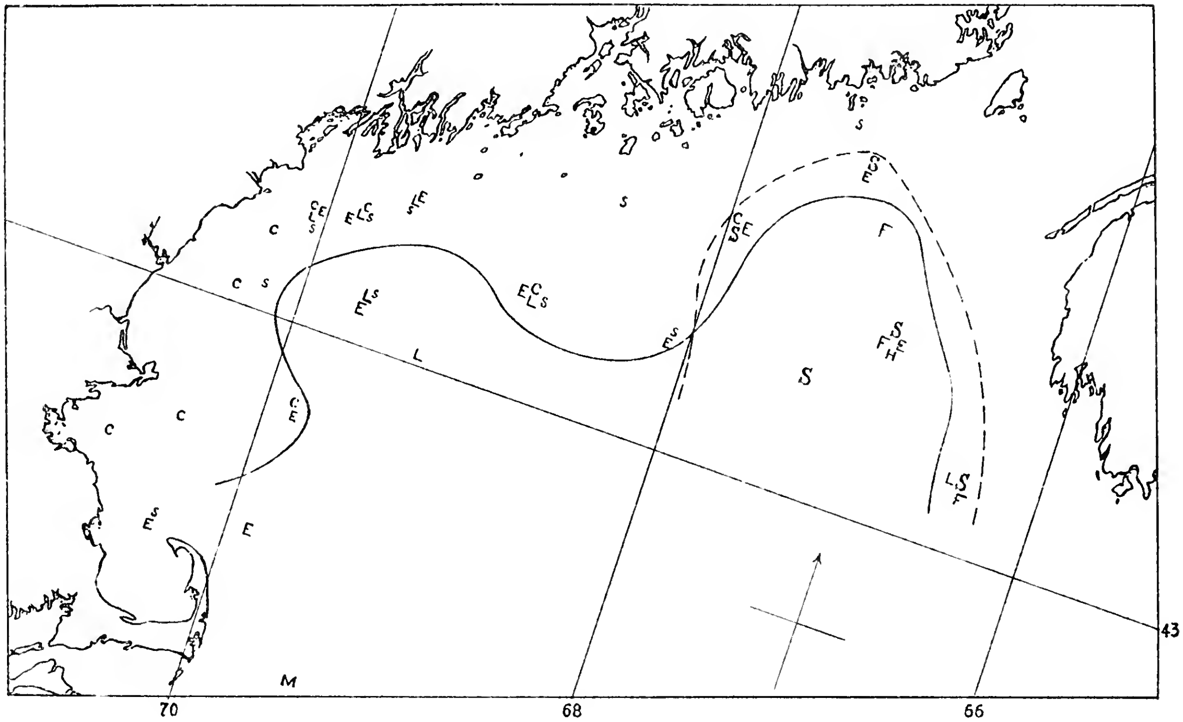

70
68
66
43

PLATE 6.

Occurrences of Medusae, Ctenophores and Siphonophores.

S. Staurophora mertensii.
A. Aglantha digitale.
P. Pleurobrachia pileus.
B. Bolinopsis infundibulum.
H. Physophora hydrostatica.
The curves mark the off-shore limit of abundant Aurelia and Cyanea.

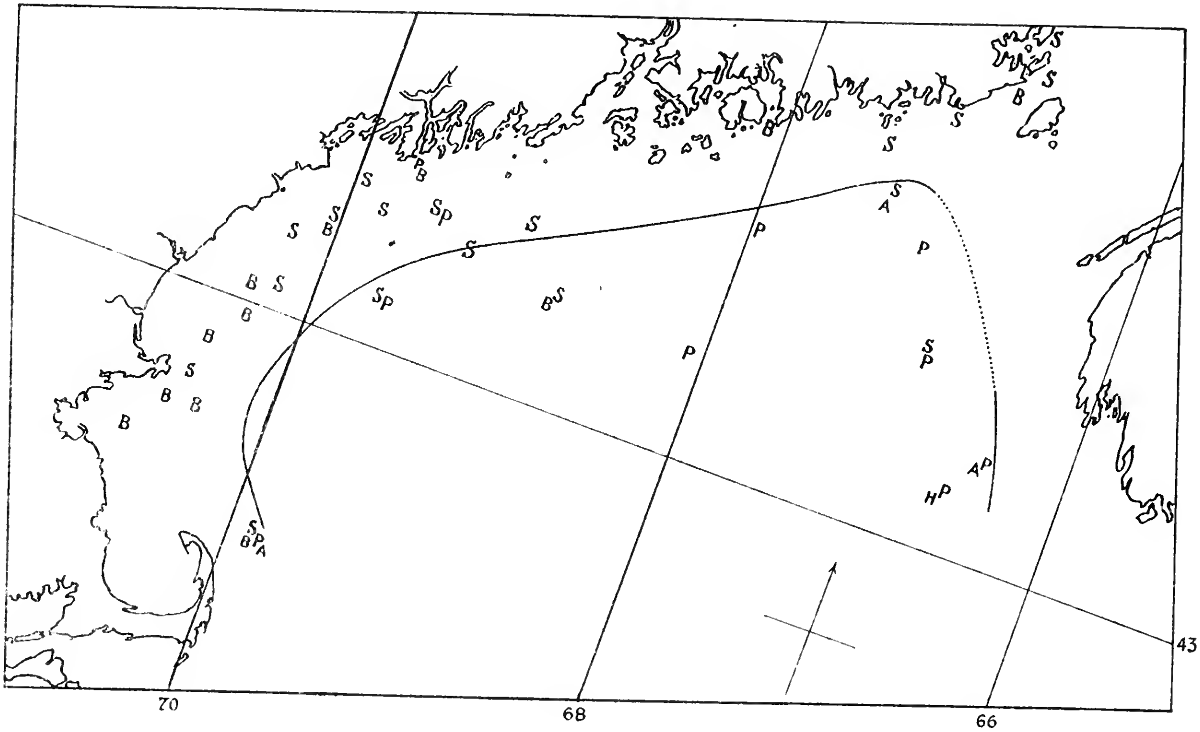

43
70
68
66

PLATE 7.

Quantitative distribution of copepods in July and August, 1912, showing regions in which they were very abundant (1); intermediate (2); scarce (3); (see page 129).

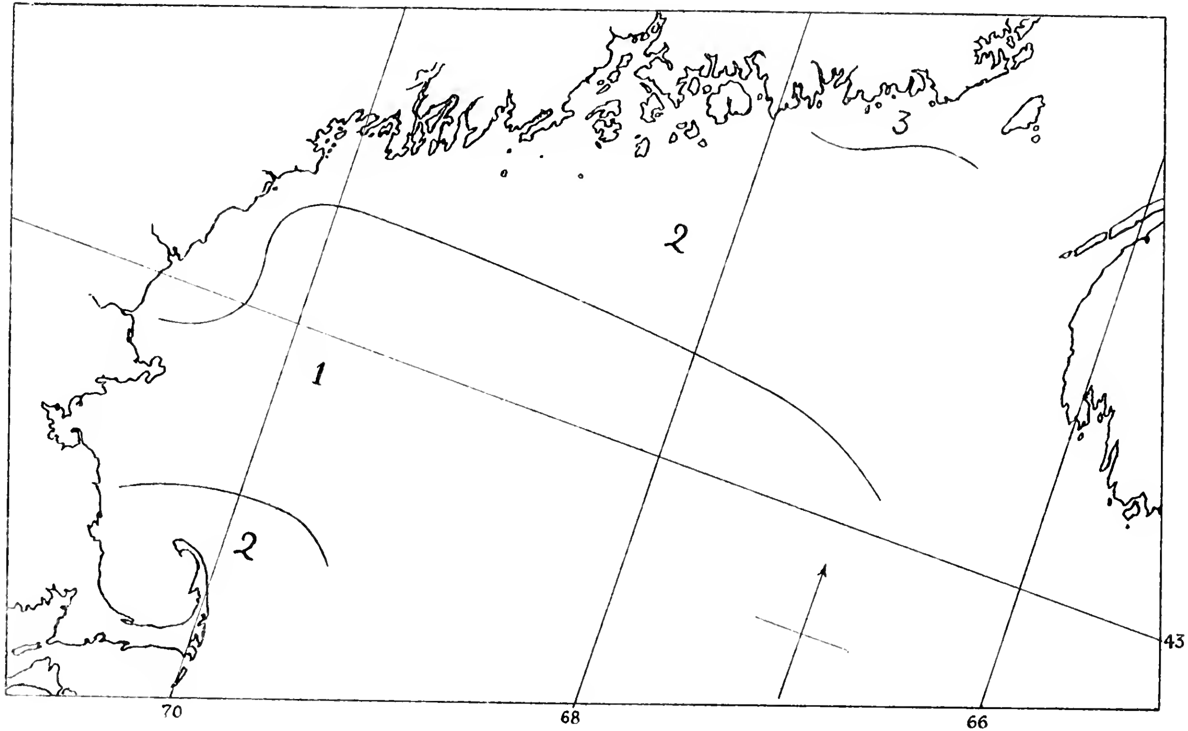

3
2
1
2
43
70
68
66

PLATE 8.

Distribution of microplankton, July and August, 1912.

Abundant Ceratium plankton.

Intermediate Ceratium plankton.

Scanty Ceratium plankton.

Mixed plankton.

Scanty mixed plankton.

Abundant diatom plankton.

Intermediate diatom plankton.

Scanty diatom plankton.

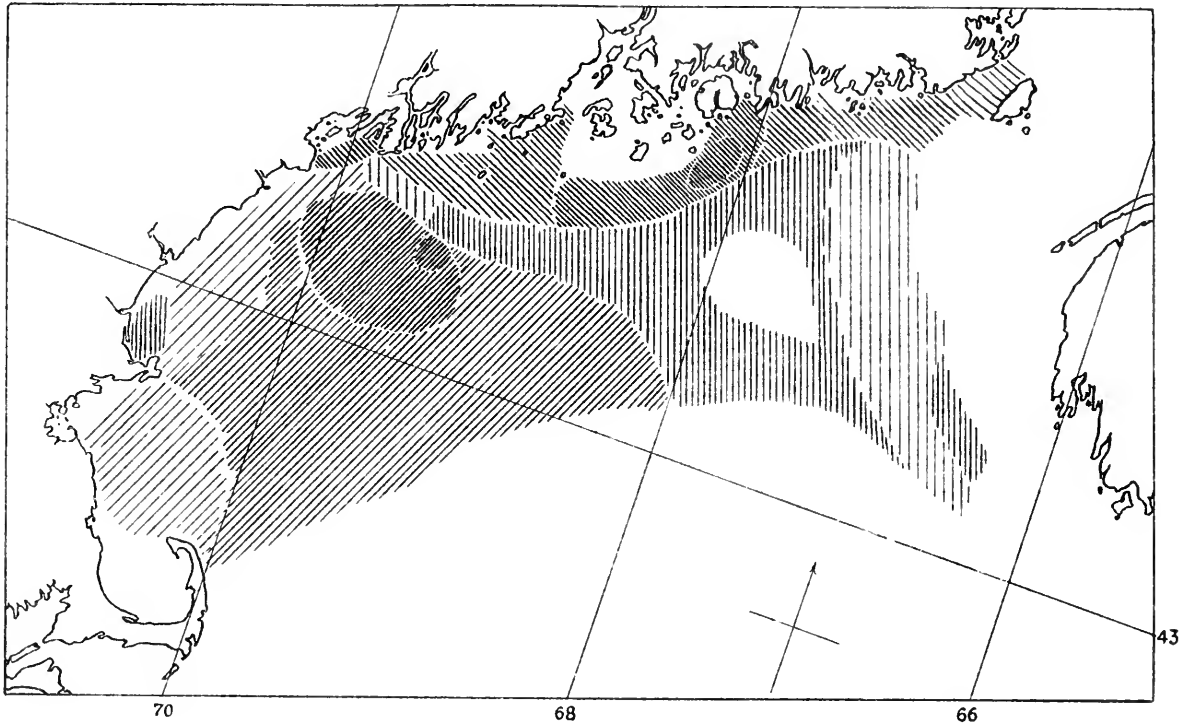
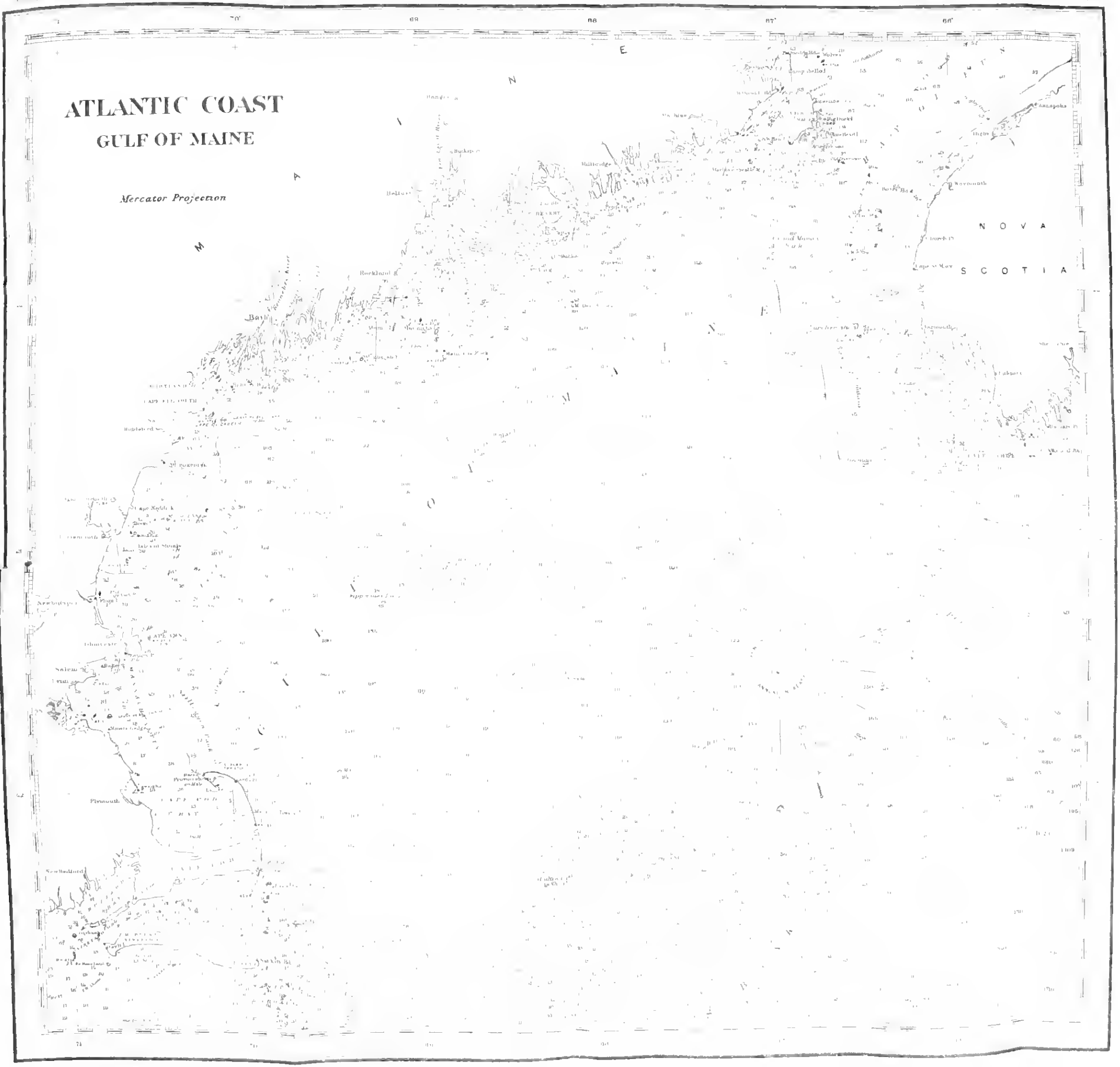

43
70
68
66

PLATE 9.

Chart of the Gulf of Maine, with stations occupied by the Grampus, July and August, 1912, and surface temperatures.


ATLANTIC COAST
GULF OF MAINE
Mercator Projection
NOVA SCOTIA
Bath
Rockland
Gloucester
Salem
Plymouth
New Bedford
Weymouth
Annapolis
Yarmouth
Cape Cod Bay

The following Publications of the Museum of Comparative Zoölogy are in preparation: —

LOUIS CABOT. Immature State of the Odonata, Part IV.
E. L. MARK. Studies on Lepidosteus, continued.
" On Arachnactis.
A. AGASSIZ and C. O. WHITMAN. Pelagic Fishes. Part II., with 14 Plates.
H. L. CLARK. The "Albatross" Hawaiian Echini.

Reports on the Results of Dredging Operations in 1877, 1878, 1879. and 1880, in charge of ALEXANDER AGASSIZ, by the U. S. Coast Survey Steamer "Blake," as follows:—

A. MILNE EDWARDS and E. L. BOUVIER. The Crustacea of the "Blake."
A. E. VERRILL. The Alcyonaria of the "Blake."

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieutenant Commander Z. L. TANNER, U. S. N., Commanding, in charge of ALEXANDER AGASSIZ, as follows:—

K. BRANDT. The Sagittae.
" The Thalassicolae.
O CARLGREN. The Actinarians.
R. V. CHAMBERLIN. The Annelids.
W. R. COE. The Nemerteans.
REINHARD DOHRN. The Eyes of Deep-Sea Crustacea.
H. J. HANSEN. The Cirripeds.
" The Schizopods.
HAROLD HEATH. Solenogaster.
W. A. HERDMAN. The Ascidians.
S. J. HICKSON. The Antipathids.
E. L. MARK. Branchiocerianthus.
JOHN MURRAY. The Bottom Specimens.
P. SCHIEMENZ. The Pteropods and Heteropods.
THEO. STUDER. The Alcyonarians.
—— The Salpidae and Doliolidae.
H. B. WARD. The Sipunculids.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of ALEXANDER AGASSIZ, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding, as follows:—

R. V. CHAMBERLIN. The Annelids.
H. L. CLARK. The Holothurians.
—— The Volcanic Rocks.
—— The Coralliferous Limestones.
S. HENSHAW. The Insects.
R. VON LENDENFELD. The Siliceous Sponges.
—— The Ophiurans.
G. W. MÜLLER. The Ostracods.
MARY J. RATHBUN. The Crustacea Decapoda.
G. O. SARS. The Copepods.
L. STEJNEGER. The Reptiles.
C. H. TOWNSEND. The Mammals, Birds, and Fishes.
T. W. VAUGHAN. The Corals, Recent and Fossil.

PUBLICATIONS

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY

AT HARVARD COLLEGE.

There have been published of the BULLETIN Vols. I. to LIV.; of the MEMOIRS, Vols. I. to XXIV., and also Vols. XXVI. to XXIX., XXXI. to XXXIV., XXXVI. to XXXVIII., and XLI.

Vols. LV. to LVIII. of the BULLETIN, and Vols. XXV., XXX., XXXV., XXXIX., XL., XLII. to XLVIII. of the MEMOIRS, are now in course of publication.

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The following publications are in preparation:—

Reports on the Results of Dredging Operations from 1877 to 1880, in charge of Alexander Agassiz, by the U. S. Coast Survey Steamer "Blake," Lieut. Commander C. D. Sigsbee, U. S. N., and Commander J. R. Bartlett, U. S. N., Commanding.

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieut. Commander Z. L. Tanner, U. S. N., Commanding, in charge of Alexander Agassiz.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

Reports on the Scientific Results of the Expedition to the Eastern Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from October, 1904, to April, 1905, Lieut. Commander L. M. Garrett, U. S. N., Commanding.

Contributions from the Zoölogical Laboratory, Professor E. L. Mark, Director.

Contributions from the Geological Laboratory, Professor R. A. Daly, in charge.

These publications are issued in numbers at irregular intervals. Each number of the Bulletin and of the Memoirs is sold separately. A price list of the publications of the Museum will be sent on application to the Director of the Museum of Comparative Zoölogy, Cambridge, Mass.

3189

Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

Vol. LVIII. No. 3.

THE STANFORD EXPEDITION TO BRAZIL, 1911, JOHN C. BRANNER, Director. THE CHILOPODA OF BRAZIL.

By Ralph V. Chamberlin.

With Six Plates.

CAMBRIDGE, MASS., U. S. A.

PRINTED FOR THE MUSEUM.

April, 1914.

Reports on the Scientific Results of the Expedition to the Eastern Tropical Pacific, in charge of Alexander Agassiz, by the U. S. Fish Commission Steamer "Albatross," from October, 1904, to March, 1905, Lieutenant Commander L. M. Garrett, U. S. N. Commanding, published or in preparation:—

A. AGASSIZ. V.[5] General Report on the Expedition.
A. AGASSIZ. I.[1] Three Letters to Geo. M. Bowers, U. S. Fish Com.
A. AGASSIZ and H. L. CLARK. The Echini.
H. B. BIGELOW. XVI.[16] The Medusae.
H. B. BIGELOW. XXIII.[23] The Siphonophores.
H. B. BIGELOW. XXVI.[26] The Ctenophores.
R. P. BIGELOW. The Stomatopods.
O. CARLGREN. The Actinaria.
R. V. CHAMBERLIN. The Annelids.
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L. J. COLE. XIX.[19] The Pycnogonida.
W. H. DALL. XIV.[14] The Mollusks.
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S. GARMAN. XII.[12] The Reptiles.
H. J. HANSEN. The Cirripeds.
H. J. HANSEN. XXVII.[27] The Schizopods.
S. HENSHAW. The Insects.
W. E. HOYLE. The Cephalopods.
W. C. KENDALL and L. RADCLIFFE. XXV.[25] The Fishes.
C. A. KOFOID. III.[3] IX.[9] XX.[20] The Protozoa.
C. A. KOFOID and J. R. MICHENER. XXII.[22] The Protozoa.
C. A. KOFOID and E. J. RIGDEN XXIV.[24] The Protozoa.
P. KRUMBACH. The Sagittae.
R. VON LENDENFELD. XXI.[21] The Siliceous Sponges.
—— The Holothurians.
—— The Starfishes.
—— The Ophiurans.
G. W. MÜLLER. The Ostracods.
JOHN MURRAY and G. V. LEE. XVII.[17] The Bottom Specimens.
MARY J. RATHBUN. X.[10] The Crustacea Decapoda.
HARRIET RICHARDSON. II.[2] The Isopods.
W. E. RITTER. IV.[4] The Tunicates.
ALICE ROBERTSON. The Bryozoa.
B. L. ROBINSON. The Plants.
G. O. SARS. The Copepods.
F. E. SCHULZE. XI.[11] The Xenophyophoras.
H. R. SIMROTH. The Pteropods and Heteropods.
E. C. STARKS. XIII.[13] Atelaxia.
TH. STUDER. The Alcyonaria.
JH. THIELE. XV.[15] Bathysciadium.
T. W. VAUGHAN. VI.[6] The Corals.
R. WOLTERECK. XVIII.[18] The Amphipods.

[1] Bull. M. C. Z., Vol. XLVI., No. 4, April, 1905, 22 pp.
[2] Bull. M. C. Z., Vol. XLVI., No. 6, July, 1905, 4 pp.. 1 pl.
[3] Bull. M. C. Z , Vol. XLVI., No. 9, September, 1905, 5 pp., 1 pl.
[4] Bull. M. C. Z., Vol. XLVI., No. 13, January, 1906, 22 pp., 3 pls,
[5] Mem. M. C. Z., Vol. XXXIII., January, 1906, 90 pp., 96 pls.
[6] Bull. M. C. Z., Vol. L., No. 3, August, 1906, 14 pp., 10 pls.
[7] Bull. M. C. Z., Vol. L., No. 4, November, 1906, 26 pp., 4 pls.
[8] Mem. M. C. Z., Vol. XXXV., No. 1, February, 1907, 20 pp., 15 pls
[9] Bull M. C. Z., Vol. L., No. 6, February, 1907, 48 pp., 18 pls.
[10] Mem. M. C. Z., Vol. XXXV, No. 2, August, 1907, 56 pp., 9 pls.
[11] Bull. M. C. Z., Vol. LI., No. 6, November, 1907, 22 pp., 1 pl.
[12] Bull. M. C. Z., Vol. LII., No. 1, June, 1908, 14 pp., 1 pl.
[13] Bull. M. C. Z., Vol. LII., No. 2, July, 1908, 8 pp., 5 pls.
[14] Bull. M. C. Z., Vol. XLIII., No. 6, October, 1908, 285 pp., 22 pls.
[15] Bull. M. C. Z., Vol. LII., No. 5, October, 1908, 11 pp., 2 pls.
[16] Mem. M. C. Z., Vol. XXXVII., February, 1909, 243 pp., 48 pls.
[17] Mem. M. C. Z., Vol. XXXVIII., No. 1, June, 1909, 172 pp., 5 pls., 3 maps.
[18] Bull. M. C. Z., Vol. LII., No. 9, June, 1909, 26 pp., 8 pls.
[19] Bull. M. C. Z., Vol. LII., No. 11, August, 1909, 10 pp., 3 pls.
[20] Bull. M. C. Z., Vol. LII., No. 13, September, 1909, 48 pp., 4 pls.
[21] Mem. M. C. Z., Vol. XLI., August, September, 1910, 323 pp., 56 pls.
[22] Bull. M. C. Z., Vol. LIV., No. 7, August, 1911, 38 pp.
[23] Mem. M. C. Z., Vol. XXXVIII., No. 2, December, 1911, 232 pp., 32 pls.
[24] Bull. M. C. Z., Vol. LIV., No. 10, February, 1912, 16 pp., 2 pls.
[25] Mem. M. C. Z., Vol. XXXV., No. 3, April, 1912, 98 pp., 8 pls.
[26] Bull. M. C. Z., Vol. LIV., No. 12, April, 1912, 38 pp., 2 pls.
[27] Mem M. C. Z., Vol. XXXV, No. 4, July, 1912, 124 pp., 12 pls.

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PRINTED FOR THE MUSEUM.

April, 1914.

No. 3.— *The Stanford Expedition to Brazil, 1911. John C. Branner, Director. The Chilopoda of Brazil.*

By Ralph V. Chamberlin.

The Brazilian chilopods upon a study of which the present paper is primarily a report, were collected for the most part by Mr. W. M. Mann as a member of the Stanford expedition to Brazil from June to September, 1911. As indicated hereafter, in the list by localities and under the particular species concerned, he was assisted in certain localities by Prof. Harold Heath and in others by Dr. Fred Baker. The collection was made almost wholly in parts of Brazil from which either few or no chilopods whatsoever have been previously recorded; and its study, in connection with that of some other material from the country, has brought about such a relatively material increase in the known fauna, that it has seemed advisable to give a complete review of the chilopods of Brazil. The Stanford Expedition collection has been purchased by the Museum of Comparative Zoölogy.

In Dr. Brölemann's Catalogue des Myriopodes du Brésil (São Paulo, 1909. Catalogos de Fauna Braziliera, **2**, issued by the Museu Paulista), after the elimination of manifest synonyms and *nomina nuda,* there are mentioned sixteen genera and thirty-nine species of chilopods. The present paper lists seventy-one species under twenty-five genera. Of the additional forms, two families, three genera, and nineteen species have not been elsewhere recorded as occurring in Brazil, and of these one genus and seventeen species are described as new. In addition it has been deemed advisable to include descriptions of a new genus and three new species from the adjoining country of British Guiana, these having been studied in connection with the Brazilian material.

The following list shows the known geographical distribution of the species. From states not here listed no records have been published. The new forms, and those new to the Brazilian fauna, are starred. In addition to these, because of the new territory covered, nearly all of the records of species secured by the Expedition are new within Brazil and of interest and importance in throwing light upon distribution. The greater part of previously published records have been from the coastal states from Bahia southward, the most being from Bahia, Rio de Janeiro, and São Paulo. The States in which Mr. Mann and his associates worked are listed first and in order below, each being preceded by a letter; while the particular localities within the states in which collecting was carried out are indicated by a preceding number.

A. Rio Grande do Norte.

1. *Natal.* (Mann. June).

* Orphnaeus branneri, sp. nov. Scolopendra viridicornis Newport. Pselliophora nigrovittata (Meinert). Scolopopendropsis calcaratus (Pocock).

2. *Ceará-Mirim.* (Mann and Heath).

Orphnaeus brevilabiatus (Newport). Trematophycus celeris (Humbert and Saussure). Scolopendropsis calcaratus (Pocock).

B. Ceará.

3. *Ceará* (Mann).

Scolopendra viridicornis Newport.

C. Parahyba.

4. *Independencia* (Mann and Heath. Among the hills north of the town).

* Schendylurus perditus, sp. nov. * Adenoschendyla parahybae, sp. nov. Orphnaeus brevilabiatus (Newport). * Cryptops heathi, sp. nov. Pselliophora nigrovittata (Meinert).

5. *Parahyba.*

Scolopendra morsitans Linné.

D. Pará.

6. *Pará* (Mann and Baker. Chiefly in the suburb of Souza along trails through the forest. July).

Orphnaeus brevilabiatus (Newport). * Schizonampa manni, gen. et sp. nov. * Newportia collaris Kraepelin. * Newportia paraensis, sp. nov. Scolopocryptops miersii Newport. Otostigmus goeldi Brölemann. Cupipes spinifer Kraepelin. Hemiscolopendra laevigata Porat. Scolopendra viridicornis Newport. Scolopendra morsitans Linné.

Santarem.

Scolopendropsis bahiensis Brandt. Scolopendra gigantea Linné. Scolopendra morsitans Linné.

E. Amazonas.

7. *Manáos* (Mann and Baker. In and about a ruined church. August).

* Schendylurus bakeri, sp. nov. Orphnaeus brevilabiatus (Newport). Notiphilides grandis Brölemann. * Mecistocephalus punctifrons Newport. Newportia amazonica Brölemann. Newportia bicegoi Brölemann. Newportia ernsti Pocock. Newportia longitarsis (Newport). * Otostigmus amazonae, sp. nov. * Otostigmus tidius, sp. nov. Trematophycus celeris (Humbert and Saussure). Cupipes ungulatis Meinert. Cupipes ungulatis mitis Brölemann. * Cupipes amazonae, sp. nov. Scolopendra morsitans Linné. Scolopendra viridicornis Newport.

8. *Porto Velho* (Mann and Baker. September).

Newportia ernsti Pocock.

Obidos (Brazilian Guiana).

Scolopendra gigantea Linné.

Carsevenne or *Calçoene* River (Brazilian Guiana).

Adenoschendyla geayi Brölemann and Ribaut. Thalthybius (Prionothalthybius) perrieri Brölemann. Ribautia bouvieri Brölemann. Newportia collaris Kraepelin.

F. Matto Grosso.

9. *Madeira-Mamore R. R. Camp 39.* (284 km. from Porto Velho. Mann and Baker. September).

Newportia ernsti Pocock. * Newportia longitarsis sylvae, subsp. nov. * Otostigmus rex, sp. nov. * Otostigmus casus, sp. nov. Trematophycus celeris (Humbert and Saussure). * Cupipes neglectus, sp. nov. * Scolopendra explorans, sp. nov.

10. *Madeira-Mamore R. R. Camp 41.* (On the Rio Madeira 306 km. from Porto Velho. Mann and Baker. September).

* Newportia longitarsis sylvae, subsp. nov. Scolopocryptops miersii Newport. * Ostostigmus suitus, sp. nov. Scolopendra angulata Newport. Pselliophora nigrovittata (Meinert).

11. *Abuná.* (Nearly opposite mouth of Rio Abuná. Mann and Baker. September).

Trematophycus celeris (Humbert and Saussure).

Corumbá.

Aphilodon augustatus Silvestri.

Urucum.

Aphilodon angustatus Silvestri.

PERNAMBUCO.

Villa Bella.

Scolopendra gigantea Linné.

Pernambuco.

Cupipes ungulatis Meinert. Scolopendra viridicornis Newport. Orphnaeus brevilabiatus (Newport).

Rio Capivari.

Cryptops galatheae Meinert.

BAHIA.

Bahia.

Otostigmus scabricaudus (Humbert and Saussure). Trematophycus longipes (Newport). Scolopendropsis bahiensis Brandt. Scolopendropsis calcaratus (Pocock). Scolopendra viridicornis Newport. Scolopendra subspinipes Leach.

Iguarassu.

Scolopendropsis bahiensis Brandt.

Rio São Francisco.

Scolopendra viridicornis Newport.

Santo Antonio da Barra.

Scolopendropsis calcaratus (Pocock). Pselliophora nigrovittata (Meinert).

MINAS GERAES.

Otostigmus scabricaudus (Humbert and Saussure). Trematophycus brasiliensis Kraepelin.

Lagoa Santa.

(?) Geophilus (Schendylurus?) sublaevis Meinert.

RIO DE JANEIRO.

Campo Itatiaya.

Schendylurus luderwaldi Brölemann and Ribaut.

Petropolis.

Cryptops iheringi Brölemann.

Rio Espirito Santo.

Otostigmus scabricaudus (Humbert and Saussure). Trematophycus brasiliensis Kraepelin.

Rio de Janeiro.

Orphnaeus *brevilabiatus* (Newport). (?) Newportia aurantiaca (Gervais). * Mimops occidentalis, sp. nov. Otostigmus scabricaudus (Humbert and Saussure). Cormocephalus aurantiipes (Newport). Scolopendra morsitans Linné. Scolopendra subspinipes Leach.

São Paulo.

Adenoschendyla imperfossa bolbonyx Brölemann and Ribaut.

Alto da Serra.

Cryptops iheringi Brölemann. Otostigmus limbatus (Meinert). Otostigmus scabricaudus (Humbert and Saussure).

Belém.

Otostigmus caudatus Brölemann. Hemiscolopendra laevigata (Porat).

Façenda Nova Nicaragua.

Schendylurus gounellei (Brölemann).

Itapetininga.

Otostigmus caudatus Brölemann.

Piquete.

Otostigmus scabricaudus (Humbert and Saussure). Otostigmus tibialis Brölemann.

Poco Grande.

Schendylurus paulista (Brölemann).

Santos.

Otostigmus limbatus Meinert. Otostigmus tibialis Brölemann.

São Paulo.

Otostigmus caudatus Brölemann. Otostigmus tibialis Brölemann.

Paraná.

Otocryptops ferrugineus macrodon Kraepelin. Otostigmus tibialis Brölemann.

Iguassú.

Mecophilus neotropicus Silvestri.

Santa Catherina.

Blumenau.

Adenoschendyla plusiodonta (Attems).

Rio Grande do Sul.

Cryptops iheringi Brölemann. Cryptops galatheae Meinert.

Porto Allegre.

Scolopocryptops miersii Newport.

São Laurenço.

Scolopocryptops miersii Newport.

Brazil (Without more definite locality).

? Schendylurus brasilianus (Silvestri). Adenoschendyla imperfossa (Brölemann). Mecistauchenius micronyx Brölemann. (?) Newportia viridis (Gervais). Otocryptops ferrugineus (Linné). Otocryptops melanostomus (Newport). Trematophycus longipes (Newport). Scolopendra polymorpha Wood. Scolopendra alternans Leach. Cupipes brasiliensis (Humbert and Saussure). Lithobius forficatus (Linné).

It seems scarcely necessary to point out the pronounced dominance of the Scolopendroidea in the Brazilian chilopod fauna and the practically complete absence of the Lithobiomorpha, so abundant in the Northern Hemisphere. It is probable, however, that a fair representation of the Henicopidae will later be found to occur. In the Geophiloidea the Schendylidae are manifestly dominant, the Oryidae coming next; while the Geophilidae proper are at present known with certainty to be represented by but two species, one of which is here first recorded and described.

SCOLOPENDROIDEA.

Cryptopidae.

Of this family, five genera (Cryptops, Mimops, heretofore known only from China, Newportia, Otocryptops, and Scolopocryptops) are represented in the Brazilian fauna, this being about half of the total number.

Cryptops Leach.

Trans. Linn. Soc. London, 1814, **11**, p. 384.

Key to Species.

a. Tarsi of all legs distinctly biarticulate; last ventral plate with scattered dark spicules or spinous points which also cover the coxopleurae . . . . *C. iheringi* Brölemann.

aa. Tarsi of only last two pairs of legs distinctly biarticulate; last ventral plate and coxopleurae not armed with spicules.

  b. Second dorsal plate distinctly bisulcate; anterior margin of prosternum nearly straight . . . . *C. heathi*, sp. nov.

  bb. Second dorsal plate without sulci; anterior margin of prosternum distinctly biarcuate . . . . *C. galatheae* Meinert.

Cryptops iheringi Brölemann.

Rev. Museu Paulista, 1901, **5**, p. 42, pl. 1, fig. 6, 7; Kraepelin Revis. Scolop., 1903, p. 32, fig. 2; Brölemann, Cat. Myr. Brésil, 1909, p. 8.

Localities.— State of São Paulo: Alto da Serra (type loc.); State of Rio de Janeiro: Petropolis; State of Rio Grande do Sul.

Cryptops galatheae Meinert.

Vidensk medd. nat. foren. Kjøbenhavn, 1887, p. 140; Kraepelin, Revis. Scolop., 1903, p. 54.

Cryptops capivarae Pocock, Ann. mag. nat. hist., 1891, ser. 6, **8**, p. 158; Brölemann, Cat. Myr. Brésil, 1909, p. 8.

Cryptops brasiliensis Attems, Mitt. Mus. Hamburg, 1900, **18**, p. 112; Brölemann, Cat. Myr. Brésil, 1909, p. 8.

Localities.— State of Rio Grande do Sul (*brasiliensis* Attems); State of Matto Grosso: Rio Capivari (*capivarae* Pocock); Argentina: Montevideo (*galatheae* Meinert).

Cryptops heathi, sp. nov.

Color yellowish. Head a little darker than the body.

Head widest anteriorly, the sides converging caudad; caudal margin straight, meeting the edge of the first dorsal plate flush or scarcely overlapping the latter. Sulci not evident in middle and anterior portions; but rather faintly indicated caudad. Scarcely punctate.

Prosternum not punctate; with a median longitudinal furrow. Anterior margin nearly straight, being very slightly bowed caudad toward each end; bearing three bristles on each side. (Plate **1**, fig. 2).

First dorsal plate with a distinct transverse cervical sulcus which is angularly bent caudad at the middle line, the plate being depressed at this angle. Two longitudinal sulci present, but these in the type are rather weak; forking cephalad, the inner branches meeting at an angle at the median line a little caudad of the cervical sulcus and the lateral lines each meeting the sulcus farther laterad (see Plate **1**, fig. 1).

All dorsal plates from the second to twentieth longitudinally bisulcate. Plates not roughened; none of them bearing cornicles.

Last plate with a shallow median longitudinal furrow which is more evident toward the caudal end.

Ventral plates not punctate. Last ventral plate widely, semicircularly, rounded caudad.

Coxopleurae subtruncate caudally, not at all extended. Pores few, small, not reaching the caudal edge by a large space.

Anterior legs not distinctly biarticulate. Anal legs with prefemur, femur, and, less distinctly, the tibia longitudinally furrowed dorsally. Prefemur with numerous spinules of the usual character over ventral and mesal surface; elsewhere with bristles; no longitudinal glabrous area on ventral side. Femur armed similarly to the prefemur but bearing in addition to the spinules a single stout tooth on the ventral surface toward the distal end. Tibia bearing ventrally toward the mesal edge a row of stout teeth; and the first tarsal joint bearing in corresponding location two similar teeth with an elevation distad of them as shown in Plate **1**, fig. 3.

Length of type cir. 10 mm.

Locality.—State of Parahyba: Independencia! (Mann and Heath). One specimen taken in the hills north of the town.

Paracryptops Pocock.

Ann. mag. nat. hist., 1891, ser. 6, **7**, p. 227. Kraepelin, Rev. Scolop., 1903, p. 59.

Previously this genus was known only from the East Indies, from where two species had been described. Another species has been recently described from India.

Paracryptops inexpectus, sp. nov.

Color light lemon-yellow, darkest cephalad. Head darker than body, dilute orange-yellow excepting at anterior end where light yellow. Antennae and legs pale yellowish.

Cephalic plate overlapped by the first dorsal plate. Widest toward anterior end, from where the sides at first slightly and then more strongly converge to the caudal corners; anterior border of head subtriangular, notched at median line. On caudal portion with two short subparallel sulci; a pit-like depression a little distance from each lateral margin at middle of length; not punctate. Hair sparse.

Antennae composed of seventeen articles as usual. Densely clothed, with fine short hairs but these becoming longer and much sparser proximad.

Prosternum rather widely though but moderately depressed along the median longitudinal line. Anterior margin moderately extended cephalad, though less so than in *breviunguis;* margin each side of the narrow median incision broadly semicircular or with edges from rounded ectal ends to mesal incision substraight, the two sides meeting at an obtuse re-entrant angle; no distinct semilunar dental plates are present though there is a suggestion of the separation of the smooth, rounded, marginal portion suggestive of the condition in *weberi.*

First dorsal plate long; smooth; without furrows or with but very faint and short traces of a longitudinal pair toward anterior end. Submedian paired longitudinal sulci present on other dorsal plates from the second to the penult as are also the curved lateral sulci, the latter being sharply impressed excepting on the first few plates, where they are faint. Last dorsal plate with caudal produced border subtriangular, the median angle somewhat obtuse with the margin each side also forming a slight, very obtuse, angle near middle of its length. Plate with a very deep median longitudinal sulcus.

The ventral plates show a somewhat semicircular transverse impression in front of the level of the legs and a second transverse impression a little caudad of the legs, but not truely cruciform impression is indicated in the type. Last ventral plate with sides nearly straight, these converging to the semicircular caudal border.

Spiracles longitudinally elliptic.

Tarsi of anterior legs undivided. Legs clothed with sparse stiff bristles, these more spinescent on more caudal pairs. Prefemur of anal legs clothed with numerous long spines excepting dorsally and on median portion of ectal surface where they are replaced with fine hairs. Femur armed with similar or slightly more slender spines which are confined, however, more nearly to the strictly ventral surface; without teeth. Tibia without spines but bearing ventrally a longitudinal series of four teeth, these teeth curving caudad at distal ends. First tarsal joint with a single tooth at proximal end on ventral surface. Second tarsal joint without true teeth; but on ventral surface at proximal end it is extended into a conspicuous rounded process.

Length cir. 16 mm.

Locality.— British Guiana. One specimen taken at Washington, D. C., in pots of plants imported from British Guiana.

Mimops Kraepelin.

Revis. Scolop., 1903, p. 62.

This genus has heretofore been known from one species (*M. orientalis* Kraepelin) based upon a single specimen from China (Province Shensi). It was a matter of much surprise and interest, therefore, to find in the collection of the M. C. Z. two specimens of a distinct species but fully conforming to this genus in a vial with specimens of *Orphnaeus brevilabiatus* (Newport) from Rio de Janeiro. The specimens of Orphnaeus had been labeled *O. brasiliensis* by Meinert, who seems to have overlooked or to have failed to examine critically the smaller specimens of Mimops. It is, of course, quite possible that the specimens were introduced to Rio de Janeiro on ships from the East; but this must remain for the present uncertain.

Mimops occidentalis, sp. nov.

The color of the types appears to have been yellowish; but because of long preservation the original color of the specimens cannot be satisfactorily ascertained.

Cephalic plate wider than long, nearly in ratio 12: 11. A little overlapping the first dorsal plate. Widest anteriorly, with sides converging caudad; caudal margin mesally a little incurved; the anterior margin incised between bases of antennae. Longitudinally depressed in caudal region each side of middle. (Plate **1**, fig. 4).

Antennae composed of seventeen or eighteen articles, which in the proximal half are as wide as or wider than long, but distad become longer than wide.

Anterior margin of prosternum nearly straight being but very weakly widely convex; bearing two moderately high, distally rounded, dental plates separated by a median spaces or incision which is rounded at bottom and is deeper than in *orientalis* Kraepelin. All joints of prehensorial feet unarmed. Claw short and stout and but little curved. (Plate **1**, fig. 5).

First dorsal plate with a transverse sulcus a little caudad of margin of head, this sulcus bending caudad at middle region. Also with a longitudinal furrow each side of the middle extending cephalad from the caudal margin and uniting at an angle with its fellow near the middle of the plate, from where they continue as a single median furrow to the transverse sulcus (Plate **1**, fig. 4). Other dorsal plates bisulcate. The sulci of the second and third as well as of the others entirely crossing the plate. A ridge-like elevation or keel between the sulci. Plates longitudinally depressed on each side between the sulcus and the lateral margin. (Plate **1**, fig. 6). Last dorsal plate margined. Bowed out caudad with the mesal part truncate, the margin on each side of truncation slightly incurved and extending obliquely to the lateral margin. The two longitudinal sulci also evident on this plate excepting at caudal end.

Second to nineteenth ventral plates longitudinally bisulcate. First plate with a median longitudinal furrow. Especially the more posterior plates longitudinally broadly depressed each side of the middle. Last ventral plate strongly narrowed caudad, though less strongly so than in *orientalis*. Caudal margin straight or but slightly excurved; corners rounded.

Coxopleurae extended caudad in a conical process which is stouter and less cylindric than in *orientalis*. Pores small and numerous. (Plate **1**, fig. 7).

Tarsi of all legs distinctly biarticulate. Anal legs of form very similar to that of *orientalis*. Prefemur with a low dorsal elevation at distal end. Claw much shorter than tarsus.

Length 10.5 mm.

Locality.— State of Rio de Janeiro: Rio de Janeiro. Nathaniel Thayer expedition. 1864. M. C. Z.

Because of long preservation the two specimens are bleached and almost wholly bereft of hairs and spinules; accordingly, no attempt is made to describe their presence and characteristics. *Mimops orientalis* Kraepelin, the other species of the genus, is from Shensi, China. It is a much larger form and differs in numerous structural details from the present species.

Otocryptops Haase.

Abhandl. Mus. Dresden, 1887, **5**, p. 96.

Scolopocryptops Newport (in part), Trans. Linn. soc. London, 1844, **19**, p. 405. Meinert (ad part. max.), Proc. Amer. philos. soc., 1886, **23**, p. 179.

Otocryptops Kraepelin, Revis. Scolop. 1903, p. 68. Verhoeff, Bronn's Thierreich, 1907, **5**, p. 255.

Key to species.

a. Twentieth, and often also the twenty-first, legs with a spine both on tibia and on tarsus; prosternum with anterior margin bearing two to four more or less distinct teeth or dentiform elevations.

b. Basal tooth of first joint of prehensors small or but moderate in size, being at base from one eighth to one tenth as thick as the joint. . . . . *O. ferrugineus* (Linné).

bb. Basal tooth of first joint of prehensors large, being at base nearly one fourth as wide as the joint.
O. ferrugineus macrodon Kraepelin.

aa. Twentieth to twenty-third pairs of legs always lacking tibial and tarsal spines; prosternal margin smooth, without trace of teeth.
O. melanostomus (Newport).

OTOCRYPTOPS FERRUGINEUS (Linné).

Scolopendra ferruginea Linné, Syst. nat. ed., 12, 1767, **6**, p. 1063.

Scolopocryptops ferruginea Newport, Trans. Linn. soc. London, 1844, **19**, p. 406.

Scolopocryptops rufa Gervais, Insect. Aptères, 1847, **4**, p. 297.

Scolopocryptops mexicana Humbert et Saussure (non Saussure, 1860), Rev. mag. zool., 1869, p. 158.

Scolopocryptops sexspinosa Porat (non Say), Bih. Svensk. vet. akad. Handl., 1876, **4**, no. 7, p. 26. Kohlrausch (in part), Arch. naturg., 1881, **47**, **1**, p. 54.

Scolopocryptops antillarum Marsh, Trans. Ent. soc. London, 1878, p. 37.

Scolopocryptops miersii Meinert (ad part max), Proc. Amer. philos. soc., 1886, **23**, p. 181.[1]

Scolopocryptops bisulca Karsch, Abhandl. Naturw. ver. Bremen, 1887, **9**, p. 66.

Scolopocryptops strigilis Karsch, Ibid.

Scolopocryptops meinerti Pocock, Ann. mag. nat. hist., 1888, ser. 6, **2**, p. 474.

Otocryptops ferrugineus Kraepelin, Revis. Scolop., 1903, p. 72.

Otocryptops sexspinosus Brölemann (non Say, the Brazilian record), Cat. Myr. Brésil, 1909, p. 11.

Locality.— "Brazil."

This is a widely distributed species in Mexico, Jamaica, Haiti, and the Antilles generally, Central America, Ecuador, and Peru.

[1] Of the specimens in the M. C. Z. labeled by Meinert as *S. miersii* and reported upon in the paper cited above, one specimon, from Martinique, is the true *S. miersii* Newport, the others being *O. ferrugineus*.

Otocryptops ferrugineus macrodon Kraepelin.

Revis. Scolop., 1903, p. 74.

Locality.— State of Paraná: Paraná (sec. Kraepelin).

Separated by Kraepelin from the species on the basis of the larger tooth on the first joint of the prehensors as indicated in the key above.

Otocryptops melanostomus (Newport).

Scolopocryptops melanostoma Newport, Trans. Linn. soc. London, 1844, **19**, p. 406; Gervais, Insect. Aptères, 1847, **4**, p. 298.
Scolopocryptops megalocephalus Kohlrausch, Archiv. naturg., 1881, **47**, 1, p. 57.
Scolopocryptops luzonicus Kohlrausch, Ibid., p. 58.
Scolopocryptops boholiensis Kohlrausch, Ibid., p. 58.
Scolopocryptops geophilicornis Tömösvary, Termes. füzetek, 1885, **9**, p. 65.
Otocryptops luzonicus Haase, Abhandl. Mus. Dresden, 1887, **5**, p. 98.
Otocryptops luzonicus australis Haase, Ibid., p. 98.
Otocryptops longiceps Pocock, Ann. mag. nat. hist., 1890, ser. 6, **8**, p. 160.
Otocryptops melanostoma Pocock, Journ. Linn. soc. London, 1891, **24**, p. 464; Brölemann, Ann. Soc. ent. France, 1898, **67**, p. 250; Kraepelin, Revis. Scolop., 1903, p. 74, fig. 33, 34.
Otocryptops aculeatus Attems, Abhandl. Senckenb. gesellsch., 1897, **23**, p. 478.

Locality.— Brazil (recorded as *O. longiceps* by Pocock).

Also known from Argentina and Venezuela and Porto Rico, St. Vincent, etc., and occurring widely in the East Indies as well.

Scolopocryptops Newport.

Newport (in part), Trans. Linn. soc. London, 1844, **19**, p. 405; Kraepelin, Revis. Scolop., 1903, p. 76; Verhoeff, Bronn's Thierreich, 1907, **5**, p. 255.

The following is the only species known from the Western Hemisphere.

Scolopocryptops miersii Newport.

Trans. Linn. soc. London, 1844, **19**, p. 405; Meinert (in part min.), Proc. Amer. philos. soc., 1886, **23**, p. 181; Pocock, Journ. Linn. soc. London, 1893, **24**, p. 146; Silvestri, Ann. Mus. civ. stor. nat. Genova, 1895, ser. 2, **14**, p. 24; Brölemann, Ann. Soc. ent. France, 1898, **67**, p. 250; Rev. Museu Paulista, 1901, **5**, p. 42; Kraepelin, Revis. Scolop., 1903, p. 77; Brölemann, Cat. Myr. Brésil, 1909, p. 33.

Localities.— State of Matto Grosso: Madeira-Mamore R. R. camp 41 on the Rio Madeira! (W. M. Mann); State of Para: Para, suburb of Souza! (Mann and Baker); State of Rio Grande do Sul: Porto Allegre, São Laurenço.

This species is common from the southern United States southward through Mexico and Central America to Venezuela, Guiana, and Brazil.

Newportia Gervais.

Insect. Aptères, 1847, **4**, p. 298; Kraepelin, Revis. Scolop., 1903, p. 76; Verhoeff, Bronn's Thierreich, 1907, **5**, p. 251.

Newportia + *Scolopendrides*, Saussure, Rev. mag. zool. 1869, ser. 2, **21**, p. 158.

This genus, peculiar to tropical and subtropical America, is represented in Brazil by seven known species, of which four have been previously recorded. Of the three here first listed from Brazil, two are described as new. In addition, *Scolopocryptops aurantiaca* and *S. viridis* Gervais (Insect. Aptères, **4**) are probably based upon members of the present genus; but there is nothing in the original descriptions to make precise identification possible, and the names must be dropped until the types are examined, if they now be in existence.

Key to Species.

a. Distal division of tarsus of anal legs indistinctly many ringed, the divisions not clearly separated or numerable; tibia of legs, excepting the last three pairs, armed both laterally and ventrally with a stout spine; tarsus of these legs also with a stout ventral spine; spiracles very small.........(*Scolopendrides* Saussure).

b. Anal leg terminating in a well-developed claw. *N. amazonica* Brölemann.

bb. Anal leg clawless.

c. Paired longitudinal sulci of head crossed near caudal ends with a fine and distinct transverse sulcus; sulci of second dorsal plate evident from anterior margin caudad to or past the middle of plate.............*N. ernsti* Pocock.

cc. Paired longitudinal sulci of head not crossed near base by any such transverse sulcus; sulci of second dorsal plate not evident on anterior half, being present only as short lines at caudal border which bifurcate into a very short mesal branch and an ectal one that runs almost directly ectad to the lateral margin.........*N. paraensis*, sp. nov.

aa. Distal division of tarsus of anal legs composed of a limited number of articles clearly separated from each other; tibia of anterior pairs of legs with only a lateral spine; tarsi of these legs without any ventral spine; spiracles large and distinct.

(*Newportia sens. str.*).

b. First dorsal plate with a simple, semicircular or nearly semicircular transverse cervical sulcus; its paired longitudinal sulcus simple and undivided; no median, pit-like, depression caudad of median sulcus.

c. Prefemur of anal legs on dorsomesal surface with two rows of from seven to ten spinules.

N. longitarsis (Newport).

cc. Prefemur of anal legs without any spinules proper additional to the large ventral spines.

N. longitarsis sylvae, subsp. nov.

bb. First dorsal plate with the transverse cervical sulcus bent angularly caudad at middle and with a pit-like, median, depression caudad of its apex; paired longitudinal sulci bifurcating cephalad, the inner branches meeting in the depression and the lateral extending cephalo-ectad to the transverse sulcus, the branches together forming a more or less w-shaped outline.

c. First joint of tarsus of anal legs clavately thickened distad and with corner drawn out at side into a pointed angle; part of first plate in front of transverse sulcus about as long as that caudad of it.

N. collaris Kraepelin.

cc. First joint of tarsus of anal legs not thus clavately thickened distad; cervical sulcus considerably cephalad of middle of first plate............*N. bicegoi* Brölemann.

Newportia amazonica Brölemann.

Rev. Museu Paulista, 1903, **6**, p. 69, pl. 11, fig. 3, 4; Brölemann, Cat. Myr. Brésil, 1909, p. 9.

Locality.— State of Amazonas: Manáos! (Mann and Baker. This is also the type locality).

Kraepelin says (Revis. Scolop., p. 85) with reference to this species: — "S. amazonica Bröl. scheint sich von der vorsthenden Art [N.

ernsti] vornehmlich durch den Besitz eines winzigen Klaue am Ende der Tarsengeissel zu unterscheiden. Ich glaube kaum das es sich hier um eine artliche Verschiedenheit, sondern um eine individuelle Rückschlagsbildung handelt, die im interessanter Weise die Herkunft der Newportien aus Formen mit Klauen tragenden Analbeinen demonstriert."

But this author is clearly mistaken in regarding the claw thus as an individual atavistic variation, inasmuch as a normal and well-developed claw is present in all the specimens secured in the type locality by Mr. Mann (Plate 2, fig. 4). In *Newportia ernsti*, occasionally a very small and wholly straight chitinous point may occur at the tip of the tarsus (Plate 2, fig. 5), but apparently never a true claw or anything that might be regarded as properly transitional to the condition in *amazonica*. The spining of the prefemur, etc., is also constantly different, there being in all the specimens examined but four ventral spines instead of six, these being also relatively considerably larger.

Newportia ernsti Pocock.

Ann. mag. nat. hist., 1891, ser. 6, 8, p. 161; Kraepelin, Revis. Scolop., 1903, p. 85, fig. 38, 39; Brölemann, Cat. Myr. Brésil, 1909, p. 10.

Localities.— State of Amazonas: Manáos!, Porto Velho! (Mann and Baker). State of Matto Grosso: Madeira-Mamore R. R. camp 39 on the Rio Madeira (W. M. Mann).

Numerous specimens were secured at Manáos and several at each of the other two places indicated. Closely related to the preceding species.

Newportia paraensis, sp. nov.

Color yellow of a reddish tinge, with the most caudal plates darker.

Head with prosternum and prehensors and the first dorsal plate reddish brown. Antennae yellow, darkest proximally. Head with punctations distinct and numerous, not fine, more sparse in frontal region, particularly in a transverse band across its caudal portion. Two median sulci distinct forward to middle of plate and not crossed by any transverse sulcus; a median longitudinal furrow from anterior margin a little distance caudad. Caudal margin widely convex, a little incurved right of middle portion of sides straight and parallel; caudal corners widely rounded.

Antennae short, composed of sixteen (mostly) or seventeen articles. None of the articles glabrous but the first two more sparsely clothed with hair than the others, the density increasing from the second to the fourth and thereafter essentially uniform.

Anterior margin of prosternum considerably more elevated ectally than mesally; bearing two wide but very short dental plates which are weakly convex.

First dorsal plate with a strictly semicircular cervical sulcus which is entirely free from the head and at its middle nearly one third the distance from the head to the caudal margin of the plate. Median longitudinal sulci distinct, subparallel, crossing the transverse sulcus and attaining the front margin.

Second dorsal plate with the median longitudinal sulci appearing as very short lines at caudal border, each line being continuous with a sulcus extending a little cephalad of directly ectad to the lateral margin and with a very short line extending mesocephalad. The median longitudinal sulci are complete on the other plates. The third plate shows a rather wide and shallow median longitudinal furrow. Subsequent plates with a distinct narrow median longitudinal keel set off by two deep furrows. Plates from fifth caudad with a distinct longitudinal furrow on each side with also less distinct indications of similar ones on the third and fourth.

Last dorsal plate bowed considerably caudad, the protruding mesal portion truncate. Without a median sulcus or with but weak trace of such toward caudal end.

Ventral plates from the second to the penult with a strongly marked median longitudinal furrow which is continuous from the anterior margin to a little in front of the caudal border. Lateral sulci extending from anterior margin to caudal portion of plate, converging with each lateral margin. Not distinctly punctate.

Last ventral plate considerably wider than long; narrowed caudad; posterior corners well rounded; caudal margin widely though but moderately convex, slightly crenately notched each side of the middle.

Spiracles moderate; mostly elliptical, being obliquely or rather more dorsoventrally compressed.

Coxopleural processes long and straight; ending in a single slender and acute spine; process with but scattered short hairs.

Prefemur of anal legs armed ventrally with a series of six large spines and, in addition, on mesal surface with about eighteen spinules arranged in four longitudinal series. Femur armed ventrally with two spinules on proximal half and in a longitudinal line. Other joints unarmed. Tibia with rather sparse and moderately long hairs. Joints of tarsus with more numerous similar hairs. Second division of tarsus indistinctly segmented. First joint or division of tarsus considerably thicker than the second division and more slender than the tibia; half or a little more than half the length of the latter (17:32.) (Plate **2**, fig. 3).

Length of largest specimen 28 mm.

Locality.— State of Pará: Pará, suburb of Souza! (Mann and Baker). Three individuals, two adult and one immature, were secured.

Newportia longitarsis (Newport).

Scolopocryptops longitarsis Newport, Trans. Linn. soc. London, 1844, **19**, p. 407, pl. 40, fig. 10.

Newportia longitarsis Gervais, Insect. Aptères, 1847, **4**, p. 298; Humbert et Saussure, Rev. mag. zool., 1869, ser. 2, (**21**), p. 159; Miss. scient. Mex., 1872, p. 138; Pocock, Journ. Linn. soc. London, 1893, **24**, p. 416; Brölemann, Ann. Soc. ent. France, 1903, **67**, p. 251; Kraepelin, Revis. Scolop., 1903, p. 86; Brölemann, Cat. Myr. Brésil, 1909, p. 10.

Locality.— State of Amazonas: Manáos. (sc. Brölemann); Colombia; Central America, etc.

Newportia longitarsis sylvae, subsp. nov.

General color ochre-yellow, most of the dorsal plates being darker, more reddish, along caudal borders. Head darker, of a more ferruginous tinge. Antennae and legs yellowish.

Head deeply and regularly, but not densely, punctate. The paired submedian sulci present only as short impressions at caudal border; a short, wider, transverse furrow, in front of their anterior ends. A rather fine median longitudinal furrow at anterior end.

Antennae composed of from fifteen to seventeen articles, there being in one type specimen fifteen in the right antenna and sixteen in the left, one of those in the latter being, however, of double length and apparently representative of two normal articles. None of the articles shining or glabrous; but the hairs of the first two distinctly more sparse, those of third and fourth more dense, but only the fifth and subsequent articles fully clothed in the usual manner.

Prosternum with anterior margin nearly straight, being a little more elevated at each ectal end than at middle where it is very slightly notched; edge well chitinized but without true dental plates. Sub-sparsely punctate.

Cervical furrow of first dorsal plate strictly semicircular, distinctly exposed excepting laterally. Two median longitudinal sulci distinct; parallel excepting toward anterior ends where they diverge somewhat and finally meet the transverse sulcus; not at all branched anteriorly; but near caudal end each is joined by a strictly transverse sulcus which extends out toward lateral margin. Plate semicircularly depressed transversely in middle region near cervical sulcus (Plate **2**, fig. 1). Second dorsal plate with paired sulci extending entirely across length; converging cephalad and near anterior end united with a network of very fine anastomozing transverse lines or sulci (Plate **2**, fig. 1). Other dorsal plates to and including the twenty-second with two distinct and subparallel longitudinal sulci across entire length. The third plate with a fine but distinct straight sulcus running from anterior end of each longitudinal sulcus obliquely caudoectad to the lateral margin (Plate **2**, fig. 1). Plates from the fifth to the twenty-second inclusive with a longitudinal furrow between each longitudinal submedian sulcus and the lateral margin. Last dorsal plate without a median longitudinal furrow. Caudally bowed out, with the extended mesal portion truncate.

Ventral plates with the usual median longitudinal furrow joining the distinct transverse sulcus across the caudal portion of plate but not extending across the anterior portion. Also with a distinct abbreviated longitudinal sulcus on each side convergent with lateral margin. Plates sparsely punctate. Last ventral plate considerably narrowed caudad. Caudal margin moderately incurved at middle. Wider than long in about ratio 34:29.

Spiracles moderately large; mostly narrower ventrad, roundly subtriangular.

Coxopleurae of twenty-third segment with caudal processes rather short, ending in a single spine-pore area extensive.

Tarsi of anterior legs not distinctly divided. Legs clothed sparsely with stiff bristles, but with no spinules. Tibiae of anterior pairs armed laterally at distal end with a stout spine. Prefemur of anal legs armed ventrally with a row of four stout spines which increase regularly in size distad; on mesal surface with about four irregular series of small bristles and with a similar series on dorsal side near mesal edge and also similar series over ectal surface, also a few scattered longer bristles present, but no true spinules present. Femur with a stout spine on mesal surface near the proximal end and toward the ventral surface; otherwise unarmed. Other joints, so far as ascertainable from types, bearing rather scattered and short hairs, excepting the tarsi on which they are longer and more dense. Tibia broadly constricted toward each end. First article of tarsus a little more than half as long as the tibia (ratio cir. 17:30); of same thickness as the immediately succeeding articles; the latter distinct and clearly separated from each other. (Plate **2**, fig. 2).

Length cir. 36 mm.

Localities.— State of Matto Grosso: Madeira-Mamore R. R. camps 39 and 41 on the Rio Madeira! (W. M. Mann). One specimen from each locality.

Newportia collaris Kraepelin.

Revis. Scolop. 1903, p. 90.

Localities.— State of Pará: Pará, suburb of Souza! (Mann and Baker); State of Amazonas: Lower Carsevenne, Brazilian Guiana.

This second locality is the type locality and the two are the only ones recorded for the species.

Newportia bicegoi Brölemann.

Rev. Museu Paulista, 1903, **6**, p. 67, pl. I, fig. 1; Kraepelin, Revis. Scolop., 1903, p. 93.

Locality.— State of Amazonas: Manáos.

Otostigmidae.

This tropical and subtropical family is known from Australia, Asia, Africa, and the warmer parts of America. It is represented in the known fauna of Brazil by two genera, Otostigmus, the large typical genus, and Trematophycus.

Otostigmus Porat.

Bih. Svensk. vet. akad. Handl., 1876, **4**, no. 7, p. 18; Meinert, Vid. Medd. nat. foren. Kjøbenhavn, 1884, p. 118; Proc. Amer. philos. soc., 1886, **23**, p. 183; Pocock, Biol. Centr. Amer. Chilopoda, 1895, p. 25; Kraepelin, Revis. Scolop., 1903, p. 97; Verhoeff, Bronn's Thierreich, 1907, **5**, p. 254,

Branchiotrema Kohlrausch, Journ. Mus. Godef., 1878, p. 70; Archiv. naturg., 1881, **47**, 1, p. 70.
Parotostigma Pocock, Biol. Centr. Amer. Chilopoda, 1895, p. 25.

Of this genus nine species are at present known from Brazil, five of these being here described as new.

Key to Species.

a. Tarsal spines wholly absent or, rarely, a few of the legs with a much reduced spine.................. *O. limbatus* (Meinert).

aa. Tarsal spines present and distinct.

b. Dorsal plates of caudal half of body distinctly scabrous, bearing rows of fine elevated spinous points.

c. Last ventral plate without distinct median sulcus; only the two proximal articles of the antennae glabrous; with five rather small keels or keel-like elevated lines on dorsal plates of caudal portion of the body... *O. casus*, sp. nov.

cc. Last ventral plate with a distinct median longitudinal sulcus; two and a fourth or two and a half proximal articles of antennae glabrous; only a single, flat, median keel present on dorsal plates.

d. Twentieth legs without a tarsal spine; only one tooth on each dental plate distinct, the others being completely fused; head and first dorsal plate abruptly different in color from the other plates, brownish. *O. rex*, sp. nov.

dd. Twentieth legs with a tarsal spine; each dental plate with four distinct teeth; head and first dorsal plate not abruptly different in color from the other plates, olivaceous..... *O. scabricaudus* Humbert et Saussure.

bb. All dorsal plates smooth, those of the caudal half of the body not distinctly scabrous.

c. First eighteen or nineteen pairs of legs with two tarsal spines.

d. First eighteen pairs of legs with two tarsal spines; twentieth legs with a tarsal spine; dorsal plates with a conspicuously elevated double keel each side of middle, the dorsal sulcus of each side lying between the halves of this keel.......... *O. tidius*, sp. nov.

dd. First nineteen pairs of legs with two tarsal spines; twentieth legs with no tarsal spine; dorsal plates without such conspicuous keels or ridges.
O. goeldi Brölemann.

cc. Legs of only the first two to the first six pairs with two tarsal spines or all with but a single tarsal spine.

d. Last dorsal plate in the male ending in a process as long as the plate proper, in the female caudally acutely angular or at least rectangular; ventral plates wholly without furrows or pits......*O. caudatus* Brölemann.

dd. Last dorsal plate in both sexes simply bowed out caudad, not acutely angular; ventral plates with distinct depressions or pits.

e. Ventral plates from the second to the twentieth with distinct sulci reaching to beginning of caudal third or fourth of length; first six pairs of legs with two tarsal spines; only the first two articles of antennae glabrous........*O. amazonae*, sp. nov.

ee. Sulci of ventral plates indicated only as short traces at the anterior border; only the first two pairs of legs with two tarsal spines; first three articles of antennae glabrous.
O. tibialis Brölemann.

Otostigmus limbatus Meinert.

Vid. Medd. nat. foren. Kjøbehavn, 1884, p. 120; Karsch, Berl. ent. zeitschr., 1888, **32**, p. 31; Silvestri, Ann. Mus. civ. stor. nat. Genova, 1895, ser. 2, **14**, p. 766; Boll. Mus. zool. anat. comp. R. univ. Torino, 1895, **10**, p. 23; Brölemann, Rev. Museu Paulista, 1901, **5**, p. 37; Kraepelin, Revis. Scolop., 1903, p. 130; Cat. Myr. Brésil, 1909, p. 13.

Localities.— "Brazil" (sec. Meinert; spec. Mus. Copenhagen); State of São Paulo: Alto da Serra, Santos.

This species is also known from Paraguay, from where two of Meinert's typical specimens came, and from Argentina (Buenos Aires).

Otostigmus amazonae, sp. nov.

Bluish green to olive-brown; with a fine median longitudinal pale line. Head distinctly darker, deeper green. Antennae bluish green proximally, paler distad. Legs more pigmented distally than proximally; the posterior pairs green or bluish green excepting toward base.

Head shining; punctae weak and more or less scattered. The usual two longitudinal furrows of the caudal portion, these being shallow.

Antennae composed of seventeen articles of which only the first two are glabrous.

Prosternal teeth 4–4 of which the outermost on each side is more remote and is separated by a deeper interval than the others are from each other; innermost tooth on each side smallest, the two intermediate ones of nearly equal size.

Dorsal plates from the fourth segment on distinctly bisulcate. Only the twenty-first plate truly margined but the others of the posterior half of the body especially, with submarginal longitudinal furrows or depressions which simulate true margination. Plates, wholly smooth and with no indication on any of a median keel. Last plate more or less angularly produced, the margin bent in on each side of the middle (Plate **3**, fig. 2); with no developed sulci or pits, the plate somewhat longitudinally elevated along the median line and faintly depressed or furrowed along the middle of this.

Ventral plates from second to twentieth with two longitudinal sulci extending to caudal third or fourth of length where each at its end is more deeply impressed. A short pit-like, median, depression in front of the caudal margin and a less pronounced median depression farther cephalad. Last ventral plate convex. Strongly narrowed caudad; caudal margin mesally excised. With a weak median sulcus and also on each side a faint fine sulcus from anterior margin to near middle (Plate **3**, fig. 1).

Coxopleurae not produced, being caudally simply rounded; unarmed.

First six pairs of legs with two tarsal spines; the seventh to nineteenth with one; twentieth legs with none. Anal legs wholly unspined, being smooth throughout.

Length 23 and 32 mm.

Locality.— State of Amazonas: Manáos! (Mann and Baker).

Two specimens were secured.

This species seems to be related to *O. limbatus* Meinert, but is very easily separated through the differences in the spining of the tarsi as indicated in the key.

Otostigmus suitus, sp. nov.

Color olive-green with some of the dorsal plates appearing darker along the caudal margin. Antennae more brownish excepting at base.

Head distinctly punctate. Marked in front of caudal margin with two short longitudinal furrows.

Antennae seventeen jointed.[1] First two or two and a half articles glabrous (the third in type partially rubbed so that precise extent of glabrous condition is uncertain); other articles clothed densely with the usual short brown hairs.

Dorsal plates from the fourth, inclusive, caudad with two distinct median sulci; a longitudinal depression or furrow on each side, but true margination present only on the twenty-first plate, plates mostly depressed between median sulci and with a weakly developed median keel indicated on plates from the third caudad; the surface and edges of plates wholly smooth. Last dorsal plate with posterior margin bowed moderately caudad. A median pit-like depression in front of caudal margin and a keel in front of this as on the other plates. (Plate 3, fig. 4).

Prosternum with 4+4 teeth of which the second from the mesal incision on each side is the largest, the third being next.

Ventral plates without a trace of longitudinal sulci. Each with three distinct, pit-like, or more or less longitudinal, impressions arranged in a triangle with the apex cephalad, and with three short longitudinal impressions in a transverse row in front of the caudal margin. Last ventral plate strongly narrowed caudad. Truncate caudad with the corners a little rounded. Impressed with a distinct median longitudinal furrow. (Plate 3, fig. 3).

Coxopleurae of last legs without any true process, being a little roundly extended caudad; without any spines.

Length cir. 55 mm.

Locality.— State of Matto Grosso: Madeira-Mamore R. R. camp 41, on the Rio Madeira! (W. M. Mann).

One specimen was secured.

[1] On one side of type specimen there are but thirteen articles in the antenna, this being due, apparently, to breaking off of the antenna with subsequent regeneration of the distal article.

Otostigmus tidius, sp. nov.

Brown, of more or less ferruginous tinge caudad and also being darker cephalad; plates mostly darker along caudal edges. Antennae very dark.

Head finely densely punctate. With no true sulci; but on the anterior portion an unusually deep median longitudinal furrow and also a similar one caudad of the middle with on each side of the latter a short, more shallow, furrow diverging from it cephalad.

Antennae composed of seventeen articles of which the first two are glabrous.

Prosternal teeth 4+4; the three innermost on each side nearly on a level and about equal in size, but the most ectal one situated more proximad, being at about the middle of lateral edge of dental plate. Process of first joint of prehensors notched or toothed on mesal side below apex. (Plate 2, fig. 6).

All dorsal plates with a distinct median longitudinal furrow, on each side of which, in most of the plates, there is a double longitudinal ridge between the two edges or keels of which lies the longitudinal sulcus of the corresponding side. Ectad of this double keel there is a much lower, often indistinct, keel. Plates longitudinally deeply fluted or furrowed along each lateral nargin, producing the appearance of margination; but only the twenty-first plate truly margined. The keels are not well indicated on the first three or four plates. The median sulci are distinct from the fourth or fifth plates caudad. Last plate with caudal edge moderately bowed caudad. The median furrow distinct. An elevation or ridge each side of the middle divided by a weak furrow corresponding to that on the more anterior plates. (Plate 2, fig. 7).

Ventral plates with indications of the longitudinal sulci over the anterior portion, but the traces very short. Without any distinct pits or similar depressions. Last ventral plate strongly narrowed caudad. Caudally convexly rounded, not at all mesally incurved. A rather fine median longitudinal furrow present. (Plate 2, fig. 8).

Coxopleurae without true processes; but a little extended caudad, the corner being well rounded.

The first to the eighteenth pairs of legs with two tarsal spines, but the lateral spine on the eighteenth minute and that of the seventeenth intermediate in size. Nineteenth and twentieth legs with but a single tarsal spine.

Length cir. 14.5 mm.

Locality.— State of Amazonas: Manáos! (Mann and Baker). One specimen.

OTOSTIGMUS REX, sp. nov.

Dorsum, excepting the first plate, dark olive, the plates somewhat paler along the caudal borders. Head and first dorsal plate conspicuously and abruptly different in color, being clear brown or somewhat testaceous, the head darker in middle region and in a narrow band running ecto-caudad on each side. Antennae and anal legs conspicuously rosaceous in color, the pairs of legs immediately preceding the last more weakly tinged with this color; other legs very pale clear brownish, weakly tinged with greenish. Prosternum clear brown. Venter similar to legs, darkest anteriorly.

Cephalic plate punctate the punctae very fine and rather weak.

Antennae composed of seventeen articles of which the first two and a half are glabrous and shining.

Prosternum with each dental plate bearing a distinctly separated tooth at each ectal end; but with the other teeth thoroughly fused into a continuous plate with no or but obscure traces of the separate ones. The longitudinal sulcus between the two plates of moderate depth.

Dorsal plates from the sixth on with very fine paired longitudinal sulci extending entire length of plate. From the third plate caudad there are longitudinal depressions mesad of each lateral margin which become deeper in caudal region and thus more sharply separating off the edge or simulating margination. From the third plate caudad a flat median keel is indicated, this on the anterior plates being obscure but posteriorly becoming more distinctly set off by the deepening of the limiting furrows on each side of it. Plates, especially the more caudal ones, rugose in the lateral depressions, the anterior ones otherwise smooth; but the posterior plates, and especially the last five or six, while appearing to the naked eye rather smooth, under the lens are seen to be finely scabrous, bearing over the entire surface, including edges and keel, rows of small, elevated, spinous points. Last dorsal plate bowed out caudad, the extended portion convexly rounded. In front of mesal portion of caudal edge a conspicuous and deep, pit-like, depression from the anterior edge of which a median keel runs cephalad across the plate; surface finely scabrous as on the other plates.

Ventral plates without longitudinal sulci. From the third or, more indistinctly, the second to the twentieth plate with three pits, mostly deep and distinct, arranged in the form of a triangle with the median one cephalad, the three more or less clearly connected by more shallow depressions giving sometimes the appearance of a single V- or U-shaped impression. In addition there is a transverse row of three pit-like depressions in front of the caudal margin as in various related species, these pits on some of the more caudal plates lying in a more or less distinct transverse furrow. Last ventral plate long; conspicuously narrowed caudad; truncate or slightly inbent at the middle. A distinct longitudinal median sulcus across the entire length.

Coxopleurae very slightly extended at mesocaudal corners, where they are wholly unarmed.

First legs with two tarsal spines. Second to nineteenth pairs of legs with a single tarsal spine; twentieth pair with no tarsal spine. Anal legs of moderate length. Prefemur clavately widening from base distad. Wholly smooth.

Length cir. 78 mm.

Locality.— State of Matto Grosso: Madeira-Mamore R. R. camp, 39, on the Rio Madeira! (Mann and Baker).

One specimen.

This species lies in the group of forms closely allied with *scabricaudus* in which the females are not easily distinguishable. The coloration of the present species is of a characteristic type similar to that of some Scolopendras and also present in *O. caudatus* and in several African species of this genus; in these forms the head and first dorsal plate being abruptly and conspicuously different in color from the rest of the dorsum. The species also differs from *scabricaudus* in being less strongly scabrous, in having no tarsal spine on the twentieth legs, in having a larger proportion of the third antennal article glabrous, and in having all the teeth excepting the most ectal on each side of the prosternum thoroughly fused together. The type is larger than the maximum measurement recorded for *scabricaudus* (70 mm.).

Otostigmus casus, sp. nov.

Olive-green in color above, brighter along the caudal margins of plates. Head more brown. Antennae brown of greenish caste, the first two articles clearer green. Legs pale brown of dilute greenish tinge. Venter lighter olive, the last ventral plate and the coxopleurae more brownish. Prosternum light greenish brown.

Head subdensely punctate, the punctae being moderately fine and not sharply impressed or limited.

Antennae composed of seventeen articles of which the first two are glabrous and shining, the others being densely pubescent as usual.

Dorsal plates from the fifth to the twentieth with the two longitudinal sulci present and complete; fine. Lateral portions of plate from the fifth caudad depressed leaving the lateral margin distinctly elevated, especially in the middle and caudal regions, but true margination present only on the twenty-first plate. The depressed lateral portion of the plate rugose, the main rugae being longitudinal. The elevated margins, the rugae, and, less extensively, the intermediate surface, roughened with series of numerous spinulose points. From the fifth or sixth plates on a median longitudinal keel is indicated, this being at first obscure but becoming more and more distinct caudad, while at the same time on each side of it and just mesad of the sulcus appears another keel, the three keels being distinct on the caudal segments; the keels are scabrous like the lateral portions of the plates. Last dorsal plate with the posterior edge moderately bowed out caudad and mesally truncate. With three longitudinal keels corresponding to those of the other plates extending from the anterior margin caudad two thirds the length of the plate, the plate caudad of their ends having a shallow pit-like depression. Keels and general surface scabrous.

Sulci of ventral plates detectable only as very short traces at the anterior border of each. With three pit-like depressions arranged in a triangle as usual, these being of but moderate depth and size and not coalesced. In addition there are three other depressions along the caudal border separated from those of the triangle by a distinct transverse sulcus. On some of the more caudal plates the anterior median pit may be extended a considerable distance caudad as a median furrow. Last ventral plate conspicuously narrowed caudad, the sides being convex at anterior ends but straight for most of their length. Caudal margin with lateral halves straight and meeting in the middle in a slightly reentrant angle. No distinct median sulcus present.

Coxopleurae a little extended caudad at caudomesal corners which are simply rounded, no distinct process being developed, wholly unarmed.

Only the first pair of legs with two tarsal spines. Second to eighteenth pairs with a single tarsal spine. Nineteenth to twenty-first pairs unknown, being absent from the only specimen known.

Length 57 mm.

Locality.— State of Matto Grosso: Madeira-Mamore R. R. camp 39, on the Rio Madeira! (W. M. Mann).
One specimen.

Otostigmus goeldi Brölemann.

Ann. Soc. ent. France, 1898, **67**, p. 249, pl. 20, fig. 2; Kraepelin Revis. Scolop., 1903, p. 128; Brölemann, Cat. Myr. Brésil, 1909, p. 12.

Locality.— State of Para: Para (sec. Brölemann).

Otostigmus scabricaudus (Humbert and Saussure).

Branchiostoma scabricauda Humbert et Saussure, Rev. mag. zool., 1870, p. 203; Saussure et Humbert, Études Myr., 1872, p. 121, pl. 2, fig. 15, etc.; Kohlrausch, Archiv. naturg., 1881, **47**, 1, p. 75.
Otostigmus appendiculatus Porat, Bih. Svensk. vet. akad. Handl., 1876, **4**, p. 23.
Otostigma brasiliense Meinert, Vid. Medd. nat. foren, Kjøbenhavn, 1884, p. 119.
Otostigmus brasiliensis Karsch, Berl. ent. zeitschr., 1888, p. 31.
Otostigmus scabricaudus Pocock, Ann. mag. nat. hist., 1890, ser. 6, **6**, p. 142, Brölemann, Mem. Soc. zool. France, 1900, **13**, p. 96; Rev. Museu Paulista, 1901, **5**, p. 40; Kraepelin, Revis. Scolop., 1903, p. 126, fig. 61; Brölemann, Cat. Myr. Brésil, 1909, p. 13.

Localities.— State of Bahia: Bahia; State of Minas Geraes; State of Rio de Janeiro: Rio de Janeiro (type locality), Rio Espirito Santo; State of São Paulo: Alto da Serra, Piquete.

Otostigmus caudatus Brölemann.

Rev. Mus. Paulista, 1901, **5**, p. 39, pl. 1, fig. 1–3; Kraepelin Revis. Scolop., 1903, p. 132, fig. 71, 72; Brölemann, Cat. Myr. Brésil, 1909, p. 12.

Localities.— State of São Paulo: São Paulo, Belém, Alto da Serra, Itapetininga.

OTOSTIGMUS TIBIALIS Brölemann.

Rev. Mus. Paulista, 1901, **5**, p. 39, fig. 4, 5.
Otostigmus caudatus tibialis Kraepelin, Revis. Scolop., 1903, p. 132, fig. 73, 74.
Otostigmus caudatus Brölemann, Cat. Myr. Brésil, 1909, p. 13.

Localities.— State of São Paulo: São Paulo, Piquete, Alto da Sérra, Santos; State of Parana.

TREMATOPHYCUS Peters.

Reise Mozambique. 1862, **5,** p. 519.
Branchiostoma Newport (*nom. preocc.*) Trans. Linn. soc. London, 1844, **19**, p. 411; Meinert, Proc. Amer. philos. soc., 1886, **23**, p. 182.
Ptychotrema Peters (*nom. preocc.*), Monatsb. Berl. akad., 1855, p. 82.
Rhysida Wood, Journ. Acad. nat. sci. Phil., 1862, ser. 2, **5**, p. 40; Pocock, Ann. mag. nat. hist., 1891, ser. 6, **7**, p. 58; Kraepelin Revis. Scolop., 1903, p. 139; Verhoeff, Bronn's Thierreich, 1907, **5**, p. 57.
Ethmophora Pocock, Ann. mag. nat. hist., 1891, ser. 6, **7**, p. 58.

Of this genus three species are at present known from Brazil, and a fourth is practically certain to occur there and is accordingly introduced into the following key.

Key to Species.

a. At least some of the dorsal plates with the paired submedian sulci crossing entire length of plate.
  b. Only the twenty-first dorsal plate margined; prefemur of anal leg with one (or two) ventral spines.
  T. nudus (Newport).
  bb. Some of the dorsal plates cephalad of the twenty-first also distinctly margined.
    c. Prefemur of the anal legs wholly unarmed; process of coxopleurae short, subtriangular, without lateral spines.
    T. celeris (Humbert and Saussure).
    cc. Prefemur of anal legs armed with eight to thirteen spines; process of anal coxopleurae long, with one or two lateral spines in addition to the terminal ones.
    T. longipes (Newport).

aa. None of the dorsal plates with sulci crossing its entire length, these appearing at most as short traces at ends of plates. Prefemur of anal legs wholly unspined.
T. brasiliensis (Kraepelin).

TREMATOPHYCUS NUDUS (Newport).

Branchiostoma nudum Newport, Trans. Linn. soc. London, 1844, **19**, p. 412.
Branchiostoma gymnopus Kohlrausch, Arch. naturg., 1881, **47**, p. 67.
Branchiostoma gymnopus ceylonicum Haase, Abhandl. Mus. Dresden, 1887, **5**, p. 86.
Rhysida immarginata var. Pocock, Biol. Centr. Amer. Chilopoda, 1896, p. 26.
Rhysida nuda Kraepelin, Revis. Scolop., 1903, p. 144.

Locality.— While not specifically recorded from Brazil, it is distributed widely in Mexico and Central America as well as in Paraguay, so that its occurrence in Brazil is practically certain.

TREMATOPHYCUS LONGIPES (Newport).

Branchiostoma longipes Newport, Trans. Linn. soc. London, 1844, **19**, p. 411; Haase, Abhandl. Mus. Dresden, 1887, **5**, p. 84.
Branchiostoma obsoletum Porat. Bih. Svensk. vet. akad. Handl., 1876, **4**, no. 7, p. 25.
Branchiostoma gracile Kohlrausch, Archiv naturg., 1881, **47**, 1, p. 66.
Branchiostoma affine Kohlrausch, Ibid., p. 67.
Branchiostoma longipes rotundatum Haase, *loc. cit.*
Rhysida longipes Pocock, Biol. Centr. Amer. Chilopoda, 1896, p. 27; Kraepelin, Revis. Scolop., 1903, p. 148, fig. 91; Brölemann, Cat. Myr. Brésil, 1909, p. 14.

Localities.— "Brazil" (M. C. Z. coll.; also W. M. Mann, without precise locality); State of Bahia.

TREMATOPHYCUS CELERIS (Humbert and Saussure).

Branchiostoma celer Humbert et Saussure, Rev. mag. zool., 1876, ser. 2, **22**, p. 202; Kohlrausch, Arch. naturg., 1881, **47**, 1, p. 69, Meinert, Proc. Amer. philos. soc., 1886, **23**, p. 183.
Rhysida celeris Silvestri, Mus. zool. anat. comp. R. univ. Torino, 1895, **10**, p. 23; Pocock, Biol. Centr. Amer. Chilopoda, 1896, p. 27; Kraepelin, Revis. Scolop., 1903, p. 149; Brölemann, Cat. Myr. Brésil, 1909, p. 14.

Localities.— State of Matto Grosso: Madeira-Mamore R. R. camp 39, on the Rio Madeira!, Abuná, Bolivia! (W. M. Mann); State of Rio Grande do Norte: Ceará-Mirim! (Mann and Heath. The specimen from this locality variant).

Trematophycus brasiliensis (Kraepelin).

Rhysida brasiliensis Kraepelin, Revis. Scolop., 1903, p. 152, fig. 95, 96.

Localities.— State of Minas Geraes; State of Rio de Janeiro: Rio Espirito Santo.

Scolopendridae.

Of this family the genera Scolopendropsis, Cupipes, Cormocephalus (probably introduced), Hemiscolopendra, and Scolopendra are known in the Brazilian fauna.

Scolopendropsis Brandt.

Bull. sci. Acad. imper. sci. St. Peterburg, 1840, **7**, p. 24; Kraepelin Revis. Scolop., 1903, p. 179; Verhoeff, Bronn's Thierreich, 1907, **5**, p. 50.
Rhoda Meinert, Proc. Amer. philos. soc., 1886, **23**, p. 188.
Pithopus Pocock, Ann. mag. nat. hist., 1891, ser. 6, **7**, p. 223; Kraepelin, Revis. Scolop., 1903, p. 171; Verhoeff, Bronn's Thierreich, 1907, **5**, p. 259.

Two species, the only valid ones known, occur in Brazil.

Scolopendropsis bahiensis Brandt.

Bull. sci. Acad. imper. sci. St. Peterburg, 1840, **7**, p. 24; Kraepelin, Revis. Scolop., 1903, p. 171; Brölemann, Cat. Myr. Brésil, 1909, p. 31.
Rhoda thayeri Meinert, Proc. Amer. philos. soc., 1886, **23**, p. 188.
Pithopus inermis Pocock, Ann. mag. nat. hist., 1891, ser. 6, **7**, p. 223, pl. 5, f. 5; Kraepelin, Revis. Scolop., 1903, p. 172.
Scolopendropsis thayeri Brölemann, Cat. Myr. Brésil, 1909, p. 32.

Localities.— State of Bahia: Bahia, Iguarassu (the type locality of *inermis* (Pocock)). State of Para: Santarem (the type locality of *thayeri* (Mein.)).

Kraepelin suggests the identity of *thayeri* Meinert with *calcaratus* Pocock; but an examination of the type of *thayeri* shows that it is the same as the *inermis* of Pocock and that both are the same as Brandt's *bahiensis* which has long priority. Through probable error twenty-three pairs of legs were attributed to Brandt's species, although the not very probable suggestion has been made that the species is dimorphic, having some individuals with twenty-three and others with twenty-one pairs of legs.

Scolopendropsis calcaratus (Pocock).

Pithopus calcaratus Pocock, Ann. mag. nat. hist., 1891, ser. 6, **7**, p. 224, pl. 5, fig. 3.
Scolopendropis calcaratus Brölemann, Ann. Soc. ent. France, 1902, **71**, p. 651; Cat. Myr. Brésil, 1909, p. 32.

Localities.— State of Bahia: Bahia (type locality), Santo Antonio da Barra; State of Rio Grande do Norte: Natal! (W. M. Mann). Ceará-Mirim! (Mann and Heath).

Cupipes Kohlrausch.

Archiv. naturg. 1881, **47**, 1, p. 78; Kraepelin, Revis. Scolop., 1903, p. 174; Verhoeff, Bronn's Thierreich, 1907, **5**, p. 260.

Key to Species.

a. Femur or second joint of anal legs armed dorsally at distal end with two bifid spines, one on each side of the longitudinal furrow. *C. brasiliensis* Humbert and Saussure.
aa. Femur of anal legs unarmed.
  b. Only the twenty-first dorsal plate distinctly margined.
    c. Most legs with a tarsal spine; last ventral plate parallel sided, not narrowed caudad........*C. spinifer* Kraepelin.
    cc. All legs without tarsal spines; last ventral plate narrowed caudad.
      d. Prefemur of anal legs with about five to eleven spines distributed over its surface....*C. ungulatis* Meinert.
      dd. Prefemur with only two spines, these being those at dorsomesal angle of distal end. *C. ungulatis mitis* Brölemann.
  bb. Plates from seventh to tenth caudad also margined as well as the twenty-first.
    c. Coxopleura with a short but distinct process at mesocaudal corner (Plate **2**, fig. 9); each dental plate of prosternum with an elongated ectal process and a single mesal tooth at base of this (Plate **3**, fig. 5); head distinctly longer than wide..........*C. amazonae*, sp. nov.
    cc. Coxopleura with no such process, simply rounded at mesocaudal angle (Plate **3**, fig. 8); each dental plate with four subsimilar teeth of the usual form (Plate **3**, fig. 7); head equal in length and breadth......*C. neglectus*, sp. nov.

Cupipes brasiliensis (Humbert and Saussure).

Cormocephalus brasiliensis Humbert et Saussure, Rev. mag. zool., 1870, ser. 2, **22**, p. 203; Saussure et Humbert, Etude Myr. 1872, p. 124, pl. 6, fig. 17.
Cupipes brasiliensis Brölemann, Cat. Myr. Brésil, 1909, p. 8.

Locality.— Brazil.

This species was regarded, doubtfully, as the same as *C. ungulatis* Meinert by Meinert as well as by Kraepelin. But, as pointed out by Brölemann, and as indicated in the key above, the presence of the dorsal spines on the second joint of the anal legs seems clearly to separate *brasiliensis* from Meinert's species. At any rate, until the Brazilian fauna is better known, or specimens of *ungulatis* are shown to present the important variation mentioned, it would be quite premature to ignore this characteristic.

Cupipes spinifer Kraepelin.

Revis. Scolop., 1903, p. 177, fig. 117.

Locality.— State of Pará: Pará (type locality).

Known from a single specimen in the Hamburg Museum.

Cupipes ungulatis Meinert.

Proc. Amer. Philos. soc., 1886, **23**, p. 187; Brölemann, Rev. Museu Paulista, 1903, **6**, p. 64; Cat. Myr. Brésil, 1909, p. 9.

Localities.— State of Pernambuco: Pernambuco! (type locality); State of Amazonas: Manáos (sec. Brölemann).

Cupipes ungulatis mitis Brölemann.

Rev. Museu Paulista, 1903, **6**, p. 65; Cat. Myr. Brésil, 1909, p. 9.

Locality.— State of Amazonas: Manáos (type locality).

This and the preceding form are known at present from too few specimens to be able properly to judge of their precise relationship. Considerable variation has already been noted in the spining of the prefemur of *C. ungulatis;* and it may prove not possible to segregate the forms on the basis of this character.

CUPIPES AMAZONAE, sp. nov.

Dorsum olive or olive-brown; most of the plates of the middle and anterior regions of body with a blackish spot or short stripe at each lateral margin; in the plates of the median region also a dark spot on caudal border at caudal end of each sulcus or the two spots may be united as a transverse band. Head darker, more brownish and dusky. Antennae bright green. Prosternum and prehensorial feet clear brown, the latter rufous laterally and especially distally proximad of the black claw proper.

Head clearly longer than wide (46:41). Sides a little convex just behind the eyes and then substraight and a little converging to the caudal corners. Finely and uniformly subdensely punctate. The two diverging longitudinal sulci reaching or very nearly reaching the anterior margin, each terminating in a transverse sulcus slightly removed from the edge of antennal socket with which it runs parallel.

Antennae composed of seventeen articles of which the first seven are glabrous or practically so and in this respect sharply separated from the more distal group.

Prosternum with two sharply defined longitudinal sulci converging cephalad and uniting at an angle at anterior end; these sulci crossed by a transverse sulcus which is branched and has anastamoses as shown in Plate 3, fig. 5. Dental plate without true teeth, but bearing an elongate ectal process with on mesal side at base a low, dark, dentiform elevation (Plate 3, fig. 5); on one side the plate is malformed as shown in the figure, this probably being due to injury with imperfect subsequent regeneration.

Margination of the dorsal plates indicated from about the seventh caudad but not very distinctly until the tenth. Plates with an obscure low median keel defined by two indistinct longitudinal furrows; also a vague furrow laterad of each median sulcus may be indicated. Last dorsal plate with a sharply impressed median longitudinal sulcus.

Second to twentieth ventral plates with the usual two longitudinal sulci crossing the plate. A rather vague transverse furrow may be traced at the level of the legs; while on some plates indications of a very weak median longitudinal furrow may be detected. Last ventral plate clearly wider at its anterior end than long (2.6:2). Sides strongly converging caudad; plate truncate caudad, the corners a little rounded. Without a median sulcus or furrow. (Plate 2, fig. 9).

Coxopleurae with a short but distinct process at mesocaudal corner, the process bearing two spines; not spined on coxopleural margin laterad of the process proper. Porose area not fully reaching the caudal margin. (Plate **2**, fig. 9).

Anal legs with articles proximad of the tarsus much thickened, especially from side to side as usual. Prefemur and especially the femur deeply longitudinally furrowed dorsally at distal ends. Prefemur with a distinct spine at mesodistal angle on dorsal side; two small spines near upper edge of mesal surface and three more ventral, two being at the distal end ventrad of the corner spine and one toward the proximal end; in addition there are four strictly ventral spines, two in each of two rows. Femur wholly unarmed.

Length cir. 43 mm.

Locality.— State of Amazonas: Manáos! (Mann and Baker).

One specimen.

Cupipes neglectus, sp. nov.

Dorsum brown. Head olivaceous. Antennae bluish green. Legs pale.

Head equal in length and breadth. Sulci distinct, diverging cephalad and each reaching the margin at the eye. Punctae scattered.

Antennae composed of seventeen articles. In the type the antennae are considerably rubbed; but apparently the first article is wholly glabrous and the second one nearly so, the third and fourth with an intermediate number of hairs and the fifth and subsequent ones with the full complement.

Prosternum with two longitudinal submedian sulci which meet at an angle anteriorly; not crossed by any distinct transverse lines. Dental plates bearing 4+4 teeth which are of normal form and long and acute; the two intermediate teeth on each side longest; the most ectal tooth situated distinctly more proximad (Plate **3**, fig. 7).

Dorsal plates margined from the eighth or ninth segment caudad, the margination becoming more and more distinct in going toward the caudal end. Sulci continuous and very distinct on all the plates excepting the last. First to third plates with a median longitudinal furrow; the fourth plane; those from the fifth caudad with a low median longitudinal keel which is flat and set off by two shallow furrows in the usual way. Last dorsal plate with a sharply impressed median longitudinal sulcus.

Ventral plates from the second to the twentieth distinctly bisulcate. Some of the plates showing an indistinct median depression on caudal portion. Last ventral plate narrowed caudad; sides straight; caudal margin also straight. A little wider across anterior end than long (ratio cir. 39:37). With a rather weak median longitudinal sulcus.

Coxopleurae of last legs not at all produced caudad. Bearing one or two closely approximate spines at mesocaudal angle; none ectad of this. Porose area not reaching caudal margin by a considerable distance.

Length of the two types 26 and 55 mm. respectively.

Joints of the anal legs proximad of the tarsus strongly crassate as usual. The first three joints longitudinally dorsally sulcate, the sulci most distinct at distal ends and on the first two joints. Spines of prefemur very small and difficult to detect; two present close together on dorsomesal corner of distal end; a single one in line with the preceding two farther cephalad and three on the mesal surface were detected. First twenty pairs of legs without tarsal spines.

Locality.— State of Matto Grosso: Madeira-Mamore R. R. camp 39, on the Rio Madeira! (W. M. Mann).

Two specimens.

Evidently this species is related to *C. impressus* (Porat); but it may be distinguished in having the cephalic plate equal in length and breadth instead of distinctly longer (ratio 4:3), by having the last ventral plate with a median longitudinal furrow, by having fewer articles of the antennae glabrous and these less abruptly differentiated from the others, etc.

Cormocephalus Newport.

Trans. Linn. soc. London, 1844, **19**, p. 275, 419; Meinert, Proc. Amer. philos. soc., 1886, **23**, p. 205; Kraepelin, Revis. Scolop., 1903, p. 184; Verhoeff, Bronn's Thierreich, 1907, **5**, p. 262.

Rhombocephalus Newport (in part) Trans. Linn. soc. London, 1844, **19**, p. 275, 425.

This is a typically Australian, Indian, and African genus, the single species recorded from America having probably been introduced from ships.

Cormocephalus aurantiipes (Newport).

Scolopendra aurantiipes Newport, Ann. mag. nat. hist., 1844, **13**, p. 99.

Scolopendra subminiata Newport, Ibid., p. 100.

Cormocephalus aurantiipes Newport, Trans. Linn. soc. London, 1844, **19**, p. 420;

Haase, Abhandl. Mus. Dresden, 1887, **5**, p. 57; Kraepelin, Revis. Scolop., 1903, p. 197; Brölemann, Cat. Myr. Brésil, 1909, p. 7.
Cormocephalus obscurus Newport, Loc. cit., p. 420.
Cormocephalus subminiatus Newport, Loc. cit., p. 420.
Cormocephalus miniatus Newport, Loc. cit., p. 420.
Rhombocephalus brevis Newport, Loc. cit., p. 426.
Scolopendra obscura Gervais, Insect. Aptères, 1847, **4**, p. 272.
Scolopendra miniata Gervais, Ibid.
Scolopendra subminiata Gervais, Ibid.
Scolopendra brevis Gervais, Ibid.
Cormocephalus gracilis Kohlrausch, Archiv. naturg., 1881, **47**, 1, p. 86.
Cormocephalus pygomelas Kohlrausch, Ibid., p. 90.
Cormocephalus aurantiipes spinosus Haase, Loc. cit., p. 58.

Localities.— State of Rio de Janeiro: Rio de Janeiro! M. C. Z.; Brazil (without more definite locality, recorded as *C. gracilis* and *C. pygomelas* by Kohlrausch.) Reported also from Guatemala by Pocock.

Hemiscolopendra Kraepelin.

Revis. Scolop., 1903, p. 212; Verhoeff, Bronn's Thierreich, 1907, **5**, p. 261.

Hemiscolopendra laevigata (Porat).

Cormocephalus laevigatus Porat, Bih. Svensk. vet. akad. Handl., 1876, **4**, no. 7, p. 17.
Scolopendra cormocephalina Kohlrausch, Archiv. naturg., 1881, **47**, 1, p. 123.
Scolopendra longispina Meinert, Proc. Amer. philos. soc., 1886, **23**, p. 199; Brölemann, Cat. Myr. Brésil, 1909, p. 19.
Scolopendra appendiculata Daday, Termes. füzetek., 1891, **14**, p. 152.

Localities.— State of São Paulo: Belém.

Scolopendra Linné.

Syst. nat. ed. 10, 1758, **4**, p. 637; Newport, Trans. Linn. soc. London, 1844, **19**, p. 275, 377; Latzel, Myr. Ost.-Ung. monarch., 1880, **1**, p. 137; Meinert, Proc. Amer. philos. soc., 1886, **23**, p. 190; Vid. Meddl. nat. foren. Kjøbenhavn, 1886, p. 125; Kraepelin, Revis. Scolop., 1903, p. 223; Verhoeff, Bronn's Thierreich., 1907, **5**, p. 263.

Eight valid species, one of them new, are recognized in this paper as occurring in Brazil. Brölemann lists *S. viridis* Wood as occurring in Brazil, fide Meinert; but a reference to the paper cited fails to reveal any record of the species from the country by the latter author and the species is accordingly here omitted. The names falling as synonyms in this genus are very numerous. The known Brazilian species may be separated by means of the following key.

Key to Species.

a. First dorsal plate with a deeply impressed transverse cervical sulcus which may be nearly covered by the head.

b. Prefemur of the twentieth legs (as also sometimes of some of the immediately preceding pairs) armed on dorsal side at distal end one to several spines; prosternum with a fine sulcus across anterior portion.

c. Dorsal plates from the sixth or seventh caudad distinctly margined laterally.

d. At least eight or ten basal articles of the antennae glabrous, the others finely pubescent, the hairs not in rows; coxopleural process with nine spines or points. . . . . *S. gigantea* Linné.

dd. Only four or five basal articles of antennae glabrous; hairs of the others often in streaks or rows; points of the coxopleural process fewer.

e. Ventral plates without longitudinal sulci; margination of dorsal plates beginning at seventh segment; femur of twentieth and also of nineteenth legs with one or two spines at distal end above.
S. angulata Newport.

ee. Ventral plates of second to twentieth segments with two deep longitudinal sulci crossing the entire length of plate; margination of dorsal plates beginning with the fifth; femur of twentieth legs lacking spine at distal end above.
S. viridicornis Newport.

cc. Margination of dorsal plates beginning only with the eleventh to fourteenth segment.

Four basal articles of antennae glabrous, the others densely pubescent; none of dorsal plates with sulci passing across entire length; claw of anal legs with two minute basal spines. . . . . *S. explorans*, sp. nov.

bb. Prefemur of twentieth legs not at all armed at distal end above; prosternum with no transverse sulcus across entire width of anterior portion.

Head wholly without longitudinal sulci; last dorsal plate with a median longitudinal sulcus; antennae composed of from twenty-five to thirty-one articles of which the eighth to seventeenth proximal ones are glabrous.
S. polymorpha Wood.

aa. First dorsal plate without any such deeply impressed transverse cervical sulcus.

b. Prefemur of nineteenth and twentieth pairs of legs armed dorsally at distal end with from one to six spinous teeth; head with longitudinal sulci............*S. alternans* Leach.

bb. Prefemur of nineteenth and twentieth pairs of legs unarmed at distal end above; head without longitudinal sulci.

c. Prefemur of anal legs armed ventrally with from six to nine spines; last dorsal plate with a fine median longitudinal sulcus.....................*S. morsitans* Linné.

cc. Prefemur of anal legs with only three, or less, ventral spines or sometimes (in varieties) with none; last dorsal plate without a median sulcus.....*S. subspinipes* Leach.

Scolopendra gigantea Linné.

Syst. nat. ed. 10, 1758, **1**, p. 638; Kraepelin, Revis. Scolop., 1903, p. 233; Brölemann, Cat. Myr. Brésil, 1909, p. 17.

Scolopendra gigas Leach, Trans. Linn. soc. London, 1814, **11**, p. 383; Meinert, Proc. Amer. philos. soc., 1886, **23**, p. 191.

Scolopendra insignis Gervais et Goudot, Ann. Soc. ent. France, 1844, **2**, p. 29.

Scolopendra prasinipes Wood, Proc. Acad. nat. sci. Phil., 1862, p. 11.

Scolopendra epileptica Wood, Ibid.

Scolopendra annulipes Lucas, Bull. Soc. ent. France, 1884, ser. 6, **4**, p. 74; Brölemann, Cat. Myr. Brésil, 1909, p. 18.

Localities.— State of Amazonas: Obidos! James and Hunnewell, Nathaniel Thayer expedition. M. C. Z.; State of Para: Santarem! (Chas. Linden, M. C. Z.); State of Pernambuco: Villa Bella! (J. C. Fletcher; M. C. Z.). Lucas's type of *S. annulipes* was also from Brazil, the definite locality not being indicated.

Scolopendra angulata Newport.

Ann. mag. nat. hist., 1844, **13**, p. 97; Pocock, Journ. Linn. soc. London, 1893, **24**, p. 146; Brölemann, Cat. Myr. Brésil, 1909, p. 17.
Scolopendra puncticeps Wood, Proc. Acad. nat. sci. Phil., 1862, p. 14.
Scolopendra punctiscuta Wood, Ibid.
Scolopendra prasina C. L. Koch, Myr. 1864, **2**, p. 23, fig. 146; Meinert, Proc. Amer. philos. soc., 1886, **23**, p. 192.
Scolopendra nitida Porat, Bih. Svensk. vet. akad. Handl., 1876, **4**, no. 7, p. 8.
Scolopendra respublicana Giebel, Zeitschr. ges. naturw., 1879, **52**, p. 326.

Localities.— State of Matto Grosso: Madeira-Mamore, R. R. camp 41, on the Rio Madeira! (W. M. Mann); Brazil (without more definite locality, reported by Porat as *nitida* by Pocock and by Kraepelin).

The species is widely distributed elsewhere in South America and in the Antilles.

Scolopendra viridicornis Newport.

Ann. mag. nat. hist., 1844, **13**, p. 97; Kraepelin, Revis. Scolop., 1903, p. 236; Brölemann, Cat. Myr. Brésil, 1909, p. 9.
Scolopendra punctidens Newport, Loc. cit.
Scolopendra cristata Newport, Loc. cit.; Meinert, Proc. Amer. philos. soc., 1886, **23**, p. 192.
Scolopendra variegata Newport, Loc. cit., p. 98.
Scolopendra hopei Gray, List Myr. Brit. mus., 1844, p. 45.
Scolopendra herculeana C. L. Koch, Myr., 1863, **1**, p. 22, fig. 20.
Scolopendra morsitans C. L. Koch, Ibid., p. 37, fig. **33**.
?*Scolopendra costata* C. L. Koch, Myr., 1863, **2**, p. 25, fig. 147.

Localities.— State of Rio Grande do Norte: Natal! (W. M. Mann); State of Pará: Pará; State of Bahia: Bahia, Rio São Francisco (sec. Koch); State of Pernambuco; State of Amazonas: Manáos, Amazon River! (J. C. Fletcher, M. C. Z.); State of Ceará: Ceará or Fortaleza! (W. M. Mann); Brazil without definite locality (Chas. Linden, M. C. Z.; and sec. Porat and Kohlrausch, as *S. cristata*; Gray, as *S. hopei*; and Newport and Kohlrausch, as *viridicornis*).

Judging by the number of specimens secured by Mr. Mann, the species is very common at Natal.

Scolopendra explorans, sp. nov.

Dorsum dark olive, the plates being somewhat darker at the caudal borders and in a transverse row of areas or spots across the anterior half. Head darker excepting along the caudal border where it is much lighter, somewhat testaceous. Antennae olivaceous. Legs testaceous, excepting the posterior pairs, especially the ultimate, which are of a somewhat cherry-red color, particularly distad. Venter light brown. Prosternum dark brown; the prehensors somewhat rufous proximad of the black claws.

Cephalic plate with two very fine submedian sulci diverging cephalad across entire length of plate. Very finely and subdensely uniformly punctate.

Antennae of moderate length. Composed of seventeen articles of which the first four are subglabrous and subdensely finely punctate; the other articles very densely clothed with fine brownish pubescence. Articles from the sixth distad not more than one and a half times longer than wide.

Prosternum and prehensors subdensely punctate with fine punctae. With no median sulcus but with a distinct though fine transverse sulcus, caudad of which there is a mesal, shallow depression. Each dental plate with a large isolated tooth at ectal end and apparently three thoroughly fused teeth mesad of this, there being only slight indications of any divisions in the fused piece.

First dorsal plate with a distinct cervical sulcus. Very finely punctate, the punctae being rather more scattered than on the head. No sulci detected on the second plate. The third to twentieth plates with paired longitudinal sulci extending full length of plate, fine. Finely punctate like the first plate, but the punctae becoming fainter and fainter caudad. First indications of lateral margination shown on the eleventh to fourteenth plate, the margination becoming more and more strongly marked caudad. Last dorsal plate without a median keel. Not punctate. Convexly arched on anterior portion, the posterior being more flattened. Caudal margin rather strongly bowed out caudad, the border being depressed in front of the median portion of the margin.

Ventral plates either wholly without sulci or with very short traces of these at anterior border. Punctae fine, becoming faint caudad. Last ventral plate narrowed caudad. Caudal margin subtruncate, being but weakly rounded; mesally slightly notched or incurved. Without median longitudinal sulcus.

Caudal process of coxopleurae of anal legs very short; ending in three or four spines or points, the coxopleurae being otherwise unarmed. Pores very fine and numerous.

First pair of legs with two tarsal spines. Second to nineteenth pairs with a single tarsal spine. Prefemur of nineteenth legs dorsally at distal end with a single spine; that of the twentieth with two spines; the femur of the latter pair dorsally at distal end also with a single spine. Prefemur of twentieth legs unarmed ventrally.

Prefemur of anal legs with the corner process at distal end above ending in two stout points or teeth; ventrally with five spines arranged in two transverse or somewhat oblique rows, a distal row, composed of three spines, being at about the middle of length of joint, and a more proximal one of two spines (or in three longitudinal rows, 2, 2, 1); mesally with three or four spines in two longitudinal rows; and along dorsomesal edge with two spines in addition to a single one more strictly dorsal. Femur with two spines on proximal half along dorsomesal edge with a third one ventrad of these on the mesal surface; and, in addition, also a spine at distal end on mesodorsal corner. Claw with two basal spines which are very small.

Length cir. 83 mm.

Locality.— State of Matto Grosso: Madeira-Mamore R. R. camp 39, on the Rio Madeira! (W. M. Mann).

This interesting species is evidently close to *S. armata* described by Kraepelin from Venezuela (Maracaibo), with which it is characteristically separated from all others now known. Among the more important differences between these two species, so far as the description of *armata* permits of comparison, may be mentioned the complete absence of any spines on the twentieth legs; the dense pubescence of antennae on all articles distad of the fourth; the distinct punctation of the first dorsal plate; the margination of the dorsal plates from the eleventh to fourteenth caudad instead of from the eighteenth or nineteenth; the absence of paired sulci passing entirely across any of the plates; the presence of two spines at base of claw of anal legs instead of but one, etc.

SCOLOPENDRA POLYMORPHA Wood.

Proc. Acad. nat. sci. Phil., 1862, p. 11; Kraepelin, Revis. Scolop., 1893, p. 241.

Scolopendra copeiana Wood, Journ. Acad. nat. sci. Phil., 1862, ser. 2, **5**, p. 27; Pocock, Biol. Centr. Amer. Chilopoda, 1895, p. 19.

Scolopendra mysteca Humbert et Saussure, Rev. mag. zool., 1869, ser. 2, **21**, p. 157.

Scolopendra pachypus Kohlrausch, Archiv. naturg., 1881, **47**, 1, p. 113.
Scolopendra leptodera Kohlrausch Ibid.; Brölemann, Cat. Myr. Brésil, 1909, p. 19.

Locality.— Brazil (type of *leptodera* Kohlrausch, which has been restudied by Kraepelin and identified with *polymorpha*).

This is a very common species in the southern United States and in Mexico. It has also been recorded from Venezuela.

Scolopendra alternans Leach.

Trans. Linn. soc. London, 1812, **11**, p. 383; Meinert, Proc. Amer. philos. soc. 1886, **23**, p. 193; Kraepelin, Revis. Scolop., 1903, p. 244; Brölemann, Cat. Myr. Brésil, 1909, p. 15.
Scolopendra morsitans Palisot de Beauvois (non Linné), Ins. Afr. Amer., 1805–1821, p. 152.
Scolopendra sagraea Gervais, Ann. sci. nat., 1837, ser. 2, **7**, p. 50; Brandt, Bull. sci. Acad. imper. sci. St. Peterburg, 1840, **7**, p. 57.
Scolopendra complanata Newport, Ann. mag. nat. hist., 1844, **13**, p. 98.
Scolopendra grayii Newport, Ibid.
Scolopendra multispinata Newport, Ibid.
Scolopendra incerta, Newport, Trans. Linn. soc. London, 1844, **19**, p. 404.
Scolopendra crudelis C. L. Koch, Syst. Myr., 1847, p. 387; Myr., 1864, **2**, p. 36, fig. 158, 159; Meinert, Proc. Amer. philos. soc., 1886, **23**, p. 194.
Scolopendra cubensis Saussure, Mém. Soc., phys. hist. nat. Genève, 1860, **15**, p. 387.
Scolopendra testacea Wood, Journ. Acad. nat. sci. Phil., 1862, ser. 2, **5**, p. 26.
Scolopendra torquata Wood, Ibid.
Scolopendra longipes Wood, Ibid.
Scolopendra alternans Meinert, Proc. Amer. philos. soc., 1886, **23**, p. 193; Kraepelin, Revis. Scolop., 1903, p. 244; Brölemann, Cat. Myr. Brésil, 1909, p. 15.

Locality.— Brazil! (M. C. Z.).

This is a very common species in the West Indies, etc.

Scolopendra morsitans Linné.

Syst. nat. ed. 10, 1758, **1**, p. 638; Kraepelin, Revis. Scolop. 1903, p. 250; Brölemann, Cat. Myr. Brésil, 1909, p. 19.
(For synonymy and bibliography cf. Kraepelin, Loc. cit.).

Localities.— State of Amazonas: Manáos; State of Parahyba: Parahyba! (Nathaniel Thayer expedition, M. C. Z.); State of

Pará: Pará! (Nathaniel Thayer expedition, M. C. Z.); State of Bahia: Santarem! (M. C. Z.); State of Rio de Janeiro: Rio de Janeiro! (M. C. Z.); Brazil, without definite locality; (recorded by Gervais as *brandtiana* and *platypoides;* by Saussure as *brandtiana;* by Porat as *longicornis;* also specimens in M. C. Z., with no more definite label).

This is a cosmopolitan species.

Scolopendra subspinipes Leach.

Trans. Linn. soc. London, 1814, **11**, p. 383; Kraepelin, Revis. Scolop., 1903, p. 256; Brölemann, Cat. Myr. Brésil., 1909, p. 25.
(For synonymy and bibliography cf. Kraepelin, Loc. cit.).

Localities.— State of Bahia: Bahia! (Nathaniel Thayer expedition, M. C. Z.); State of Rio de Janeiro: Rio de Janeiro! (M. C. Z.); Brazil without definite locality (M. C. Z.); also recorded by Gervais as *audax;* by Newport as *gervaisi*, and *placeae;* by Koch, Kohlrausch, and Brölemann as *armata*).

GEOPHILOIDEA.

Schendylidae.

Of this family, the largest of the Geophiloidea in the known fauna, three genera are found in Brazil, Schendylurus, Adenoschendyla, and Thalthybius (Ballophilini).

Schendylurus Silvestri.

Mitth. Naturh. mus. Hamburg, 1907, **24**, p. 245; Brölemann et Ribaut, Bull. soc. ent. France, 1911, p. 192; Arch. Mus. hist. nat., 1912, ser. 5, **4**, p. 113.
Schendyla Brölemann (ad. part. max.), Cat. Myr. Brésil, 1909, p. 6.

The Brazilian species known may be separated by means of the key. *Schendylurus brasilianus* Silvestri, probably belonging to this genus, is not taken up, the published description being too meager to furnish sufficient information.

Key to Species.

a. Pairs of legs less than fifty.
 b. Ventral pores occurring on the first sternite; pores on each sternite divided into three areas; cephalic plate scarcely longer than wide.
 Pairs of legs forty-one.
 S. luderwaldi Brölemann and Ribaut.
 bb. No ventral pores on the first sternite; ventral pores, at least on the anterior sternites, in an undivided area; cephalic plate considerably longer than wide.
 c. Antennae three times or more the length of the cephalic plate; last article of anal legs longer and conspicuously more slender than the penult; pairs of legs (♀) 47.
 S. perditus, sp. nov.
 cc. Antennae but two times, or less, the length of the cephalic plate; last article of anal legs of nearly same length and thickness as the penult; pairs of legs (♀) thirty-seven.
 S. bakeri, sp. nov.
aa. Pairs of legs near or above sixty.
 b. Prebasal plate not exposed........*S. gounellei* Brölemann.
 bb. Prebasal plate exposed............*S. paulista* Brölemann.

SCHENDYLURUS LUDERWALDI Brölemann and Ribaut.

Bull. Soc. ent. France, 1911, p. 220; Arch. Mus. hist. nat., 1912, ser. 5, **4**, p. 117, fig. 48–52.

Locality.— State of Rio de Janeiro: Campo Itatiaya (Mus. Paul. coll.).

SCHENDYLURUS BAKERI, sp. nov.

Very pale; more densely pigmented anteriorly, where the color is pale lemon-yellow. Head and the prosternum with prehensors chestnut or with slight tendency to ferruginous. Antennae similar to head but lighter.

Body moderate; conspicuously narrowed from a little back of the middle caudad, but only moderately attenuated cephalad. Hairs of body and legs sparse, those of the legs chiefly toward the distal ends of articles as usual, these also being longer than the more proximal ones.

Cephalic plate widest in front of middle where it bulges convexly on each side; sides of head caudad of this straight and a little converging to level of posterior end of first joint of prehensors (femur), then abruptly more strongly converging to the caudal corners which are not rounded; caudal margin straight; anteriorly the head is convexly widely rounded. Longer than wide, the ratio being nearly 43:38.

Antennae short being only 1.9— times longer than the cephalic plate; scarcely attenuated. Hairs very short, denser on the more distal articles, with hairs longer and more sparse on the proximal ones. Articles short, decreasing distad, with the sides more nearly straight than in *perditus*; ultimate article not much differing in length from the two preceding taken together.

Prebasal plate exposed.

Basal plate conspicuously narrowed cephalad; trapeziform. Two and a third times wider than long. Slightly more than one third as long as the cephalic plate (ratio 1:2.8–2.9).

Claws of prehensorial feet when closed attaining the front margin of the cephalic plate. Joints all unarmed within as usual. Sides of prosternum for most of length nearly straight and but slightly converging caudad, more abruptly rounding into caudal corners. Much wider than long, the ratio being 47:34. Longer than the first joint of prehensors in ratio 3:2.

Dorsal plates mostly showing a fine median sulcus in addition to the lateral ones. Anterior prescuta short, those of the middle and posterior regions becoming rather long, the last few then again short.

Spiracles all circular; the first considerably larger than the second, the others decreasing caudad and those of the posterior region very small or minute.

First fourteen or fifteen sternites angularly produced at middle of caudal margin, the process small; process fitting into an excavation in the succeeding segment as usual. The anterior margin of the second sternite conspicuously extended from sides to middle, that of the third segment similarly but less strongly produced, that of the fourth merely convexly bowed out, and those of the succeeding ones straight, or nearly so, or even a little incurved. Ventral pores present on all sternites excepting the first and the last; pore area subcircular, with the pores numerous. Sternites mostly showing a longitudinal median furrow which is deepest just in front of the middle, and a weaker transverse furrow which curves across in front of the pore area.

Last ventral plate very wide; trapeziform; the sides moderately converging caudad; caudal margin mesally incurved as in *manni* (Plate 4, fig. 7).

Coxopleural pores appearing as two large pits on each side, these being wholly covered by the last ventral plate excepting for a small ectal portion of each (Plate 4, fig. 7).

First pair of legs a little more slender than the second, but not at all or but slightly shorter. Posterior pairs of legs longer and proportionately more slender than the anterior ones.

Anal legs (♀) much longer than the penult. Scarcely thickened. The ultimate article about equal in length to the preceding one and not more slender; but the last two articles together more slender than the tibia. Hairs more numerous than on other legs, especially on the proximal joints (Plate 4, fig. 7). Pairs of legs (♀) forty-seven.

Length 24 mm.

Locality.— State of Amazonas: Manáos! (Mann and Baker).

One female.

Manifestly close in the main structural features to *S. perditus.* It is a materially larger form; has forty-seven pairs of legs as against thirty-seven in the latter species, has the antennae relatively much shorter; and the last article of the anal legs is proportionately much shorter and thicker as shown in the figures.

Schendylurus perditus, sp. nov.

Body whitish, tinged with dilute lemon-yellow which is more evident anteriorly. Head and prosternum with prehensors ferruginous. Antennae brownish yellow of faint ferruginous tinge.

Moderate or slender; only slightly attenuated cephalad, more abruptly so caudad. Hair very sparse and mostly short over body, and those of legs also sparse.

Cephalic plate evidently longer than wide, the ratio being about 5: 4.4. Widest toward anterior end where the sides are convex; from this region caudad the sides are more nearly straight and converge at first moderately and then more abruptly toward the posterior corners; caudal margin appearing considerably incurved. Frontal suture not present. (Plate 4, fig. 1).

Labral margin armed in the type with eighteen rather large, subacute, and strongly chitinous denticles, those at the sides being smaller, with apices turned mesad, and more acute than the more median ones.

First maxillae of usual structure; outer branch robust, without lappets.

Claw of palpus of second maxillae long, distally slender and acute and strongly curved; pectinate along both edges, the divisions long and slender.

Antennae moderately long, being three and a fifth times as long as the cephalic plate, only a little attenuated distad. Articles of proximal portion moderately long, each somewhat clavately widening from proximal and distad; the five articles preceding the ultimate short and relatively wider. Hairs of the last six or seven articles very short and rather numerous, on the more proximal articles becoming much more sparse and manifestly longer.

Prebasal plate exposed.

Basal plate trapeziform, the sides convex. About one third as long as the cephalic plate and 2.4–2.5 times wider than long.

Claws of the prehensors when closed not fully attaining the front margin of the head. Claws smooth. All articles unarmed within as usual.

Prosternum with sides for most of length nearly straight, a little converging caudad, more abruptly rounding mesad at posterior corners. Anterior margin well chitinized; but not at all denticulate; mesal incision between lateral portions shallow, semicircular; sloping from each side to the middle, there forming an obtuse reentrant angle. Prosternum much wider than long, the ratio being about 25: 18; longer than the outer length of femur in about ratio 3: 2. Hairs of prehensors sparse and in part moderately long; those of prosternum very sparse and short. (Plate 4, fig. 2).

Prescuta of the anterior and of the posterior fourths of length short, the others being moderately long. Sulci sharply impressed.

Spiracles all circular; the first conspicuously larger than the second, the others decreasing in size caudad and becoming very small or minute in the posterior region.

The more anterior sternites with a rather narrow angular median caudal process which fits into a corresponding excavation in the succeeding sternite. Each with a subcruciform impression which is considerably expanded in the region where the furrows cross. Pores beginning on the second segment where there are from forty to forty-five in the type; pores present on all succeeding sternites excepting the last, those of the penult segment being fewer in number; pores arranged in an undivided circular area.

Last ventral plate wide, trapeziform, the sides being nearly straight and converging caudad; caudal margin angularly excised at middle, convex laterally toward and about each caudal corner. (Plate **4**, fig. 3).

Each coxopleura with glands in the form of two large pits which are entirely simple and homogeneous; the anterior pore wholly and the posterior one mostly covered by the last ventral plate. (Plate **4**, fig. 3).

First pair of legs a little more slender than the second but only slightly shorter. Posterior legs longer and proportionately more slender than the anterior ones. Anal legs much longer than the penult. Slender in the female. The distal joint somewhat longer that the preceding one and much more slender. Pairs of legs (♀) thirty-seven.

Locality.— State of Parahyba: Independencia! hills north of the town. (Mann and Heath).

Schendylurus gounellei (Brölemann).

Schendyla gounellei Brölemann, Ann. Soc. ent. France, 1902, **71**, p. 685; Cat. Myr. Brésil., 1909, p. 6.

Schendylurus gounellei Brölemann et Ribaut, Arch. Mus. hist. nat., 1912, ser. **5**, **4**, p. 119, fig. 6, 62–67.

Locality.— State of São Paulo: Façenda Nova Nicaragua.

Schendylurus paulista (Brölemann).

Schendyla paulista Brölemann, Rev. Museu Paulista, 1903, **6**, p. 83, pl. 1, fig. 6–7; Cat. Myr. Bresil., 1909, p. 6.

Locality.— State of São Paulo: Poco Grande.

In many ways close to the preceding species and possibly but a variety of it.

(?) Schenydlurus brasilianus (Silvestri).

Nannophilus brasilianus Silvestri, Ann. soc. ent. Belg., 1907, **41**, p. 346.

Schendyla brasiliana Brölemann, Cat. Myr. Brésil., 1909, p. 6.

Locality.— Brazil (precise locality not indicated).

The generic position of this species cannot be determined from the original description. It appears not to be a true Nannophilus under which genus it was described, and is most probably a member of Schendylurus.

ADENOSCHENDYLA Brölemann and Ribaut.

Bull. Soc. ent. France, 1911, p. 192; Nouv. Arch. Mus. hist. nat., 1912, ser. 5, **4**, p. 194.

Three species and one variety of this genus, which is peculiar to tropical and subtropical America, are known from Brazil. Of these, one is here first described.

The genus is close to Pectiniunguis. Pectiniunguis and Adenoschendyla lack claws on the anal legs in contrast with species of the southwestern United States (*montereus, heathi,* etc.) The latter species differ as well in other respects and may be placed under a distinct genus to be known as Nyctunguis (*P. montereus* Chamb., type).

Key to Species.

a. Prebasal plate not exposed; none of the pore areas of the sternites are divided.......................... *A. plusiodonta* (Attems).

aa. Prebasal plate exposed; some of the sternites of the median or posterior region of body longitudinally divided or geminate.

- b. Head much longer than wide (ratio 4:3 to 4:3.5), pairs of legs fifty-three to fifty-nine.
  - c. Pores present on first sternite; head wider caudad than cephalad, longer than wide in ratio 4:3; pairs of legs 59 (♀); length 40 mm......... *A. parahybae,* sp. nov.
  - cc. No pores present on first sternite; head of same width anteriorly and posteriorly, longer than wide in ratio 4:3.5; pairs of legs 53 (♂)–55 (♀); length 25 mm. *A. geayi* Brölemann and Ribaut.
- bb. Head but slightly longer than wide (ratio not more than 10:9), widest cephalad; pairs of legs forty-seven to fifty-three.
  - c. Claw of palpus of second maxillae of usual form. *A. imperfossa* (Brölemann).
  - cc. Claw of palpus of second maxillae globular at base. *A. imperfossa bolbonyx* Brölemann and Ribaut.

Adenoschendyla parahybae, sp. nov.

Mostly pale yellowish white, becoming more densely pigmented anteriorly, lemon-yellow. Head dilute ferruginous or orange, darker in a band immediately caudad of frontal region. Prosternum a little paler than the head, with the prehensors much lighter, yellow. Antennae yellow.

Rather slender with the body considerably attenuated cephalad and also very strongly at caudal end. Hairs sparse, of moderate length, more numerous caudad.

Cephalic plate much longer than wide (4:3). Widest caudad, conspicuously narrowed or constricted in frontal region at anterior end; anterior border subtriangular; caudal margin slightly concave; sides nearly straight from a little in front of caudal corners cephalad to frontal region. (Plate 5, fig. 1).

Antennae strictly filiform as usual. Long, being a little more than three times the length of the cephalic plate. Articles mostly long, excepting those immediately preceding the ultimate. Ultimate article longer than the two preceding taken together. Hairs of articles of distal region very short, dense; those of proximal articles conspicuously longer and more sparse.

Prebasal plate a little exposed, the cephalic plate not overlapping the basal.

Basal plate with sides straight, strongly converging cephalad; three times wider than long.

Claws of the prehensors when closed about even with the front margin of the cephalic plate; claws large and well overlapping; robust; articles all unarmed within as usual.

Prosternum wider than long in about ratio 7:5; one and a half times longer than the outer height of the femur of prehensors; sides converging from the anterior corners to the caudal and straight excepting towards ends; anterior margin sloping a little caudad of directly mesad from the ectal ends to the mesal incision, which is shallow, laterally strongly chitinized but with no signs of teeth.

Dorsal plates bisulcate; the sulci on the anterior plates distinct caudad as far as a fine transverse furrow a little in front of the caudal margin, this transverse furrow being in the form of a pair of concave impressions meeting at a cephalically directed angle; a fine median longitudinal sulcus also present as may also be one or two less distinct ones on each lateral part. Anterior prescuta short, the others increasing in length to the caudal region where they are moderately long, the last ones being again short.

Spiracles all circular; the first one much larger than the second and the latter likewise considerably larger than the third; the others gradually decreasing caudad, in the posterior region becoming minute.

The first sixteen sternites with the caudal border produced at the middle, the distinct process in each case fitting into a corresponding excavation in the succeeding segment. Ventral pores present on all sternites excepting the ultimate; on the sternite as far back as the twenty-fifth or twenty-sixth, the pores are in a single distinct subcircular area; caudad of this the areas are more irregular, with a distinct tendency for each to become longitudinally divided into two areas or geminate.

Last ventral plate very wide; sides nearly straight, strongly converging caudad; caudal corners rounded; caudal margin a little crenately incised a little each side of the middle. Rather densely clothed with fine short hairs, especially on the caudal portion.

Coxopleurae subdensely clothed over the ventral area with fine short hairs.

First pair of legs shorter and more slender than the second, the next few pairs gradually attaining the full size; anterior pairs of legs conspicuously more robust than the posterior ones.

Anal legs in the female much longer than the penult; very slender. Ultimate joint longer than the penult, very slender and ending in a minute membranous point but with no trace of a real claw. Hairs long and sparse. (Plate **5**, fig. 3). Pairs of legs fifty-nine.

Length 40 mm.

Locality.— State of Parahyba: Independencia! (Mann and Heath).

The present species differs from *plusiodonta* (Attems) in the much greater length and different shape of the cephalic plate, this in *plusiodonta* being only about as long as wide; in having the prebasal plate exposed; in the greater number of pairs of legs; in the character of the ventral pore areas, etc. The two species are similar in regard to the processes and pits of the anterior plates.

ADENOSCHENDYLA PLUSIODONTA (Attems).

Pectiniunguis plusiodontus Attems, Zool. jahrb. Syst., 1903, **18**, p. 193, pl. 13, fig. 18; Chamberlin, Proc. Acad. nat. sci. Phil., 1904, p. 654.

Adenoschendyla plusiodonta Brölemann et Ribaut, Nouv. Arch. Mus. hist. nat., 1912, ser. 5, **4**, p. 106.

Locality.— State of Santa Catherina: Blumenau.

ADENOSCHENDYLA IMPERFOSSA (Brölemann).

Schendyla imperfossa Brölemann, Rev. Mus. Paulista, 1901, **5**, p. 44, pl. **1**, fig. 8–13; Cat. Myr. Brésil, 1909, p. 6.
Adenoschendyla imperfossa Brölemann et Ribaut, Nouv. Arch. Mus. hist. nat. 1912, ser. 5, **4**, p. 107.

Locality.— Brazil. (Museu Paulista).

ADENOSCHENDYLA IMPERFOSSA BOLBONYX Brölemann and Ribaut.

Brölemann et Ribaut, Nouv. Arch. Mus. hist. nat., 1912, ser. 5, **4**, p. 107, fig. 18–23.

Locality.— State of São Paulo (type Museu Paulista).

ADENOSCHENDYLA GEAYI Brölemann and Ribaut.

Bull. Soc. ent. France, 1911, p. 219; Nouv. arch. Mus. hist. nat., 1912, ser. 5, **4**, p. 108, pl. 2, fig. 24–30, pl. 3, fig. 31–32.

Locality.— State of Amazonas (Brazilian Guiana, Lower Carsevenne or Calçoene, Geay, collector).

THALTHYBIUS Attems.

Zool. jahrb. Syst., 1900, **13**, p. 139; 1903, **18**, p. 183.

PRIONOTHALTHYBIUS Brölemann.

Arch. zool. exp. et gen., 1909, ser. 5, **3**, p. 334.

THALTHYBIUS (PRIONOTHALTHYBIUS) PERRIERI Brölemann.

Bull. Mus. hist. nat., 1909, p. 1, fig. 8–10.

Locality.— State of Amazonas (Brazilian Guiana, Upper Carsevenne or Calçoene; Geay, collector).

Of Uncertain Position.

(?) GEOPHILUS SUBLAEVIS Meinert.

Natur. tiddskr., 1870, ser. 3, **7**, p. 72.

Locality.— State of Minas Geraes: Lagoa Santa.

This is certainly not a true *Geophilus*, being in all probability a member of the present family. It seems likely to prove to belong to Schendylurus. The anal legs are unarmed; the last ventral plate very wide with pores on coxopleurae said to be absent by Meinert but no doubt to be found after proper treatment with potash as has been shown to be true with various species of Schendylurus, etc., which at first were considered to lack the pores; the prosternum and joints of prehensors, unarmed, the claws of the latter not surpassing the front margin of the head; pairs of legs 67.

ORYIDAE.

ORPHNAEUS Meinert.

Myr. Mus. Hauniensis, 1870, **1**, p. 17; Proc. Amer. philos. soc., 1886, **23**, p. 230; Zool. jahrb. Syst., 1903, **18**, p. 200; Verhoeff. Bronn's Thierreich, 1908, **5**, p. 294.

Chomatobius Humbert et Saussure, Rev. mag. zool., 1870, p. 205; Miss. scient. Mex., 1872, p. 145.

ORPHNAEUS BRANNERI, sp. nov.

Dorsum yellowish brown, darker cephalad where the tergites are margined with a more deeply red stripe. The anterior dorsal plates, excepting the first one, with a conspicuous black spot on the anterior portion, this consisting typically of a narrow transverse stripe along the anterior margin connected at the middle by means of a broad neck with two short curved marks diverging from each other and bending out laterad near the middle of the plate; this mark in going from segment to segment caudad becoming less and less developed and finally disappearing entirely. No distinct geminate dark stripe such as is so characteristic of *brevilabiatus*. Basal and cephalic plates deep ferruginous; prosternum and prehensors ventrally similar but paler, the claws black. Antennae like cephalic plate but pale at their very tips. Venter pale testaceous, darker cephalad. Legs similar to venter.

Body large and robust; strongly attenuated both cephalad and caudad. Hairs of body very fine and short as are also the few hairs of the legs.

Cephalic plate conspicuously wider than long, the ratio being about 48:39. Widest caudad, where the sides are convex; moderately converging anteriorly in front of the middle to the anterior corners; lateral portions of anterior margin converging from the anterolateral corners to an obtuse angle at the middle; caudal margin widely, weakly convex. Plate with subdense, uniform, fine punctae. Hairs very fine and short, numerous.

First maxillae with inner division sharply set off; short and broad, apically rounded, not membranous. Outer division with the second and third articles not separated by a suture; short and thick; slightly membranous at tip on mesal side; membranous lappets of moderate length, the distal one wide and rather dorsal in position. Coxae of the second maxillae broadly joined at middle; with the usual oval opening toward the caudal end of each side. Claw of palpus rather small, bearing along each edge a fringe of about nine or ten spines.

Antennae very short, being but 1.68 times the length of the cephalic plate. Flattened; very wide at base, then strongly narrowed, especially distad of about the proximal fourth. Proximal articles very short, much wider than long, the more distal ones relatively longer; the ultimate article not much differing in length from that of the two preceding ones taken together. Hairs very fine and short, dense distad, becoming less so proximad.

Prebasal plate not exposed.

Basal plate embracing the cephalic. Very wide, with sides convex and not strongly converging cephalad; nearly one half as long as the cephalic plate (ratio about 2.1:1), and very nearly three times as wide as long; finely and subdensely punctate like the head. Hairs similar to those of the head but considerably fewer in number.

Claws of the prehensors when closed very nearly but not wholly attaining the front margin of the cephalic plate; all joints unarmed; claws stout.

Prosternum much wider than long, the ratio of width to length being 2.25–2.3:1; longer than the outer height of femur in ratio 25:14; subdensely punctate as are also the proximal articles of the prehensors. (Plate **5**, fig. 5).

Dorsal plates with a pair of longitudinal deeply impressed sulci on the middle portion and an additional longitudinal sulcus farther laterad on each side less sharply impressed; indications on some segments also of a shallow median longitudinal median furrow. First dorsal plate considerably wider than the second and at its ends bent ventrad toward the base of each leg and crenately incised on the caudal side near each corner (Plate 5, fig. 1).

Spiracles large; all elliptic, the anterior ones being oblique but more nearly horizontal than vertical, becoming strictly longitudinal caudad; first spiracle not larger than the second; those of the caudal region smaller as usual. Suprascutella large and distinct in the posterior region but absent in the anterior.

Ventral pores in two broad transverse bands connected at the ends and thus forming a quadrangle. Enclosed area mostly with a distinct transverse furrow or row of impressed spots or the whole area roughened with irregular impressions, in most more deeply impressed longitudinally at middle.

Last ventral plate pentagonal, the sides strongly converging caudad and the caudal margin straight. Marked with a longitudinal median furrow which is not especially deep.

Coxopleurae rather large, coxiform; longer than thick in the direction of thinnest diameter; the trochanter only about one third as long.

Anal legs in male considerably shorter than the penult; composed of six articles [1] which decrease in diameter regularly from base distad. Pairs of legs 77.

Length 88 mm.; length of antennae, 2.2 mm.; greatest width of body, 3.3 mm.; width of first dorsal plate 1.9 mm.

Locality.— State of Rio Grande do Norte: Natal! (Mann).

While this species is close in many features to *brevilabiatus*, it is very easily separated from this wide-spread form. It is most readily distinguished by the antennae which are much shorter, extending only to the caudal end of the basal plate or thereabouts, whereas in *brevilabiatus* they reach upon or toward the caudal end of the second pediferous segment; also the antennae are conspicuously wider at the base and more strongly attenuated (Plate 5, fig. 4). The dorsal plate of the first segment is clearly different, being bent farther ventrad of ends and being more considerably notched on caudal side toward each caudolateral corner. It lacks the conspicuous geminate dorsal black stripe so characteristic of *brevilabiatus*.

[1] The right leg of the type specimen appears to have been regenerated. It is shorter than the other and consists of but five articles.

ORPHNAEUS BREVILABIATUS (Newport).

Geophilus brevilabiatus Newport, Trans. Linn. soc. London, 1844, **19**, p. 436.
Geophilus lineatus Newport, Ibid.
Geophilus guillemini Gervais, Insect. Aptères, 1847, **4**, p. 311.
Chomatobius brasilianus Humbert et Saussure, Rev. mag. zool., 1870, p. 205; Miss. scient. Mex., 1872, p. 146, pl. 6, fig. 24.
Orphnaeus brasiliensis Meinert, Myr. Mus. Hauniensis, 1870, **1**, p. 20; Proc. Amer. philos. soc., 1886, **23**, p. 232; Bollman, Proc. U. S. nat. mus., 1888, **11**, p. 337; Brölemann, Mem. Soc. Zool. France, 1900, **13**, p. 92; Ann. Soc. ent. France, 1902, **71**, p. 652; Zool. anz., 1903, **26,** p. 178; Rev. Mus. Paulista, 1903, **6**, p. 71; Attems, Zool. jahrb. Syst., 1903, **18**, p. 201; Cat. Myr. Brésil, 1909, p. 5.
Orphnaeus brevilabiatus Pocock, Journ. Linn. soc. London, 1893, **24**, p. 472; Biol. Centr. Amer. Chilopoda, 1895, p. 40.
Orphnaeus brasilianus nigropictus Attems, Loc. cit., p. 203.

Localities.— State of Rio Grande do Norte: Ceará-Mirim! (Mann and Heath); State of Parahyba: Independeneia! (Mann and Heath); State of Amazonas: Manáos; State of Pará: Pará; State of Pernambuco: Pernambuco; State of Rio de Janeiro: Rio de Janeiro!.

NOTIPHILIDES Latzel.

Myr. Öst-Ung. monarch., 1880, **1**, p. 20; Zool. anz., 1880, **3**, p. 546; Meinert, Proc. Amer. phil. soc., 1886, 23, p. 233; Attems, Zool. jahrb. Syst., 1903, **18**, p. 233; Verhoeff, Bronn's Thierreich, 1908, **5**, p. 292.

NOTIPHILIDES GRANDIS Brölemann.

Rev. Mus. Paulista, 1903, **6**, p. 71, pl. 1, fig. 8–11.

Locality.— State of Amazonas: Manáos.

It was possibly a specimen of this species to which Cook gave the name *Heniorya longissima;* but as no description of the species is given both the generic and specific names, as Brölemann justly suggests, stand purely as *nomina nuda.*

APHILODONTIDAE.

MECISTAUCHENUS Brölemann.

Brasilophilus Brölemann, Bull. Soc. ent. France, 1907, p. 283. Verhoeff, Bronn's Thierreich, 1908, **5**, p. 286.

Mecistauchenus micronyx Brölemann.

Aphilodon micronyx Brölemann, Rev. Mus. Paulista, 1901, **5**, p. 46; Cat. Myr. Brésil., 1908, p. 3.
Mecistauchenus micronyx Brölemann, Bull. Soc. ent. France, 1907, p. 283.

Locality.— Brazil (precise locality not reported).

Aphilodon Silvestri.

Comm. Mus. nac. Buenos Aires, 1898, **1**, p. 39; Attem. Zool. jahrb. Syst., 1903, **18**, p. 215, 283; Verhoeff, Bronn's Thierreich, **5**, p. 279, 282; Silvestri, Boll. Lab. zool. R. sc. Agricol. Portici, 1909, **4**, p. 53.

Aphilodon angustatus Silvestri.

Rend. R. accad. Lincei, ser. 5, **18**, p. 269; Boll. Lab. zool. R. sc. Agricol. Portici, 1909, **4**, p. 56.

Locality.— State of Matto Grosso: Urucum, Corumbá. Also reported from Paraguay and Argentina.

Mecophilus Silvestri.

Rend. R. accad. Lincei, 1909, ser. 5, 1, **18**, p. 268.

Mecophilus neotropicus Silvestri.

Rend. R. accad. Lincei, 1909, ser. 5, 1, **18**, p. 269.

Locality.— State of Paraná: Iguassú.

Mecistocephalidae.

Mecistocephalus Newport.

Proc. Zool. soc. London, 1842, p. 178; Trans. Linn. soc. London, 1844, **19**, p. 276; Meinert, Naturh. tiddskr., 1870, ser. 3, **7**, p. 92; Latzel, Myr. Ost-Ung. monarch., 1880, **1**, p. 160; Meinert, Proc. Amer. philos. soc., 1886, **23**, p. 212; Haase, Abhandl. Mus. Dresden, 1887, **5**, p. 100.
Lamnonyx Attems, Zool. jahrb. Syst., 1903, **18**, p. 210; Verhoeff, Bronn's Theirreich, 1908, **5**, p. 273.

Mecistocephalus punctifrons Newport.

Proc. Zool. soc. London, 1842, p. 179; Trans. Linn. soc. London, 1844, **19**, p. 429; Meinert, Naturh. tiddskr., 1870, ser. 3, **7**, p. 97; Chamberlin, Ent. news, 1913, p. 122.
Mecistocephalus guildingi Newport, Loc. cit., p. 429; Meinert, Loc. cit., p. 96; Latzel, Mitt. Mus. Hamburg, 1895, **12**, p. 101; Pocock, Trans. Linn. soc. London, 1893, **24**, p. 470; Attems, Zool. jahrb. Syst., 1903, **18**, p. 209.
Mecistocephalus sulcicollis Tömösvary, Termes. füzetek, 1885, **5**, p. 64.
Lamnonyx punctifrons Attems, Loc. cit., p. 211.

Locality.— State of Amazonas: Manáos! (Mann and Baker).

This appears to be the first record of the occurrence of a member of the Mecistocephalidae in Brazil. The species is common in the Bermudas and West Indies. It must logically be regarded as the type of Mecistocephalus proper, the other species originally included under this name by Newport having been removed to other genera. It would seem that Newport did not at the time he erected the genus, know or have in hand any species congeneric with *carniolensis* and that in consequence there appears no justifiable way of continuing the prevalent practice of applying the name Mecistocephalus to the genus including these species.

As no difference of distinctive value has been pointed out between *punctifrons* and *guildingii* and as different authors refer to American specimens at times under one and at other times under the other name, I have united the two as one species as was long ago suggested by Meinert. If the form occurring in the western hemisphere shall be found to differ definibly from that of the eastern hemisphere, it must bear the name *guildingii*.

Tygarrup, gen. nov.

Body widest near middle, attenuated moderately cephalad and more strongly caudad.

Head large. Cephalic plate longer than wide, narrowed caudad. Frontal suture present.

Antennae long, filiform.

Clypeus proper large, triangularly extending forward in middle to between antennae, at middle being three times greatest length of labrum; clothed with few hairs.

Labrum tripartite, the median piece narrow and caudally one-toothed; the lateral pieces smooth, not longitudinally striate; not much bowed.

From each anteroectal corner of labrum a suture extends obliquely cephaloectad, separating the median from the lateral divisions of the ventral portion of the cephalic plate; lateral division narrowed caudad, the mesal edge strongly chitinized and extended cephalad into an angular process as in related genera.

Mandibles with pectinate lamellae only.

First maxillae with coxae completely separated, though closely appressed at median line. Inner branch clearly separated from coxa; subtriangular; distally prolonged into a conspicuous membranous lobe which is nearly as long as the proximal portion. Outer branch with second and third divisions completely coalesced; narrow; extended distally into a long membranous lobe like that of inner division; no lappets present. Second maxillae with coxae rather short; coalesced at median line but more narrowly than in Mecistocephalus, etc. Pore of salivary gland on ectal portion of coxosternum near middle of length, not at caudal angle, the passage extending ectad to lateral margin. Palpi terminating in short, nearly straight, claws.

Prehensors large, much exposed from above.

Claws extending beyond front margin of head. Some of joints mesally armed.

Basal plate narrow.

Prebasal plate not exposed. Pleurae exposed at sides of basal plate.

Dorsal plates bisulcate.

Ventral pores absent.

Last ventral plate subtriangular. Coxopleurae large, porose.

Anal legs with six joints distad of coxopleurae; clawless.

Anal pores present.

Type.— *T. intermedius*, sp. nov.

This genus is most closely related, apparently, to that embracing *carniolensis*, *limatus*, etc. (Mecistocephalus of most authors). It is different chiefly in the following points:— the materially greater shortness of the coxopleurae of the second maxillae and particularly the difference in position of the salivary pore, this being at about middle of length and toward lateral margin, not at extreme caudal angle as in Mecistocephalus, etc.; and the lateral divisions of the labrum being unarmed, that is smooth, and not longitudinally striate. Also the hairs of labrum are much more sparse. From Mecistocephalus proper (*punctifrons* Newport, etc.) it may readily be separated through the absence of the strongly chitinized process or tooth on the ventral border of head at anteroectal end of lateral division and the much shorter coxosternum of the second maxillae and difference in position of pore; the smaller middle piece of the labrum; and the larger clypeus, which extends cephalad in triangular form to near level of antennae. It agrees with the latter genus in the unarmed character of the lateral pieces of the labrum and also in the large size of the membranous lobe of the inner division of the first maxillae.

Tygarrup intermedius, sp. nov.

Yellowish; in type with a pale median longitudinal line paralleled or limited on each side by a somewhat darker stripe which is deepest cephalad and caudad, but these not evident in younger specimens. Head and prosternum with prehensors pale ferruginous. Antennae and legs pale.

Head widest at level of labrum, conspicuously narrowed caudad with posterior corners well rounded; caudal margin straight; sides oblique and somewhat incurved from ends of frontal suture to ectal side of base of antennae; anterior margin substraight, narrowly semicircularly excised at middle. Longer than wide in ratio 100:73. Pleural piece of ventral side of head plate with mesal edge strongly chitinized and ending cephalad in a pointed process as usual but with no trace of a tooth at cephaloectal angle. Clypeal region with hairs very sparse. Hairs of dorsal surface small and sparse.

Labrum with the median piece very narrow, the sides of this being for most of length nearly parallel or but little converging caudad, its caudal end narrowing to a subacute tooth. Greatest length of labrum (*i. e.* at ends) about one third the median length of the clypeal area.

Inner branch of the first maxillae with basal portion subtriangular in outline; the membranous distal division as long as or nearly as long as the basal, widening distad with mesal side concave and the ectal convex. Outer branch narrow, subcylindric, narrowing but moderately to the beginning of the long membranous distal division which is as long as the proximal division and widens distad like that of the inner division which it overtops by a short distance.

Coxosternum of second maxillae rather short; median portion membranous; mesocaudal portion also membranous and not sharply defined. Pore close to outer edge, to which a passage from it leads, and a little caudad of middle of length, five or six bristles forming a row parallel with and a little removed from the anterior margin on each side. Claw of palpus small and pale, nearly straight, with a denticle on mesal side toward base.

Antennae nearly 2.4 times longer than the head. Articles moderate in length, decreasing very gradually distad. Ultimate article (in mature specimen) shorter than the two preceding taken together in about the ratio 3:4, in young specimens longer than these two.

Claws of the prehensors when closed reaching to the end of the first antennal segment. Claw without a true tooth within, there being, however, a slight low, rounded, chitinous elevation; intermediate joints unarmed; prefemur (femuroid) at distal end on mesal side with a distally rounded tooth projecting cephalomesad.

Prosternum a little wider cephalad than caudad; 1.3 times longer than wide; 1.9 times as long as length of prefemur on ectal side. Prosternum bearing on anterior margin each side of mesal incision a basally broad, conical tooth. Mesal incision with sides almost parallel, rounded at bottom. Basal plate a little overlapped both by head and by first dorsal plate; twice as wide as long; ratio of width at caudal end to that at anterior end as 45:34; head about 4.5 times longer.

Prescuta of posterior and median region short; those of anterior region very short.

Anterior ventral plates with a deep median longitudinal sulcus on caudal part and ending at about middle of plate in the angle of a short v or u-shaped impression, the arms of which diverge cephalad. This median sulcus becomes gradually weaker caudad, fading out and disappearing near the twenty-first segment, the u-shaped impression disappearing farther cephalad.

Spiracles circular, rather large; first one largest, with the third considerably smaller and the second intermediate, the other decreasing gradually caudad as usual.

First pair of legs greatly reduced, being only about two thirds the length of the second ones and much more slender. Anterior and posterior pairs not sensibly differing in length or thickness.

Last ventral plate triangular or shield-shaped, the sides being convex; narrowly truncate at caudal apex.

Coxopleurae moderately enlarged; each with two large pores partially covered by the ventral plate and over free ventral and lateral surface with regularly spaced, moderately numerous, smaller pores but these larger and fewer than those of Mecistocephalus, etc.

Anal legs much longer than the penult but proportionately slender. Hair moderate in size, subsparse. Ultimate article narrowed distad, terminating in an obscure membranous tip.

Length of type, cir. 18 mm.

Locality.— British Guiana (taken at Washington, D. C., in pots of plants imported from that country).

One adult, or nearly adult, and three adolescent specimens.

GEOPHILIDAE.

The new genus and species described below, and *Ribautia bouvieri* Brölemann from the Carsevenne are the only representatives of this family, in the strict sense, at present known to occur within Brazil. Both genera belong to Chilenophilinae. Here also belongs Taiyuna, of which a representative from British Guiana is described.

SCHIZONAMPA, gen. nov.

Frontal suture not evident. Basal plate wide; overlapped by the cephalic plate. Antennae filiform. Dorsal plates bisulcate.

Labrum free; tripartite; the median piece of moderate size, triangular, with the free edge armed with teeth; lateral pieces fringed with more slender, spinescent processes.

Outer process of first maxillae uniarticulate; bearing well-developed membranous lappets. Inner branch seemingly set off by suture; Coxae fused at middle.

Second maxillae with coxae almost completely separated at middle, the connection being narrow and membranous. Pleurosternal sutures strongly developed. Palpus triarticulate, terminating in a large simple claw. Femur bearing at distoectal corner a strongly chitinized acute process; tibia also bearing a similar process in a nearly corresponding, or slightly more dorsal position. (Plate 6, fig. 6).

Prehensorial feet large, conspicuously exposed from above, and extending well beyond the front margin of the head; dentate within.

Prosternum without distinctly developed chitinous lines. Basal plate trapeziform; wide.

Ventral pores not evident.

Last ventral plate wide. Coxopleural pores appearing as two large pits on each side.

Anal pores not evident (in type).

Anal legs with seven joints distad of the coxopleura, the small terminal article not bearing a claw. The extra article of the anal legs is at least strongly simulated on all the other legs, but especially the more posterior ones, by a contracted terminal division of the tarsus which for the most part is clearly distinct. (Plate 6, fig. 7).

Genotype.— *Schizonampa manni*, sp. nov.

This interesting genus is the second of the Chilenophilinae to be reported from Brazil, Ribautia being the first. Taiyuna, recorded from British Guiana, is the only other representative of the group at present known from South America.

Schizonampa may readily be separated from the other known genera of the Chilenophilinae lacking a claw on the anal legs and having the small additional distal article as shown in the following key.

Key to Genera of Section embracing Schizonampa.

a. Ventral pores present; distomesal angle of coxa of second maxillae prolonged; first maxillae without lappets. *Proschizotaenia* Silvestri.

aa. Ventral pores absent; distomesal angle of coxa of second maxillae not prolonged; first maxillae with lappets.

- b. Pores occurring as two large pits on each coxopleura; femur and tibia of second maxillae prolonged into an acute, strongly chitinized process at distoectal angle. . *Schizonampa*, gen. nov.
- bb. Coxopleural pores small and isolated; tibia not prolonged at distoectal angle.
  - c. First maxillae with two long membranous lappets on each side. . . . . *Watophilus* Chamberlin.
  - cc. First maxillae with but a single lappet on each side, this being borne on the femur. . . . . *Alloschizotaenia* Brölemann.

Schizonampa manni, sp. nov.

Slender; sides of body nearly parallel over most of length, but conspicuously attenuated at caudal end and moderately attenuated toward head. Body sparsely hirsute with short hairs; hairs of legs few, those present commonly arranged mostly toward the distal ends of articles.

Color of body very pale, whitish yellow, the yellow being very dilute. Head with basal plate, prosternum, and prehensors, darker, somewhat light orange or dilute ferruginous; the antennae also similar.

Cephalic plate much longer than wide (ratio about 4:29) narrowest cephalad; a little constricted in front of region where frontal suture would be if present, between which level and the caudal corners the sides are substraight or only very slightly convex; hairs sparse and mostly short or very short. Frontal plate not discrete. (Plate 6, fig. 1).

Antennae short, being only 1.9 longer than the cephalic plate; attenuated. Articles mostly short, decreasing in size distad, those between the fifth and the ultimate being especially short; ultimate article longer than the two preceding taken together. Hairs on the first four or five articles moderate in length, sparse, those of the more distal articles considerably shorter and more dense. (Plate 6, fig. 1).

Basal plate trapeziform as usual; much overlapped by the cephalic plate as also by the first succeeding tergite. Exposed portion very short, at the median line being but one eighth as long as the cephalic plate and being about 4.5 or 4.6 times wider than long. (Plate 6, fig. 1, 2).

Clypeal region without any porose area; areolae distinct and uniform excepting for a median area on the anterior portion in which the areolae are conspicuously reduced in size and on which four hairs are borne, the clypeal region being elsewhere glabrous.

Median piece of labrum rather large, triangular, bearing along the free margin five large acute and strongly chitinized teeth; lateral pieces with a fringe or more numerous slender spinescent processes. (Plate 6, fig. 4).

First maxillae bearing ectally on each side one moderately long membranous lappet. Coxosternum mesally incised, but the coxae well fused for most of length of contact. (Plate 6, fig. 5).

Coxae of second maxillae almost completely separated, there being only caudally a pale membranous connecting bridge. Pleurosternal sutures strongly developed. Coxa not at all produced at mesodistal angle. Femur and tibia bearing at distoectal angles a distinct, acute, well chitinized process, that of the tibia being somewhat more dorsal in position than that of the femur. Claw large and simple. (Plate 6, fig. 6).

Claws of the prehensor when closed extending much beyond the anterior margin of the cephalic plate; attaining the distal end of the second antennal article. Claw not crenulate; armed at base with a stout tooth which is subtruncate distally. Intermediate articles without trace of teeth, but the femur bearing on mesal side toward distal end a stout, bluntly rounded, tooth and also bulging in a small well-rounded eminence near the proximal third where there is indication of a suture such as is frequently present (apparently of trochanter).

Lateral margin of prosternum parallel for most of their length, incurving only toward caudal ends. Prosternum a very little wider than long (ratio cir. 18:17); longer than the femur on outer side in about ratio 17:11; anterior margin bearing two low and rounded, strongly chitinous, teeth; hairs very sparse. (Plate 6, fig. 3).

The paired sulci of the tergites distinct; in addition to these a median longitudinal sulcus may be evident in the anterior region. Prescuta very short in the anterior region, becoming moderately long in the median and posterior regions. Hairs mostly very short.

Spiracles all circular. The first one distinctly larger than the second, the others gradually decreasing caudad as usual.

First pair of legs reduced, being shorter and decidedly more slender than the second. Posterior pairs of legs relatively but very little more slender than the anterior ones. A small third tarsal division simulating or corresponding to the extra one of the anal legs is evident on all legs but especially the more posterior pairs; it is short and considerably more slender than the preceding one.

Anterior ventral plates with a rather deeply impressed median longitudinal sulcus which extends entirely across the plate. First ten or eleven sternites produced caudad into a wide triangular process or lobe which fits into a recess in the anterior border of the succeeding plate in each case. Ventral pores not detected.

Last ventral plate very wide; trapeziform, the sides slightly convex anteriorly but substraight for most of length, strongly converging caudad; caudal margin straight. (Plate 6, fig. 7).

Coxopleural pores consisting of two large pits on each side; of these pits the anterior one each side is wholly covered by the ventral plate and the caudal one is covered excepting for a small portion. (Plate 6, fig. 7).

Anal legs much longer than the penult; slender in the female. Second joint of tarsus long and slender; the third very short and abruptly more narrow. (Plate 6, fig. 7). Pairs of legs in the type thirty-seven.

Length 13 mm.

Locality.— State of Pará: Pará! (Mann and Baker).

One female specimen was secured.

RIBAUTIA Brölemann.

Arch. zool. exp. et gen., 1909, ser. 5, **3**, p. 335.

RIBAUTIA BOUVIERI Brölemann.

Bull. Mus. hist. nat., 1909, p. 7, fig. 19–26.

Locality.— State of Amazonas: Brazilian Guiana, on the upper Carsevenne or Calçoene (Geay, collector).

TAIYUNA Chamberlin.

Pomona college jour. ent., 1912, **4**, p. 661.

This genus was previously known only from California and Arizona in which states three species are known to occur.

TAIYUNA AUSTRALIS, sp. nov.

Color yellow, of weak orange tinge cephalad. Head and prehensors darker, brown. Antennae similar to head, but paler distad.

Body attenuated cephalad, more strongly so caudad; moderately robust.

Head widest a little caudad of level of labrum from where the sides converge a little and are straight to the rounded posterior corners and also converge slightly cephalad to the similarly rounded anterior corners; posterior margin widely, somewhat flatly, convex; anterior margin with each side straight, extending from corner a little cephalad of mesad to the middle where there is a distinct notch. In type the head is 1.38+ times longer than wide.

Inner branch of first maxilla terminating in an auriculiform membranous lobe at distoectal corner; bearing 3 to 5 bristles. Distal joint of outer branch long, apically rounded with the dorsoectal edge strongly chitinized; bearing about six bristles; membranous lappets long and spinulose, the distal one larger than the proximal, and extending much beyond distal end of the outer branch.

Coxae of second maxillae united at middle merely by a narrow membranous bridge; more strongly chitinized along edge below distomesal angle at which there is no trace of a process. Pleurosternal suture strongly marked as usual; salivary pore opening through the mesal border toward the anterior end in the usual way. Joints of palpus all without processes; femuroid narrowed proximally; claw small, simple.

Antennae short, 1.8 times as long as head; attenuated. Articles decreasing uniformly in length from the first to the penult; ultimate article about equal in length to the two preceding ones taken together. Hairs of proximal articles sparse, distally becoming shorter and finer and more dense.

Claws of prehensorial feet when closed reaching to or a little beyond distal end of first antennal joint; stout. Claw armed at base with a small, distally rounded tooth. Intermediate joints with slight, low and broad, chitinous denticles. First joint toward distal end and a little proximad of the corner with a thick rounded tooth.

Anterior margin of prosternum unarmed; mesal incision very slight, semicircular. Prosternum wider than long in ratio 64:59; 1.64 times as long as outer length of prefemur; sides straight, only slightly converging from anterior end to the rounded caudal corners.

Basal plate trapeziform, strongly narrowed cephalad; sides slightly convex caudad and slightly concave cephalad. 2.9 times as wide as median length, $\frac{1}{4}$ as long as head. Overlapped both by cephalic and by first dorsal plate; the length of exposed portion to total length inclusive of covered ends as 3:4. Plate as a whole about 1.85 times wider than long.

Anterior prescuta short, those of middle region becoming long and exceeding half the length of the major scuta, those of caudal region again short. Hairs short and sparse.

Eight or ten of the first ventral plates with a triangular lobe on caudal border fitting into an excavation in the succeeding plate. Plates smooth, without pronounced furrows, or in some showing a shallow median longitudinal depression.

Spiracles large, circular, or with the anterior ones very slightly longer dorsoventrally. First spiracle much exceeding the second in size, the others gradually decreasing caudad.

Legs of first pair a little more slender than the second, only slightly shorter. Anterior and posterior pairs not at all or but little differing in length and robustness.

Last ventral plate narrow; sides at first but slightly converging caudad, but more decidedly so toward posterior corners; caudal margin subtruncate. Depressed along the median longitudinal line.

Coxopleurae moderately inflated; ventrally pierced by about 14 or 16 pores, part of which are arranged along and partly covered by the last ventral plate; a pore somewhat larger than the others is isolated midway between the most caudal of the other pores and the distal end of coxopleura.

Anal legs moderately long; slender, the joints decreasing in diameter from the femur distad; second tarsal joint moderately attenuated distad and bearing a very small and slender but distinct claw.

Length about 42 mm.

Locality.— British Guiana. (Taken at Washington, D. C., in pots of plants imported from that country).

LITHOBIOMORPHA.

Lithobiidae.

Lithobius Leach.

Trans. Linn. soc. London, 1814, **11**, p. 381; Latzel, Myr. Ost-Ung. monarch., 1880, **1**, p. 31; Meinert, Proc. Amer. philos. soc., 1886, **23**, p. 174; Verhoeff, Bronn's Thierreich, 1907, **5**, p. 239.

Lithobius forficatus (Linné).

Scolopendra forficata Linné, Syst. nat. ed. 10, 1758, **1**, p. 638.
Lithobius forficatus Stuxberg, Ofvers. Kong. vet. akad. Forh., 1875, p. 27; Fedrizzi, Atti Soc. Ven-Trenk., 1875, **5**, p. 205; Latzel, Myr. Ost-Ung. monarch., 1880, **1**, p. 57; Meinert, Proc. Amer. philos. soc., 1886, **23**, p. 176.
Lithobius parvolus Fedrizzi, Loc. cit., p. 213.
Lithobius trilineatus Brölemann, Cat. Myr. Brésil., 1908, p. 33.
(For extended synonymy and bibliography cf. Stuxberg, Loc. cit.).

Locality.— Recorded from Brazil as *Lithobius trilineatus,* the type being the only record of the species or genus from the country. It was probably introduced.

SCUTIGEROMORPHA.

Scutigeridae.

Pselliophora Verhoeff.

Sitz. Gesellsch. nat. freunde Berlin, 1904, p. 259; Bronn's Thierreich, 1907, **5**, p. 230.

PSELLIOPHORA NIGROVITTATA (Meinert).

Scutigera nigrovittata Meinert, Proc. Amer. philos. soc., 1886, **23**, p. 173; Pocock, Biol. Centr. Amer., 1895, p. 650; Brölemann, Ann. Soc. ent. France, 1902, **71**, p. 650; Brölemann, Cat. Myr. Brésil, 1908, p. 34.

Localities.— State of Rio Grande do Norte: Natal! (W. M. Mann. Numerous specimens); State of Parahyba: Independencia! (Mann and Heath); State of Matto Grosso: Madeira-Mamore R. R. camp 41, on the Rio Madeira! (W. M. Mann); State of Bahia: Santo Antonio da Barra); Also Brazil, without special locality (M. C. Z.).

PLATE 1.

Cryptops heathi Chamberlin.

1. Dorsal view of head and first dorsal plate.
2. Prosternum and prehensors.
3. Anal leg.

Mimops occidentalis, Chamberlin.

4. Dorsal view of head and first dorsal plate.
5. Prosternum and prehensorial feet.
6. Last dorsal plate.
7. Last ventral plate and coxopleurae.

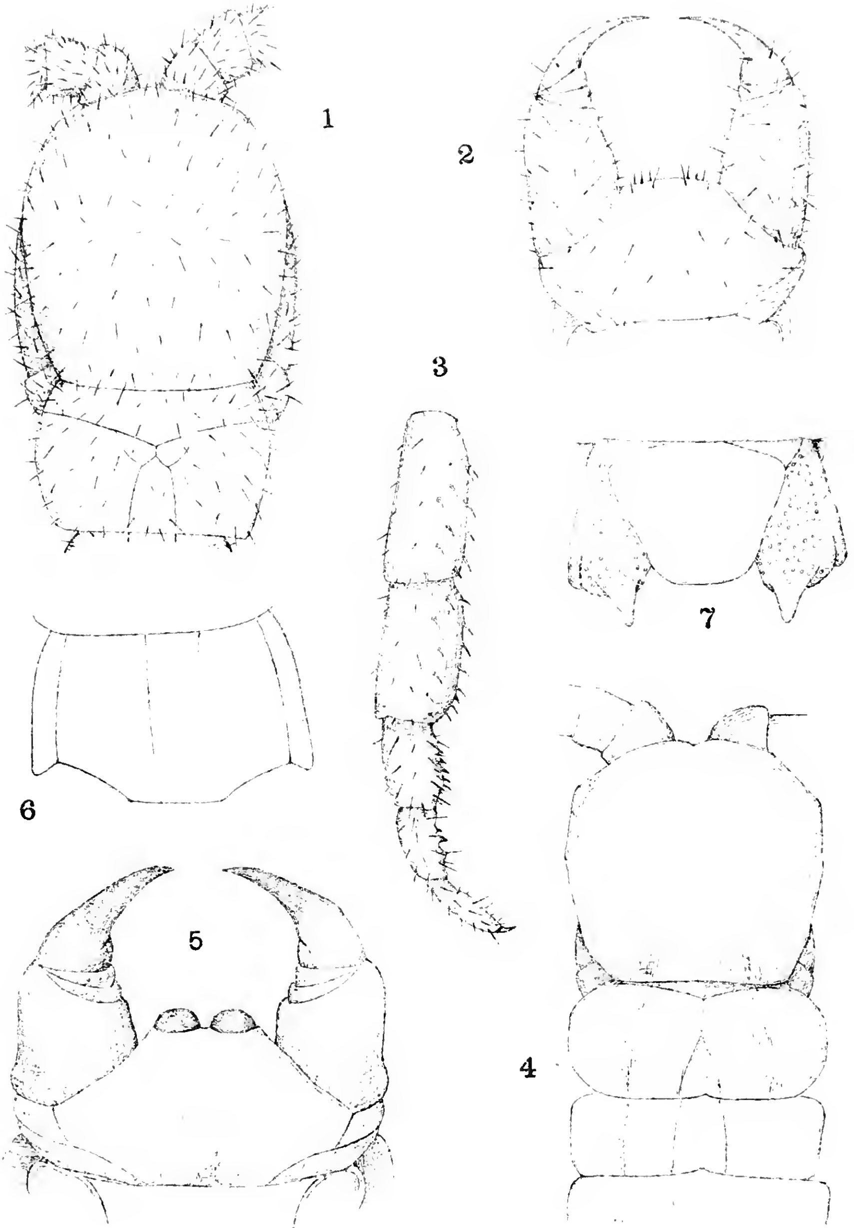
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PLATE 2.

Newportia longitarsis sylvae Chamberlin.

1. Dorsal view of head and first dorsal plates.
2. Anal legs with distal articles of tarsus omitted.

Newportia paraensis, Chamberlin.

3. Anal leg.

Newportia amazonica Brölemann.

4. Lateral view of distal end of tarsus showing claw.

Newportia ernsti Pocock.

5. Lateral view of distal end of tarsus showing chitinous point or rudimentary claw occasionally present in some individuals.

Otostigmus tidius Chamberlin.

6. Prosternum and prehensors.
7. Last dorsal plate.
8. Last ventral plate.

Cupipes amazonae Chamberlin (cf. Plate 3).

9 Last ventral plate and coxopleurae.

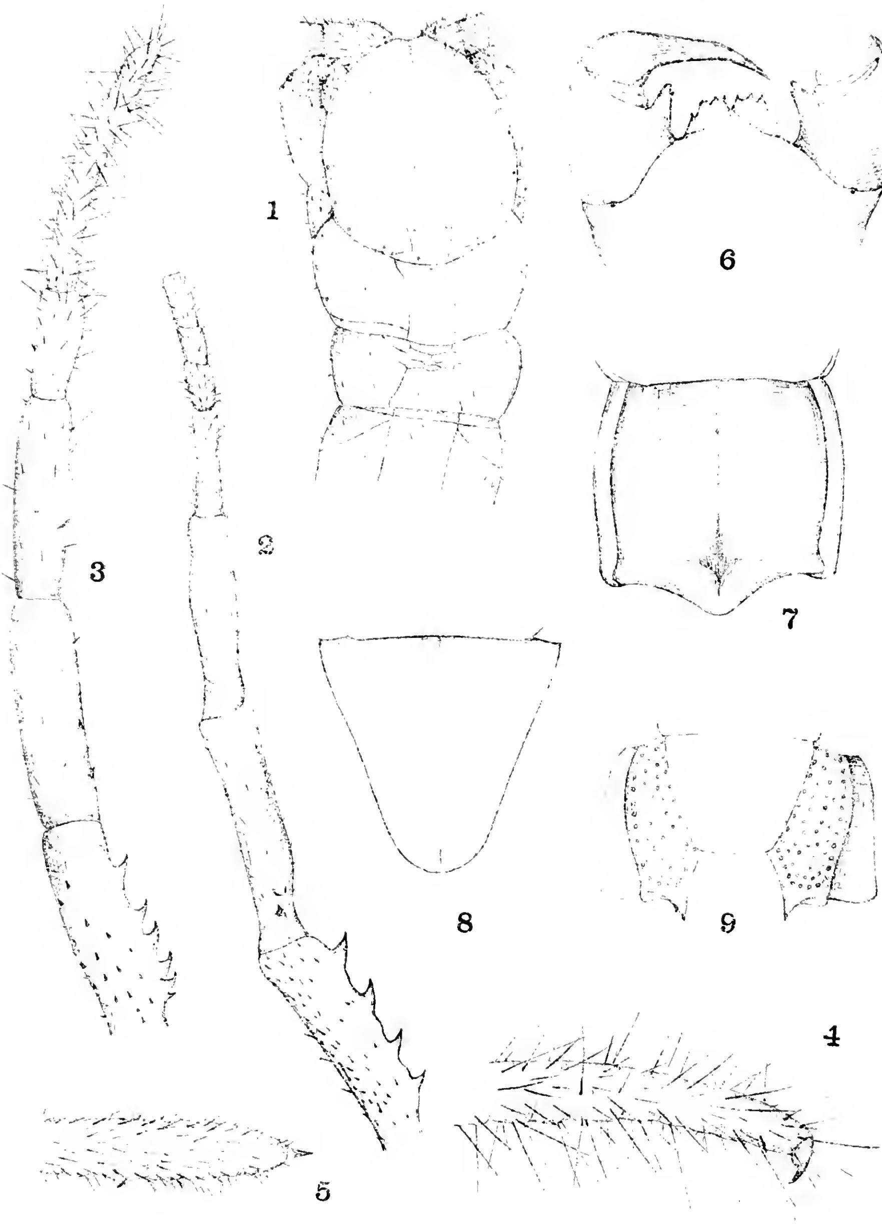
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PLATE 3.

Otostigmus amazonae Chamberlin.

1. Last ventral plate.
2. Last dorsal plate.

Otostigmus suitus Chamberlin.

3. Last ventral plate.
4. Last dorsal plate.

Cupipes amazonae Chamberlin (cf. Plate **2**).

5. Prosternum (in part and prehensors).
6. Distal portion of anal leg showing claw, etc.

Cupipes neglectus Chamberlin.

7. Prosternum (in part) and prehensors.
8. Last ventral plate and coxopleurae.

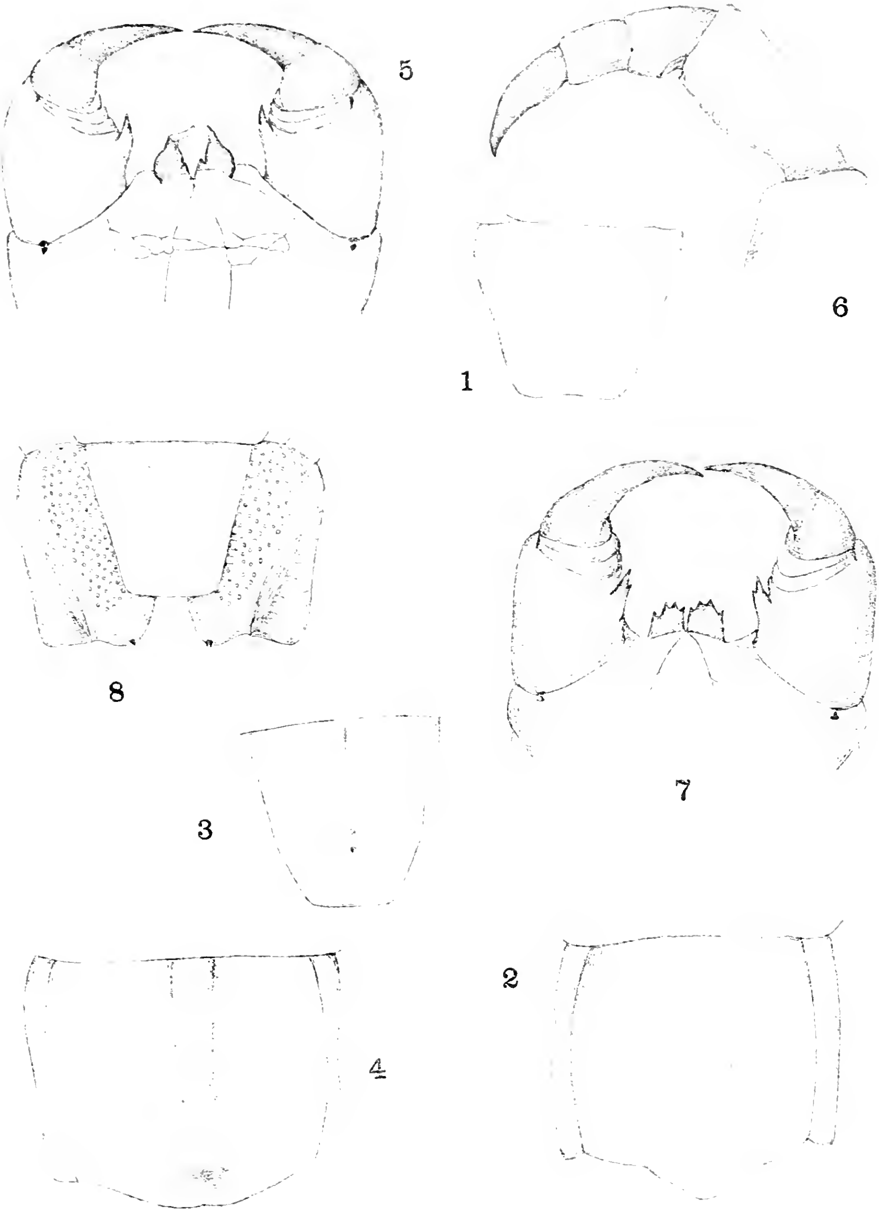
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PLATE 4.

Schendylurus perditus Chamberlin.

1. Cephalic region, dorsal view.
2. Cephalic region, ventral view.
3. Caudal region, ventral view.
4. Antenna (on same scale of magnification as fig. 1, 2).

Schendylurus bakeri Chamberlin.

5. Cephalic region, dorsal view.
6. Cephalic region, ventral view.
7. Caudal region, ventral view.
8. Antenna (on same scale of magnification as fig. 5, 6).

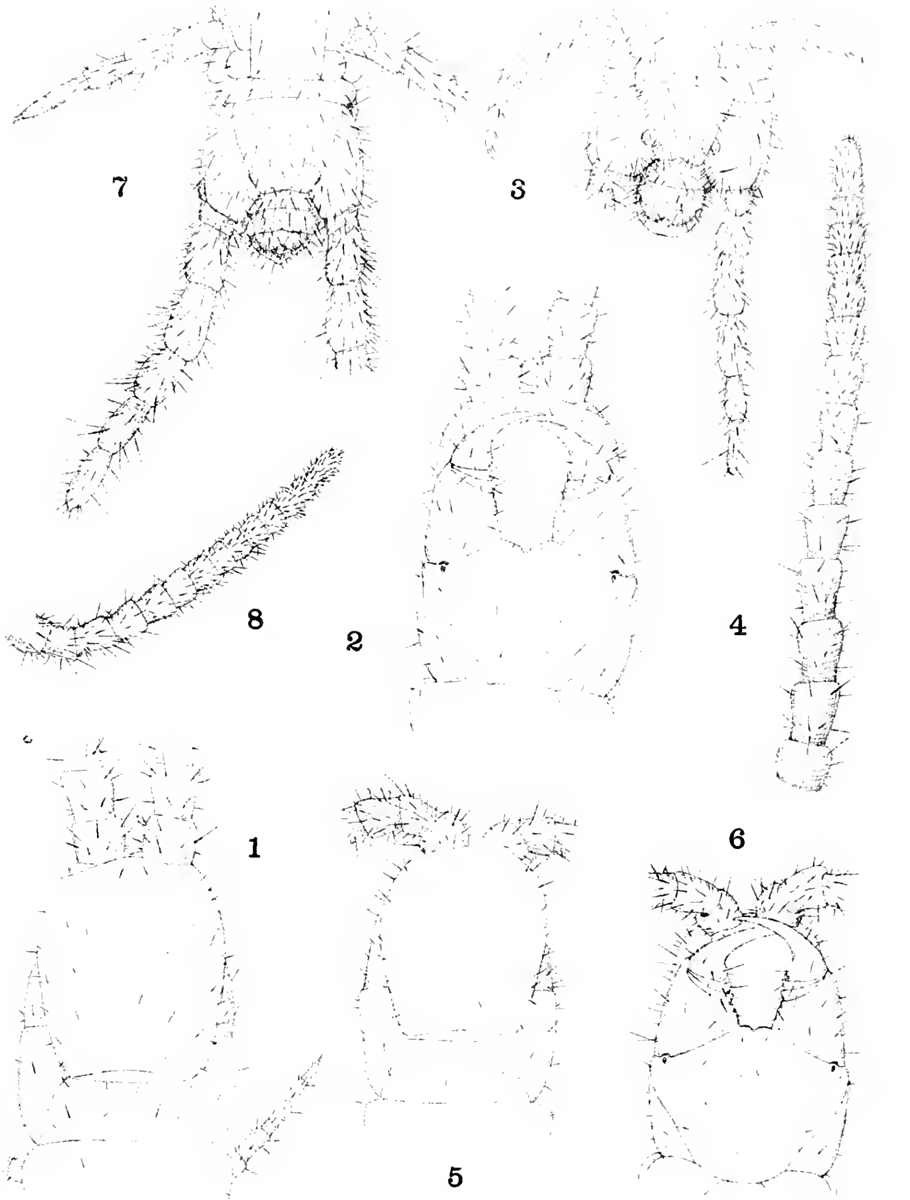
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PLATE 5.

Adenoschendyla parahybae Chamberlin.

1. Cephalic region, dorsal view.
2. Cephalic region, ventral view.
3. Caudal regions, ventral view.

Orphnaeus branneri Chamberlin.

4. Cephalic region, dorsal view.
5. Cephalic region, ventral view.
6. Caudal region, ventral view.

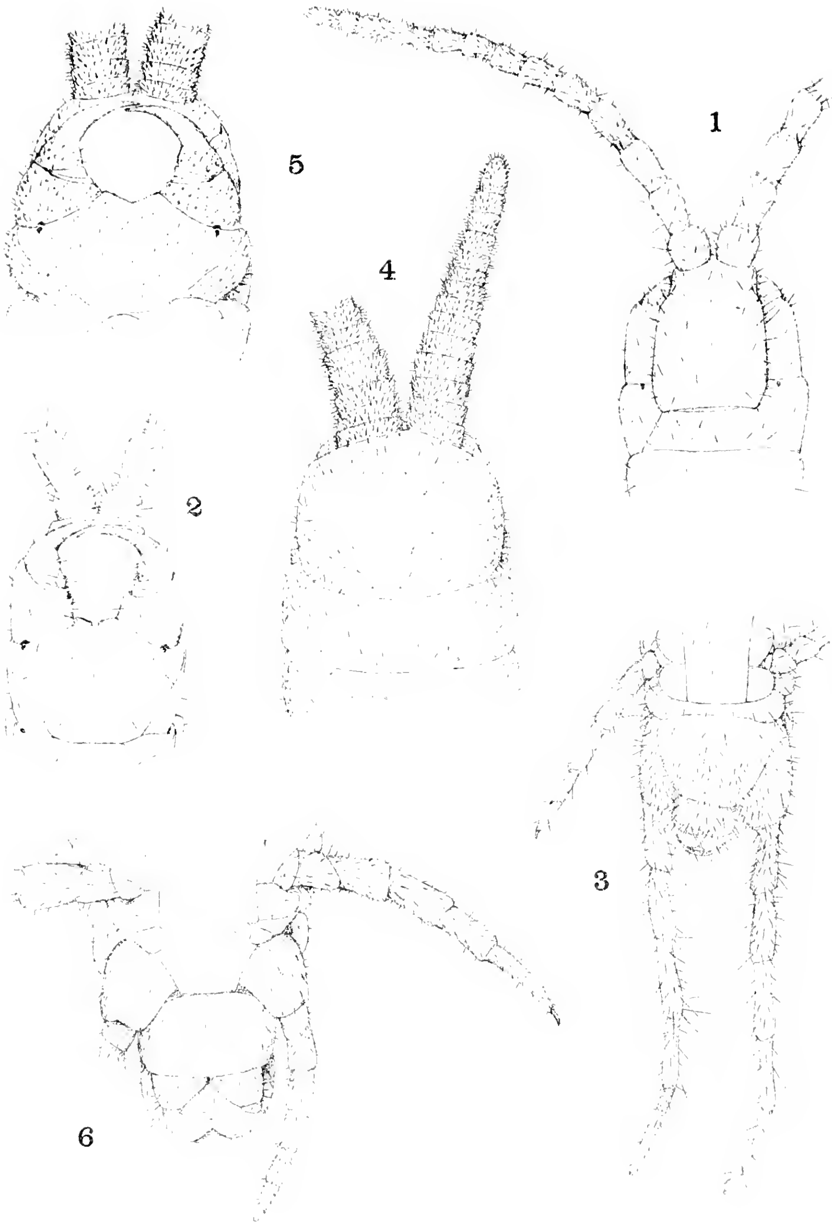
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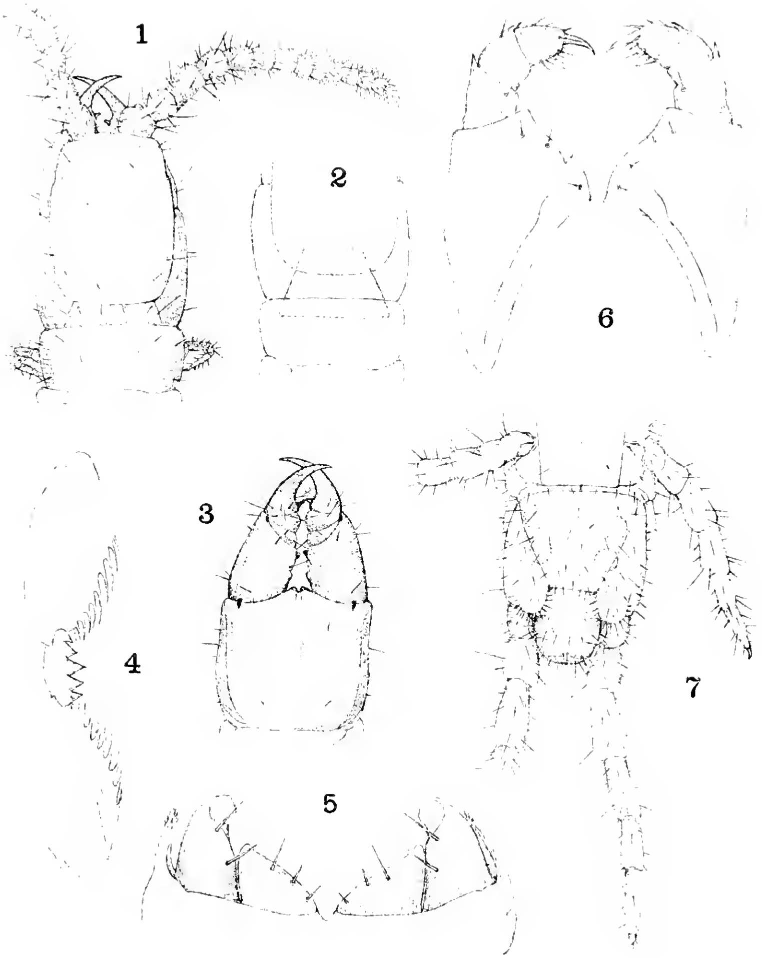
PLATE 6.

Schizonampa manni Chamberlin.

1. Cephalic region, dorsal view.
2. Outline showing relations of basal plate.
3. Prehensors, ventral view.
4. Labrum.
5. First pair of maxillae.
6. Second maxillae.
7. Caudal region, ventral view.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The following Publications of the Museum of Comparative Zoölogy are in preparation: —

LOUIS CABOT. Immature State of the Odonata, Part IV.
E. L. MARK. Studies on Lepidosteus, continued.
" On Arachnactis.
A. AGASSIZ and C. O. WHITMAN. Pelagic Fishes. Part II., with 14 Plates.
H. L. CLARK. The "Albatross" Hawaiian Echini.

Reports on the Results of Dredging Operations in 1877, 1878, 1879, and 1880, in charge of ALEXANDER AGASSIZ, by the U. S. Coast Survey Steamer "Blake," as follows:—

A. MILNE EDWARDS and E. L. BOUVIER. The Crustacea of the "Blake."
A. E. VERRILL. The Alcyonaria of the "Blake."

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieutenant Commander Z. L. TANNER, U. S. N., Commanding, in charge of ALEXANDER AGASSIZ, as follows:—

K. BRANDT. The Sagittae.
" The Thalassicolae.
O CARLGREN. The Actinarians.
R. V. CHAMBERLIN. The Annelids.
W. R. COE. The Nemerteans.
REINHARD DOHRN. The Eyes of Deep-Sea Crustacea.
H. J. HANSEN. The Cirripeds.
" The Schizopods.
HAROLD HEATH. Solenogaster.
W. A. HERDMAN. The Ascidians.
S. J. HICKSON. The Antipathids.
E. L. MARK. Branchiocerianthus.
JOHN MURRAY. The Bottom Specimens.
P. SCHIEMENZ. The Pteropods and Heteropods.
THEO. STUDER. The Alcyonarians.
—— The Salpidae and Doliolidae.
H. B. WARD. The Sipunculids.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of ALEXANDER AGASSIZ, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding, as follows:—

R. V. CHAMBERLIN. The Annelids.
H. L. CLARK. The Holothurians.
—— The Volcanic Rocks.
—— The Coralliferous Limestones.
S. HENSHAW. The Insects.
R. VON LENDENFELD. The Siliceous Sponges.
—— The Ophiurans.
G. W. MÜLLER. The Ostracods.
MARY J. RATHBUN. The Crustacea Decapoda.
G. O. SARS. The Copepods.
L. STEJNEGER. The Reptiles.
C. H. TOWNSEND. The Mammals, Birds, and Fishes.
T. W. VAUGHAN. The Corals, Recent and Fossil.

PUBLICATIONS

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY

AT HARVARD COLLEGE.

There have been published of the BULLETIN Vols. I. to LIV.; of the MEMOIRS, Vols. I. to XXIV., and also Vols. XXVI. to XXIX., XXXI. to XXXIV., XXXVI. to XXXVIII., XLI., and XLIV.

Vols. LV. to LVIII. of the BULLETIN, and Vols. XXV., XXX., XXXV., XXXIX., XL., XLII., XLIII., XLV. to XLVIII. of the MEMOIRS, are now in course of publication.

The BULLETIN and MEMOIRS are devoted to the publication of original work by the Officers of the Museum, of investigations carried on by students and others in the different Laboratories of Natural History, and of work by specialists based upon the Museum Collections and Explorations.

The following publications are in preparation:—

Reports on the Results of Dredging Operations from 1877 to 1880, in charge of Alexander Agassiz, by the U. S. Coast Survey Steamer "Blake," Lieut. Commander C. D. Sigsbee, U. S. N., and Commander J. R. Bartlett, U. S. N., Commanding.

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieut. Commander Z. L. Tanner, U. S. N., Commanding, in charge of Alexander Agassiz.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

Reports on the Scientific Results of the Expedition to the Eastern Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from October, 1904, to April, 1905, Lieut. Commander L. M. Garrett, U. S. N., Commanding.

Contributions from the Zoölogical Laboratory, Professor E. L. Mark, Director.

Contributions from the Geological Laboratory, Professor R. A. Daly, in charge.

These publications are issued in numbers at irregular intervals. Each number of the Bulletin and of the Memoirs is sold separately. A price list of the publications of the Museum will be sent on application to the Director of the Museum of Comparative Zoölogy, Cambridge, Mass.

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Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

Vol. LVIII. No. 4.

NOTES ON THE ONTOGENY OF PARADOXIDES, WITH THE DESCRIPTION OF A NEW SPECIES FROM BRAINTREE, MASS.

By Percy E. Raymond.

With One Plate.

CAMBRIDGE, MASS., U. S. A.:

PRINTED FOR THE MUSEUM.

April, 1914.

Reports on the Scientific Results of the Expedition to the Eastern Tropical Pacific, in charge of Alexander Agassiz, by the U. S. Fish Commission Steamer "Albatross," from October, 1904, to March, 1905, Lieutenant Commander L. M. Garrett, U. S. N., Commanding, published or in preparation:—

A. AGASSIZ. V.[5] General Report on the Expedition.
A. AGASSIZ. I.[1] Three Letters to Geo. M. Bowers, U. S. Fish Com.
A. AGASSIZ and H. L. CLARK. The Echini.
H. B. BIGELOW. XVI.[16] The Medusae.
H. B. BIGELOW. XXIII.[23] The Siphonophores.
H. B. BIGELOW. XXVI.[26] The Ctenophores.
R. P. BIGELOW. The Stomatopods.
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[1] Bull. M. C. Z., Vol. XLVI., No. 4, April, 1905, 22 pp.
[2] Bull. M. C. Z., Vol. XLVI., No. 6, July, 1905, 4 pp., 1 pl.
[3] Bull. M. C. Z., Vol. XLVI., No. 9, September, 1905, 5 pp., 1 pl.
[4] Bull. M. C. Z., Vol. XLVI., No. 13, January, 1906, 22 pp., 3 pls.
[5] Mem. M. C. Z., Vol. XXXIII., January, 1906, 90 pp., 96 pls.
[6] Bull. M. C. Z., Vol. L., No. 3, August, 1906, 14 pp., 10 pls.
[7] Bull. M. C. Z., Vol. L., No. 4, November, 1906, 26 pp., 4 pls.
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[11] Bull. M. C. Z., Vol. LI., No. 6, November, 1907, 22 pp., 1 pl.
[12] Bull. M. C. Z., Vol. LII., No. 1, June, 1908, 14 pp., 1 pl.
[13] Bull. M. C. Z., Vol. LII., No. 2, July, 1908, 8 pp., 5 pls.
[14] Bull. M. C. Z., Vol. XLIII., No. 6, October, 1908, 285 pp., 22 pls.
[15] Bull. M. C. Z., Vol. LII., No. 5, October, 1908, 11 pp., 2 pls.
[16] Mem. M. C. Z., Vol. XXXVII., February, 1909, 243 pp., 48 pls.
[17] Mem. M. C. Z., Vol. XXXVIII., No. 1, June, 1909, 172 pp., 5 pls., 3 maps.
[18] Bull. M. C. Z., Vol. LII., No. 9, June, 1909, 26 pp., 8 pls.
[19] Bull. M. C. Z., Vol. LII., No. 11, August, 1909, 10 pp., 3 pls.
[20] Bull. M. C. Z., Vol. LII., No. 13, September, 1909, 48 pp., 4 pls.
[21] Mem. M. C. Z., Vol. XLI., August, September, 1910, 323 pp., 56 pls.
[22] Bull. M. C. Z., Vol. LIV., No. 7, August, 1911, 38 pp.
[23] Mem. M. C. Z., Vol. XXXVIII., No. 2, December, 1911, 232 pp., 32 pls.
[24] Bull. M. C. Z., Vol. LIV., No. 10, February, 1912, 16 pp., 2 pls.
[25] Mem. M. C. Z., Vol. XXXV., No. 3, April, 1912, 98 pp., 8 pls.
[26] Bull. M. C. Z., Vol. LIV., No. 12, April, 1912, 38 pp., 2 pls.
[27] Mem. M. C. Z., Vol. XXXV, No. 4, July, 1912, 124 pp., 12 pls.

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No. 4.— *Notes on the ontogeny of Paradoxides, with the description of a new species from Braintree, Mass.*

By Percy E. Raymond.

Paradoxides *harlani* is so large and striking a fossil, its occurrence is such an oasis in the sterility of Massachusetts palaeontology, and its discovery and subsequent history borders so closely upon the domain of romance, that it has become one of the most widely known of all the older invertebrate fossils. Although repeatedly described and figured and known from abundant material, the species has never been studied from the phylogenetic standpoint, and it has not, therefore, been brought out how strikingly different this species really is from most of the other members of the genus. In studying the specimens from the viewpoint of an investigation of the growth stages and relationship to other forms, the writer has been forced to the conclusion that there are really two species present in the Hayward quarry at Braintree, and the new species is now named in honor of the Messrs. Hayward, father and son, who have long been proprietors of the quarry which has furnished these trilobites, and who have served science by the care with which they have conserved good specimens.

Paradoxides harlani Green.

Plate, fig. 3–6.

Paradoxides harlani Green, Amer. journ. sci., 1834, **25**, p. 336. W. B. Rogers, Proc. Boston soc. nat. hist., 1856, **6**, p. 27–29, 40–41. Stodder, Ibidem, p. 369. W. B. Rogers, Amer. journ. sci., 1856, ser. 2, **22**, p. 296, Edinb. New philos. jour., 1856, new series, **4**, p. 301; 1857, **6**, p. 314. C. T. Jackson, Comptes rend. Acad. sci. Paris, 1856, **43**, p. 883; 1858, **46**, p. 251, Proc. Boston soc. nat. hist., 1859, **7**, p. 51, 75. W. B. Rogers, Ibidem, p. 86. Ordway, Ibidem, 1860, **7**, p. 427, 1861, **8**, p. 1–5, fig. 2. C. T. Jackson, Ibidem, p. 58. Dana, Man. geol., 1863, p. 189, fig. 245. Walcott, Bull. 10, U. S. geol. surv., 1884, p. 45, pl. 7, fig. 3; pl. 8, fig. 1b, c, e, (non 1, 1a, 1d); pl. 9, fig. 1. Grabau, Occ. papers Boston soc. nat. hist., 1900, **4**, p. 681, pl. 35, fig. 3 (after Walcott); pl. 36 (the type); pl. 37; pl. 38, fig. 1b, c, e; non 1, 1a, 1d (after Walcott); pl. 39 (after Walcott). Shimer, Amer. journ. sci., 1907, ser. 4, **24**, p. 178. Walcott, Smithsonian misc. coll., 1910, **53**, p. 254, fig. 12, 13, (non 10, 11).

Paradoxides spinosus W. B. Rogers, Geol. Penn., 1858, **2**, p. 816, fig. 590. Barrande, Bull. Soc. geol. France, 1860, **17**, p. 551; Proc. Boston soc. nat. hist., 1860, **7**, p. 369.

This species has often been described and is too well known to require any formal description here; but I wish to emphasize certain features which, while now recognized, really have more importance than has previously been ascribed to them. As seen by the references cited above, Barrande considered *P. harlani* as identical with the Bohemian *P. spinosus*. This identification was immediately controverted by Ordway, and later writers have not accepted it; but of the two really vital differences of *P. harlani* from *P. spinosus* and most other species, only one has ever received attention. Ford (Amer. journ. sci., 1881, ser. 3, **22**, p. 250) has called attention to the fact that the species of Paradoxides may be divided into two groups, in one of which the second segment of the thorax is always prolonged beyond the others, while in the other group the second segment is in no way distinguishable from the others. To the first group belong the Bohemian and South European species, while the Scandinavian, British, and American forms belong to the second group. *Paradoxides spinosus* has the second segment extended, while *P. harlani* has not.

The second feature in which *P. harlani* differs from other species, and one which makes it almost unique, is the wide, depressed brim at the anterior end of the cranidium. Of the forty-six recognizable species of Paradoxides whose cranidium is known, only four, *Paradoxides bennetti* Salter, *P. groomi* Lapworth, *P. regina* Matthew, and *P. harlani* Green have a rimless brim (though there is a possible fifth, *P. brachyrhachis* Linnarsson). Of these, only two, *P. harlani* and *P. regina* have a wide brim in front of the glabella. All other species of Paradoxides described from adult specimens have the glabella reaching nearly or quite to the anterior margin.

Among the numerous cranidia obtained from the Paradoxides beds at Braintree, there are some of the smaller ones which have a rim on the front of the cranidium, and the front of the glabella almost reaches the rim. These specimens have been considered by previous writers to be the young of *P. harlani*, and it was believed that in later stages of growth the anterior part of the cranidium became widened and flattened. Specimens recently obtained by the writer from Mr. Hayward's collection show that this could not have been the case, for there are specimens of the broad brimmed type which are of the same size or smaller than some of those showing the rim. The rimmed forms must therefore belong to another species, which is here described as *P. haywardi.* The largest cranidium of the rimmed form obtained is 35 mm. long, while the smallest cranidium with the brim and no rim is 19 mm. long (M. C. Z., No. 22, Pl., fig. 3). On this specimen the part of the brim in front of the glabella is 2.25 mm. wide, or nearly 12% of the total length. On a specimen 34 mm. long it is 4.5 mm. long, or 13%, while on a large cranidium, 103 mm. long, it is 12 mm. wide, or 11%. On the numerous cranidia between the smallest and largest it varies from 10% to 13% of the length, showing that while it grows wider during the growth of the individual, it is relatively about the same width in all cranidia above 19 mm. long. What it might be in smaller specimens we have as yet no means of knowing.

The significance of this wide brim on the cranidium of *P. harlani* is best appreciated after studying the ontogeny of Paradoxides.

Ontogeny of Paradoxides.

The smallest specimen of Paradoxides known is that described by Barrande as *Hydrocephalus saturnoides* (Systeme Silurien du centre de la Bohême, 1852, 1, p. 380, pl. 49). This specimen is slightly over 1 mm. long, the cephalon is oval, and makes up five sixths of the total length. The glabella is large, oval, makes up most of the cephalon, extends to the front of the head, and has no glabella furrows, though there is a median longitudinal furrow. The palpebral lobes form the lateral margins of the cephalon, but judging from the appearance of the cranidium, the free cheeks would have been present even at this early stage, had the specimens been complete. The occipital segment is prominently set off from the rest of the cephalon, and extends to the long, intergenal spines which cross it at right angles. One thoracic segment and a pygidium are present. From the inferred presence of the free cheeks and the presence of a thoracic segment, it is evident that this is not a protaspis, but that several moults have already taken place.

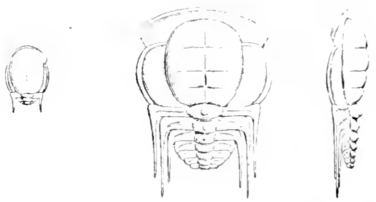

Fig. 1.— *Hydrocephalus saturnoides*, showing two of the stages of development. After Barrande. Note the wide, oval glabella. Compare with Plate, fig. 9.

The second specimen described by Barrande is 1.33 mm. long, the cephalon occupying three fourths of the length and the thorax and pygidium one fourth. The thorax contains three segments. The cephalon has three glabellar furrows which cross the entire glabella. Three more stages of development are illustrated by Barrande, in the last of which the test is about 2 mm. long, the cephalon being a little over 1. mm. In the third, fourth, and fifth stages the first two segments of the thorax bear backward-directed spines and the intergenal spines are still present. The most conspicuous feature of the cephalon in stage five is the presence of a narrow, smooth, flat brim on the front of the cranidium. This is first seen in stage four and becomes wider in stage five. The three glabellar furrows and the median longitudinal furrow are still present at stage five, but the median furrow is not so conspicuous as in the smaller specimens.

The ontogeny of Olenellus indicates that the palpebral lobes are formed by the recurved pleura of the second glabellar lobes. It is very important to note that in these specimens known as *Hydrocephalus saturnoides* the anterior ends of the palpebral lobes join the glabella in front of the anterior glabellar furrows, thus indicating that the furrows present are 2, 3, and 4. Beyond stage five Barrande did not trace any line, but the writer believes that *Paradoxides orphanus* and *P. pusillus* represent the next stages of this same species. In the M. C. Z. there is a cranidium 1.5 mm. long, identified as *P. pusillus*, but answering better to the description of *P. orphanus*, which in some measure fills the gap between the largest of Barrande's figured specimens of *H. saturnoides* and the smallest of his *P. orphanus* and *P. pusillus*. In this specimen the anterior brim is narrow, occupying about the same proportion of the whole length as is shown in Barrande's figure of *P. orphanus*. Glabellar furrows 2, 3, and 4 all cross the whole glabella, as in *H. saturnoides* instead of 3 and 4 only, as in *P. pusillus*, but the connection between the two sides on furrow 2 is quite shallow. This specimen, moreover, adds another pair of furrows at the sides just in front of the palpebral lobes, as in *P. pusillus*. From this specimen to a typical *pusillus* with a wide brim, the collection contains all stages, so there is no doubt of the connection in that direction. Barrande has figured (*Loc. cit.*, 1872, **1**, suppl. pl. 9, fig. 22, 23), an entire specimen of *P. pusillus* 2.5 mm. long, the cephalon of which makes up 55% of the length. Seven free segments are present, and the pygidium contains three or four more. The cephalon has a wide brim, 23% of the whole length, and there are no intergenal spines present, though the first two segments of the thorax have long spines, the spines of the second being longer than the first.

In the M. C. Z. there is a complete specimen of *P.* "*pusillus*" which is 4.5 mm. long, or about twice as large as the one figured by Barrande. The cephalon is 2 mm. long, or 44% of the whole length, and the brim is narrower than in the last specimen. Both the genal spines and those of the second thoracic segment are long, but the first thoracic segment has lost its spines. There are about fifteen thoracic segments ending in free spines, but those back of the tenth are crowded into an extremely small space. (See Plate, fig. 9).

The largest cranidium of *P. pusillus* in the collection is 4.5 mm. long, and Barrande does not mention any larger. In this largest specimen the brim is only .5 mm. wide, thus occupying but 13% of the length, showing that with increase in size the brim is becoming shortened again. Furrows 3 and 4 cross the glabella, while 2 does not. Furrow 1 is present and distinct at the sides.

Next to this specimen stands our smallest cranidium of *P. rugulosus* Hawle and Corda, which is 4 mm. long and practically identical with the largest of *P. pusillus*, but furrows 2 are a little more faint, furrows 4 turn more obliquely backward, and the posterior ends of the palpebral lobes are a little closer to the glabella. From this small specimen we have all gradations up to a full-grown *P. rugulosus* with a cranidium 27 mm. long. In the adult *P. rugulosus* the anterior furrow is very narrow, the glabella being almost in contact with the rim.

Whether this line of development is based entirely upon one species or not, the fact remains that in the development of the brim of Paradoxides there is a change from the very youngest where there is no brim to a youthful stage where the brim is wide, then back to a later adult stage in which the brim is again diminished almost to nothing. In the matter of the brim, therefore, *P. harlani* retains at maturity a youthful characteristic, lost in *P. rugulosus* when less than 10 mm. long.

There is a certain amount of evidence that the line traced above from *Hydrocephalus saturnoides* through *Paradoxides orphanus* and *P. pusillus* to *P. rugulosus* represents the growth stages of one species. There are in the collections at the M. C. Z. specimens in all stages between *P. pusillus* and the adult *P. rugulosus*, and the only sharp break is between the largest specimen of *Hydrocephalus saturnoides* and the smallest of *P. orphanus* or *P. pusillus*. In the matter of the brim there is no break, for we see it gradually becoming wider and wider in specimens of *H. saturnoides*, it continues getting wider in *P. orphanus* and *P. pusillus* up to a certain stage, then decreases in width in the larger *pusillus* and the young of *rugulosus*. The only great change between

Hydrocephalus saturnoides and *P. orphanus* is the introduction just at this point of the anterior pair of glabellar furrows and the reduction in size of the glabella. But the furrows come in where we would have predicted them, just in front of the palpebral lobes. And this brings out a point, which was wholly unexpected, that in this species of Paradoxides the glabella of the youngest specimens known is smooth and unsegmented, and gains its furrows during growth. This will be referred to again later.

There are also external indications which indicated that the above series may be a natural one. *Hydrocephalus saturnoides, P. orphanus,* and *P. pusillus* all palpably represent immature individuals and have been generally so considered. Hydrocephalus was placed by Barrande as akin to Paradoxides, and by Beecher was referred to that genus. Barrande separated it from Paradoxides, first, on account of the course of the facial suture, which left the genal spine on the fixed instead of the free cheeks; second, on account of the longitudinal furrow on the glabella; and third, because of the few thoracic segments, there never being more than twelve.

The third characteristic merely indicates immature specimens and need not be considered. In regard to the second one of the remarkable features of *P harlani* is that this same longitudinal furrow of the glabella is present, at least as a line of weakness, in very large specimens. As to the first, the spines on the fixed cheeks are merely the terminal spines of the palpebral lobes, the intergenal or "interocular" spines known also in the young of Olenellus. From the form of the cranidium it is evident that entire specimens had free cheeks, and they doubtless bore the true genal spines. There is, therefore, no reason for separating Hydrocephalus from Paradoxides.

In regard to occurrence, all four species come from the Cambrian band in the vicinity of Skrey, and so far as known are found together in the same beds. Most of the specimens of *H. saturnoides* in the M. C. Z. collection are from Teirovic, from which locality there are also specimens of *P. pusillus* and *P. rugulosus.* All are in the same kind of matrix and have the same sort of preservation. At Slap, where *P. rugulosus* is most abundant, *H. saturnoides* seems less common, though *P. pusillus* is quite common.

Of the Bohemian species, *P. sacheri* Barrande, *P. lyelli* Barrande, *P. bohemicus* (Boeck), and *P. rotundatus* Barrande seem to be confined to the Ginetz band of the Cambrian, hence it is unlikely that these young should belong to any of those species. *Paradoxides spinosus* (Boeck) is very common in the band of Skrey and when I began to study these specimens, I supposed them to be the young of that species. That they do not belong to that species is, however, shown convincingly by the eyes. The adult of *P. rugulosus* has the palpebral lobes touching the glabella at their anterior ends and reaching the occipital furrow behind, while in the adult of *P. spinosus* the eye is much shorter, and does not reach either the glabella or the occipital furrow. Barrande has figured (*Loc. cit.*, pl. 12, fig. 7) a specimen of *P. spinosus* with a glabella 4.5 mm. long in which the eyes have the same position as in the adult, while in the Museum series, specimens this size have the *rugulosus* type of long eyes. The thorax of *P. pusillus* is of the *spinosus* rather than the *rugulosus* type, but that is a character which might change readily during growth from a size of 4 mm. up to the size of the adult *P. rugulosus*. It is, however, possible that the young of the two species would be, in the earliest stages, indistinguishable.

Young Specimens of Paradoxides.

Bohemia.

Hydrocephalus carens Barrande and *Paradoxides inflatus* Corda make a short series showing the early growth stages of some as yet unidentified species. Barrande figures nine stages in the growth of *H. carens*, the smallest specimen being 2 mm. long and the largest 4 mm. The thorax and pygidium together show three segments in the smallest

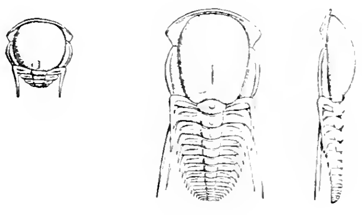

Fig. 2.

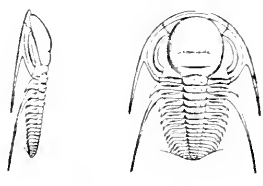

Fig. 3.

Fig. 2.— *Hydrocephalus carens* Barrande. After Barrande. This series shows two stages in the development. Compare with Plate, fig. 3.
Fig. 3.— *Paradoxides inflatus* Corda. After Barrande.

and fifteen in the largest. The glabella is almost circular and shows no glabellar furrows in the first four stages described, and only No. 4 is present in the last five. Intergenal spines are present on all, and on specimens 6–9 the first two segments of the thorax have terminal spines, those of the first segment being the longer. Barrande figures an entire specimen of *P. inflatus* Corda, 5 mm. long, which differs from *H. carens* only in possessing free cheeks, glabellar furrow No. 3, and in having the terminal spines of the first thoracic segment reduced to normal, while the second pair have increased in length. Into what species this form finally developed there is no way of determining without more material. It is interesting to note, however, that the development agrees with the series described above in that the glabella is first smooth, and the glabellar furrows are added during the nepionic stages. They seem to be greatly retarded in this form, as only two furrows (Nos. 3 and 4) have been formed in the largest specimen figured by Barrande. It may be noted that in this form, as in *Hydrocephalus saturnoides,* the brim on the cranidium widens constantly during the known stage of growth, though it never achieves any great width. The M. C. Z., contains a single specimen of *P. inflatus* (No. 651) about 5 mm. long from Velka in the Cambrian band of Ginetz. All the other specimens recorded have come from the band of Skrey, but that it does occur in the more southern band suggests that it may possibly be the young of some form which in the adult has only two pairs of glabellar furrows, possibly *P. bohemicus* (Boeck).

The M. C. Z. contains a single minute specimen (No. 33) 1 mm. long of a young "Hydrocephalus" which is in many respects quite unlike *H. saturnoides.* (Plate, fig. 8). The specimen differs from that form in having the glabella narrow, expanding forward. The occipital ring and furrow are well marked, the glabellar furrows 2, 3, and 4 are deeply impressed, extend across the glabella and divide it into ring-like lobes. The anterior lobe, which is composed of lobes 1 and 2, is transversely oval, and nearly twice as wide as that portion of the glabella back of it. Furrows 1 are faintly indicated, and the frontal lobe has a deep longitudinal furrow which does not reach lobe 3. The palpebral lobes are long, and extend into spines behind the occipital segment. The brim is narrow, and the truncation at the sides is so slight that it is doubtful if free cheeks were present. This specimen is about the size of the smallest specimen of *H. saturnoides,* and it does not seem that it could represent a younger stage in the development of that species, but it appears probable that it is the protaspis of another form. From the outline of the posterior end of the specimen, it seems probable that it is complete, and that the small posterior projection represents the proto-pygidium.

The young specimen of *P. spinosus* figured by Barrande has already been alluded to. Its chief interest lies in the fact that so small a specimen, only 11 mm. long, should be so like the adult. The chief differences are that the eyes are slightly longer, the genal spines arise further forward on the head, and the terminal spines of the second thoracic segment are much longer. These terminal spines of the second segment seem the most persistent of the juvenile characters, and as has already been stated, all the Bohemian species have some remnant of these spines in the adult stage.

The youngest specimen of *P. bohemicus* yet seen is that figured by Barrande (*Loc. cit.*, pl. 10, fig. 25). It is 14 mm. long, not including spines, and exhibits only two youthful characteristics. The eyes are long, and the terminal spines of the second thoracic segment are greatly prolonged. The glabella shows only two furrows (Nos. 3 and 4) the same as in the adult.

Outside Bohemia young Paradoxides are evidently exceedingly rare and have been figured only incidentally. Nothing except a few cranidia seems to have been found.

Scandinavia.

The youngest Scandinavian specimen known is that figured by Linnarsson as the type of his species *P. aculeatus*. This is a cranidium slightly less than 2 mm. long from the *Paradoxides oelandicus* zone of Borgholm. There is a relatively wide brim in front of the glabella, the palpebral lobes extend from the second glabellar lobes to the posterior margin, intergenal spines are present, the glabella is long and narrow, expands slightly forward and has four pairs of glabellar furrows. It resembles a young Paradoxides more than *Hydrocephalus saturnoides* does, as the glabella is of a more normal shape. This specimen[1] is probably the young of either *P. sjogreni* or *P. oelandicus*, more likely of the former, as Linnarsson figures another small cranidium 5.5 mm. long which he refers to that species, though with doubt. This latter specimen also has a wide brim and four pairs of furrows. The adults of both *P. sjogreni* and *P. oelandicus* have a narrow border, and the glabella almost touches the rim.

Great Britain.

Salter figures (Quart. journ. geol. soc., 1869, **25**, pl. 3, fig. 8–10) three young specimens of *Paradoxides hicksi*. These specimens are

[1] Lindstroem considers this the young of *P. oelandicus*. K. Svensk. vet.-akad. Handl., 1901, **34**, no. 8, p. 17.

young cranidia in the *pusillus* stage. They have four pairs of glabellar furrows, long eyes, and a wide brim. The adult has four pairs of furrows, short eyes well forward, and no brim. Hicks, in the description, says of these specimens: — "In the young the margin is equal all around, and a considerable space, also, separates the glabella from the anterior margin. This space gradually diminishes as the individual grows; and the glabella enlarges until, as in the fully grown species, the margin becomes fully obliterated."

America.

Paradoxides tenellus Billings from Newfoundland is another form described from a young specimen in the *pusillus* stage. The typical cranidium is 6 mm. long, shows four pairs of furrows on the glabella, has long palpebral lobes and a wide brim. This species may possibly be the young of *P. decorus*, a very imperfectly known species which Billings describes from a cranidium about 26 mm. long, and which has four pairs of furrows, but has the glabella in contact with the rim. It occurs in the same locality as *P. tenellus*.

Matthew presents notes on the young of *P. eteminicus* and *P. acadius*, and figures three specimens of these species in the *pusillus* stage. All have wide brims, long palpebral lobes, and four pairs of furrows. They are the young of forms whose glabellas nearly or quite touch the anterior rim, and which retain the four pairs of furrows and long palpebral lobes at maturity.

Summary on Ontogeny.

From the above survey of the material now available for the study of the ontogeny of Paradoxides, we see that the youngest shell or protaspis is very similar to that of Olenellus. The glabella in the youngest specimens of both species of "Hydrocephalus" is specialized and unlike that of any other trilobite of which the young is known, in that it occupies a large part of the head, is very wide, and bears no transverse furrows. The first furrow to appear is a median longitudinal one, which is obliterated at an early stage. Glabellar furrows are introduced in young stages, and in later stages of development there seems to be no reduction of furrows by their obliteration successively from the front backward, such as is seen in some of the later trilobites. The glabella occupies the whole length of the cranidium in the youngest stages known, becomes proportionately shorter during some of the early nepionic stages (*pusillus* stages), and becomes longer again in the neanic and early ephebic stages. The palpebral lobes are in general very much longer in young stages than in later ones, but many species are primitive in this regard, and retain the long eyes at maturity (*P. rugulosus* group). Most of the adult characteristics are assumed at an early age, so that specimens 6–10 mm. long are often almost identical in form with the adult; but certain minor features such as the lateral extention of the second thoracic segment, persist well on into the ephebic stages.

Application to P. harlani. It will now be seen why the form of the brim of this species is so important. The wide brim is a feature which, in this genus, is decidedly larval in character, and in such forms as are known to have had it, it is lost at an early age, when the cephalon was 6–10 mm. long. Its retention in large adults like *P. harlani* is most unusual. Another result arrived at above is applicable to *P. harlani*. It was found that the glabellar furrows were not lost by the adult, but that, on the contrary, the adult had more furrows than the young. None of the very young of *P. harlani* are known, but the smallest glabellas now before us (11 mm. long) show two pairs of furrows which cross the glabella and another pair, (No. 2), which are faintly indicated at the sides. The small cranidium figured (Plate, fig. 3) which is 19 mm. long, shows a similar condition, but the No. 2 furrows are much more distinct. In some of the largest specimens (glabella 100 mm. long) furrows 1 and 2 are both distinct, and most specimens with cranidia more than 40 mm. long show all four pairs of furrows. In these two features, then, the wide brim and the slow acquisition of glabellar furrows this species is very primitive.

The palpebral lobes in the smallest specimen mentioned above reach from the glabella back to the occipital furrow, and their chord is 6 mm. in length. In specimen No. 22 they meet the glabella, but terminate 1 mm. in front of the occipital furrow, and the chord of the lobe is 7 mm. In the adult this eye is proportionately much smaller, for, on a cranidium 79 mm. long the posterior end of the lobe is 9 mm. from the occipital furrow and 8 mm. from the glabella, the chord of the lobe being 21 mm. Thus the proportion of the length of the chord of the palpebral lobe to the length of the cranidium in the smallest specimen is .50, in the second, .32, and in the adult, .26, or a reduction of about one half. In common with most other species of Paradoxides, *P. harlani* shows a great lateral extension of the fixed cheeks during the process of growth.

Eight of the largest cranidia in the collection, varying from 60 to 120 mm. long, show a longitudinal cracking along the median line which strongly recalls the median longitudinal furrow of Hydrocephalus. In this case it is not exactly a furrow, but the crushing along this line of so many specimens indicates a line of weakness here. The backward or forward turning of the third and fourth furrows of the glabella at the median line in so many species is also probably to be connected with this furrow.

Comparison with other Species.

As mentioned above, there are only a few rimless species of Paradoxides, and it is with such forms alone that *P. harlani* can be compared. It has been compared most commonly with *P. spinosus* (Boeck); but from that species it differs, not only in the possession of a rimless brim and the absence of the terminal spines on the second thoracic segment, but also in the pygidium, which in *P. harlani* is larger and longer and has a much longer axial lobe than the Bohemian species.

The species which lack the rim, besides *P. harlani*, are *P. bennetti* Salter, *P. groomi* Lapworth, and *P. regina* Matthew. *P. bennetti* is very similar to *P. harlani* in the shape of the glabella, the possession of four pairs of glabellar furrows, and medium sized eyes. The genal spines appear to be shorter, and according to the single specimen in the M. C. Z., the brim is not so wide. In this specimen, the second segment does not seem to be enlarged as indicated by Salter and mentioned by Ford, but is actually smaller than the first.

Paradoxides groomi is known only from fragments which indicate a species similar to *P. harlani*, but with narrower thorax and, according to Cobbold's description, shorter fixed cheeks.

The principal differences between *P. regina* Matthew and *P. harlani* seems to lie in the pygidium, which is more quadrangular in outline and has a shorter axial lobe in the former species than in the latter. Outside the pygidium it is, as has been pointed out by Grabau, exceedingly difficult to point out differences between the two species. The majority of specimens of *P. harlani* have a narrower cephalon and glabella than the Acadian form, but as Grabau has already shown in his table of measurements, we have specimens of a wide form which correspond very closely to the dimensions of Dr. Matthew's specimen. Incidentally I might mention that the Geological section of the M. C. Z. has recently acquired a specimen of *P. harlani* with a cranidium 138 mm. long, or 18 mm. longer than the cranidium of Dr. Matthew's specimen of *P. regina*. This, restored on the basis of the dimensions of the wide form, would exceed both in width and length the *P. regina;* but, unfortunately it appears to belong to the narrow type, and would therfore cover considerably less area than that species.

Paradoxides haywardi sp. nov.

Plate, fig. 1, 2, 7.

Paradoxides harlani Walcott, *partim*, Bull. 10, U. S. geol. surv., 1884, pl. 8, figs, 1, 1a, 1d.

Among the many cranidia which have been collected at the Hayward quarry at Braintree there are a number which at the anterior end differ markedly from *Paradoxides harlani*. Instead of having a flattened rimless brim, they have an elevated striated marginal rim separated from the glabella by a narrow furrow. Moreover, the outline of the margin of the anterior end of the cranidium, instead of being a smooth curve as in *P. harlani*, is obtusely pointed, the two segments of the rim being straight and meeting at an angle of about 150° in front of the axial line of the glabella. The glabella is convex, semicircular in front, widest opposite the anterior ends of the palpebral lobes. The dorsal furrows are strongly marked and come together in front of the glabella. No specimen so far seen shows any traces of glabellar furrows No. 1, and No. 2 when present, are only slightly impressed and do not show at all in most specimens. No. 3 are quite strong but usually do not meet at the centre, though in one or two specimens they appear to. No. 4 extend across the glabella. The occipital ring is wide and bears a small median tubercle. The eyes are of medium size for the genus. The palpebral lobe does not reach the occipital furrow behind, nor is it connected with the glabella at the front.

No free cheek has been seen which can be assigned with certainty to this species. Free cheeks seem to be less common than any other parts of trilobites at the Braintree locality.

One specimen in the collection shows a part of a thorax still connected with a cranidium, though the body is partially shoved under the head. Eleven segments are present. The axial lobe is about one third the total width, and the pleura are marked by wide grooves which cross them diagonally, the grooves extending out to the point where the pleura begin to taper into spines. These grooves occupy a much larger proportion of each pleuron than do those of *P. harlani*. The terminal spines appear to be rather longer and more slender than in *P. harlani*. The second spine is not longer than the others.

The pygidium differs strikingly from that of *P. harlani*, and is the one figured by Walcott (*Loc. cit.*, pl. 8, fig. 1d). This pygidium differs from the one found on entire specimens of *P. harlani* in being broader than long, and in having the axial lobe distinctly rounded instead of triangular. The last five segments of this specimen (M. C. Z. No. 20) are much longer than those on the average specimen of *P. harlani*, and it is seen from the small entire specimen in the collection of Mr. W. P. Haynes that it belongs to *P. haywardi*. A second pygidium of this type is in the M. C. Z. (No. 652) and a third in the Geological section of the M. C. Z. A nearly entire specimen which is in the collection of Mr. Winthrop P. Haynes has seventeen thoracic segments and shows that the short pygidium assigned above to this species really belongs to it. Mr. Haynes's specimen is largely exfoliated, and the substance of the pygidium is entirely gone. Its outline is, however, indicated on the matrix, and it is of the broad short type, apparently 9 mm. long and 15 mm. broad. The whole trilobite is about 105 mm. long and is quite narrow, the thorax being about 55 mm. wide at the first segment.

Types.— As the holotype of this species I have selected cranidium No. 16 (Plate, fig. 1) recently presented to the M. C. Z. by Mr. Lemuel Hayward. The left side of this cranidium is very well preserved, but the right side is broken and the broken piece partially thrust under the glabella. Furrow 3 is distorted.

As paratypes I have selected specimens Nos. 17, and 18, both of which are illustrated. All are in the M. C. Z.

Measurements. Holotype.— Cranidium 35 mm. long; glabella 31 mm. long, 23 mm. wide at front of eyes; chord of palpebral lobe 13 mm. long; rim 2 mm. wide at front of glabella, 4 mm. wide at corner of cranidium.

Paratypes.— No. 17. Cranidium 32 mm. long; glabella 30 mm. long, 22 mm. wide at front of eyes.

No. 18. Cranidium and eleven thoracic segments, 76 mm. long as it stands, but as some segments are pushed under the head, the actual length was probably about 80 mm.; width of axial lobe at 2d segment 20 mm.; total width of thorax, not including terminal spines, 58 mm.

Remarks.

As may be seen by the following quotation, the specimens here separated as a new species have not escaped observation. Dr. Walcott (*Loc. cit.*, p. 46), in discussing the broad and narrow forms of *P. harlani* says:—"In the head the greatest variation is seen in the contour of the frontal margin, and the gradual development of the frontal limb and rim. On the smallest specimens the frontal limb is very short and more or less rounded. With the increase in size, the space between the glabella and the marginal rim increases in width, and the latter broadens and flattens out." It is not the narrow form of *P. harlani* as described by Walcott and Grabau which I am separating as a new species, but the form with the narrow brim and raised, striated rim. Judging from the above quotation, this form has been placed as the young of the narrow form of *P. harlani*. As has been shown under the description of *P. harlani* above, material recently collected shows that the young of *P. harlani* had a broad flat rimless brim, similar to that of the adult, so that the rimmed forms can not be referred to that species.

Comparison with other Species.

Paradoxides haywardi is a much more normal type of Paradoxides than *P. harlani*, and it is therefore comparable to a far greater number of species. From *P. harlani* itself, it differs, as has already been pointed out, in having an angular instead of a rounded frontal margin, and in having a narrow brim and thickened rim on the front of the cranidium, in the absence of the anterior pair of glabellar furrows, and probably in the wider furrows and narrower spines on the pleura of the thorax. It resembles *P. eteminicus* Matthew more closely than any other American form, but differs from that species in having shorter eyes, the lobes of which do not touch the glabella or neck ring, in lacking the anterior pair of glabellar furrows, and in having a wider groove separating the glabella from the rim. Most of these same differences and others obtain between *P. abenacus* Matthew, *P. acadius* Matthew, *P. micmac* Hartt, *P. lamellatus* Hartt, and *P. haywardi*. *P. regina* Matthew and *P. bennetti* Salter appear to have the wide margin of *P. harlani;* and of Billings's two Newfoundland species, *P. tenellus* seems to be based on immature specimens, and *P. decorus* is not well known.

Of the numerous British species, *P. aurora* Salter, *P. hicksi* Salter, and *P. forchhammeri* Angelin have the glabella reaching on to the rim, *P. davidis* is of the *P. tessini* type with the elongated terminal spines of the pleura, as is also, presumably, *P. bohemicus salopiensis* Cobbold, of which the thorax is not known. *P. groomi* Lapworth is of the *P. harlani* type, *P. harknessi* Hicks agrees with the new species in the presence of a furrow between the glabella and rim, but the eye lobes are much longer and more narrow, and the glabella is narrower and retains the first pair of furrows. *P. intermedius* Cobbold is quite similar in form of glabella, groove and rim, to *P. haywardi*, but the palpebral lobes are too long and reach both the neck ring and the glabella. The *Paradoxides rugulosus* Hawle and Corda, Cobbold, also has the long eye lobes and the first pair of glabellar furrows, and, moreover, differs from the true *rugulosus* in lacking the furrow which should separate the glabella from the rim.

Turning now to the Scandinavian species, we find that *P. forchhammeri* Angelin, *P. hicksi palpebrosus* Linnarsson, *P. oelandicus* Sjogren, and *P. tumidus* Angelin all have the glabella reaching the rim, and most of them have other features in which they differ strikingly from *P. haywardi*, while *P. affinis* Angelin, and *P. tessini* Brongniart and its varieties of course have the long terminal spines on the pleura. *P. tuberculatus* Angelin is known only from a fragment which has a large tubercle on the fixed cheek opposite the basal lobes of the glabella. *P. brachyrhachis* Linnarsson appears to be a rimless species with four pairs of glabellar furrows, and so comparable to *P. harlani*, while *P. aculeatus* is based on a very immature specimen. There is, therefore, no Scandinavian species very closely allied to *P. haywardi*.

Of the Bohemian species, *P. bohemicus* (Boeck) is quickly eliminated because in the adult the glabella reaches the rim and the terminal segments of the pleura are elongated. *P. desideratus* is probably not a Paradoxides, but possibly an Albertella, and *P. expectans* also is doubtfully a Paradoxides. *P. imperialis* is known only from a fragment of the thorax, while *P. inflatus* Corda, *P. pusillus* Barrande, and *P. orphanus* Barrande are evidently based on very immature specimens. *P. spinosus* and *P. rotundatus* Barrande both have glabellas which in the adult touch the anterior rim and retain all four pairs of furrows in most cases. *P. rugulosus* and *P. sacheri* both have the groove in front of the glabella, but *P. rugulosus* has very long eye lobes, touching the glabella and occipital ring, while *P. sacheri* has very short diagonal furrows and very curving spines on the thorax. *P. lyelli* has a long narrow glabella which touches the marginal rim.

Only a few forms are known from southern Europe (Spain, France, Sardinia). *P. asper* Bornemann is founded on fragments and its right to be called a Paradoxides is queried by Pompeckj. *P. mediterraneus* Pompeckj is very similar to *P. rugulosus*,— was so identified by Bergeron,— and the cephalon is therefore similar to that of *P. haywardi*. *P. barrandei* Barrois has the whole four pairs of glabellar furrows and the glabella touches the marginal rim, but *P. prodoanus* de Verneuil and Barrande, which is very similar, has a narrow furrow between the glabella and rim, but the eyes are very close to the glabella, their anterior ends touch it, and the posterior ends also curve in unusually close to the glabella.

It appears then that *P. haywardi* is most closely allied to *P. eteminicus* Matthew of the St. John area in New Brunswick, *P. intermedius* Cobbold from Comley in Stropshire, England, and *P. rugulosus* Hawle and Corda, and *P. mediterraneus* Pompeckj of central and southern Europe. These four species, so far as they are known, all seem to belong to the *P. rugulosus* group in which the eye lobes are very long, the glabella is separated from the marginal rim by a furrow (*P. eteminicus* has a very narrow furrow) and have a rather long pygidium, the posterior margin of which is straight or concave in outline (the pygidium of *P. intermedius* is an exception). The eyes of *P. haywardi* are not of the *P. rugulosus* type, nor is the short wide pygidium. It may be noted, however, that the pygidium is not very different from that of *P. intermedius* Cobbold, to which *P. haywardi* seems on the whole to be most closely allied.

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P. mediterraneus Pompeckj, Zeitschr. Deutschen geol. gesellsch., 1901, **53**, heft 1, p. 2, pl. 1, fig. 1–3.
P. pradoanus Verneuil and Barrande, Bull. Geol. soc. France, 1860, ser. 2, **17**, p. 526, pl. 6, fig. 1–6.

EXPLANATION OF PLATE.

Fig. 1. *Paradoxides haywardi* Raymond. The holotype. Hayward quarry, Braintree, Mass. Nat. size. No. 16, M. C. Z.

Fig. 2. The same species. A cranidium from the same locality. Nat. size. No. 17, M. C. Z.

Fig. 3. *Paradoxides harlani* Green. The cranidium of a young specimen from the same locality as the above. Nat. size. No. 22, M. C. Z.

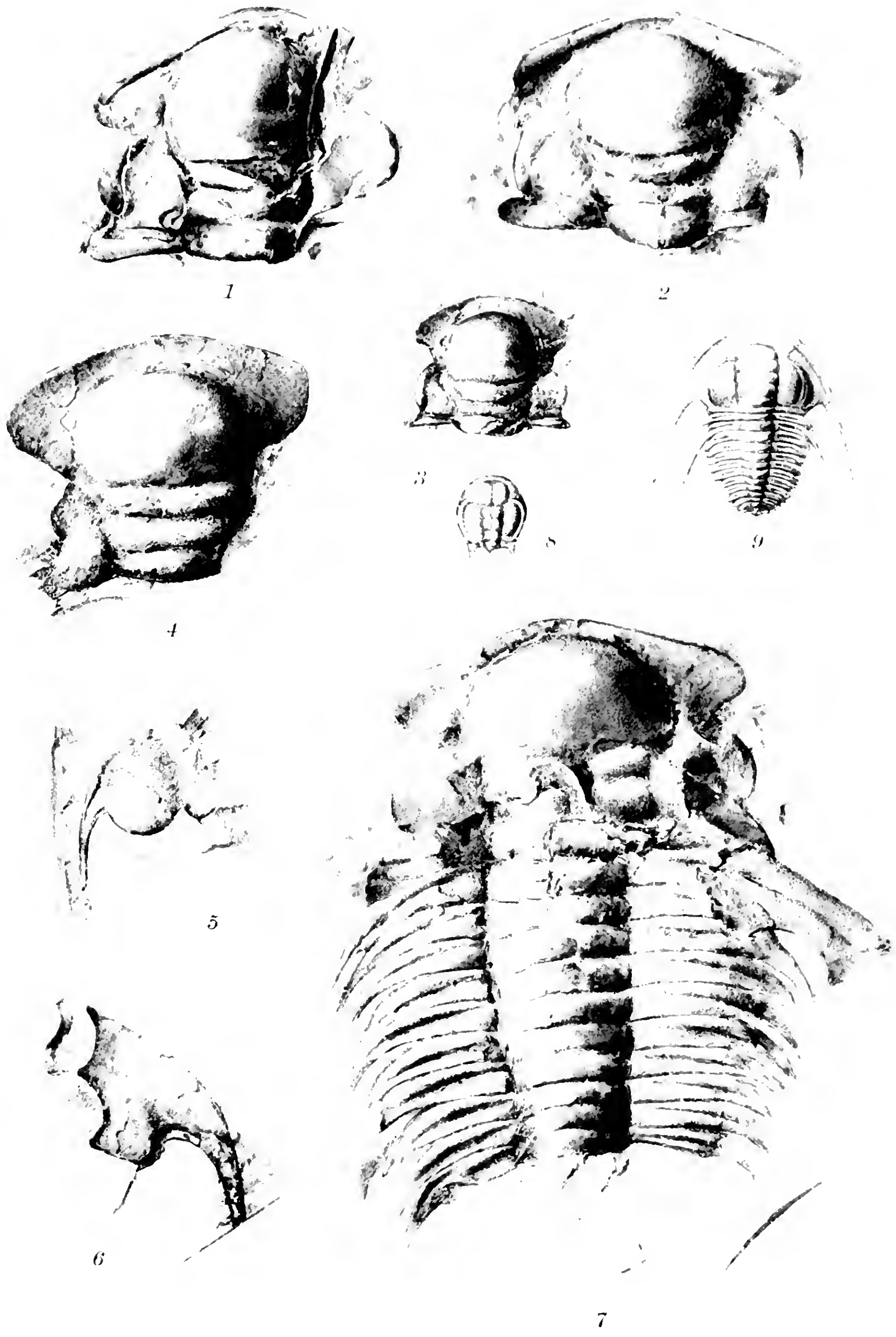
Fig. 4. The same species. An imperfect cranidium of about the same size as the cranidia of *P. haywardi* shown in fig. 1, 2. Same locality. Nat. size. No. 23, M. C. Z.

Fig. 5, 6. *Paradoxides harlani* ? Green. The free cheeks of young individuals, referred to *P. harlani* rather than to *P. haywardi*, merely on account of the greater abundance of the first named species. Same locality as above. Nat. size. No. 24, 25, M. C. Z.

Fig. 7. *Paradoxides haywardi* Raymond. A specimen retaining a part of the thorax. The cranidium is imperfect and has been pushed back over the thorax. A part of an overturned free cheek is present at the side. Same locality. Nat. size. No. 18, M. C. Z.

Fig. 8. Paradoxides sp. ind. A protaspis from the Middle Cambrian at Teirovic, Bohemia. × 16. No. 33, M. C. Z., Schary coll. (The median depression is too long in the figure).

Fig. 9. *Paradoxides rugulosus* Hawle and Corda. A young individual from Slap, near Skrey, Bohemia. × 8. No. 423, M. C. Z., Schary coll.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The following Publications of the Museum of Comparative Zoölogy are in preparation: —

LOUIS CABOT. Immature State of the Odonata, Part IV.
E. L. MARK. Studies on Lepidosteus, continued.
" On Arachnactis.
A. AGASSIZ and C. O. WHITMAN. Pelagic Fishes. Part II., with 14 Plates.
H. L. CLARK. The "Albatross" Hawaiian Echini.

Reports on the Results of Dredging Operations in 1877, 1878, 1879, and 1880, in charge of ALEXANDER AGASSIZ, by the U. S. Coast Survey Steamer "Blake," as follows:—

A. MILNE EDWARDS and E. L. BOUVIER. The Crustacea of the "Blake."
A. E. VERRILL. The Alcyonaria of the "Blake."

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieutenant Commander Z. L. TANNER, U. S. N., Commanding, in charge of ALEXANDER AGASSIZ, as follows:—

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" The Thalassicolae.
O CARLGREN. The Actinarians.
R. V. CHAMBERLIN. The Annelids.
W. R. COE. The Nemerteans.
REINHARD DOHRN. The Eyes of Deep-Sea Crustacea.
H. J. HANSEN. The Cirripeds.
" The Schizopods.
HAROLD HEATH. Solenogaster.
W. A. HERDMAN. The Ascidians.
S. J. HICKSON. The Antipathids.
E. L. MARK. Branchiocerianthus.
JOHN MURRAY. The Bottom Specimens.
P. SCHIEMENZ. The Pteropods and Heteropods.
THEO. STUDER. The Alcyonarians.
—— The Salpidae and Doliolidae.
H. B. WARD. The Sipunculids.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of ALEXANDER AGASSIZ, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding, as follows:—

R. V. CHAMBERLIN. The Annelids.
H. L. CLARK. The Holothurians.
—— The Volcanic Rocks.
—— The Coralliferous Limestones.
S. HENSHAW. The Insects.
R. VON LENDENFELD. The Siliceous Sponges.
—— The Ophiurans.
G. W. MÜLLER. The Ostracods.
MARY J. RATHBUN. The Crustacea Decapoda.
G. O. SARS. The Copepods.
L. STEJNEGER. The Reptiles.
C. H. TOWNSEND. The Mammals, Birds, and Fishes.
T. W. VAUGHAN. The Corals, Recent and Fossil.

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OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY

AT HARVARD COLLEGE.

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Vols. LV. to LVIII. of the BULLETIN, and Vols. XXV., XXX., XXXV., XXXIX., XL., XLII., XLIII., XLV. to XLVIII. of the MEMOIRS, are now in course of publication.

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Reports on the Results of Dredging Operations from 1877 to 1880, in charge of Alexander Agassiz, by the U. S. Coast Survey Steamer "Blake," Lieut. Commander C. D. Sigsbee, U. S. N., and Commander J. R. Bartlett, U. S. N., Commanding.

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieut. Commander Z. L. Tanner, U. S. N., Commanding, in charge of Alexander Agassiz.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

Reports on the Scientific Results of the Expedition to the Eastern Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from October, 1904, to April, 1905, Lieut. Commander L. M. Garrett, U. S. N., Commanding.

Contributions from the Zoölogical Laboratory, Professor E. L. Mark, Director.

Contributions from the Geological Laboratory, Professor R. A. Daly, in charge.

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Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

Vol. LVIII. No. 5.

NOTES ON THE ONTOGENY OF ISOTELUS GIGAS DEKAY

By Percy E. Raymond.

With Three Plates.

CAMBRIDGE, MASS., U. S. A.

PRINTED FOR THE MUSEUM.

April, 1914.

Reports on the Scientific Results of the Expedition to the Eastern Tropical Pacific, in charge of Alexander Agassiz, by the U. S. Fish Commission Steamer "Albatross," from October, 1904, to March, 1905, Lieutenant Commander L. M. Garrett, U. S. N., Commanding, published or in preparation:—

A. AGASSIZ. V.[5] General Report on the Expedition.
A AGASSIZ. I.[1] Three Letters to Geo. M. Bowers, U. S. Fish Com.
A. AGASSIZ and H. L. CLARK. The Echini.
H. B. BIGELOW. XVI.[16] The Medusae.
H. B. BIGELOW. XXIII.[23] The Siphonophores.
H. B. BIGELOW. XXVI.[26] The Ctenophores.
R. P. BIGELOW. The Stomatopods.
O. CARLGREN. The Actinaria.
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C. A. KOFOID and J. R. MICHENER. XXII.[22] The Protozoa.
C. A. KOFOID and E. J. RIGDEN XXIV.[24] The Protozoa.
P. KRUMBACH. The Sagittae.
R. VON LENDENFELD. XXI.[21] The Siliceous Sponges.
—— The Holothurians.
—— The Starfishes.
—— The Ophiurans.
G. W. MÜLLER. The Ostracods.
JOHN MURRAY and G. V. LEE. XVII.[17] The Bottom Specimens.
MARY J. RATHBUN. X.[10] The Crustacea Decapoda.
HARRIET RICHARDSON. II.[2] The Isopods.
W. E. RITTER. IV.[4] The Tunicates.
ALICE ROBERTSON. The Bryozoa.
B. L. ROBINSON. The Plants.
G. O. SARS. The Copepods.
F. E. SCHULZE. XI.[11] The Xenophyophoras.
H. R. SIMROTH. The Pteropods and Heteropods.
E. C. STARKS. XIII.[13] Atelaxia.
TH. STUDER. The Alcyonaria.
JH. THIELE. XV.[15] Bathysciadium.
T. W. VAUGHAN. VI.[6] The Corals.
R. WOLTERECK. XVIII.[18] The Amphipods.

[1] Bull. M. C. Z., Vol. XLVI., No. 4, April, 1905, 22 pp.
[2] Bull. M. C. Z., Vol. XLVI., No. 6, July, 1905, 4 pp.. 1 pl.
[3] Bull. M. C. Z , Vol. XLVI., No. 9, September, 1905, 5 pp., 1 pl.
[4] Bull. M. C. Z., Vol. XLVI., No. 13, January, 1906, 22 pp., 3 pls.
[5] Mem. M C. Z., Vol. XXXIII., January, 1906, 90 pp., 96 pls.
[6] Bull. M. C. Z., Vol. L., No. 3, August, 1906, 14 pp., 10 pls.
[7] Bull. M. C. Z., Vol. L., No. 4, November, 1906, 26 pp., 4 pls.
[8] Mem. M. C. Z., Vol. XXXV., No. 1, February, 1907, 20 pp., 15 pls
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[10] Mem. M. C Z., Vol. XXXV, No. 2, August, 1907, 56 pp., 9 pls.
[11] Bull. M. C. Z., Vol. LI., No. 6, November, 1907, 22 pp., 1 pl.
[12] Bull. M. C. Z., Vol. LII., No. 1, June, 1908, 14 pp., 1 pl.
[13] Bull. M. C. Z., Vol. LII., No. 2, July, 1908, 8 pp., 5 pls.
[14] Bull. M. C. Z., Vol. XLIII., No. 6, October, 1908, 285 pp., 22 pls.
[15] Bull. M. C. Z., Vol LII., No. 5, October, 1908, 11 pp., 2 pls.
[16] Mem. M. C. Z., Vol. XXXVII., February, 1909, 243 pp., 48 pls.
[17] Mem. M. C. Z., Vol. XXXVIII., No. 1, June, 1909, 172 pp., 5 pls., 3 maps.
[18] Bull. M. C. Z., Vol. LII., No. 9, June, 1909, 26 pp., 8 pls.
[19] Bull. M. C. Z., Vol. LII., No. 11, August, 1909. 10 pp., 3 pls.
[20] Bull. M. C. Z., Vol. LII., No. 13, September, 1909, 48 pp., 4 pls.
[21] Mem. M. C. Z., Vol. XLI., August, September, 1910, 323 pp., 56 pls.
[22] Bull. M. C. Z., Vol. LIV., No. 7, August, 1911, 38 pp.
[23] Mem. M. C. Z., Vol. XXXVIII., No. 2, December, 1911, 232 pp., 32 pls.
[24] Bull. M. C. Z., Vol. LIV., No. 10, February, 1912, 16 pp., 2 pls.
[25] Mem. M. C. Z., Vol. XXXV., No. 3, April, 1912, 98 pp., 8 pls.
[26] Bull. M. C. Z., Vol. LIV., No. 12, April, 1912, 38 pp., 2 pls.
[27] Mem M. C. Z., Vol. XXXV, No. 4, July, 1912, 124 pp., 12 pls.

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NOTES ON THE ONTOGENY OF ISOTELUS GIGAS DEKAY

BY PERCY E. RAYMOND

WITH THREE PLATES

CAMBRIDGE, MASS., U. S. A.
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APRIL, 1914.

No. 5.— *Notes on the ontogeny of Isotelus gigas Dekay.*

By Percy E. Raymond.

Introduction.

A partial description of the ontogeny of three of our common asaphids, *Isotelus gigas, I. maximus,* and *Basilicus barrandi,* is given on the following pages. The study is based on many hundreds of good specimens, but, as always in palaeontologic work, the material leaves something to be desired, and further specimens will add materially to our knowledge. The important protaspis stages are still missing.

The outstanding result of the study is the discovery that an *Isotelus gigas,* when 3 to 5 mm. long, has almost exactly the same form as an adult specimen of *Basilicus barrandi,* thus providing an excellent example of recapitulation, for the beginning of the range of *Basilicus* antedates that of Isotelus. Another interesting fact is that while *Isotelus gigas* is the most specialized species of the genus, it is one of the first to appear, and apparently one of the first to die out, while the ones which survived to the end of the Ordovician were the more primitive forms, *Isotelus maximus* and *I. iowensis.*

Two of the three species of the Chazy, *Isotelus harrisi* and *I. platymarginatus,* do not seem to have had any influence on the more persistent and widespread species which belong to the interior faunas. *Isotelus harrisi* (Ann. Carnegie mus., 1905, **3**, p. 343) has a broad flattened cranidium, and is not allied to any other species except the Russian *I. stacyi,* to which Schmidt compared it. *Isotelus platymarginatus* (Ann. Carnegie mus., 1910, **7**, p. 66) has a very wide depressed border on both shields, and is quite unlike any of the later species. The third species, *I. arenicola* (Ottawa naturalist, 1910, **24**, p. 130), is more like *I. iowensis* or *I. gigas,* and may have given rise to one or both of those species. While it has the specialized long pygidium, the axial lobe is narrow and the genal spines are retained at maturity.

Isotelus gigas Dekay.

Plate **1**, fig. 1, 2; Plate **2**, fig. 2–5; Plate **3**, fig. 3.

Isotelus gigas Dekay, Ann. Lyceum nat. hist. N. Y., 1824, **1**, p. 176, pl. 12, fig. 1. Green, Monthly Amer. journ. geol., 1832, **2**, p. 560; Monog. trilobites N. Amer., 1832, p. 68, casts 21, 22. Milne Edwards, Crustacés, 1840, **3**, p. 298. Vanuxem, Rept. Third geol. dist. N. Y., 1842, p. 46, fig. 1. Emmons, Rept. Geol. dist. N. Y., 1842, p. 389, fig. 1. Hall, Pal. N. Y., 1847, **1**, p. 231, pls. 60–63. Emmons, Amer. geol., 1855, **1**, pt. 2, p. 215, pl. 16, fig. 12. W. B. Rogers, Geol. Penn., 1858, **2**, p. 819, fig. 610. Miller, Cincinnati quart. journ. sci., 1874, **1**, p. 138. Clarke, Pal. Minn., 1897, **3**, pt. 2, p. 701 (*partim*) fig. without number. Weller, Pal. N. J., 1902, **3**, p. 192, pl. 14, fig. 6, 7 (non 5). Raymond and Narraway, Ann. Carnegie mus., 1910, **7**, p. 53, pl. 15, fig. 1, 2. Raymond, Trans. Roy. soc. Canada, 1912, ser. 3, **5**, sect. 4, pl. 2, figs. 7, 8; pl. 3, fig. 6.

Isotelus planus Dekay, Ann. Lyceum nat. hist. N. Y., 1824, **1**, p. 178, pl. 13, fig. 7. Green, Monthly Amer. journ. geol., 1832, **2**, p. 560; Monog. trilobites N. Amer., 1832, p. 68, cast 23.

Isotelus cyclops Green, Monthly Amer. journ. geol., 1832, **2**, p. 560, pl., fig. 7; Monog. trilobites N. Amer., 1832, p. 69, cast. 24.

Isotelus megalops Green, Monog. trilobites N. Amer., 1832, p. 70, cast 25.

Isotelus stegops Green, Monog. trilobites N. Amer., 1832, p. 71, casts 26, 27.

Isotelus jacobus Clarke, Pal. Minn., 1897, **3**, pt. 2, p. 706, footnote.

? *Asaphus platycephalus* Stokes, Trans. Geol. soc. London, 1823, ser. 2, **1**, pl. 27, no description. Buckland, Geol. and min., 1837, **2**, p. 73, pl. 45, fig. 12; Ibidem, 1867, pl. 63.

Asaphus platycephalus Bronn, Lethaea geogn., 1835, **1**, p. 115, pl. 9, fig. 8; Ibidem, 1851–1856, **1**, p. 632, pl. 9, fig. 8; pl. 9, fig. 5. Burmeister, Die org. der trilobiten, 1843, p. 127, pl. 2, fig. 12; Ray society edition, 1846, p. 110, pl. 2, fig. 12. Walcott, Bull. M. C. Z., 1881, **8**, p. 198, pl. 2, fig. 9.

Asaphus gigas Dalman, K. Svensk. vet. akad. Handl., 1826, p. 276; Om Palaeaderna, 1827, p. 91; Ueber die Palaeaden, 1828, p. 70.

Asaphus planus Dalman, K. Svensk. vet. akad. Handl., 1826, p. 276; Om Palaeaderna, 1827, p. 91; Ueber die Palaeaden, 1828, p. 70.

Asaphus megistos Billings, Geol. Canada, 1863, p. 184, fig. 182.

Brongniartia isotelea Eaton, Geol. text book, 1832, p. 33, pl. 2, fig. 12.

The following have been erroneously referred to this species:—

Isotelus gigas Portlock, Geol. rept. Londonderry, 1843, p. 295, pl. 7, fig. 1; pl. 8, fig. 1. McCoy, Synopsis Silurian foss. Ireland, 1846, p. 53. Brögger, Bihang K. Svensk. vet. akad. Handl., 1886, **11**, p. 31, pl. 1, fig. 18 (= *Isotelus platyrhachis* Steinhart, teste Schmidt). Clarke, *partim*, Pal. Minn. **3**, 1897, pt. 2, p. 703, fig. 5 (= *Isotelus iowensis*). Weller, Pal.

N. J., 1902, **3**, pl. 14, fig. 5. copy of preceding (= *Isotelus iowensis*). Grabau and Shimer, N. A. index fossils, 1910, **2**, p. 293, fig. 1602 (= *Isotelus latus* Raymond).

Asaphus (*Isotelus*) *gigas* Salter, Mem. Geol. surv., Unit. Kingdom, 1861, dec. 11, pl. 3; Mon. Brit. Silur. tril., 1865, p. 161, pl. 21, fig. 1–5; ? pl. 25, fig. 1. Reed, Lower Silur. tril. Girvan dist., 1904, p. 45, pl. 7, fig. 1.

Asaphus gigas ? Nicholson and Etheridge, Mon. Silur. foss. Girvan dist., 1879, fasc. 2, p. 153, pl. 10, fig. 18, 19; Mem. Geol. surv. Silur. rocks Brit., 1899, **1**, Scotland, p. 509, 513 514 (= *Isotelus instabilis* Reed).

Asaphus platycephalus Nieszkowski, Arch. naturk. Liv.- Est.- und Kurl., 1857, ser. 1, p. 551, pl. 1 (= *Isotelus remigerus* Eichwald and *I. robustus* Roemer, teste Schmidt). Billings, Geol. Canada, 1863, p. 181, fig. 183 (= *Isotelus latus* Raymond); Cat. Silur. foss. Anticosti, 1866, p. 24, fig. 7 (= *Isotelus latus* Raymond); p. 26, fig. 8b (= *Brachyaspis altilis* Raymond); Quart. journ. Geol. soc. London, 1870, **26**, p. 486, pls. 31, 32 (= *Isotelus latus* Raymond).

From the above synonymy, text-book and catalogue references have for the most part been omitted, as have also references where there is neither description nor original figure. So far as can be judged from the published figures and descriptions, none of the foreign specimens referred to this species really belong to it, and most of those which have at one time or another been so referred are now known by other names.

Ontogeny.

In a recent paper (Ann. Carnegie mus., 1910, **7**, p. 53), Mr. Narraway and the writer summarized the ontogeny of *Isotelus gigas*. The Walcott collection in the M. C. Z. contains more complete material than we then had, and permits a study of the species from the stage in which it had a length of only 3 mm.

The smallest specimen (No. 36) in the collection is 3 mm. long, and has the same width at the genal angles. It is exposed from the lower side, and retains the hypostoma in position. The details of the thorax and pygidium are not well shown, but the cephalon occupies at least one half the length, and the pygidium is considerably smaller. The genal spines are long, extending back nearly to the posterior end of the pygidium (Fig. 2). Another specimen, 5 mm. long, is also exposed from the lower side, and shows the hypostoma. In both, the hypostomas are deeply cleft behind, and rather flat, without the convex body of the hypostoma of either Isoteloides or Asaphus.

The smallest specimen (No. 45) showing the dorsal aspect of the shell is 3.5 mm. long as it lies in the matrix, but as the pygidium is somewhat bent under the body, the actual length is probably .5 mm. greater. The cephalon is 2 mm. long and 4 mm. wide (semicircular) and is bordered by a wide (.5 mm.) concave brim. The glabella is convex, abruptly elevated above the brim at the front, bounded at the sides by deep dorsal furrows which converge backward. Between the eyes the glabella is marked by a pair of deep glabellar furrows. Behind them, on the narrowest part of the glabella, is a median tubercle, and on each side at this point is an isolated basal lobe. In short, the glabella is like that of an adult specimen of Basilicus (Plate **1**, fig. 1).

The facial suture can not be made out with absolute certainty on these smallest specimens. On a specimen with the cephalon 1.75 mm. long it seems to be marginal in front, while on a finely preserved cephalon 4 mm. long (No. 37), it is certainly intramarginal (Fig. 1).

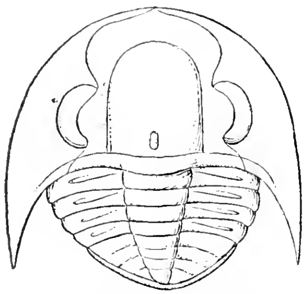


Fig. 1. *Isotelus gigas* Dekay. A small specimen in the Ogygites stage, the facial sutures being intramarginal. The pygidium is incurved so that the posterior part is not well shown. × 6. M. C. Z. No. 37.

The eyes in the smallest specimens are very large, and only about one half their own length from the posterior margin. On a cephalon 2.25 mm. long, the eyes are 1 mm. long and each forms a semicircle, the palpebral lobes almost touching the glabella in front. The posterior corner of the eye is only .3 mm. from the posterior margin of the cephalon. The eye is therefore relatively much larger than in the adult, but no further forward. The growth after this stage is more rapid in front of the eyes than behind them, and a cephalon 3 mm. long has the eyes still only 1 mm. long.

The thorax of the smallest specimens shows few peculiarities other than the narrowness of the axial lobe. The specimen which is 3 mm. long has the axial lobe .5 mm. wide, or .2 the total width of the thorax.

The smallest specimen with a well-preserved pygidium is 3.5 mm. long, and the pygidium is 1.25 mm. long and 2.5 mm. wide. The axial lobe is very convex, narrow, and is prominent all the way to the end. There is a narrow concave border, and the axial lobe reaches to and overhangs this border. The pleural lobes are convex, somewhat triangular, and crossed by four pairs of furrowed ribs. The axial lobe has one strong, and two weak rings at the anterior end. Another pygidium, 2 mm. long, shows the furrowed ribs, but less strongly, and pygidia 3 mm. long are quite smooth, except for the rather prominent axial lobe. The pygidia of young specimens are much smaller than the cephala, being both shorter and narrower.

Summary of characters of specimens less than 5 mm. long. The cephalon makes up one half the entire length, and has a greater area than all the remainder of the shell; it is semicircular in outline, with a wide concave brim, and long genal spines. The eyes are very large, close to the glabella and to the posterior border. The glabella is convex, prominent at the front, narrow behind, and expanding forward, with a median tubercle between the isolated lobes at the posterior end. The free cheeks apparently do not meet in front.

The thorax consists of two or three segments; the axial lobe is less than one fourth the total width. The pleura are flat to the fulcrum, which is far out, and are there turned down abruptly. Each pleuron bears a straight furrow, which extends beyond the fulcrum.

The pygidium is small, semicircular, with narrow, prominent axial lobe, and narrow, concave border. The pleural lobes are crossed by distinct, furrowed ribs, and there are rings on the anterior end of the axial lobe.

Changes during development.— It will be shown in the sequel that some of these youthful characters are lost much more quickly than others. The first to be changed is the marginal position of the facial suture, and the most persistent is the genal spine. The ribs on the pygidium disappear very early, while new segments are still being added to the thorax. Then the glabella becomes flattened, the axial lobe becomes wider, the eyes relatively smaller, the genal spines shorter, and the cephalon more triangular and smoother.

Outline of cephalon and pygidium.— The outlines of the shields, and their changes, were quite fully discussed by Raymond and Narraway, but the present more complete material has furnished some additional facts. In the smallest specimens so far seen, both the cephalon and pygidium are one half as long as wide, and regularly semicircular. In the cephalon, this condition persists until this shield reaches a length of about 4 mm., when the ratio of length to breadth begins to rise, and at the same time the sides of the cephalon become straighter, so that the general form becomes subtriangular, instead of semicircular. This change takes place rapidly, so that a cephalon 12 mm. long is three fourths as long as wide, and few specimens of any size have a higher ratio than this. Most cephala whose length is between 12 mm. and 30 mm. have this ratio (length divided by width), between .72

and .80. In specimens with cephala over 30 mm. long, the growth seems to be more rapid in the transverse direction, and the ratio drops again. It is only .62 in the two largest specimens in the collection, the largest cephalon being 60 mm. long. The form in these large specimens remains subtriangular, and does not return to the semicircular outline of the young.

Pygidia show a similar series of changes, but the index rises higher, and does not show so great a falling off in large specimens. In the adults, the pygidia are usually of about the same length, or a little longer, than the cephala, but are always narrower, hence the higher index. In specimens where the length of the cephalon is .75 the width, the length of the pygidium is generally .80 the width. In the larger specimens, where the indices of both shields have begun to drop, the difference is more noticeable, the index of the cephalon being .62 while the index of the pygidium is .77 in one well-preserved specimen. Raymond and Narraway found occasional specimens in which the length equaled the width, but in the present collection the highest index noted was .85.

In small specimens, the pygidium is about one half as long as the cephalon, and the two shields do not reach quite equal length until the whole animal has attained a length of about 50 mm. In specimens more than 100 mm. long there is a tendency for the pygidium to exceed the cephalon in length, the difference being as much as 10 mm. in some large specimens. That the pygidium does, in the adult, finally reach the same length as the cephalon, seems to be due, not to an acceleration in growth at any particular time, but rather to a retardation of the longitudinal growth of the cephalon, during the process of widening. The pygidium never becomes quite as wide as the cephalon, so that more energy can be put into longitudinal growth.

Glabella and axial lobe of the pygidium.— The glabella soon loses its convexity and prominence, as well as its furrows, basal lobes, and median tubercle. These features are still visible on a cephalon 4.5 mm. long, but are faint, and the front of the glabella no longer rises abruptly from the brim. The outline of the glabella is still distinguishable on a cephalon 7.5 mm. long, but it is there hardly more convex than in the adult. Something of the form of the glabella can be made out on most specimens, whatever the size, but it is rather smoothly merged into the general surface of the cephalon in all specimens with a cephalon more than 8 mm. long.

The axial lobe of the pygidium remains convex and conspicuous somewhat longer than the glabella does. On a specimen 9.5 mm.

long, where the glabella is quite flat, the axial lobe of the pygidium is prominent, even at the posterior end, which rises abruptly from the flattened border. It would be expected that the pygidium would retain its youthful characters longer than the cephalon, for it is really younger, and has had less time to change. On a specimen 18 mm. long, (pygidium 5.5 mm. long), the axial lobe is fairly prominent, but does not extend quite to the border, and is less convex throughout its length than in the smaller specimens. It is of course, more or less distinguishable on specimens of all sizes, but is very faint on pygidia more than 25 mm. long, except under certain conditions of preservation. The axial lobe also grows shorter as the shell increases in length. In young specimens it reaches and overhangs the flattened border while in large individuals the posterior end is at a distance in front of the border equal to the width of the border itself.

Border.— The border on the cephalon and pygidium, which is very wide in the young specimens, becomes much narrower with further growth. In very young specimens its width is equal to one fourth the length of the cephalon, but in the adult it is only about one sixth the length. In the young the plane of the brim is horizontal, but in older specimens it becomes gradually more inclined and less concave. This fact has an important bearing upon the relative primitiveness of the asaphids with a border and those without. In a previous paper (Trans. Roy. Soc. Canada, 1912, ser. 3, **5**, sect. 4, p. 111), I have considered the absence of a depressed border to be primitive in this family, but evidence seems to be accumulating that the contrary is the case. Beside the above, one may cite the condition seen in certain species of Onchometopus, especially *O. simplex*, and an undescribed form from the Eden at Cincinnati. In these species, the pygidia, which, as has just been shown, have a tendency to lag behind the cephala in development, often have a very decided trace of a depressed border, as though they may have been developed from an Isotelus-like form. Further, all the strongly segmented asaphids, like Basilicus, Ogygopsis, Ogygiocaris, and Ogygites, have more or less of a border, and it is only the rather smooth forms, like Nileus, Asaphus, Onchometopus, and the like, which lack it.

Genal spines.— The reduction of the genal spines during life was discussed at length by Clarke (Pal. Minn., 1897, **3**, pt. 2, p. 704), and the present collection confirms the previous statements. The smaller specimens, however, show that the spines of the young were even longer than was supposed, for specimens 3.5 to 5 mm. long bear spines which extend back as far as the posterior end of the pygidium. The smallest specimens do not seem to have the spines quite so long, but this may be an accident of preservation. A specimen 8 mm. long has spines extending to the front of the pygidium, and one 18 mm. long has them reaching the sixth segment. Specimens about 30 mm. long show spines extending to the fourth segment, and those 35 to 50 mm. long show small, narrow spines reaching the third segment. Specimens above 55 mm. long do not show any spines at the angles, except in the case of a few specimens, which retain them as youthful characters are sometimes retained by adults of any species.

Thorax.— The full number of segments is attained when the animal is about 8 or 9 mm. long, and the following are measurements of specimens with less than 8 segments: —

2 segments; specimen, 3 mm. long:
3 segments; 2 specimens, 3.5 and 5 mm. long, respectively:
4 segments; 1 specimen, 5.5 mm. long:
5 segments; 1 specimen, 7 mm. long:
6 segments; 1 specimen, 8 mm. long:
7 segments; 1 specimen, 6.5 mm. long:
8 segments; smallest specimen, 9.5 mm. long.

In the smallest specimens the axial lobe of the thorax is very narrow, being only one fifth the total width in the specimen which is 3 mm. long. A specimen 5 mm. long has a thorax of three segments, and the axial lobe is one fourth the width of the thorax. In a specimen 8 mm. long this ratio has risen to .30 and one 10 mm. long has the axial lobe .40 of the width of the thorax, while a specimen 18 mm. long has the same index. Specimens 29 and 32 mm. long have the index .46, and one 38 mm. long has the axial lobe one half the total width of the thorax, which is the normal ratio for adults of this species. The exact ratio .50 was found in eleven specimens varying in length from 38 to 130 mm. and the greatest departure noticed in all the specimens measured was .05, the ratio varying from .45 to .53, the latter index being found in a specimen 181 mm. long.

Summary of the ontogeny.— Basilicus stage. The glabella is convex, narrowed behind, with a median tubercle and basal lobes. The brim is wide and horizontal, the cephalon semicircular in outline, the genal angles produced into long spines. The axial lobe of the thorax is narrow, the pygidium has a prominent axial lobe, and the pleural lobes of the pygidium are ribbed.

Ogygites stage. The glabella soon becomes flattened, and the facial sutures intramarginal, as in the adult of Ogygites.

ISOTELUS stage. The cephalon and pygidium both become smooth, and the axial lobe widens, as in the adult of Isotelus.

ISOTELUS GIGAS stage. The cephalon and pygidium become triangular, and the spines are lost from the genal angles, a combination of characters distinguishing this species.

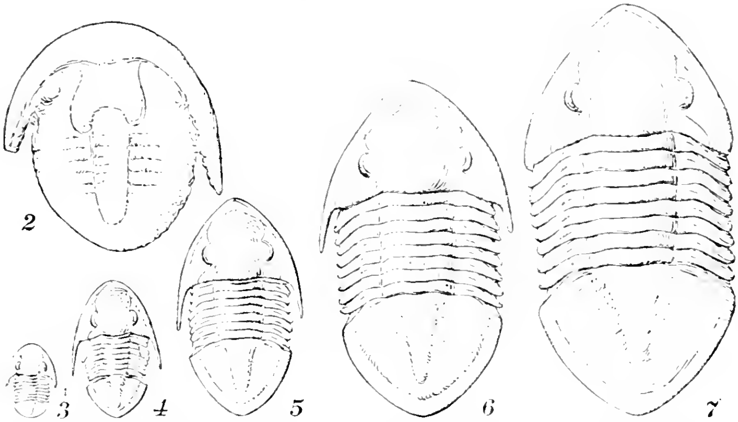


Fig. 2.— A very small specimen of *Isotelus gigas*, exposed from the under side. This specimen shows the rounded cephalon and pygidium and divided hypostoma, though it is too poorly preserved to show how many thoracic segments are present. × 10. M. C. Z. No. 36.

Fig. 3–7.— The same species. A series of specimens showing the changes from rounded shields, narrow axial lobe, and long genal spines of the young to the pointed shields, wide axial lobe, and spineless cheeks of the adult. Fig. 3, 4 represent an *Isotelus maximus* stage, 5 and 6 an *I. iowensis* stage and 7 is as small a specimen as is often found showing all the characteristics of the adult of *I. gigas*. Natural size. M. C. Z. Nos. 48, 38–41.

ISOTELUS IOWENSIS Owen.

Plate **2**, fig. 6; Plate **3**, fig. 1, 2.

Isotelus iowensis, Owen, Rept. Geol. sur. Wisc., Iowa, Minn., 1852, p. 577, pl. 2a, figs. 1–7. Clarke, 1897, Pal. Minn., 1897, **3**, pt. 2, p. 704.

Although mentioned occasionally in faunal lists, this species seems to have been pretty generally neglected. It is so closely allied to *Isotelus gigas*, that, where the two species occur together, as at Trenton Falls, it seems almost like hair-splitting to recognize two species. Essentially, it is an *Isotelus gigas* which retains at maturity certain youthful characters usually lost by that species. Thus, the adult *Isotelus iowensis* has long genal spines, extending to the fifth, sixth, or seventh segment, an axial lobe a little less than half the width of the thorax (.41 to .46), and pygidia show a fairly convex axial lobe, and traces of ribs on the pleural lobes. The pygidia are also somewhat more rounded than those of *Isotelus gigas*, although fully as long. As minor features of the species, it may be noted that the anterior portion of the glabella is quite well defined, and the geniculation of the pleural lobes of the pygidium is further from the dorsal furrows than in *Isotelus gigas*. The collection contains a number of cranidia and pygidia, and two complete specimens from the Maquoketa at Elgin, Iowa, and a single complete specimen which is presumably from Iowa but not labeled as to locality, so that direct comparisons can be made with the specimens from Trenton Falls, and the specimens from the eastern and western localities are found to agree in all particulars. The specimens from Trenton Falls have usually been identified as *Isotelus maximus*.

Two specimens from the Lowville and Black River at Ottawa, Ontario, described by Raymond and Narraway (Ann. Carnegie mus., 1910, **7**, p. 56, pl. 15, fig. 3) as Isotelus sp. ind. probably belong to this species. They were separated from *Isotelus gigas* because they had more rounded pygidia with a rather prominent axial lobe, and they have a rather narrow axial lobe in the thorax. In 1910 there was no opportunity of comparing the specimens from Ontario with *Isotelus iowensis*, but I now find that they agree very closely with the specimens from Iowa.

The specimen from the "Hudson River" at Granger, Minnesota, figured by Dr. Clarke[1] as a specimen of *Isotelus maximus*, is, as figured, an excellent example of *I. iowensis*, the shields being too long and narrow for a typical specimen of *I. maximus*.

The type of this species, which is now in the collection at the Walker Museum of the University of Chicago, was obtained from the Maquoketa shale, which is of Upper Ordovician (Richmond) age, according to the most recent correlations. The specimens from the Trenton, though sometimes larger, are too much like the Iowa specimens to be distinguished as a distinct species at the present time.

Additional note:— Since this paper was written Mr. A. W. Slocum's excellent account (Field mus. nat. hist., publ. 171, Geol. ser. 4, no. 3, p. 48, pl. 13, fig. 1, 2) of the trilobites of the Maquoketa beds of Fayette

[1] Pal. Minn., 1897, **3**, pt. 2, p. 703, fig. 5; also reproduced by Weller as *Isotelus gigas*, Pal. N. J., 1902, **3**. pl. 14, fig. 5.

Co., Iowa, has appeared. He describes and figures *Isotelus iowensis* from specimen obtained at the type locality. Mr. Slocum figures (Pl. 13, fig. 2) one remarkable specimen which has the appearance of possessing an epistome, and he has described the sutures as indicating the presence of this plate. Mr. Slocum was kind enough to show me this specimen, and while there are certain lines which have decidedly the appearance of epistomal sutures, I am unable to believe that this species has an epistome, that plate being entirely unknown among the Asaphidae. The facial suture is described by Slocum as marginal, but although it is nearly so, many specimens show clearly that it is intramarginal or "Isoteliform."

The M. C. Z. contains two specimens from the Moquoketa of Iowa which show the doublure of the cephalon. Both show a median vertical suture such as is seen in all other Asaphidae and one of them (M. C. Z. No. 435) shows at the left a suture such as that on Mr. Slocum's specimen. There is no corresponding one on the right side, however, and the other specimen (M. C. Z. No. 442) shows no trace of such a suture on either side. Just what these lines indicate is not at present evident.

Isotelus maximus Locke.

Isotelus maximus Locke, Second ann. rept. Geol. surv. Ohio, 1838, p. 246, fig. 8, 9. Clarke, Pal. Minn., 1897, **3**, pt. 2, p. 701 (not fig. 5–7). Raymond and Narraway, Ann. Carnegie mus., 1910 **7**, p. 55, fig. 3.

Isotelus megistos Locke, Trans. Amer. assoc. geol. and nat., 1841, p. 221, pl. 6; Amer. journ. sci., 1842, ser. 1 **42**, p. 366, pl. 3. Meek, Pal. Ohio, 1873, **1**, p. 157, pl. 14, fig. 13. Miller, Cincinnati quart. journ. sci., 1874, p. 137.

Asaphus megistos Walcott, Science, 1884, **3**, p. 200, fig. 1.

Typical and well-preserved specimens of this species from about Cincinnati are very easily distinguished from specimens of *Isotelus gigas* from Trenton Falls, or specimens of *Isotelus iowensis* from Iowa, but they are not always so easily separated from the other two species of Isotelus found with them at Cincinnati. The chief reason for the confusion which has arisen as to the characteristics of the two species, *Isotelus gigas* and *I. maximus*, is that five species, belonging to two genera, have been identified under these two names. At Cincinnati, the common asaphids are *Isotelus gigas*, *I. maximus*, *I. latus*, and undescribed species of Isotelus and of Onchometopus. At Trenton Falls the only species are *Isotelus gigas* and *I. iowensis*, but the *I. iowensis* there has been called *I. maximus.* As *I. iowensis* has certain characters half-way between *I. gigas* and *I. maximus,* this misidentification has served to throw the Cincinnati specimens into hopeless confusion. The following key will show the more important characters which separate the genera of asaphids occurring in the formations from the Chazy to the Richmond.

A. Depressed or concave border on both shields.
 a. Surface of shields ribbed.
  1. Free cheeks meeting in front .... *Ogygites.*
  2. Free cheeks separated in front .... *Basilicus.*
 b. Surface of shields not ribbed.
  1. Axial lobe narrow, prominent .... *Isoteloides.*
  2. Axial lobe wide, depressed..................... *Isotelus.*
B. Concave border on pygidium only.
 a. Eyes very large .... *Nileus.*
 b. Eyes small but very high .... *Vogdesia.*
C. No concave border on either shield.
 a. Free cheeks meeting in front .... *Onchometopus.*
 b. Free cheeks separated in front .... *Brachyaspis.*

The four more common species of Isotelus in the Middle and Upper Ordovician can be separated as follows:—

A. Shields about three fourths as long as wide.
 a. Adult without genal spines. Shields subtriangular. . *I. gigas.*
 b. Adult with genal spines. Shields rounded...... *I. iowensis.*
B. Shields less than three fourths as long as wide, regularly rounded.
 a. Adult without genal spines .... *I. latus.*
 b. Adult with genal spines .... *I. maximus.*

This may at first sight seem to be an arbitrary arrangement of the species, but these are not the only characteristics in which the above species differ, the other points being given in the general discussion of each species. The geographical distribution is also in agreement with the above separation. For instance, the specimens which I have described as *Isotelus latus* were considered by Billings the female of *I. gigas,* but if this is true, why are all the hundreds of specimens found at Trenton Falls, the narrow form?

I have measured an extensive series of each species, and find the ratio of length to the width of the shields to be an important clue to their identification. From the above key, it might seem that it would be difficult to distinguish pygidia of *Isotelus gigas*, *I. maximus*, and *I. iowensis*, but such is not the case. If the pygidium has straight sides, it can quickly be placed as *I. gigas*. If the posterior end is rounded, it might be taken for either *I. iowensis* or *I. maximus*, but if the ratio of length to breadth is above .65 it is probably *I. iowensis*, and if below, *I. maximus*. In all cases, however, one must be dealing with adult specimens, and must take all characteristics into account. With isolated young specimens, it is not always possible to state to what species they belong, as the specific characters are not assumed until late in life. A case in point is the young specimen described by Meek as *Proëtus spurlocki* (Pal. Ohio, 1873, **1**, p. 161, pl. 14, fig. 12).

Proëtus spurlocki Meek.

The type of this species (Plate **1**, fig. 3) which is in the Dyer collection in the M. C. Z., is clearly a young Isotelus, but whether it is the young of *Isotelus gigas* or of *I. maximus*, the writer is not able to decide. The specimen is 8.5 mm. long, and when compared with a specimen of the same size from Trenton Falls, the only apparent difference is that the specimen from Cincinnati has only seven thoracic segments, while the *Isotelus gigas* has eight. Both have long cheek spines, small pygidia, rather long cephalons, and narrow axial lobe. The ratio of length to width in the cephalon of the "Proëtus" is rather high, (.69), for a specimen of *Isotelus gigas* of this size, but it is also much higher than one would expect in *I. maximus*. The smallest specimen in the collection which is surely identifiable as *Isotelus maximus* is considerably larger than the type of *P. spurlocki*, being 16 mm. long. In this specimen, the length of the cephalon is .62 of the width. This is slightly above the average for adult specimens, where this ratio ranges from .57 to .60.

The specimens of *Proëtus spurlocki* which have been found at Cincinnati seem to have all come from the Eden shale, where *Isotelus maximus* seems to be more common than *I. gigas*, and on that ground the presumption would be that this specimen belongs to the former species. It seems very probable, in any case, that the young of the two species would be alike at this stage of development.

Changes during the life history of Isotelus maximus.— *Isotelus maximus* seems to be a much less variable form than *I. gigas*. Being, for the genus, a relatively primitive form, it reaches its specific habit quite early, and the principal variations among the specimens more than 20 mm. long are in the matter of size and the shortening and thickening of the genal spines.

Nearly all the specimens in the Dyer collection are either incomplete or enrolled, so that the specimens have to be considered, not in terms of their total length, but in accordance with the length of one of their shields. The smallest specimen in the collection has a pygidium 6 mm. long, and the largest pygidium is 128 mm. long. This species differs from *I. gigas* in that the two shields become equal at an early age, and stay equal throughout the greater part of the adult stage. One adult specimen, (cephalon 46 mm. long), has the pygidium shorter and more nearly semicircular than the cephalon, which is the reverse of what is found in *I. gigas*. There are not enough good specimens to show whether this is the general rule in this species. According to the measurements of thirteen specimens from Cincinnati, the length of the cephalon averages a trifle less than .6 the width, and the pygidium is usually a little longer, the average being .64. The axial lobe of the thorax averages about .42 of the total width, and there is surprisingly little variation, the extremes being .40 and .44. The axial lobe is then generally a little narrower than in *I. gigas*.

Isotelus maximus from Toronto, Ontario.— Through the courtesy of Prof. W. A. Parks, I have been able to study a series of very fine specimens in the collection at the University of Toronto. The specimens were all from the Lorraine in the vicinity of Toronto, and were very well preserved, though generally a little flattened. So far as the writer could determine from the large collection at the University, and from a short experience in the field, *Isotelus maximus* is the only asaphid present in the Lorraine at Toronto. The specimens are quite large, ranging from 70 to 285 mm. in length, and they are extended, not enrolled as is generally the case with the specimens from Cincinnati. They show remarkably short, wide cephalons, the average ratio of length to width of 11 cephalons, 9 of which were over 50 mm. long, being .46, and the range of variation, .43 to .51. The pygidia are in all cases longer than the cephalons, and the ratio for fifteen specimens averages .59. The axial lobe of the thorax also averages a little narrower than in specimens from Cincinnati, the average of fifteen specimens being .374, and the limits of variation .34 to .40.

The largest specimen which was well enough preserved to yield accurate measurements was 262 mm. long. The cephalon made up .30 of the length, the thorax .33, and the pygidium .37. The greatest width was .69 of the length. The Dyer collection contains a poorly preserved specimen from Morrow, Ohio, seven of whose thoracic segments together measure 112 mm. in length. If this specimen had the same proportions as the one from Toronto, it would, when complete, have been 384 mm. long, and 260 mm. wide at the genal angles, thus giving a very large surface area.

Basilicus barrandi (Hall).

Plate **1**, fig. 4, 5; Plate **2**, fig. 1, 7.

Asaphus barrandi Hall, Foster and Whitney Rept. Lake Superior land dist., 1851, pt. 2, p. 210, pl. 27, fig. 1, a–d; pl. 28. Geol. Wisc., 1862, **1**, p. **41**, fig. 4.
Asaphus romingeri Walcott, 28th ann. rept. N. Y. state mus., 1879, p. 78.
Asaphus wisconsensis Walcott, Ibid., p. 79.
Ptychopyge ulrichi Clarke, Pal. Minn., 1897, **3**, pt. 2, p. 709, figs. 12, 13.
Basilicus romingeri Raymond and Narraway, Ann. Carnegie mus., 1910, **7**, p. 49, pl. 15, fig. 9, 10; pl. 16, fig. 1–4.

When Raymond and Narraway wrote, they did not have access to the Foster and Whitney report, or they would probably have adopted Hall's name for this rather common Black River Basilicus. In view of the remarkable resemblance of the young of *Isotelus gigas* to the adult of this Basilicus, it deserves to be more adequately figured than it has been hitherto. The species seems to be of wide geographic and narrow vertical range, and should be better known than it is.

Hall's types of *Asaphus barrandi* consisted of an entire specimen with the cephalon mutilated and showing the hypostoma in place, two imperfect pygidia, a free cheek, and a good pygidium. These specimens are preserved in the American museum of natural history, where I have had the opportunity to study them, through the courtesy of Dr. E. O. Hovey, Curator of Geology. Four of the specimens, (Hall, Loc. cit., pl. 27, fig. 1b, c, d, and pl. 28), including the entire specimen, are from Platteville, Wisconsin, and one, (pl. 27, fig. 1a), is from St. Joseph Island, Ontario. Platteville may, then, be considered the type locality for the species.

Asaphus romingeri and *A. wisconsensis* were described by Walcott without illustration, but are represented by a considerable number of fragmentary specimens in the Walcott collection of the M. C. Z. Two imperfect cranidia from the Black River at Russia, Herkimer county, N. Y., have attached to them original labels indicating that they are the types of the two species. These labels have, however, been interchanged, for the specimen having the wide border in front is labeled *A. romingeri*, while the description states that *A. wisconsensis* has the wide border. With the exception of this single character, the width of the flat border in front of the glabella, the two types are in perfect agreement. Raymond and Narraway, without seeing the types, hazarded the opinion that Walcott's two names represented only one species, and cited the fact that in their collections, the border was wider in young specimens than in older ones. It is true that the type of *Asaphus romingeri* is larger than that of *A. wisconsensis*, but the other specimens in the collection fail to bear out our suggestion. Beside the type, there is only one other specimen which will answer the definition of *Asaphus romingeri*, and that is somewhat smaller than the type of *A. wisconsensis*, while there are several specimens of *A. wisconsensis* which are larger than the type of *A. romingeri*. This difference in the width of the border certainly does exist among adult specimens, and while it does not seem to be of specific value, it is a character which may later prove of use.

Clarke's types of *Ptychopyge ulrichi* were two pygidia from Cannon's Falls, Minnesota, and they agree with pygidia from Platteville, Wisconsin, and Newport, New York, except that a complete pygidium of the same size as Clarke's large fragment shows a much shorter form than is indicated by his outline restoration.

The collection of the M. C. Z. contains, beside the specimens in the Walcott collection, which are all from Russia (Newport), New York, a number of cranidia and pygidia, and one nearly complete specimen, from Platteville, Wisconsin. The specimens in the Walcott collection were presumably all used in describing *Asaphus romingeri* and *A. wisconsensis*, although there are pygidia present, a fact not mentioned in the original descriptions.

The nearly entire specimen is flattened, and is somewhat imperfect in several particulars, but shows fairly accurately the general proportions of the animal. The cephalon is large, occupying .43 of the length of the animal, while the thorax occupies .27, and the pygidium .30. The axial lobe is narrow, .32 of the total width, and the cephalon and pygidium are both nearly semicircular, the length of the cephalon being .55 of the width, and the length of the pygidium .53 of the width. These general proportions accord very well with a specimen of *Isotelus gigas* 3.5 mm. long, except that the thorax being complete in the Basilicus, it makes the whole animal longer.

Separated cranidia from St. Joseph Island, Lake Huron, (in collection of the Geological survey of Canada), from Ottawa, Ontario, (in collection of J. E. Narraway, Esq.), from Faribault, Minnesota, (in collection of the Carnegie museum), from Platteville, Wisconsin, and from Newport, New York, have been compared, and measurements taken to determine the ratio of the length of the glabella to the total length of the cephalon. It was found that the glabella was relatively shorter on young specimens than on older ones, although there was not much difference. A cranidium 7 mm. long has the glabella .78 of the total length, while a specimen 62 mm. long has the glabella .88 of the length. The width of the brim is therefore relatively only about half as great in the old specimen as in the young one. On the adult specimen of *A. wisconsensis* in which the brim is widest, it occupies .19 of the length, and on the specimen on which it is narrowest it occupies only .12, the average being .15. On the type of *A. romingeri* it occupies only .07 of the length, and on the only other specimen of this sort, it occupies .11. With the exception of these two specimens, cranidia from all the localities conform closely to the general average.

The agreement in proportions and ribbing among the pygidia from the localities just mentioned is remarkable. The proportion of length to width is quite constant in specimens above 20 mm. long, and is usually about .60. The ribbing on the larger specimens is only a little less strong than on the small ones, and all have the same number of ribs and rings. The largest pygidium in the collection is from Platteviile, and is 64 mm. long and about 105 mm. wide.

EXPLANATION OF PLATES.

PLATE 1.

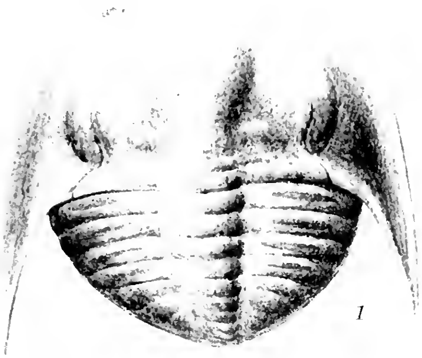
Fig. 1.— *Isotelus gigas* DeKay. An immature specimen with (apparently) three segments in the thorax. From the Trenton at Trenton Falls, N. Y. × 15. No. 45, M. C. Z., Walcott coll.

Fig. 2.— The same species. A somewhat larger but still immature individual showing the short rounded pygidium of the young. Thorax partially buried in the matrix. From the Trenton at Trenton Falls, N. Y. × 6. No. 48, M. C. Z., Walcott coll.

Fig. 3.— *Isotelus maximus* ? Locke. The type of *Proëtus spurlocki* Meek. From the Eden at Cincinnati, Ohio. × 6. No. 43, M. C. Z., Dyer coll.

Fig. 4.— *Basilicus barrandi* (Hall). A specimen with a narrow brim, similar to the type of *Asaphus romingeri* Walcott. From the Leray-Black River at Newport, N. Y. × $\frac{3}{2}$. No. 46, M. C. Z. Walcott coll.

Fig. 5.— The same species. A nearly complete but flattened specimen somewhat restored about the eyes and at the posterior end of the pygidium. From the Black River at the quarry on Limestone Creek, near Platteville, Wisc., the type locality of the species. ×$\frac{3}{2}$ No. 34, M. C. Z., Whitney coll.



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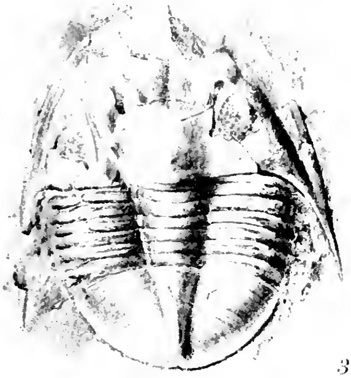

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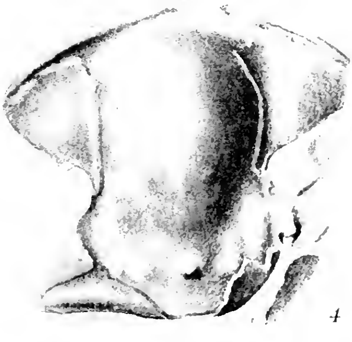

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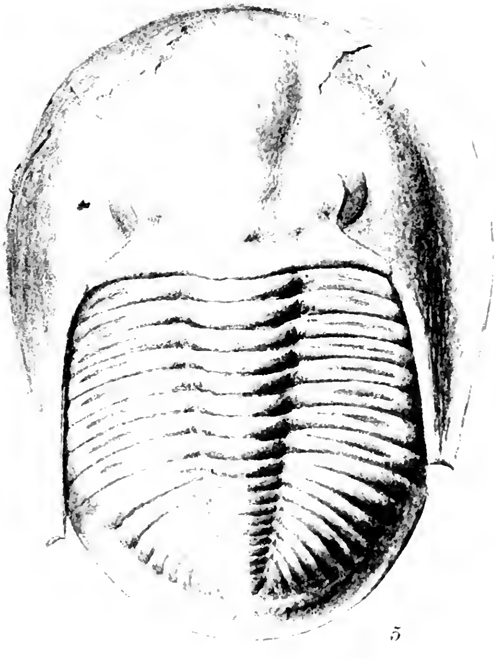

5

HELIOTYPE CO., BOSTON

PLATE 2.

Fig 1.— *Basilicus barrandi* (Hall). The imperfect cranidium which was the type of *Asaphus wisconsensis* Walcott. From the Leray-Black River at Newport, N. Y. × $\frac{3}{2}$. No. 47, M. C. Z., Walcott coll.

Fig. 2–5.— *Isotelus gigas* Dekay. Young specimens in various stages of growth, illustrating the change from the rounded to the pointed pygidium and the shortening of the genal spines. From the Trenton at Trenton Falls, N. Y. × $\frac{3}{2}$. No. 48, 38, 39, 40, M. C. Z., Walcott coll.

Fig. 6.— *Isotelus iowensis* Owen. An imperfect specimen from an unknown locality in Iowa. To be compared with a young *Isotelus gigas* from Trenton Falls (fig. 5) and with a young *I. iowensis* from the same locality (Plate **3**, fig. 2). × $\frac{3}{2}$. No. 420, M. C. Z., ? Sir Charles Lyell coll.

Fig. 7.— *Basilicus barrandi* (Hall). The specimen which was the type of *Asaphus romingeri* Walcott. From the Leray-Black River at Newport, N. Y. × $\frac{3}{2}$. No. 35, M. C. Z., Walcott coll.

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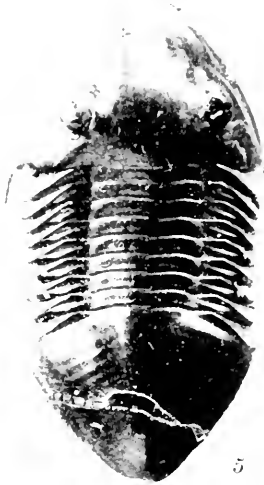

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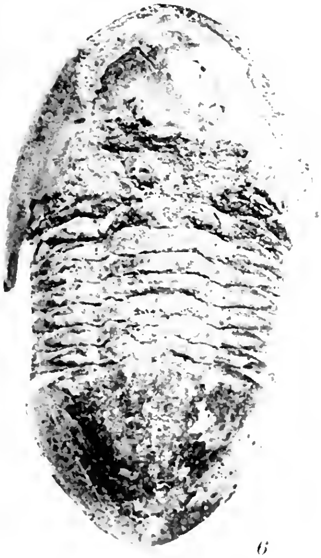

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7

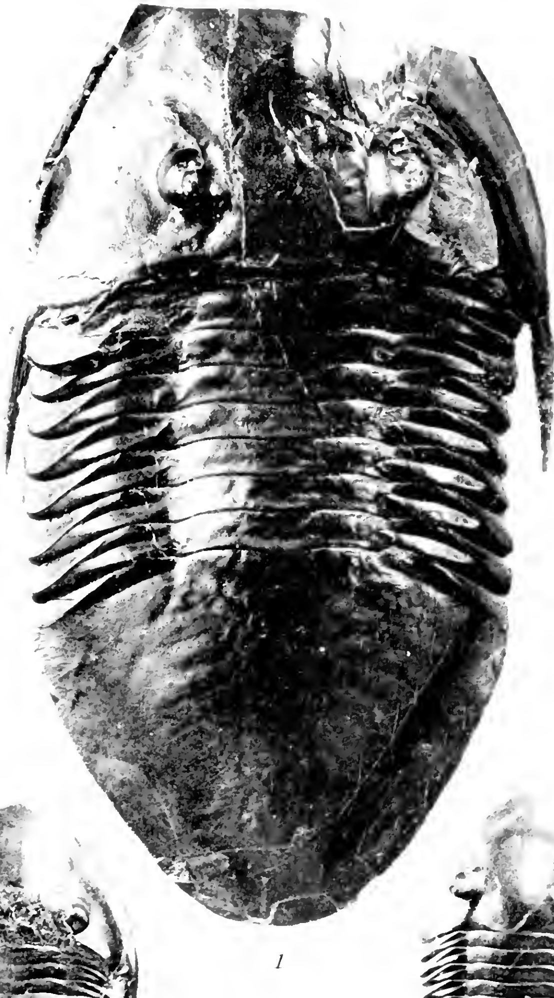
HELIOTYPE CO., BOSTON

PLATE 3.

Fig. 1.— *Isotelus iowensis* Owen. A large specimen from the Trenton at Trenton Falls, N. Y. 7 mm. longer than natural size. No. 422, M. C. Z., Walcott coll.

Fig. 2.— The same species. A small specimen from the same locality as the last, for comparison with fig. 3, and with fig. 6, Plate **2**. No. 421, M. C. Z., Walcott coll.

Fig. 3.— *Isotelus gigas* Dekay. A small specimen showing all the characteristics of the adult. For comparison with fig. 2. From the Trenton at Trenton Falls, N. Y. No. 41, M. C. Z., Walcott coll.



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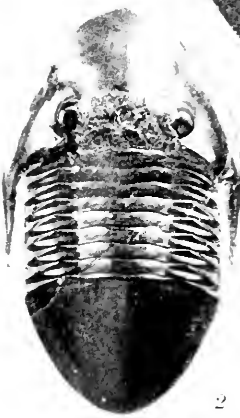

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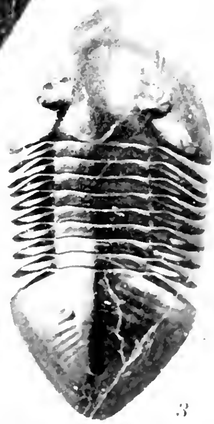

3

HELIOTYPE CO., BOSTON

The following Publications of the Museum of Comparative Zoology are in preparation: —

LOUIS CABOT. Immature State of the Odonata, Part IV.
E. L. MARK. Studies on Lepidosteus, continued.
" On Arachnactis.
A. AGASSIZ and C. O. WHITMAN. Pelagic Fishes. Part II., with 14 Plates.
H. L. CLARK. The "Albatross" Hawaiian Echini.

Reports on the Results of Dredging Operations in 1877, 1878, 1879, and 1880, in charge of ALEXANDER AGASSIZ, by the U. S. Coast Survey Steamer "Blake," as follows:—

A. MILNE EDWARDS and E. L. BOUVIER. The Crustacea of the "Blake."
A. E. VERRILL. The Alcyonaria of the "Blake."

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieutenant Commander Z. L. TANNER, U. S. N., Commanding, in charge of ALEXANDER AGASSIZ, as follows:—

K. BRANDT. The Sagittae.
" The Thalassicolae.
O. CARLGREN. The Actinarians.
R. V. CHAMBERLIN. The Annelids.
W. R. COE. The Nemerteans.
REINHARD DOHRN. The Eyes of Deep-Sea Crustacea.
H. J. HANSEN. The Cirripeds.
" The Schizopods.
HAROLD HEATH. Solenogaster.
W. A. HERDMAN. The Ascidians.
S. J. HICKSON. The Antipathids.
E. L. MARK. Branchiocerianthus.
JOHN MURRAY. The Bottom Specimens.
P. SCHIEMENZ. The Pteropods and Heteropods.
THEO. STUDER. The Alcyonarians.
—— The Salpidae and Doliolidae.
H. B. WARD. The Sipunculids.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of ALEXANDER AGASSIZ, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding, as follows:—

R. V. CHAMBERLIN. The Annelids.
H. L. CLARK. The Holothurians.
—— The Volcanic Rocks.
—— The Coralliferous Limestones.
S. HENSHAW. The Insects.
R. VON LENDENFELD. The Siliceous Sponges.
—— The Ophiurans.
G. W. MÜLLER. The Ostracods.
MARY J. RATHBUN. The Crustacea Decapoda.
G. O. SARS. The Copepods.
L. STEJNEGER. The Reptiles.
C. H. TOWNSEND. The Mammals, Birds, and Fishes.
T. W. VAUGHAN. The Corals, Recent and Fossil.

PUBLICATIONS

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY

AT HARVARD COLLEGE.

There have been published of the BULLETIN Vols. I. to LIV.; of the MEMOIRS, Vols. I. to XXIV., and also Vols. XXVI. to XXIX., XXXI. to XXXIV., XXXVI. to XXXVIII., XLI., and XLIV.

Vols. LV. to LVIII. of the BULLETIN, and Vols. XXV., XXX., XXXV., XXXIX., XL., XLII., XLIII., XLV. to XLVIII. of the MEMOIRS, are now in course of publication.

The BULLETIN and MEMOIRS are devoted to the publication of original work by the Officers of the Museum, of investigations carried on by students and others in the different Laboratories of Natural History, and of work by specialists based upon the Museum Collections and Explorations.

The following publications are in preparation:—

Reports on the Results of Dredging Operations from 1877 to 1880, in charge of Alexander Agassiz, by the U. S. Coast Survey Steamer "Blake," Lieut. Commander C. D. Sigsbee, U. S. N., and Commander J. R. Bartlett, U. S. N., Commanding.

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieut. Commander Z. L. Tanner, U. S. N., Commanding, in charge of Alexander Agassiz.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

Reports on the Scientific Results of the Expedition to the Eastern Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from October, 1904, to April, 1905, Lieut. Commander L. M. Garrett, U. S. N., Commanding.

Contributions from the Zoölogical Laboratory, Professor E. L. Mark, Director.

Contributions from the Geological Laboratory, Professor R. A. Daly, in charge.

These publications are issued in numbers at irregular intervals. Each number of the Bulletin and of the Memoirs is sold separately. A price list of the publications of the Museum will be sent on application to the Director of the Museum of Comparative Zoölogy, Cambridge, Mass.

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Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

Vol. LVIII. No. 6.

NOTES ON A COLLECTION OF BIRDS FROM YUNNAN.

By Outram Bangs and John C. Phillips.

CAMBRIDGE, MASS., U. S. A.:

PRINTED FOR THE MUSEUM.

April, 1914.

REPORTS ON THE SCIENTIFIC RESULTS OF THE EXPEDITION TO THE EASTERN TROPICAL PACIFIC, IN CHARGE OF ALEXANDER AGASSIZ, BY THE U. S. FISH COMMISSION STEAMER "ALBATROSS," FROM OCTOBER, 1904, TO MARCH, 1905, LIEUTENANT COMMANDER L. M. GARRETT, U. S. N., COMMANDING, PUBLISHED OR IN PREPARATION:—

A. AGASSIZ. V.[5] General Report on the Expedition.
A. AGASSIZ. I.[1] Three Letters to Geo. M. Bowers, U. S. Fish Com.
A. AGASSIZ and H. L. CLARK. The Echini.
H. B. BIGELOW. XVI.[16] The Medusae.
H. B. BIGELOW. XXIII.[23] The Siphonophores.
H. B. BIGELOW. XXVI.[26] The Ctenophores.
R. P. BIGELOW. The Stomatopods.
O. CARLGREN. The Actinaria.
R. V. CHAMBERLIN. The Annelids.
S. F. CLARKE. VIII.[8] The Hydroids.
W. R. COE. The Nemerteans.
L. J. COLE. XIX.[19] The Pycnogonida.
W. H. DALL. XIV.[14] The Mollusks.
C. R. EASTMAN. VII.[7] The Sharks' Teeth.
S. GARMAN. XII.[12] The Reptiles.
H. J. HANSEN. The Cirripeds.
H. J. HANSEN. XXVII.[27] The Schizopods.
S. HENSHAW. The Insects.
W. E. HOYLE. The Cephalopods.
W. C. KENDALL and L. RADCLIFFE. XXV.[25] The Fishes.
C. A. KOFOID. III.[3] IX.[9] XX.[20] The Protozoa.
C. A. KOFOID and J. R. MICHENER. XXII.[22] The Protozoa.
C. A. KOFOID and E. J. RIGDEN XXIV.[24] The Protozoa.
P. KRUMBACH. The Sagittae.
R. VON LENDENFELD. XXI.[21] The Siliceous Sponges.
—— The Holothurians.
—— The Starfishes.
—— The Ophiurans.
G. W. MÜLLER. The Ostracods.
JOHN MURRAY and G. V. LEE. XVII.[17] The Bottom Specimens.
MARY J. RATHBUN. X.[10] The Crustacea Decapoda.
HARRIET RICHARDSON. II.[2] The Isopods.
W. E. RITTER. IV.[4] The Tunicates.
ALICE ROBERTSON. The Bryozoa.
B. L. ROBINSON. The Plants.
G. O. SARS. The Copepods.
F. E. SCHULZE. XI.[11] The Xenophyophoras.
H. R. SIMROTH. The Pteropods and Heteropods.
E. C. STARKS. XIII.[13] Atelaxia.
TH. STUDER. The Alcyonaria.
JH. THIELE. XV.[15] Bathysciadium.
T. W. VAUGHAN. VI.[6] The Corals.
R. WOLTERECK. XVIII.[18] The Amphipods.

[1] Bull. M. C. Z., Vol. XLVI., No. 4, April, 1905, 22 pp.
[2] Bull. M. C. Z., Vol. XLVI., No. 6, July, 1905, 4 pp., 1 pl.
[3] Bull. M. C. Z , Vol. XLVI., No. 9, September, 1905, 5 pp., 1 pl.
[4] Bull. M. C. Z., Vol. XLVI., No. 13, January, 1906, 22 pp., 3 pls.
[5] Mem. M. C. Z., Vol. XXXIII., January, 1906, 90 pp., 96 pls.
[6] Bull. M. C. Z., Vol. L., No. 3, August, 1906, 14 pp., 10 pls.
[7] Bull. M. C. Z., Vol. L., No. 4, November, 1906, 26 pp., 4 pls.
[8] Mem. M. C. Z., Vol. XXXV., No. 1, February, 1907, 20 pp., 15 pls
[9] Bull M. C. Z., Vol. L., No. 6, February, 1907, 48 pp., 18 pls.
[10] Mem. M. C Z., Vol. XXXV, No. 2, August, 1907, 56 pp., 9 pls.
[11] Bull. M. C. Z., Vol. LI., No. 6, November, 1907, 22 pp., 1 pl.
[12] Bull. M. C. Z., Vol. LII., No. 1, June, 1908, 14 pp., 1 pl.
[13] Bull. M. C. Z., Vol. LII., No. 2, July, 1908, 8 pp., 5 pls.
[14] Bull. M. C. Z., Vol. XLIII., No. 6, October, 1908, 285 pp., 22 pls.
[15] Bull. M. C. Z., Vol. LII., No. 5, October, 1908, 11 pp., 2 pls.
[16] Mem. M. C. Z., Vol. XXXVII., February, 1909, 243 pp., 48 pls.
[17] Mem. M. C. Z., Vol. XXXVIII., No. 1, June, 1909, 172 pp., 5 pls., 3 maps.
[18] Bull. M. C. Z., Vol. LII., No. 9, June, 1909, 26 pp., 8 pls.
[19] Bull. M. C. Z., Vol. LII., No. 11, August, 1909, 10 pp., 3 pls.
[20] Bull. M. C. Z., Vol. LII., No. 13, September, 1909, 48 pp., 4 pls.
[21] Mem. M. C. Z., Vol. XLI., August, September, 1910, 323 pp., 56 pls.
[22] Bull. M. C. Z., Vol. LIV., No. 7, August, 1911, 38 pp.
[23] Mem. M. C. Z., Vol. XXXVIII., No. 2, December, 1911, 232 pp., 32 pls.
[24] Bull. M. C. Z., Vol. LIV., No. 10, February, 1912, 16 pp., 2 pls.
[25] Mem. M. C. Z., Vol. XXXV., No. 3, April, 1912, 98 pp., 8 pls.
[26] Bull. M. C. Z., Vol. LIV., No. 12, April, 1912, 38 pp., 2 pls.
[27] Mem M. C. Z., Vol. XXXV, No. 4, July, 1912, 124 pp., 12 pls.

Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

VOL. LVIII. NO. 6.

NOTES ON A COLLECTION OF BIRDS FROM YUNNAN.

BY OUTRAM BANGS AND JOHN C. PHILLIPS.

CAMBRIDGE, MASS., U. S. A.:

PRINTED FOR THE MUSEUM.

APRIL, 1914.

No. 6.— *Notes on a Collection of Birds from Yunnan.*

By Outram Bangs and John C. Phillips.

The Museum of Comparative Zoölogy acquired in the autumn of 1912 a series of 1,376 bird skins made by a Japanese collector in southern Yunnan. This collection appears to represent well the ornis of the region, and contains, as might be expected, a rather large number of undescribed forms.

Mr. Collingwood Ingram (Novitates zoologicae, Dec. 1912, **19**, p. 269–310) has published a complete list of the birds thus far recorded from Yunnan. The basis of his work was a small collection, "a few hundred specimens," apparently from the same source as our own, the localities and dates being the same.

Mr. Ingram's paper mentions from this province 352 species and subspecies, to which we have been able to add seventy-eight, thirteen of which appear not to have been described before.

The greater part of our collection was made at Mengtsze, near the southern border of the province, from which the other collecting points, Linan Fu, Shi-ping, and Loukouchai are only a short distance away. Mengtsze is an important town, and at the present time the new railroad runs by within a few miles of it. The town is situated on a plateau of red sand or clay, at an elevation of about 4,500 feet. The plain is some twenty by twelve miles in extent, and is bordered by mountains, at a distance of about a day's journey from the town, which run up to 8,000 feet.

Mr. E. H. Wilson, the well-known botanist and traveller, who has visited Mengtsze, informs us that the country is a rather poor one, the population having been sadly depleted by the Mohammedan war and by bubonic plague. Forested areas are now to be found only on the higher hills, the Mengtsze plain being entirely denuded of trees and composed largely of grass land. The climate is healthy and comparatively cool for the tropics. There is only a short rainy season in mid-summer and the rest of the year is dry and sunny. The region is fairly well watered and there is some artificial irrigation. Rice, maize, sugar-cane, and sweet potatoes are grown, but agriculturally the country is not at all a rich one.

It is probable that most of the bird collecting was done in the forest of pine and mixed deciduous trees upon the hills near Mengtsze, as

Mr. Wilson informs us that the plain about the city is almost birdless. The region appears to be a favorite winter resort for many species of birds, whose breeding grounds are either in the higher mountains near by or in north central and eastern China. The series of a species often contains two subspecies, one, sometimes both of which do not breed in the immediate vicinity. This is made evident by the date on the labels, although no field notes accompanied the collection. Bird collecting was carried on through every season of the year, and the commoner resident species are almost always represented by skins in fresh autumnal or winter dress, and by well-worn summer specimens.

We have marked with an asterisk, each species not in Ingram's list. All measurements are given in millimeters, and for all new descriptions Ridgway's color standard (Washington, 1912) has been used.

PHASIANIDAE.

FRANCOLINUS CHINENSIS (Osbeck).

1 ♂, Mengtsze, 26 May, 1911.

*ARBORICOLA RUFOGULARIS EUROA, subsp. nov.

2 ♂'s, Mengtsze, March, July.

Type:— adult ♂, M. C. Z., No. 61,841, Mengtsze, 18 March, 1911.

Characters.— General coloration darker and richer, and size larger than in true *A. rufogularis* Blyth from Sikhim. The white central shaft stripes of the flank feathers are reduced to mere lines; crown greyer and less olivaceous, especially towards the forehead; scapulars and greater wing coverts with larger black areas.

Measurements of the type: wing, 160, tarsus, 42, culmen from base of forehead, 25.

* BAMBUSICOLA OLEAGINIA, sp. nov.

Type, and only specimen:— adult ♂, M. C. Z. No. 61,839, Mengtsze, 12 December, 1910.

Characters.— Somewhat similar to *B. fytchii* Anderson, of Assam and Upper Burma, but postorbital region black instead of ferruginous; ground color of upper parts much darker and more olivaceous, with dark central stripes of feathers of the back black instead of ferruginous.

All wing coverts more uniform in color and much darker than in *B. fytchii;* chest more uniform, almost lacking the white spots; black markings of flanks more extensive and more irregular in shape, the feathers of this region often being nearly solid black barred with white; rump and upper tail coverts plain dark olivaceous, wholly lacking the markings of *B. fytchii.*

Measurements: wing, 143, tail feathers, 100, culmen, 20.5, tarsus, 48.

Gennaeus nycthemerus (Linné).

1 adult ♀, 2 immature, Mengtsze.

Phasianus elegans Elliot.

1 adult, ♂, Mengtsze, 27 May, 1910.

This extends the range of *P. elegans* in a southwesterly direction. This specimen is like those in the M. C. Z. from western Szechwan taken by the late Walter R. Zappey.

Treronidae.

Sphenocercus sphenurus (Vigors).

Adult ♂ and ♀, Mengtsze, July.

The ♂ agrees fairly well with the two male specimens from northern India in M. C. Z., but the ♀ is a much darker green on the upper parts and a slightly richer green below, than in Indian females.

Columbidae.

Columba hodgsoni (Vigors).

3 specimens, Loukouchai, Jan., Feb.

These agree entirely with a ♂ from Darjeeling, India, in M. C. Z.

Peristeridae.

Turtur orientalis Latham.

3 specimens, all immature, Mengtsze, June, July, Sept.

Onopopelia humilis (Temminck).

15 specimens, Mengtsze, March, April, May, Sept., Oct., 1910.

Spilopelia tigrina (Temminck & Knip).

6 specimens, Mengtsze, May, July, Aug., Oct.

These specimens are more or less intermediate between *tigrina* and *chinensis*, as Ingram has pointed out (Nov. zool., 1912, **19**, p. 272) in the case of his birds from the same locality, and do not run very true to type. One has very dark shaft stripes on the upper wing coverts but is grey on the under tail coverts.

Rallidae.

Eulabeornis striatus jouyi (Stegneger).

1 adult ♂, Mengtsze, Aug., 1910.

Wing 122; this is maximum for the above race according to Stejneger (Proc. U. S. nat. mus., 1886).

Limnobaenus fuscus (Linné).

14 specimens, Mengtsze, May, June, 1910.

Amaurornis phoenicura (Forster).

2 ♂'s, Mengtsze, March, May.

Gallinula chloropus orientalis Horsfield.

10 specimens, Mengtsze, Feb., May.

Colymbidae.

Tachybaptus fluviatilis philippensis (Bonnaterre).

1 adult, 1 immature, Mengtsze, Sept., Nov.

LARIDAE.

* HYDROCHELIDON LEUCOPAREIA SWINHOEI Mathews.

4 specimens, Mengtsze, 6 June, 1911.

These birds are all in immature plumage and probably belong to this race. They are small; wing 193; 195; 200 and 201 mm.

CHARADRIIDAE.

MICROSARCOPS CINEREUS (Blyth).

3 specimens, Mengtsze, April, Oct.

PLUVIALIS DOMINICUS FULVUS (Gmelin).

2 specimens, ♂ and ♀, Mengtsze, April, Nov.

CHARADRIUS DUBIUS DUBIUS (Scopoli).

4 specimens, Mengtsze, March, Sept.

* CHARADRIUS DUBIUS JERDONI (Legge).

1 adult ♀, Mengtsze, 5 March. This specimen has a wing only 101.5 mm. long and therefore would seem to belong to the small race that breeds in the Himalayas.

* TRINGA TOTANUS (Linné).

4 specimens, Mengtsze, 10 Sept., 1910.

* TRINGA NEBULARIA GLOTTOIDES (Vigors).

8 specimens, Mengtsze, Sept., Oct., Nov., Dec., 1910.

The eastern race of the Green-shanks has been formally recognized by Matthews under the above name. If it can be maintained at all, it certainly is only a very close subspecies. We can find no differences in measurements between eastern and western specimens and no color differences in skins in breeding plumage. In winter plumage eastern skins appear to be just a trifle paler than western ones.

* Tringa glareola (Gmelin).

11 specimens, Mengtsze, Aug., Sept., Nov., 1910.

Tringa ochropus assami Mathews.

1 ♀, Mengtsze, 5 Sept., 1910.

* Xenus cinereus (Güldenstein).

1 ♂, Mengtsze, 19 Sept., 1910.

* Pisobia damacensis (Horsfield).

1 ♂, Mengtsze, 25 April, 1911.

* Limosa limosa melanuroides Gould.

1 ♂, Mengtsze, 1 Sept., 1910.

We quite agree with Mathews that the eastern Black-tailed godwit is a well-marked race, at once differing from the western form by its much inferior size.

Gallinago gallinago gallinago (Linné).

1 adult ♀, Mengtsze, 27 Oct., 1910. This specimen is perfectly typical of the western race of the snipe.

* Gallinago gallinago uniclavus Hodgson.

4 specimens, both sexes, Mengtsze, Oct., Dec., 1910, all typical of the eastern form (that breeds in northeastern Siberia).

* Gallinago strenua (Ruhl).

6 specimens, Mengtsze, Sept., Dec.

* Scolopax rusticola Linné.

2 specimens, Mengtsze, March, Dec.

Rostratula bengalensis (Linné).

3 specimens, Mengtsze, May, Sept., Oct.

Cursoriidae.

* Glareola maldivarum (Forster).

6 specimens, Mengtsze, July, 1910.

Gruidae.

Megalornis grus lilfordi (Sharpe).

1 adult unsexed, Mengtsze, but without date.

Ibididae.

* Ibis melanocephalus (Latham).

1 adult ♀, Mengtsze, 1 May, 1910.

Ciconiidae.

* Pseudotantalus leucocephalus (Gmelin).

5 specimens, Mengtsze, Aug., Oct., Nov.

Ardeidae.

Herodias intermedia Wagler.

6 specimens, Mengtsze, July, Aug.

* Nycticorax nycticorax nycticorax (Linné).

1 ♂ and 1 ♀, Mengtsze, Sept.

Butorides javanica javanica (Horsfield).

3 specimens, Mengtsze, Aug., 1910.

Bubulcus coromandus (Boddaert).

2 specimens, Mengtsze, 1 Aug., 1910.

Ixobrychus sinensis (Gmelin).

1 ♂ and 1 ♀, Mengtsze, 16 June, 1911.

Ixobrychus cinnamomeus (Gmelin).

7 specimens, Mengtsze, April, May, June.

Anatidae.

* Nettion crecca (Linné).

1 ♀, Mengtsze, Oct.

Falconidae.

Circus melanoleucus (Forster).

4 specimens, both sexes, Mengtsze, Feb., April, May.

* Circus aeruginosus (Linné).

1 specimen, unsexed, Mengtsze, May, 1910.

* Circus spilonotus Kaup.

1 ♀, Mengtsze, March.

Accipiter nisus (Linné).

4 specimens, Mengtsze, June, Oct., Nov.

* Lophospizias trivirgatus (Temminck).

1 ♂, Mengtsze, Sept., 1910.

CERCHNEIS TINNUNCULUS JAPONICUS (Temminck & Schlegel).

1 ♂ and 1 ♀, Mengtsze, 27 Oct., 20 Nov.

CERCHNEIS TINNUNCULUS SATURATA Blyth.

6 specimens, Mengtsze, 11 March, 8 April, 20 July, 16 Oct., 27 Oct., 25 Nov.

These examples are extreme of this large, very dark form, while the two specimens of *C. t. japonicus* are typical of that race. The birds collected in Szechwan and Hupeh by Mr. W. R. Zappey and referred to *saturata* by Thayer and Bangs, prove in the light of this material, to be almost exactly intermediate between *saturata* and *japonicus*.

STRIGIDAE.

* OTUS MALAYANA (Hay).

1 ♂ and 1 ♀, adults, Mengtsze, 12 Oct., 16 Oct., 1910.

The ♂ is in the brown phase and the ♀ in the grey. ♂ wing, 85; ♀ wing, 93. These birds unquestionably are referable to this species.

Ingram recorded *Otus lempiji erythrocampe* (Swinhoe) from Mengtsze, but our collection from the same place contained no Scops owl belonging to that group of the genus.

* NINOX SCUTULATA BURMANICA Hume.

2 adults, 1♀, one with sex undetermined, Mengtsze, 29 July, 16 Oct., 1910.

No Ninox was listed from Yunnan by Ingram, but a specimen from Quaylom, Yunnan, taken by Anderson had been recorded by Sharpe (Cat. birds Brit. mus., **2**, p. 162).

Our two skins appear to belong to this form, which even Hartert (Vögel Paläark. fauna) says he does not know very well. They are much larger than two Malacca trade skins of *N. scutulata malaccensis* (Eyton) in M. C. Z. Compared with several specimens of *N. scutulata scutulata* (Raffles) from the Riu Kiu Islands and the Philippines the Yunnan birds while of the same size, are of a different shade of brown above and have very greyish heads. They are also somewhat different below, the ground is slightly paler and the markings, especially on the belly, have a more transverse and less longitudinal appearance.

CORACIIDAE.

* EURYSTOMUS ORIENTALIS CALONYX Sharpe.

1 ♂, Mengtsze, 12 Oct., 1910.

ALCEDINIDAE.

ALCEDO ISPIDA BENGALENSIS Gmelin.

8 specimens, Mengtsze, Feb., April, June, Aug., Nov.

* HALCYON PILEATUS (Boddaert).

5 specimens, Mengtsze, April, Sept., Oct.

HALCYON SMYRNENSIS FUSCUS (Boddaert).

24 specimens, Mengtsze, May, June, July, Aug., Sept., Oct., Nov.

MEROPIDAE.

MEROPS PHILIPPINUS Linné.

13 specimens, Mengtsze, April, July, Aug., Sept.

UPUPIDAE.

UPUPA EPOPS SATURATA Lönnberg.

10 specimens, Mengtsze, Feb., March, Aug., Sept., Oct.

All of these are referable to this form which is probably only a migrant in southern Yunnan.

UPUPA EPOPS, sub. sp.?

14 specimens, Mengtsze, May, June, July, Aug., Oct., Nov.

This series represents the breeding Hoopoe of the region. While nearer to *saturata* than to any of the other subspecies, this race cannot quite be referred to that form. The specimens in the series do not run true. Some approach *indica* in the character of the crest-feathers, although not nearly so reddish in general coloration as are extreme examples of that form. Others can hardly be separated from European examples of true *epops*. While others again might easily pass for *saturata*.

Many of the specimens were in worn breeding plumage when killed.

We regret leaving this bird without a name, and perhaps all specimens from the region should be referred to *saturata*, with the statement that the breeding individuals are not typical, but such a course seems unscientific.

CAPRIMULGIDAE.

CAPRIMULGUS MONTICOLA Franklin.

1 ♂, Mengtsze, 1 Aug., 1910.

* CAPRIMULGUS MACRURUS AMBIGUUS Hartert.

1 ♀, Mengtsze, 4 Dec., 1910.

MICROPODIDAE.

APUS AFFINIS SUBFURCATUS (Blyth).

7 specimens, Mengtsze, April, June; Loukouchai, June.

CUCULIDAE.

* HIEROCOCCYX SPARVEROIDES Vigors.

1 specimen, without data.

* CUCULUS CANORUS TELEPHONUS Heine.

3 specimens, Mengtsze, 3 to 15 May, 1911.

* CUCULUS CANORUS BAKERI Hartert.

6 specimens, Mengtsze, April, May, June, July.

These skins agree exactly with Hartert's description, showing all the characters of the subspecies. This form is the breeding bird of the region, and *telephonus*, of course, is only a migrant in southern Yunnan.

Cuculus optatus Gould.

1 adult ♂, Mengtsze, 8 April 1911.

Cacomantis merulinus (Scopoli).

11 specimens, Mengtsze, May, Aug., Sept.

Eudynamis orientalis honoratus (Linné).

17 specimens, Mengtsze, April, May, June, July, Sept., Oct.

Capitonidae.

Cyanops davisoni (Hume).

1 ♂ 1 ♀, Loukouchai, Feb., June.

* Cyanops franklini (Blyth).

6 specimens, Loukouchai, Jan., Feb., 1911.

Picidae.

Picus canus sordidior Rippon.

8 specimens, Mengtsze, March, July, Nov.; Shi-ping, Feb., March.

Dryobates hyperythrus subrufinus (Cabanis & Heine).

1 ♀, Mengtsze, 14 March.

The present example of this rare bird agrees exactly with the two specimens from Szechwan collected by Mr. W. R. Zappey.

Dryobates cabanisi cabanisi (Malherbe).

5 specimens, Mengtsze, Oct., 1910, Jan., 1911; Shi-ping, Feb., March, 1911; Linan Fu, Feb., 1911.

Dryobates pygmaeus scintilliceps (Swinhoe).

10 specimens, Linan Fu, Feb.; Mengtsze, March, April, Sept., Nov.; Loukouchai, Feb.

Picumnus innominatus chinensis (Hargitt).

3 ♂'s, Mengtsze, April, 1911; Loukouchai, Dec., 1910, Feb., 1911. These skins are slightly smaller and in color somewhat brighter on the lower back than a specimen collected by Mr. W. R. Zappey in Hupeh.

* Sasia ochracea Hodgson.

1 adult ♂, Loukouchai, Jan., 1911.

Jynx torquilla japonica Bonaparte.

10 specimens, Mengtsze, Oct., Nov.; Loukouchai, Dec.; Shi-ping, Feb.

Hirundinidae.

Chelidon rustica gutturalis (Scopoli).

8 specimens, Mengtsze, April, May, June, July, Oct.; Loukouchai, Dec.

Chelidon tytleri (Jerdon).

4 specimens, Mengtsze, Dec., 1910.

* Chelidon daurica striolata (Temminck & Schlegel).

3 specimens, Mengtsze, June, 1911.

Muscicapidae.

* Cyornis tickelliae glaucicomans Thayer & Bangs.

6 specimens, Mengtsze, April, June, Aug., Sept., Oct.

* Niltava sundara denotata, subsp. nov.

2 specimens, ♂ and ♀, Mengtsze, Oct., Dec.

Type:— adult ♂, M. C. Z., No. 61,905, Mengtsze, 14 October, 1910.

Characters.— Similar to true *N. sundara* but slightly larger; back pure black, not washed with purple as in the latter form; underparts paler yellowish especially on the lower abdomen; chin and throat solid black, not at all washed with purple; neck spot pale blue. (Rood's blue, Ridgway, 1912); blue of head abruptly contrasted with the black of the mantle.

Measurements: ♂, *Type*, wing, 83, tarsus, 21, culmen from base of forehead, 16; ♀, No. 61,906 M. C. Z., wing, 78, tarsus, 22, culmen, 17.

* Niltava davidi La Touche.

3 specimens, both sexes, Mengtsze, April, Oct.

Thayer and Bangs (Bull. M. C. Z., 1909, **52**, p. 141) overlooked La Touche's name when describing their *Niltava lychnis*. There is, however, a chance that their bird from Hupeh is subspecifically distinct from *N. davidi* La Touche, which came from northwestern Fokien. The two males in the present collection agree almost exactly with La Touche's description of *N. davidi* and differ from the type of *N. lychnis* in having the crown brighter blue and the chin, sides of the head and throat washed with dark, bluish purple, whereas in the type of *N. lychnis* these areas are dead black.

Muscicapa latirostris (Raffles).

5 specimens, Mengtsze, Feb., May, Sept.

* Muscicapa muttui Layard.

1 ♂, Mengtsze, 14 April, 1911.

Muscicapa strophiata Hodgson.

2 specimens, 1 ♂ and 1 ♀, Mengtsze, Nov., 1910, April, 1911.

* Muscicapa parva albicilla Pallas.

4 specimens, Mengtsze, April, Oct.

Muscicapa melanoleuca melanoleuca Hodgson.

3 specimens, Mengtsze, March, Oct.

* Muscicapa mugimaki Temminck.

1 ♂, Mengtsze, April, 1911.

Chelidorhynx hypoxantha (Blyth).

4 specimens, Mengtsze, Feb., March, Dec.

Rhipidura albicollis (Vieillot).

11 specimens, Mengtsze, Feb., March, April, July; Loukouchai, Jan.

* Hypothymis azurea azurea (Boddaert).

1 ♂ and 1 ♀, Mengtsze, 6 Sept., 16 Oct.

* Cyanoptila cyanomelana (Temminck).

1 ♂, immature, Mengtsze, 18 Oct., 1911.

Tchitrea incii (Gould).

11 specimens, Mengtsze, April, Aug., Sept., Oct.

Culicapa ceylonensis Swainson.

2 specimens, Mengtsze, Oct.

Cryptolopha burkii tephrocephalus (Anderson).

7 specimens, Mengtsze, March, April, Oct.

* Cryptolopha trivirgatus eiuncidus, subsp. nov.

Type, and only specimen: — adult ♂, M. C. Z., No. 61,985, Mengtsze, 16 September, 1910.

Characters.— Similar to true *C. trivirgatus* (Strickland); but general color of underparts very much paler and brighter yellow, clear lemon-yellow on throat and chin; sides of head clearer and paler yellow; the black stripes on the top of the head narrower anteriorly; general color of upper parts more yellowish and less greenish; rump and upper tail coverts especially so.

Measurements: wing, 55, tarsus, 17, exposed culmen, 9.

Stoparola melanops (Vigors).

13 specimens, Mengtsze, March, April, July, Aug., Sept., Oct.; Loukouchai, June.

Campophagidae.

Pericrocotus brevirostris ethologus, subsp. nov.

17 specimens, both sexes, Mengtsze, Feb., March, April, July, Sept.; Shi-ping Feb.; Loukouchai, Dec.

On comparison of a large series of specimens it seems best to divide *P. brevirostris* (Vigors) into three subspecies, based on the coloration of the adult male plumage. The forms are about alike in size, and the females of the three are rather similar. Oates (Fauna of British India), has already alluded to the differences in color shown by the two Indian forms. The Chinese is quite different from either and has the under wing coverts and axillars nearly as yellow as in *Pericrocotus igneus* Blyth although otherwise not in the least like that species.

Vigors's description and Gould's figure, both based on the same specimens, clearly were taken from the eastern form of intense coloration; M'Clelland's *P. affinis* is synonymous.

The Yunnan skins are not typical of the Chinese form as defined below, and though nearer to it than to true *P. brevirostris* are intermediate, as might be expected on geographical grounds, between the two.

The three races may be briefly defined as follows:—

1. *Pericrocotus brevirostris brevirostris* (Vigors).

Range.— Eastern Himalayas from Sikkim and Assam, through Manipur etc. to Tenasserim.

Characters.— Adult ♂ with the red of underparts and rump intense scarlet, sometimes almost scarlet-red; under wing coverts and axillars Grenadine red.

2. *Pericrocotus brevirostris flavillaceus*, subsp. nov.

Type: — Adult ♂, M. C. Z. No. 24,146, Koolloo Valley, northern India. M. M. Carleton.

Range.— More western Himalayas and Plains of India.

Characters.— Adult ♂ with the red of underparts and rump, including the under wing coverts and axillars Grenadine red.

3. *Pericrocotus brevirostris ethologus*, subsp. nov.

Type: — Adult ♂, M. C. Z., No. 51,487, Hsienshan, Hupeh, China, May 28, 1907, W. R. Zappey.

Range.— Central, western, and northern China. (Birds from southern Yunnan are not typical).

Characters.— Adult ♂ with the red of underparts and rump, flame scarlet, much mixed with orange on chest, and with white on belly; under wing coverts and axillars much yellower than in the other forms — orange-chrome; throat decidedly more greyish black than in the other races.

Pericrocotus roseus (Vieillot).

2 ♂'s, Mengtsze, March, Oct.

* Pericrocotus cantonensis Swinhoe.

6 specimens, Mengtsze, April, Oct.

* Campophaga lugubris (Sundeval).

3 specimens, Mengtsze, March, Oct.

Campophaga melanoptera (Rüppell).

8 specimens, Mengtsze, March, April, May, Oct.

Pycnonotidae.

Chloropsis hardwickei Jardin & Selby.

5 specimens, Loukouchai, Jan., Feb.

Hypsipetes leucocephalus (Gmelin).

16 specimens, Mengtsze, March, April, Nov.

Iole holti Swinhoe.

16 specimens, Mengtsze, Jan., March, April; Loukouchai, Jan., Feb.

Criniger tephrogenys henrici Oustalet.

5 specimens, Loukouchai, Feb.

* Alcurus striatus paulus, subsp. nov.

2 specimens, Loukouchai, Feb.

Type: — Adult ♂, M. C. Z. No. 62,006 Loukouchai, 5 February, 1911.

Characters.— Similar in color to true *striatus* of the Himalayas, but size much less.

Measurements:

		wing	culmen	tarsus	tail feathers
♂	62,006	102	15	18	90
♀	62,007	93	13	18	83

Remarks.— Oates (Fauna of British India, 1889) pointed out the difference in size between birds from the Himalayas and those from Tenasserim and Manipur. Our specimens agree in measurements with those from the latter region and are so much smaller than Himalayan examples as to leave no choice but to give this little form a name.

Xanthixus flavescens (Blyth).

1 ♂, Loukouchai, 7 Feb., 1911.

Pyconotus atricapillus (Vieillot).

2 specimens, Mengtsze, March, April.

Pyconotus xanthorrhous J. Anderson.

5 specimens, Mengtsze, Jan., 1911; Loukouchai, Feb.

* Spizixus semitorques Swinhoe.

5 specimens, Loukouchai, Jan., Feb., Dec.

Spizixus canifrons ingrami, subsp. nov.

6 specimens, Mengtsze, March, Aug., Sept.; Loukouchai, Dec.

Type: — Adult ♂, M. C. Z. No. 62,008, Mengtsze, 18 March, 1911.

Characters.— Similar to true *canifrons* of the Khasi Hills, Manipur; but throat grey and not brown; ear coverts pale ashy grey; underparts dull olive-green, not greenish yellow as in true *canifrons*. Size similar.

Measurements:

		wing	culmen	tarsus	tail feathers
♂	62,008	95	12	20	92
♀	62,009 topotype	92	11	19	82

Remarks.— All the above characters were noticed by Ingram but he hesitated to give the Yunnan form a name on account of insufficient material.

Timeliidae.

Ianthocincla canora (Linné).

1 ♂, Loukouchai, 12 June, 1911.

Ianthocincla cinereiceps styani Oustalet.

1 ♂, Loukouchai, 6 Feb.

* Ianthocincla lustrabila, sp. nov.

Type, and only specimen: — Adult ♂, M. C. Z. No. 62,014, Loukouchai, 11 February, 1911.

Characters.— Somewhat like *I. milni* David of Fokien but ear coverts grey instead of white; whole top of head and hind neck brilliant mars-orange (Ridgway, 1912) forming a cap sharply contrasted with the olive-colored mantle; lower back, rump, and upper tail coverts medal bronze instead of "golden olive" (David).

Measurements: wing, 99, culmen, 17, tarsus, 40, tail feathers, 107.

POMATORHINUS MACCLELLANDI ODICUS, subsp. nov.

7 specimens, Shi-ping, Feb., June, Aug., Sept., Oct.

Type: — ♂ adult, Mengtsze, M. C. Z., No. 61,999, 22 June, 1911.

Characters.— Differs from both true *P. m. macclellandi* Jerdon from Assam and *P. m. gravivox* David from central China in having sides, flanks, and under tail coverts uniform rich orange rufous. Throat and foreneck unspotted as in true *macclellandi*, thus differing from *gravivox*.

Measurements:

		wing	culmen	tarsus	tail feathers
♂	61,999	84	28	35	93
♂	62,000	90	30	35	90
♂	62,001	87	29	36	95
♂	62,002	86	28	34	96
♀	62,003	87	27	37	90
♀	62,004	89	29	36	95
♂	62,005	90	30	34	95

POMATORHINUS RUFICOLLIS RECONDITUS, subsp. nov.

9 specimens, Mengtsze, Mar., Sept., Nov.; Shi-ping, March; Loukouchai, Feb.

Type: — adult ♂, M. C. Z. No. 62,046, Mengtsze, 22 November, 1910.

Characters.— Similar to true *P. ruficollis* Hodgson of the Himalayas and to *P. ruficollis styani* Seebohm of the Yangtsze Valley, but differing from both in the color of the bill which is wholly yellow except for a small dusky patch at base of upper mandible; in color differing from true *ruficollis* in being much more olivaceous and less reddish brown above, tail and wings more olivaceous and less reddish brown; stripes on breast much more distinct and in the adult bright ferruginous; from *styni* the new form differs in color in being very slightly darker on the upper parts the striping below is very different, being more distinct and much more ferruginous. Our bird differs from *P. stridulus* Swinhoe which Hartert regards as a species, in lacking the sharp contrast between the colors of the back and tail and in having a much longer bill.

Measurements:

		wing	culmen to base of forehead	tarsus	tail feathers
♂	62,046	74	23	30	85
♂	62,047	76	23	30	85
♂	62,048	80	24	30	83
♂	62,054	72	24	29	80

Dryonastes sannio (Swinhoe).

23 specimens, Mengtsze, Jan., April, May, June, July, Aug., Sept.; Loukouchai, Jan., June.

The specimens of this long series differ a little in color from those taken by Zappey in Hupeh and Szechwan, being slightly more olivaceous and less rusty brown on the upper side. We have seen no specimens of *D. sannio* from the type locality, Amoy, if it and the Hupeh birds are the same, then *D. albosuperciliaris* of Godwin and Austen from Manipur Valley near Kaibi, which is usually thrown into synonymy, may apply to our Yunnan birds.

Pyctorhis sinensis (Gmelin).

22 specimens, Mengtsze, Jan., April, May, June, Sept., Nov., Dec.; Loukouchai, June, Dec.

* Alcippe nepalensis hueti (David).

11 specimens, Mengtsze, Jan., Feb.

These birds cannot be distinguished from specimens of true *hueti* taken in Hupeh and Szechwan by Zappey.

Proparus genestieri (Oustalet).

13 specimens, Mengtsze, Jan., March, April, May, Aug., Nov.; Loukouchai, Feb.

The average wing measurement of thirteen specimens is only 58 mm. The original description of this bird (Bull. Mus. Paris, 1897, **3**, p. 210), gives the wing at 70. Ingram says that four of his five specimens are small, but does not give measurements.

STACHYRIS NIGRICEPS Hodgson.

1 ♂, Loukouchai, 10 Feb., 1911.

STACHYRHIDOPSIS RUFICEPS (Blyth).

4 specimens, Mengtsze, Feb., Dec.

MIXORNIS RUBRICAPILLA (Tickell).

1 ♂, Mengtsze, 18 June, 1911.

* MYIOPHONEUS CAERULEUS (Scopoli).

1 adult ♂, Mengtsze, 3 May, 1911.

MYIOPHONEUS EUGENEI Hume.

8 specimens, Mengtsze, March, 1911; Loukouchai, Feb., Dec.

* BRACHYPTERYX CRURALIS SENENSIS Rickett.

1 adult ♂, Mengtsze, 28 March, 1911.

This example agrees exactly with Rickett's description of the northwestern Fokien bird. It probably is only a migrant in Yunnan.

* ACTINODURA RAMSAYI YUNNANENSIS, subsp. nov.

18 specimens, Mengtsze, May; Loukouchai, Jan., Feb., Dec.

Type:— adult ♂, M. C. Z. No. 62,025, Loukouchai, 29 January, 1911.

Characters.— Similar to true *A. ramsayi* Walden of the Karen-nee Hills, Burma, but much smaller, wing 81 to 87, tarsus 24 to 30, and color of crown much deeper brown (Sudan brown to antique brown, Ridgway, 1912).

Measurements:

		wing	culmen	tarsus	tail feathers
♂	62,025	85	14	30	112
♀	62,015	85	14	28	114

Malacias desgodinsi (David & Oustalet).

4 specimens, Loukouchai, Feb.

Siva cyanuroptera wingatei Ogilvie-Grant.

19 specimens, Mengtsze, March, April, Aug., Sept., Oct., Nov., Dec.

In this long series the character given by Ingram is very apparent, viz.: — "Secondaries never margined posteriorly, with a distinct white edge as in *cyanuroptera*." They are however sometimes slightly tipped with white.

Siva castaneicauda Hume.

1 ♂ and 1 ♀, Mengtsze, Jan., Feb.

Yuhina diademata Verreaux.

4 specimens, Loukouchai, Feb., Dec.; Mengtsze, March.

Yuhina occipitalis Hodgson.

2 specimens, Mengtsze, Jan.

Ixulus flavicollis rouxi Oustalet.

10 specimens, Mengtsze, Jan., Feb., March.

Leiothrix lutea lutea (Scopoli).

3 specimens, Mengtsze, Feb.

Pterythius aeralatus Tickell.

1 ♂, Loukouchai, 13 Feb., 1911.

* Pterythius melanotis Hodgson.

1 ♂ and 1 ♀, Loukouchai, Feb.

Mesia argentauris Hodgson.

1 ♂, Loukouchai, 6 Feb.

* Minla jerdoni J. Verreaux.

8 specimens, adults of both sexes, Mengtsze, Jan., Feb., Sept. Ingram refers the specimens examined by himself, from western Yunnan to *Minla igneitincta* Hodgson. Our skins, however, all winter and autumn killed, belong to the Chinese form having olive backs, and wholly bright yellow underparts and under wing coverts, the sides flecked with olive-green.

Probably the species is a winter visitor only to our region.

* Paradoxornis guttaticollis David.

3 males, Mengtsze; Loukouchai, Feb., March, Dec.

* Suthora webbiana webbiana Gray.

3 specimens, both sexes, Loukouchai, Jan., Feb., 1911.

On geographical grounds one might expect these skins to be referable to *S. w. suffusa* Swinhoe. Such, however, is clearly not the case. The crown and edges of the primaries in all three examples is rich vinaceous rufous and the back is of the shade peculiar to true *webbiana* and different from the shade shown in *suffusa*.

All three were taken in winter and the collection contains no summer nor spring examples; it is therefore, we think, safe to assume that they were merely winter stragglers of the northern form. The specimens afford the following measurements in mm.

		wing	culmen	tarsus	tail feathers
♂ ad.	62,956	49.	8	19.5	55.
♀ ad.	62,957	50.	8.5	20.	60.
♀ ad.	62,958	47.	7.5	19.	58.

Troglodytidae.

* Pnoepyga pusilla Hodgson.

1 adult ♀, Mengtsze, 18 March, 1911.

We have no specimens for comparison. The adult ♀ seems rather larger than measurements given for Indian birds and it may prove to belong to a different race. Wing, 50, tarsus, 19, exposed culmen, 9.

Turdidae.

Oreocincla aureus (Holandre).

5 specimens, Mengtsze, Jan., Feb., Oct.

* Turdus obscurus Gmelin.

6 specimens, Mengtsze, Oct., Nov.

Turdus fuscatus Pallas.

12 specimens, Mengtsze, March, Nov.; Shi-ping, March; Linan Fu, Feb., Loukouchai, Dec.

Turdus merula mandarinus Bonaparte.

11 specimens, Shi-ping, March; Linan Fu, Feb.

Monticola erythrogaster (Vigors).

1 adult ♂, Loukouchai, 8 Dec., 1910.

Monticola solitarius pandoo (Sykes).

19 specimens, Mengtsze, Jan., March, July, Nov.; Loukouchai, Jan., Feb., June, Dec.; Shi-ping, Feb.; Linan Fu, Feb.

The series taken by Mr. Zappey in Hupeh and Szechwan should have been referred to this race (Mem. M. C. Z., **40**, p. 175).

* Enicurus guttatus bacatus, subsp. nov.

1 ♂ and 1 ♀, Loukouchai, Feb.

Type:— Adult ♀, M. C. Z. No. 62,033, taken at Loukouchai, 14 February, 1911.

Characters.— Very similar to true *guttatus* Gould, of India; size about the same, but immediately recognized by the much larger and more numerous white spots on the back, the maximum diameter of which is 4 mm.

* Enicurus schistaceus Hodgson.

7 specimens, Loukouchai, Feb., Dec.

Chaimarrornis leucocephala (Vigors).

14 specimens, Mengtsze, Nov., Jan., Feb., March; Loukouchai, Dec., Jan., Feb., April.

Rhyacomis fuliginosa fuliginosa (Vigors).

14 specimens, Mengtsze, Dec., Jan., Feb., Nov.; Loukouchai, Feb.

Phoenicurus auroreus leucopterus (Blyth).

18 specimens, Mengtsze, Jan., March, Oct., Nov., Dec.

Phoenicurus frontalis Vigors.

2 specimens, Mengtsze, March.

Ianthia cyanura (Pallas).

11 specimens, Loukouchai, Feb., Dec.; Mengtsze, Jan., April, Nov., Dec.

* Ianthia practica, sp. nov.

1 ♂ and 1 ♀ adults, Mengtsze, April; Loukouchai, Feb.

Type:— No. 62,035 M. C. Z., adult ♂, Loukouchai, 14 February, 1911.

Characters.— Adult male most like the adult male of *I. rufulata* Hodgson but the color of the whole upper parts is dark tyrian blue instead of dark ultramarine blue (Ridgway 1912). The superciliary stripe is shining Chapman's blue instead of Rood's blue; shoulder patch somewhat brighter blue; base of the feathers of superciliary region dusky instead of white; white areas of lower parts much whiter and not so clouded with dusky. Size similar except the bill, which is smaller and more slender.

Measurements:

		wing	culmen	tarsus	tail feathers
♂	62,035 type	83	9	25	63
♀	62,036	82	9	25	65

* CALLIOPE CALLIOPE (Pallas).

11 specimens, Mengtsze, April, May.

NOTODELA LEUCURA (Hodgson).

2 ♂'s, Mengtsze, July, Aug.

COPSYCHUS SAULARIS SAULARIS (Linné).

20 specimens, Mengtsze, Feb., March, April, Oct.; Loukouchai, Dec.; Linan Fu, Feb.; Shi-ping, March.

SAXICOLA TORQUATA INDICA (Blyth).

8 specimens, Mengtsze, Aug., Nov., Dec.; Loukouchai, Feb.

Ingram referred his one male from Mengtsze to this form. Our skins probably also belong here, although they seem somewhat to approach *S. torquata stejnegeri* Parrot and may be intermediate. All being in winter or in immature plumage renders positive identification rather difficult. They are small, the wing in the series of eight skins, ranging from 67 to 70 mm.

SAXICOLA CAPRATA BICOLOR (Sykes).

2 ♂'s, Mengtsze, Feb., March.

Oreicola ferrea haringtoni Hartert.

11 specimens, Mengtsze, Jan., Feb., March, Oct., Nov., Dec.

Sylviidae.

Sutoria sutoria phyllorrhaphea (Swinhoe).

8 specimens, Mengtsze, April, May, July, Aug.

* Acrocephalus arundinaceus orientalis Temminck & Schlegel.

2 ♂'s, Mengtsze, April, Aug.

* Cisticola cisticola tintinnabulans (Swinhoe).

10 specimens, Mengtsze, Jan., March, April, May, July.

Franklinia gracilis (Franklin).

8 specimens, Mengtsze, Jan., April, May, Sept.

Oreopneuste subaffinis (Ogilvie-Grant).

1 ♂, Mengtsze, 3 July, 1910.

Oreopneuste fuscatus (Blyth).

5 specimens, Mengtsze, April, May.

Reguloides proregulus proregulus (Pallas).

1 ♂ and 1 ♀, Mengtsze, June; Loukouchai, Dec., 1910.

Reguloides superciliosus superciliosus (Gmelin).

4 specimens, Mengtsze, April, July, Sept., Oct.

Acanthopneuste borealis borealis (Blasius).

1 ♀, March, 1911.

Acanthopneuste lugubris (Blyth).

2 ♂'s, Mengtsze, April, May.

* Acanthopneuste coronata (Temminck).

4 specimens, Mengtsze, Aug.

Acanthopneuste trochiloides (Sundeval).

1 ♂ and 1 ♀, Mengtsze, June, Oct.

Acanthopneuste davisoni Oates.

1 ♂, Mengtsze, 21 Oct., 1910.

Phyllergates coronatus (Jerdon & Blyth).

1 ♀, Mengtsze, 29 July, 1911.

* Horornis canturians Swinhoe.

1 ♂, Mengtsze, 18 Nov., 1910.

* Horornis fortipes davidiana (Verreaux).

2 ♂'s, Mengtsze, May, June.

Suya superciliaris Anderson.

7 specimens, Mengtsze, April, May, Aug.

Suya crinigera yunnanensis Harrington.

3 specimens, Mengtsze, March, May.
These skins are very dark in color, and agree with the account of this recently described form.

Prinia inornata exter Thayer & Bangs.

12 specimens, Mengtsze, Jan., March, April, June, Sept.
This series agrees with specimens from Szechwan collected by Zappey, although the Yunnan specimens average a trifle smaller and paler.

Laniidae.

Lanius hypoleucus Blyth.

3 specimens, Mengtsze, 19, 23, 25 Aug.

* Lanius schach schach (Linné).

14 specimens, Shi-ping, 4 March; Loukouchai, 20, 21, 22 Dec.; Mengtsze, Jan., March, June, July, Aug., Sept.

Lanius schach tephronotus (Vigors).

1 ♂, Loukouchai, 21 Dec.

Lanius tigrinus Drapiez.

3 specimens, Mengtsze, April, Aug.

Lanius nasutus nigriceps Franklin.

1 ♂, Linan Fu, 20 Feb.

* Lanius fuscatus Lesson.

1 specimen, without exact data.

Lanius cristatus cristatus Linné.

4 specimens, Mengtsze, May, Sept., Oct.; Loukouchai, Dec.

* Lanius cristatus superciliosus Latham.

1 ♀, Mengtsze, 12 May.

Paridae.

Parus rex David.

4 specimens, Loukouchai, Feb., March.

Parus major commixtus Swinhoe.

14 specimens, Mengtsze, March, April, Aug., Sept., Oct., Nov., Dec.; Loukouchai, Dec.; Linan Fu, Feb.

Aegithaliscus concinnus Gould.

9 specimens, Mengtsze, Jan., Feb., March, Aug., Dec.

Sittidae.

Sitta europaea montium La Touche.

1 ♂, Loukouchai, 25 Jan.

Dendrophila frontalis (Horsfield).

4 specimens, Loukouchai, Feb., June, July.

Zosteropidae.

Zosterops palpebrosa mussoti Oustalet.

10 specimens, Mengtsze, Jan., April, May, July, Aug., Sept.

The wing averages 52 in this series, just as in Oustalet's series from Szechwan, and the color agrees perfectly with his description. Ingram has suggested that his Yunnan birds may be referable to this race and there seems to us no doubt that this is so.

Dicaeidae.

Dicaeum ignipectus ignipectus (Hodgson).

4 specimens, Mengtsze, Jan., March; Loukouchai, Feb.

* Dicaeum olivaceum Walden.

7 specimens, Mengtsze; Loukouchai, April, June, Sept., Oct.

Nectariniidae.

Aethopyga sanguinipectus Walden.

13 specimens, Loukouchai, Feb.; Asanzai, April.

Aethopyga dabryi Verreaux.

28 specimens, Mengtsze, Feb., March, April, Aug.

* Arachnothera magna (Hodgson).

4 specimens, Loukouchai, Feb.

Motacillidae.

Motacilla alba hodgsoni Blyth.

3 specimens, Mengtsze, Sept., Oct.

* Motacilla alba ocularis Swinhoe.

7 specimens, Mengtsze, Feb., April, June.

Motacilla boarula melanope Pallas.

6 specimens, Mengtsze, April, May, Sept., Oct., Nov.

Budytes citreola citreola (Pallas).

4 specimens, Mengtsze, April.

* Budytes citreola citreoloides Gould.

1 ♂, Mengtsze, 7 March, 1911.

Dendronanthus indicus (Gmelin).

3 specimens, Mengtsze, May.

Anthus trivialis hodgsoni Richmond.

5 specimens, Mengtsze, Jan., April, Oct., Nov.

Anthus richardi richardi Vieillot.

3 specimens, Mengtsze, March, Oct.

Anthus rufulus rufulus Vieillot.

5 specimens, Mengtsze, March, April, Aug., Oct.

ANTHUS ROSEATUS Blyth.

1 ♂ and 1 ♀, Mengtsze, April.

* OREOCORYS SYLVANUS (Hodgson).

1 adult ♂, Mengtsze, 5 June, 1911.

ALAUDIDAE.

ALAUDA GULGULA COELIVOX Swinhoe.

3 specimens, Mengtsze, April, Oct.

Wing, 89 to 92. These specimens are strongly and darkly marked on the upper breast and are in general color very reddish. They probably belong to this race, although our series is small for comparison.

FRINGILLIDAE.

* EOPHONA MELANURA MIGRATORIA Hartert.

5 specimens, Linan Fu, Feb.

SPINUS AMBIGUUS (Oustalet).

10 specimens, Mengtsze, Jan., Feb., March, Dec.

PASSER RUTILANS CINNAMOMEA (Gould).

3 specimens, Mengtsze, April; Linan Fu, Feb.

PASSER MONTANUS MONTANUS Linné.

11 specimens, Mengtsze, April, Aug., Oct., Nov.

CARPODACUS ERYTHRINUS ROSEATUS (Hodgson).

7 specimens, Mengtsze, Feb., March, April, Dec.

* LOXIA CURVIROSTRA HIMALAYENSIS (Blyth).

1 adult ♂, Mengtsze, 20 March, 1911.

Emberiza pusilla Pallas.

10 specimens, Mengtsze, Jan., March, April, Nov., Dec.

Emberiza fucata arcuata Sharpe.

2 specimens, Mengtsze, March, April.

Emberiza aureola Pallas.

3 specimens, Mengtsze, April, May.

* Emberiza rutila Pallas.

3 specimens, Mengtsze, April; Loukouchai, Jan.

Emberiza spodocephala melanops Blyth.

5 specimens, Mengtsze, Jan., April, Oct., Dec.

Melophus melanicterus (Gmelin).

25 specimens, Mengtsze, March, April, May, Aug.; Loukouchai, Dec.; Linan Fu, Feb.; Shi-ping, Feb.

Ploceidae.

Munia punctata topela Swinhoe.

14 specimens, Mengtsze, Jan., Feb., March, April, Aug., Nov.; Loukouchai, Dec.

Sporaeginthus flavidiventris (Wallace).

10 specimens, Mengtsze, March, May, June, July; Loukouchai, June.

Sturnidae.

Spodiopsar nemoricolus (Jerdon).

12 specimens, Mengtsze, April, June, Aug., Oct.

* Spodiopsar sericeus (Gmelin).

1 ♂, Linan Fu, 20 Feb., 1911.

Aethiopsar cristatellus Gmelin.

23 specimens, Mengtsze, Jan., March, Aug., Sept., Dec.

Oriolidae.

Oriolus indicus Jerdon.

7 specimens, Mengtsze, April, May, Sept., Oct.

Dicruridae.

Chibia hottentotta (Linné).

3 specimens, Mengtsze, Sept., Oct.

Buchanga atra cathoeca Swinhoe.

21 specimens, Mengtsze, April, May, June, July, Aug., Oct.

Buchanga cineracea pyrrhops (Hodgson).

12 specimens, Mengtsze, Jan., Feb., March, April, Oct.; Shi-ping, Feb., March.

These specimens are similar in color to true *cineracea* but are larger than specimens of that form from Java. They agree with measurements given by Sharpe (Cat. birds Brit. mus.) for *pyrrhops* of Hodgson, by which name they undoubtedly should be known.

* Buchanga leucogenys leucogenys Walden.

4 specimens, Mengtsze, Oct.

This series agrees with birds from Cochin China and the Malay Peninsula in being dark grey in color. It has been suggested by Hartert (Nov. zool., **17**, p. 248) that there may be a northern and southern race.

Our material now shows that such is the case, and that the series of birds collected by Mr. W. R. Zappey in Szechwan and Hupeh are very much paler, almost whitish grey in color. For this pale northern form we propose the name *Buchanga leucogenys cerussata*, subsp. nov.

Type:— Adult ♂, M. C. Z. 52,035 Ichang, Hupeh, China, June 19, 1907, W. R. Zappey.

Characters.— Similar in size to *B. l. leucogenys*, but much paler and more whitish grey throughout, with light face area larger and more clearly defined.

Corvidae.

Coloeus dauuricus (Pallas).

3 specimens, Mengtsze, June, Dec.

Coloeus neglectus (Schlegel).

1 unsexed, Mengtsze.

Pica pica sericea Gould.

10 specimens, Mengtsze, Jan., Feb., March, May, June, Dec.

Urocissa erythrorhyncha (Gmelin).

10 specimens, Mengtsze, Feb., March, April, Oct., Dec.

Dendrocitta himalayensis (Vigors).

2 specimens, Loukouchai, June.

The following Publications of the Museum of Comparative Zoölogy are in preparation: —

LOUIS CABOT. Immature State of the Odonata, Part IV.
E. L. MARK. Studies on Lepidosteus, continued.
" On Arachnactis.
A. AGASSIZ and C. O. WHITMAN. Pelagic Fishes. Part II., with 14 Plates.
H. L. CLARK. The "Albatross" Hawaiian Echini.

Reports on the Results of Dredging Operations in 1877, 1878, 1879, and 1880, in charge of Alexander Agassiz, by the U. S. Coast Survey Steamer "Blake," as follows:—

A. MILNE EDWARDS and E. L. BOUVIER. The Crustacea of the "Blake."
A. E. VERRILL. The Alcyonaria of the "Blake."

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieutenant Commander Z. L. Tanner, U. S. N., Commanding, in charge of Alexander Agassiz, as follows:—

K. BRANDT. The Sagittae.
" The Thalassicolae.
O CARLGREN. The Actinarians.
R. V. CHAMBERLIN. The Annelids.
W. R. COE. The Nemerteans.
REINHARD DOHRN. The Eyes of Deep-Sea Crustacea.
H. J. HANSEN. The Cirripeds.
" The Schizopods.
HAROLD HEATH. Solenogaster.
W. A. HERDMAN. The Ascidians.
S. J. HICKSON. The Antipathids.
E. L. MARK. Branchiocerianthus.
JOHN MURRAY. The Bottom Specimens.
P. SCHIEMENZ. The Pteropods and Heteropods.
THEO. STUDER. The Alcyonarians.
—— The Salpidae and Doliolidae.
H. B. WARD. The Sipunculids.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding, as follows:—

R. V. CHAMBERLIN. The Annelids.
H. L. CLARK. The Holothurians.
—— The Volcanic Rocks.
—— The Coralliferous Limestones.
S. HENSHAW. The Insects.
R. VON LENDENFELD. The Siliceous Sponges.
—— The Ophiurans.
G. W. MÜLLER. The Ostracods.
MARY J. RATHBUN. The Crustacea Decapoda.
G. O. SARS. The Copepods.
L. STEJNEGER. The Reptiles.
C. H. TOWNSEND. The Mammals, Birds, and Fishes.
T. W. VAUGHAN. The Corals, Recent and Fossil.

PUBLICATIONS

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY

AT HARVARD COLLEGE.

There have been published of the BULLETIN Vols. I. to LIV.; of the MEMOIRS, Vols. I. to XXIV., and also Vols. XXVI. to XXIX., XXXI. to XXXIV., XXXVI. to XXXVIII., XLI., and XLIV.

Vols. LV. to LVIII. of the BULLETIN, and Vols. XXV., XXX., XXXV., XXXIX., XL., XLII., XLIII., XLV. to XLVIII. of the MEMOIRS, are now in course of publication.

The BULLETIN and MEMOIRS are devoted to the publication of original work by the Officers of the Museum, of investigations carried on by students and others in the different Laboratories of Natural History, and of work by specialists based upon the Museum Collections and Explorations.

The following publications are in preparation:—

Reports on the Results of Dredging Operations from 1877 to 1880, in charge of Alexander Agassiz, by the U. S. Coast Survey Steamer "Blake," Lieut. Commander C. D. Sigsbee, U. S. N., and Commander J. R. Bartlett, U. S. N., Commanding.

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieut. Commander Z. L. Tanner, U. S. N., Commanding, in charge of Alexander Agassiz.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

Reports on the Scientific Results of the Expedition to the Eastern Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from October, 1904, to April, 1905, Lieut. Commander L. M. Garrett, U. S. N., Commanding.

Contributions from the Zoölogical Laboratory, Professor E. L. Mark, Director.

Contributions from the Geological Laboratory, Professor R. A. Daly, in charge.

These publications are issued in numbers at irregular intervals. Each number of the Bulletin and of the Memoirs is sold separately. A price list of the publications of the Museum will be sent on application to the Director of the Museum of Comparative Zoölogy, Cambridge, Mass.

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Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

Vol. LVIII. No. 7.

MAMMALS FROM THE BLUE NILE VALLEY.

By Glover M. Allen.

CAMBRIDGE, MASS., U. S. A.:

PRINTED FOR THE MUSEUM.

July, 1914.

REPORTS ON THE SCIENTIFIC RESULTS OF THE EXPEDITION TO THE EASTERN TROPICAL PACIFIC, IN CHARGE OF ALEXANDER AGASSIZ, BY THE U. S. FISH COMMISSION STEAMER "ALBATROSS," FROM OCTOBER, 1904, TO MARCH, 1905, LIEUTENANT COMMANDER L. M. GARRETT, U. S. N., COMMANDING, PUBLISHED OR IN PREPARATION:—

A. AGASSIZ. V.[5] General Report on the Expedition.
A. AGASSIZ. I.[1] Three Letters to Geo. M. Bowers, U. S. Fish Com.
A. AGASSIZ and H. L. CLARK. The Echini.
H. B. BIGELOW. XVI.[16] The Medusae.
H. B. BIGELOW. XXIII.[23] The Siphonophores.
H. B. BIGELOW. XXVI.[26] The Ctenophores.
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C. A. KOFOID and J. R. MICHENER. XXII.[22] The Protozoa.
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E. C. STARKS. XIII.[13] Atelaxia.
TH. STUDER. The Alcyonaria.
JH. THIELE. XV.[15] Bathysciadium.
T. W. VAUGHAN. VI.[6] The Corals.
R. WOLTERECK. XVIII.[18] The Amphipods.

[1] Bull. M. C. Z., Vol. XLVI., No. 4, April, 1905, 22 pp.
[2] Bull. M. C. Z., Vol. XLVI., No. 6, July, 1905, 4 pp., 1 pl.
[3] Bull. M. C. Z., Vol. XLVI., No. 9, September, 1905, 5 pp., 1 pl.
[4] Bull. M. C. Z., Vol. XLVI., No. 13, January, 1906, 22 pp., 3 pls.
[5] Mem. M. C. Z., Vol. XXXIII., January, 1906, 90 pp., 96 pls.
[6] Bull. M. C. Z., Vol. L., No. 3, August, 1906, 14 pp., 10 pls.
[7] Bull. M. C. Z., Vol. L., No. 4, November, 1906, 26 pp., 4 pls.
[8] Mem. M. C. Z., Vol. XXXV., No. 1, February, 1907, 20 pp., 15 pls.
[9] Bull. M. C. Z., Vol. L., No. 6, February, 1907, 48 pp., 18 pls.
[10] Mem. M. C. Z., Vol. XXXV, No. 2, August, 1907, 56 pp., 9 pls.
[11] Bull. M. C. Z., Vol. LI., No. 6, November, 1907, 22 pp., 1 pl.
[12] Bull. M. C. Z., Vol. LII., No. 1, June, 1908, 14 pp., 1 pl.
[13] Bull. M. C. Z., Vol. LII., No. 2, July, 1908, 8 pp., 5 pls.
[14] Bull. M. C. Z., Vol. XLIII., No. 6, October, 1908, 285 pp., 22 pls.
[15] Bull. M. C. Z., Vol. LII., No. 5, October, 1908, 11 pp., 2 pls
[16] Mem. M. C. Z., Vol. XXXVII., February, 1909, 243 pp., 48 pls.
[17] Mem. M. C. Z., Vol. XXXVIII., No. 1, June, 1909, 172 pp., 5 pls., 3 maps.
[18] Bull. M. C. Z., Vol. LII., No. 9, June, 1909, 26 pp., 8 pls.
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[21] Mem. M. C. Z., Vol. XLI., August, September, 1910, 323 pp., 56 pls.
[22] Bull. M. C. Z., Vol. LIV., No. 7, August, 1911, 38 pp.
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[24] Bull. M. C. Z., Vol. LIV., No. 10, February, 1912, 16 pp., 2 pls.
[25] Mem. M. C. Z., Vol. XXXV., No. 3, April, 1912, 98 pp., 8 pls.
[26] Bull. M. C. Z., Vol. LIV, No. 12, April, 1912, 38 pp., 2 pls.
[27] Mem. M. C. Z., Vol. XXXV., No. 4, July, 1912, 124 pp., 12 pls.

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July, 1914.

No. 7.— *Mammals from the Blue Nile Valley.*

By Glover M. Allen.

In January and February, 1913, I accompanied Dr. J. C. Phillips on his expedition up the Blue Nile and the Dinder River in the interests of the Museum. A considerable effort was made to collect the birds (see Bull. M. C. Z., December, 1913, **58**, p. 1–28) and mammals of the region, and Dr. Phillips has generously left to me the working out of the latter. Our route lay along the Blue Nile, from Sennar, where our real start was made, to Singa, the present seat of government for Sennar Province. At this point we crossed to the north bank, for the south bank is a game reserve, and proceeded along it to the Abyssinian border, stopping at Fazogli, an outlying 'gebel' of the Abyssinian foothills. We later retraced our steps to Abu Tiga, and thence crossed over to the Dinder, an affluent of the main river, that becomes partly dry in the rainless season. The upper portion of this river seemed to have been very little disturbed, and large game was abundant and very unsuspicious. Along the Blue Nile, however, and on the lower parts of the Dinder, the native population is increasing and there is much travelling up and down along the river banks. On the Blue Nile especially, parties of Arabs and negroes are constantly passing, and English officials make their rounds between Singa and Roseires or other points. With the increase of native population, the clearing of the land, and disturbance incident to human occupation, the large game must inevitably be gradually driven back or exterminated by hunting. It is generally believed that the native population of the Sudan, during the time of the Mahdi and his successor (1883–1898) was reduced through war, famine, and disease about 75%, amounting to the almost total extinction of the inhabitants along the Rahad and Dinder, as well as on the Blue Nile, so that many of the villages marked on the older maps no longer exist. This no doubt has been favorable for the increase of large game in later years. On these rivers now, however, the habitations are being reëstablished gradually, and population will doubtless reclaim the country in time. It therefore has seemed worth while to record the more striking facts we noted concerning the habits and distribution of the larger mammals, for they must eventually be much reduced or destroyed altogether. A few species seem better adapted to survive than others and these, on the Blue Nile, for example, already show through their difference of habits, compared to their congeners of the upper Dinder, an adaptation to the changing conditions.

The entire country up to the Abyssinian border is monotonously flat, and covered largely with an open forest of thorn trees among which the red-barked gum-arabic tree is conspicuous. A very few

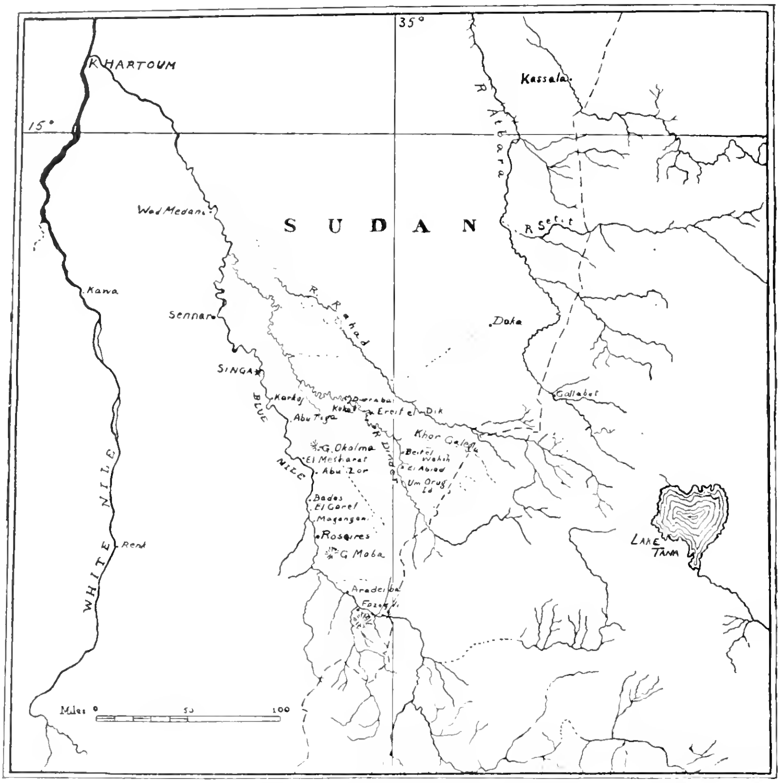

Fig. 1.— Sketch map of the Blue Nile Valley.

small and isolated hills or 'gebels' project here and there abruptly from the plain, and alone break its monotony. The Blue Nile has cut a channel through this broad plain, but so steep are its banks for many miles in succession, that access to the water is difficult, and hardly to be obtained except where gullies, cut down during the torrential rains of the wet season, afford a passage. As settlements increase along the rivers, the native villages are planted at such spots, termed 'mesharats,' or "places where one can get down to the water." Since the large mammals are also dependent on these for reaching the water, the settlements result in driving them farther and farther away where there are 'mesharats' at a distance from habitations, with their accompaniment of droves of cattle, yelping dogs, and native hunters.

The luxuriant growth of tall grass that springs up after the summer rains becomes exceedingly dry by late autumn, and the natives set fire to it and burn the country for many hundreds of square miles. The soil itself becomes transformed from a mass of sticky mud in the wet season to a hard baked or a powdery condition, often much cracked and very difficult for walking. Such unfavorable conditions appear to have had a direct influence in reducing the ground-living species to a minimum, so that it was very hard to obtain small mammals, and even in comparatively sheltered places the number of species was disappointingly few. According to local report, there is much more large game along the Blue Nile during the wet season and just previous to it, in April and May, when the drying up of the smaller and remoter pools forces the animals to seek the main stream. The rank growth of vegetation during the summer rains also causes a more general dispersal.

There has been but little collecting done in the area covered, though travellers have from time to time sent specimens to Europe. As long ago as 1842, Sundevall published descriptions of mammals obtained in Sennar by the Swedish traveler Hedenborg, but as then used, Sennar was a somewhat indefinite term applied to the country between the White and the Blue Niles. Rüppell and Heuglin later did much exploration in northeastern Africa, including journeys into the Sudan. They gave names to many of the species whose range includes the Blue Nile country. What has since been done in the study of the mammalian fauna of the region has been of fragmentary nature, and consists chiefly of reports on occasional specimens sent by Europeans to the museums of England and Germany. In 1898, Lord Lovat's expedition crossed from southern Abyssinia to the Blue Nile Valley, and obtained a few specimens from the latter region, including a new multimammate mouse, described by de Winton (1900). Captain S. S. Flower, of the Gizeh Zoölogical Gardens has several times been in the region to obtain living animals for the splendid collection under his charge. Mr. A. L. Butler, head of the Game Preservation Department of the Sudan, also knows the country well and has sent many specimens of birds and mammals to the British Museum.

In general the mammalian fauna may be said to be typically African, with almost no trace of Eurasian species. It is a continuation of that of the upper Nile, though rather more reduced, and in the region covered, quite without any of the desert species found in the Saharan sands to the north and northwest.

The list of species observed follows.

Syncerus aequinoctialis (Blyth).

Nile Valley Buffalo.

Bubalus caffer aequinoctialis Blyth, Proc. Zool. soc. London, 1866, p. 372.
Bubalus azrakensis Matschie, Sitzb. Ges. naturf. freunde, Berlin, 1906, p. 169.

In his review of the African buffaloes Matschie describes *Bubalus azrakensis* as a new species; it is based upon an imperfect skull from Roseires on the Blue Nile. He says that it belongs to those forms in which the horn is strongly bowed downward and differs from all the other species in that the inwardly bent tips of the horns turn suddenly back at the ends. This appearance is shown in his photographic figure, in which, however, one of these tips is broken off. Moreover, as the figure shows, the skull is that of an immature animal in which the basal portions of the horns are unsolidified and have not been preserved, although the spread is 84 cm., a fairly large size for Nile Valley animals. The horns of three old bulls shot by Dr. Phillips on the Dinder River, are heavy and massive, the bases very broad, but not joining medially on the forehead, nor are they convex in this region as in the *caffer* type, but flattened, ridged, and broadly excavated. Their downward sweep reaches only about to the level of the orbit and the tips are blunt and rather short, due in part to wear. Cotton (1912) says that the horns of cows have a deeper curve than those of the bulls and are not so wide. The long points, backwardly turned, of Matschie's *azrakensis* seem more like an individual variation in an immature animal. In view of these facts, it does not appear that the Buffalo of this region is satisfactorily distinguished from *aequinoctialis* of the White Nile, so that it is best at present to use this latter name to include the Buffalo of the Blue Nile as well. The generic name Syncerus was revived in 1911 by Hollister to distinguish the African Buffalo from the Water Buffalo — Bubalus.

The following measurements of Dr. Phillips's specimens were made in the field:—

	1	2	3
	mm.	mm.	mm.
Nose to root of tail	2615	2470	2400
Tail (from anterior base to tip)	785	700+	795
Calcaneum to tip of hoof	595	610	615
Ear from meatus to tip	—	290	290
Standing height at shoulder	1680	1570	1660
Half girth back of fore leg	—	1150	1145
Fore hoof, length of under side	190	180	170
" " greatest breadth	135	140	125
Hind hoof, length of under side	140	160	160
" " greatest breadth	110	125	110
Greatest expanse of horns, outside	745	850	880
Greatest width of basal expansion of horn	210	230	210

From these measurements it appears that the animal with the smallest spread of horns was the largest in body. The one with the broadest spread, however, (880 mm. = 34.5 inches) did not have the broadest base. The greater size of the anterior hoofs is also apparent; and is greatest in the largest-bodied specimen with the least spread of horns.

Buffalo are now rare on the Blue Nile, at least along the north bank where our route lay. The only place where we learned of their presence was near a small native village called Omdurman, a few days' journey below Roseires. Here apparently was a small herd of perhaps eight or ten, that came almost nightly to the edge of a large marsh or to the vegetable gardens of the natives. They were very wary and during the day were not to be discovered, for they frequented the thickest cover along the river. As the natives are without firearms, the Buffalo have little to fear from them, though with shouts and firebrands at night the men often frighten them from the growing crops. Passing sportsmen, or English officials, however, sometimes stop to hunt here. Cotton (1912) notes Buffalo at El Garef. Matschie's specimen of *B. azrakensis* is said to have come from Roseires, but may not have been shot in that immediate vicinity.

It was not until we reached the Dinder that we found Buffalo in any numbers. As the district was closed for a time, we were obliged to retrace our steps from Roseires several days' journey down stream before we were allowed to cross over, a two days' march to the Dinder. This stream goes partly dry in the rainless season, so is much less disturbed and only very sparingly settled by natives. At El Kuka we first found Buffalo tracks, but these indicated only a few scattered animals. Continuing several days' journey to the vicinity of Um Orug, a large island in the stream bed, we finally came upon Buffaloes in such numbers as are hardly to be found elsewhere in Africa at the present day. At Khor Galegu was the last native village, and at some distance above this began a series of so-called 'meres,' which are great marshy areas often a mile long, and even at this dry season (February) moist or even boggy, with a rank growth of high grass, now largely eaten down by the wild game. For to these places resorted the large ruminants for miles around. It was near such a meadow, near Um Orug that we encountered a herd of some 250 Buffalo as they came at sunset to drink at a large pool in the river bed. Later we saw what was no doubt the same herd on a great 'mere' below this spot. On a 'mere' near a camping spot called Beit el Wahsh, we saw a second herd of about 100 old and young, and near a camp El Abiad, a herd of some sixty or more on a similar 'mere.' A very large old bull was seen here, that seemed to have been driven from the herd and was at the opposite side of the 'mere.' This and two other old bulls that were found together on another 'mere' far from any herd, fell to Dr. Phillips's rifle. They were all much battle-scarred, and one had lost an eye, and its ears were badly torn.

The appearance of a herd of Buffalo at a distance is highly characteristic. They mass closely together, and their great black bodies form a solid rank, whose outline is hardly broken by the heads and horns, as these are carried nearly on a level with the back. The small White Egret often feeds close among the herds. At Abiad we saw a large flock of these birds, their white plumage in strong contrast to the black bulk of the great beasts.

Strepsiceros strepsiceros chora (Cretzschmar).

Northern Greater Kudu.

Antilope chora Cretzschmar, Rüppell's Atlas reise nördlichen Afrika. Säugeth., 1826, p. 22.

Pocock (1905) has proposed to distinguish the Greater Kudu of northern Africa as a distinct race from that of South Africa, and revives Cretzschmar's name for it. It is readily distinguished by its fewer white body stripes.

Unquestionably the Kudu is the finest of the antelopes of the Nile

Valley. Its wariness, its love for hilly or broken ground, its keenness of sense, and its handsome appearance make it by far the most noteworthy of the large game mammals of the country it inhabits. Its present distribution along the Blue Nile is very interesting, as it frequents the narrow and intermittent strip of broken ground a short distance back from the river where torrential streams have worn little valleys or 'khors' in a soil locally harder or more gravelly than most of the level plain of the great river. Here there is more or less good cover, clumps of thorn bush, tall grass, or vines, which added to the irregular nature of the ground, forms a tolerable shelter.

The method of hunting is to follow the track and by keen watching and silent following, to discover the animal before he is aware of the pursuit. Owing to the somewhat dense cover, however, or the dry grass and twigs, this is a difficult matter. It is usually the case, that the bulls are apt to be solitary and are much more difficult to approach than the cows, which often go in bands of three or four. We startled a company of three near Gebel Maba, and were told of a band of four being seen near Roseires. The former is a favorite haunt, an isolated and irregular hill, very stony, though with few large boulders, and covered with thorn trees. Mr. Savage at Roseires had lately taken a bull with fine head a few miles back from that post, and said that it was accompanied by a cow. Dr. Phillips at one time found a bull and calf together near Magangani, and spent much time following others at various points as far down the river as the neighborhood of El Mesharat, where he heard one giving its characteristic bellow. This sound is made by both bulls and cows. Near Magangani, Dr. Phillips was once watching a Kudu cow as she was lying down, a hundred yards distant. Presently she rose to her feet and began to bellow at regular intervals of five seconds. As described by Dr. Phillips the sound is a single low explosive puff, like that of a distant freight engine heavy laden. This bellow he several times heard while following a Kudu track but the wary antelope always kept ahead just out of vision. The bleaching skulls and skeletons of male Kudu are not infrequently found, but those of cows much less often. Some perhaps are killed by lions, or wounded by hunters and lost. Certainly however, there are comparatively few bulls left along the Blue Nile.

On the Dinder River, the Kudu is practically absent except in a small stretch just below Um Orug, where Dr. Phillips heard the characteristic bellow and saw tracks. No doubt there are Kudu above this point but we did not go farther.

There is much variation in the angle at which the horns come off from the skull, as well as in the openness of coiling of the separate horns. Some are more open and divaricating, others a slightly closer spiral and the horns nearer together. The native hunters consider that there are two sorts of Kudu, which really are but the extremes of these two types. They call the former *ghazâwi*, the latter *karóri*, and believe each animal is the property of some spirit who marks his animal that he may be known to his owner. The slit ear of one specimen is thus taken to be such a mark.

The hoofs are remarkably delicate in proportion to the size of the animal and to an experienced eye, make a characteristic track.

In the stomach of an 11-foot crocodile killed above Bados, Dr. Phillips found what seemed to be the hoofs of a Kudu.

Tragelaphus decula (Rüppell).

Abyssinian Bushbuck.

Antilope decula Rüppell, Neue wirbelth. fauna Abyssinien. Säugeth., 1835, p. 11, pl. 4.

A few Bushbuck may be found along the Blue Nile at Abu Zor and beyond, but they are uncommon and solitary in habits. At El Garef we heard in the early evening what our native hunters assured us was their curious sharp bark of alarm, reminding one of a small terrier. Cotton (1912) mentions finding Bushbuck at Bados and Magangani. It is apparently less common on the Dinder, for we met with it but once, at Um Orug where Dr. Phillips obtained a young male.

Egocerus equinus bakeri (Heuglin).

Baker's Roan Antelope.

Hippotragus bakeri Heuglin, Nova acta Acad. Leop. Carol., 1863, **30**, art. 2, p. 16, pl. 2, fig. 6.

This fine Antelope is still to be found in small numbers on the north bank of the Blue Nile in the vicinity of Bados. They are shy, however, and seem to use much caution in approaching the river to drink. This they do at some very early hour, and are far back in the dry thorn bush by daybreak. At Magangani, near Roseires, a small herd passed within a stone's throw of our encampment during the night, on the way to the water. Cotton speaks of finding one at Gebel Maba, some distance above Roseires, but there seem to be few beyond that point. At Bados we spent a day hunting the Roan, with a skilful native tracker. The animals were well back from the river, and after about an hour's walk we reached their country, and spent some hours following tracks on the powdery "cotton soil" in the thorn scrub. The tracks were mostly of single animals or pairs, and we found where they had roamed about stopping here and there to bite off a green twig of a particular species of thorn, white-barked and with small obovate leaves. The Antelope were extremely shy and several broke away before we had even sighted them. Finally Dr. Phillips successfully stalked to within ninety yards of one lying apparently asleep under a 'laloab' tree, at noon. But the watchful animal was quick to detect the motion of the binoculars, even at that distance and down wind, and leaped to its feet, a fine imposing creature. When startled at close range, the Roan as it bounds away makes a sound like a "sneezing cough."

On the Dinder, there are many more than on the Blue Nile. For some distance above the villages where the river bank is more or less travelled by Arab gum pickers and hunters, the Roan are shy, and their tracks, which we began to find at the camping spot, El Kuka, usually led straight back into the thorn scrub, so that it was fully a mile from the stream before the trails began to break up. Beyond the junction of the Galegu we saw many Roan. They had evidently been little disturbed here and travelled in bands of as many as fifteen to twenty-five, taking no apparent precaution to avoid the river borders. Unlike the other antelopes, they seemed to avoid the open 'meres' but were usually in the scattered tree growth, or the edge of the tall grass and bushes near the stream. They seemed to browse rather than graze. At Abiad several came to water at a pool of the Dinder, in mid-afternoon, and it was interesting to see some drop to their knees to drink, though others drank standing.

Owing to its wariness and its habit of retiring far back from the travelled river banks, this large species will no doubt continue to survive along the Blue Nile for some time longer. Cotton (1912, p. 53) believes that they drink only about twice a week, so are able to go a long way from water. He says they are still common on the Setit and the Atbara Rivers, in the uninhabited portions, but no longer exist on the Rahad.

The stomach of one contained in the first compartment over a peck of the small twigs and leaves of a gray-barked thornbush, as well as a number of 'laboab' fruits, whose large stones are evidently masticated with the cud, instead of being regurgitated as with the smaller gazelle.

Gazella soemmerringi (Cretzschmar).

Ariel or Sömmerring's Gazelle.

Antilope soemmerringii Cretzschmar, Rüppell's Atlas reise nördlichen Afrika. Säugeth., 1826, p. 49, pl. 19.

Of this species, Cotton (1912, p. 57) writes: "On the Atbara.... it was a rare animal; but throughout the Setit it was very abundant, and on the Rahad, from a march or two above Hawata to the Abyssinian border, the ariel were to be numbered only by thousands, and their presence obviously accounted for the number of lions. There were large herds on the Galegu and Dinder, but not many of them, and on the Blue Nile I did not see a single specimen." It is the only species of gazelle that we found in all the country traversed. Cotton did not learn of its presence on the Blue Nile, but we saw a few back from the river near Bados, which appears to be the last remaining stretch of good game country on the north side of the river. This is no doubt because there is an area of marsh along the river which allows the animals to come to water without passing too close to villages. They must drink very early in the morning, for they are well back in the thorn scrub by daylight. On the south bank of the Blue Nile there are good numbers still, as we were informed by some officers of the Scots Guards, who obtained several heads there during our stay in the country. That side of the river is much less populated and is a reserve for use of officials only. In crossing from the Blue Nile to the Dinder, from Abu Tiga, we saw a single bunch of three Ariel, but they are clearly very scarce in the region.

It was not until we had proceeded some distance up the Dinder that the Ariel began to appear. Near Ereif el Dik, a camp site by the bank, we saw a few coming from the water in early forenoon, and from this point on to Um Orug they were common, far outnumbering all the other antelopes. At times they were in sight nearly all day in smaller or larger bands; frequently we started them in the forenoon at eight or nine o'clock coming from the water, and I have seen them come to drink as late as 12.30 P. M., for here they seemed to have been undisturbed for some while, and had lost much of their wariness of human kind. They are a most social species and gather into bands that number often fifty, seventy-five or a hundred approximately, of both sexes, and in early February the females were often accompanied by young fawns. It was common to find single animals as well, and these were usually old bucks. One which Dr. Phillips shot, showed many battle scars about the neck from the horns of some others of its kind, by which it had probably been driven from the herd. Once I saw a young buck butting playfully at the rear of one in front, and on another occasion Dr. Phillips had a good opportunity to observe their manner of fighting. Two bucks were seen fencing. They would lower their heads and catch each other's horns by the hook-like tips. Then followed a sort of tug-of-war in which one tried to pull the other about while their horns were thus interlocked. Sometimes they would butt at each other, and inflict sharp digs on the neck with the incurved tips of the horns.

The chief food seemed to be grass, which was very closely grazed down on the 'meres.' Away from these places there was very little green vegetation except bushy growth, but everywhere the sprouting grass stalks were cropped off, and it was clear that green pasturage was none too plentiful for the big herds. The Ariel eat quantities of the date-shaped fruit of a species of thorn tree called the 'laloab,' which they pick up from the ground. This has a thin but juicy and rather acrid pulp with a large stone, enclosing a seed which is ground and eaten by the negroes. The stones appear to be regurgitated after the pulp has been digested, and it was common to find little heaps of half a dozen or so of these, quite cleaned, deposited on the ground. Our native hunters said that these were left by the Gazelles, after having been regurgitated, and though we did not actually see the process, there is no reason for doubting that this is the truth.

These Gazelles seemed to be the most wary of the smaller antelopes. When feeding on the open with other grass-eating species, they were usually the first to take fright at our approach, and would move off, slowly at first, gathering sometimes into dense bunches like sheep, which they further simulated in their very whitish appearance. They are very conspicuous against the dark "cotton soil" or the burned areas, but among the dry and withered grass or on sand the contrast was less. They are constantly switching their tails from side to side, both when running or when standing, as though from sheer nervousness. I have seen the same habit in the Thompson's and Grant's gazelles. When surprised near the drinking places, they always seemed much concerned to get back from the belt of tall grass or shrubbery near the bank of the stream, but on reaching the more open thorn scrub, would stop to look about. Evidently they feared lions or leopards lying in wait at such places. Lions certainly kill good numbers, and we found the remains of several recent "kills." It was noticeable that most of these were youngish animals of small horns, no doubt the less experienced or less wary members of the herds. Occasionally aged animals are also killed, possibly because they are less able to escape through battle wounds or sickness. The result is therefore that in nature, the greatest mortality is among the youthful and inexperienced or among the aged and outworn. The finest specimens tend thus to be left to perpetuate the herd. It is worth noting that the effect of human game-protective laws is more or less the reverse, for the sportsman is usually content to let the poorer heads go, and to cull out those with the finest horns. In addition to lions, the Ariel evidently have much to fear from the crocodiles that lurk in all the large pools. In the stomach of one shot at Gosar, Dr. Phillips found horns of three Ariel, a doe and two small bucks, apparently. If possible the Gazelles will drink at a shallow pool in preference to a large deep one, in which there are likely to be crocodiles. It would be interesting to know how active these Gazelles are by night. While marching by moonlight along the Dinder, we once came upon two that seemed to be grazing, and again in the dim light preceding dawn I found a few single animals moving about near the stream.

The type locality of this species is the border of the Red Sea, but it has not yet been shown that the Ariel of the eastern Sudan is different, although two other races are described from more southern areas.

Cervicapra bohor (Rüppell).

Bohor Reedbuck.

Redunca bohor Rüppell, Mus. Senckenbergianum, 1845, **3**, p. 182.

The Reedbuck is no longer common on the Blue Nile, and we met with it at but two places, El Mesharat and Bados. It is a most unsuspicious animal and no doubt one that will soon be much reduced in numbers. It has a way of standing broadside to the intruder, the hind feet one in advance of the other, and with graceful head turned, it sniffs the air and watches until certain that there is cause for alarm, when it bounds away with tremendous leaps. On the Dinder it was very common above El Kuka, and on the great open 'meres' and along the grassy jungles by the stream bed they were found feeding throughout the day. They seemed to have been undisturbed here for a long period, and in contrast to their behavior on the Blue Nile, where they had learned to keep under cover during most of the daylight hours, they were extraordinarily tame. Unless the wind brought the taint of human scent, they were almost without fear, but stood gazing within a few yards. On the Dinder they were commonly in small groups, often an old buck with three or four does and once a younger buck On becoming alarmed the does would retreat at once leaving the old buck standing at gaze. We once came suddenly upon a youngish animal that evidently had not seen us until it suddenly looked up from feeding a few yards to one side of the trail. At once it dropped flat upon the ground with head stretched out. We watched it a few moments, and as soon as we passed on it lifted its head to gaze after us, but remained crouching among the few stalks of tall grass that afforded not the slightest cover.

Near Um Orug I watched a Reedbuck as it came to water, shortly after noon, with several Ariel. It drank much longer than they, stopping now and then to look about, but apparently quite unconcerned for the crocodiles, several of which lay a short distance off in the water. On one of the large open 'meres' we found Reedbuck active and apparently grazing by moonlight late in the evening. They were always the last of the antelope to take fright and run off when the caravan came out upon the 'mere' where they were feeding. We saw two large bucks, each with the tip of a horn broken off.

It is possible that our specimens may be referable to the race *cottoni* but material is not at hand to settle this point.

Johnson (1903) records killing a very large one on the Dinder at Durraba in 1901, but we saw none so far down that river.

Cobus defassa (Rüppell).

Abyssinian Waterbuck.

Antilope defassa Rüppell, Neue wirbelth. fauna Abyssinien. Säugeth., 1835, p. 9, pl. 3.

On the Blue Nile the Waterbuck is greatly reduced in numbers and no doubt will be practically gone in the course of a few years. We saw almost nothing of it on this river, though Dr. Phillips found a few near Adreiba above Roseires, and we were shown a fair head killed near the latter place by Mr. Savage, then acting chief of the district. Cotton, however, in 1911, found Waterbuck at Bados, but if any are to be found below this region, they must be rare indeed.

Quite different is it on the upper part of the Dinder. On reaching the stretches where the great open 'meres' begin, shortly below Um Orug, we found them really common. Cotton (1912) found them common on the Galegu, but saw only a few on the Dinder, below the junction of these two streams. He adds that they are not found on the Rahad, but are common on the Setit. We first found them a short distance above the Galegu, at Beit el Walsh, where a few were feeding on a large 'mere,' and beyond this point we saw small numbers, usually feeding in similar places. At Um Orug they were plentiful and remarkably unsuspicious. Dr. Phillips at one spot came upon a Waterbuck that allowed him to walk entirely around it at a short distance. Another that he obtained must have recently escaped from a lion as its back was deeply scratched and its belly so injured that the intestines protruded through the open wound. Shortly above the Galegu junction we saw a lion stalking an old Waterbuck in the open sandy bed of the river at about midday. On one large 'mere' at Um Orug, Dr. Phillips saw ninety-seven Waterbuck at one time, quietly feeding, and later that evening we found others there, grazing by the half moonlight. This with the Reedbuck was usually the last of the antelopes to take fright when several species were feeding together. During the heat of the day they are apt to rest under the shelter of the thorn trees, and it is common to see them in small parties consisting of a buck and two or three does.

Ourebia montana (Cretzschmar).

Abyssinian Oribi.

Antilope montana Cretzschmar, Rüppell's Atlas reise nördlichen Afrika. Säugeth., 1826, p. 11, pl. 3.

In his original description of this species, Cretzschmar gives its known range as Bahr-el-Abiad and the mountains about Fazogli (spelled "Fazuglo"). The latter are merely hills, however, so that the name "*montana*" is somewhat misleading. This is the common antelope along the Blue Nile and is called by the Arabs "ghazal." In many of its habits it corresponds to our Virginia Deer. It inhabits the edge of the tall grass jungle along the river bank, or the bushy tangles in which it finds a safe retreat. We also met with it on the slopes of the 'gebels' or hills. It is watchful and resourceful, yet hardly to be considered shy, so that it seems well adapted to survive in the presence of civilization, and will doubtless continue in the land long after the other species of antelopes have been exterminated. The country between Sennar and Singa is so travelled and cultivated that we saw none on that part of the road, but beyond the latter town we saw them almost daily. In the early morning they are about before sunrise feeding, but usually are less in evidence after six or seven o'clock, especially in the neighborhood of villages, for they retreat to cover and come out again towards evening. Yet we often saw them even at midday, standing in the tall grass, gazing attentively at us as we passed. Often they would stand thus watching till we were out of sight, but if alarmed by a suspicious movement or a too close approach they scurried off at once into the thick cover. Along the Blue Nile we saw them frequently in pairs, and singles, and a good number were accompanied by little fawns in January. Their curiosity is considerable and almost always causes them to stop, after the first dash, and stand broadside on watching intently the object of their suspicion, and thus affording the hunter an easy shot. Away from the river there were but few Oribi, and in crossing to the Dinder we saw but a single one not far from a small and partly dried waterhole. Along the Dinder, Oribi were abundant and we often saw small troops of four or five. Here they were little disturbed and surprisingly tame, allowing us often to approach within a very short distance. They frequented the edges of the open 'meres' with the other antelope, throughout the day. Their cry of alarm is a sharp whistled "phēē-u," not so hoarse, it seemed to me, as the somewhat similar whistle of the Reedbuck.

It is often difficult to distinguish Oribi from small or hornless Reedbucks, especially as the two occur together along the edges of the grass jungles, but there are several very characteristic traits that serve to identify the two. In running away the Reedbuck holds its tail tightly down between its legs, whereas the Oribi holds its tail stiffly erect, exposing the blackish skin about the anus. Its gait is also stiffer, with a sort of bobbing up and down of the hind quarters as it scurries along, whereas the Reedbuck has a much freer gait, and often takes beautiful deer-like bounds, fore feet out in front, hind feet straight out behind, as it clears some obstructing bush.

In reporting on the mammals obtained by Lord Lovat's expedition from southern Abyssinia to the Blue Nile, de Winton (1900, p. 84) states that specimens of the Beira Antelope (Dorcotragus) were brought back. According to Lord Lovat "the Beira Antelope is common all down the Blue Nile to Roseires; it inhabits the slopes leading down to the river-bed, and is also seen on the barer hill-tops." The presence of this hill-loving species in the Blue Nile Valley west of the Abyssinian hills would certainly be extraordinary, and I cannot but think that on reaching this low flat country Lord Lovat mistook the Oribi or the Duiker for the Beira which he had found in the higher land through which he had just passed. At all events we found no sign of it between Roseires and Fazogli during our trip.

Cephalophus abyssinicus Thomas.

Abyssinian Duiker.

Cephalophus abyssinicus Thomas, Proc. Zool. soc. London, 1892, p. 427.

Specimens from the eastern Sudan are currently referred to this species. We met with it in the Blue Nile Valley only, and in but few places. Cotton (1912) records seeing one at Bados and it is likely that this is about as far north as it occurs on the Blue Nile. Above this point we saw a few at Magangani, and near Gebel Maba, and some numbers near Fazogli. This is a very sedentary animal, and we repeatedly found what were presumably the same individuals near the same thickets day after day. At Magangani we saw a few along the edge of a great sea of elephant grass between the river and some undulating ridges, but at Fazogli they frequented a considerable area of alternating ridges and small gullies, which with their thickets and clumps of grass or small palms were admirable hiding places. Dr. Phillips spent much time here observing them, and found them most crafty and watchful. They were usually seen in the early part of the day singly or in pairs, and had a way of hiding in clumps of vegetation to watch the intruder or slinking adroitly off under cover of an intervening bush if followed. Those living near this native village were no doubt much hunted and had become extremely adept at keeping out of sight.

Damaliscus tiang (Heuglin).

Tiang Hartebeest.

Damalis tiang Heuglin, Nova acta Acad. Leop. Carol., 1863, **30**, art. 2, p. 22, pl. 1, fig. 1a, b.

According to Cotton (1912, p. 55) this handsome antelope is not now to be found on the Setit, Atbara, or Rahad Rivers, although it is plentiful on the Galegu. We found them rare on the Blue Nile, and saw them only in a few places, near Bados and Magangani, below Roseires. They are more or less hunted here by passing sportsmen and have become shy and watchful. They usually go in small herds of ten or less and come to water at a few places removed from the villages. After drinking they at once leave the river and are some miles back in the thorn bush by daylight. On the upper Dinder, where they seemed to have been unmolested for some time, their behavior was quite different. On our way up this river we first came upon them near a loop of the stream called Ereif el Dik (the cock's comb, in allusion to the sinuous course of the stream), where a small herd was started at noon from under some 'laloab' trees, whose date-shaped fruit they had been nibbling on the ground. But it was not until the region of the big open meadows or 'meres' was reached, at Beit el Wahsh and Abiad that they were found in numbers, while from this point to Um Orug they were very common. On one such 'mere' we estimated that nearly a thousand were in sight, feeding quietly in the open most of the day, while it was not uncommon to count seventy-five or one hundred on smaller 'meres.' Contrary to their habits along the Blue Nile, they seemed to be here under no restraint, and largely avoided the dry thorn bush, but fed on the grassy 'meres' most of the day. They were nevertheless watchful and were usually the first after the Ariel to take alarm, and to run off in a somewhat panicky way. Two female specimens collected here in mid-February contained each a large foetus.

Bubalis tora rahatensis Matschie.

Eastern Sudan Hartebeest.

Bubalis tora rahatensis Matschie, Sitzb. Ges. naturf. freunde, Berlin, 1906, p. 246.

The type of this race came from Shunfar, a tributary of the Rahad, and its describer mentions a second specimen from about thirty miles southwest of Lake Tana, adding that it apparently is found on the entire middle Blue Nile, the Rahad and the Dinder. We were unable to discover any sign of the species on the Blue Nile, however, and if it now occurs along that stream, west of the Abyssinian boundary, it must be extremely rare. On the upper Dinder, there are a few, but they are scarce indeed in comparison with the Tiang. From Abiad to

Um Orug we saw in all a fair number, usually in pairs, with other antelope on the great 'meres.' One herd of fifteen was deemed unusual. I came upon a fine lone bull drinking at a pool of the river an hour before noon. It seemed much astonished, but was not thoroughly alarmed until it got my scent, when with a loud explosive "oof" it bounded away.

GIRAFFA CAMELOPARDALIS (Linné).

Nubian Giraffe.

Cervus camelopardalis Linné, Syst. nat., ed. 10, 1758, **1**, p. 66.

Thanks to governmental protection, Giraffe are still present in small numbers in parts of the Blue Nile Valley and on the upper Dinder. Mr. A. L. Butler of the Game Preservation Department said that they had very noticeably increased of late years. We saw none during our sojourn along the Blue Nile, but discovered old tracks in numbers some miles back from that stream; these were made during the rains when the ground was soft and were still (in January) deeply impressed in the sun-baked soil. The first locality where these tracks were seen was among the gum arabic trees about Gebel Okalma, near El Mesharat. A few other tracks were found, some fairly recent, in crossing from the Blue Nile to the Dinder between Abu Tiga and Wad Shara Shara. On the upper Dinder we saw several small herds of Giraffe, usually on or near the open 'meres' or boggy areas overgrown with rank grass. A fine herd of ten was seen near Abiad, and later three others. Shortly below Um Orug we saw a herd of twenty-one and later another of twenty-five and after dark came upon a small herd that took headlong flight through the tall grass. Their chief enemy is the lion, and we several times came upon dead Giraffes that had evidently been killed by them. These were usually youngish animals with the epiphyses of the bones still separate. The lions do not eat the tough hide of the Giraffes but leave this carefully separated from the carcase, and even the vultures merely pick it clean. On a 'mere' near Abiad we found a Giraffe that seemed to have died from natural causes — an old and scabby-looking animal with no external wound apparently. The gathering vultures had only just commenced upon it.

A few young Giraffes are caught alive yearly in this region by the natives, with government permission, to be sent to Cairo or elsewhere for zoölogical gardens. The natural gait of the Giraffe when walking, is (like that of the camel) a pace — the two legs of one side acting together, but when frightened the herds go off in single file at a stiff gallop, their long necks held forward at an angle and undulating with a sinuous movement.

Hippopotamus amphibius Linné.

Hippopotamus.

Hippopotamus amphibius Linné, Syst. nat., ed. 10, 1758, **1**, p. 74.

This fine mammal is doomed to extinction in the Nile ere many years. Not only does he present an easy mark for hunters as he rests on a sandbar but on account of his occasional attacks upon small boats and the damage done to native crops, protection is not now accorded him and his destruction is even encouraged. F. L. James, writing in 1884, of "The wild tribes of the Sudan," says that at that time hippos were no longer plentiful north of Khartoum. At Berber there were still a few but they were hunted by the natives who watched for them nightly as they came from the river to feed on the growing crops. At the present time hippos are practically gone from the river above Khartoum, though Captain S. S. Flower told us that about 1908 the tracks of one were seen that had walked across the point at the junction of the White and the Blue Niles close to that city. This was most unusual even then, however, for in 1901 I. C. Johnson (1903) recorded that during a voyage up the Blue Nile from Khartoum, the first hippo seen was near the mouth of the Dinder some forty miles below Wad Medani. He supposed this to be about its northern limit at that time. We saw no hippos on the Blue Nile until well above Singa, at El Mesharat, where there were several basking on the mud flats in the middle of the stream. They have become very shy from constant persecution by sportsmen and others passing up and down to Roseires and no doubt will soon be nearly gone from this part of the stream. We several times found their well-worn paths up nearly precipitous banks into the grassy jungles along the river and frequently heard their loud guttural honking at night. At Bados one was caught by the natives in nooses set in its path. These were attached to large wooden floats, which discovered the animal's whereabouts to his captors the following morning after it had retired to the stream. Four spearmen in a large wooden boat went leisurely forth to attack their captive, a rather small specimen, but full of fight. Previous to the attack we watched the animal for some time and found that it came very regularly to the surface for air at intervals of 3.5 minutes. The fight was short but furious, the men jabbing with their spears each time the enraged beast rose to attack the broadside of the boat. When at last it rose no more, the watchers on the bank shouted exultingly and one twanged a small harp in praise of the hunters. No hippos were seen at Roseires, the head of navigation for large boats, but we observed a few above that town near Adreiba. On the Dinder there are very few, at least on the upper portion. This is partly on account of the intermittent nature of the stream, though in the larger pools an occasional one is found. At Um Orug a few skulls of young animals were seen, from which the front teeth had been removed. W. B. Cotton (1912, p. 43) says there are still a few in the Atbara and Setit Rivers, but none at all in the Rahad.

Phacochoerus africanus bufo Heller.

Nile Warthog.

Phacochoerus africanus bufo Heller, Smithsonian misc. coll., 1914, **61**, no. 22, p. 2.

Small numbers of Warthogs are still to be found along the Blue Nile and on the upper Dinder. Dr. Phillips shot one at El Mesharat and we met with a few others along the river to Roseires. On the upper Dinder we saw not a few, once a party of three large ones with four young. As noted by Cotton (1912) there seem to be few if any with large tusks in this region.

Two skulls preserved agree with Heller's description of the Nile Valley Warthog, and, as he points out, differ from the East African race in the prolongation of the parietal portion and the nearly flat interorbital region.

Diceros bicornis (Linné).

Black Rhinoceros.

Rhinoceros bicornis Linné, Syst. nat., ed. 10, 1758, **1**, p. 56.

The Rhinoceros is nearly extinct in the eastern Sudan. In the days of Sir Samuel Baker they were plentiful on the upper Atbara and the Setit, but now apparently there are extremely few between the Nile and the Abyssinian border. It is worth recording therefore, that at the present time they are quite gone from the Blue Nile, but a very few yet remain on the uppermost reaches of the Dinder River, about a day's march beyond Um Orug Island, as our native hunters told us. According to our Arab guide who had hunted this region, one was killed in 1911 on the 'mere' near El Abiad by a white hunter, who mistook it at night for a Buffalo. Beyond Um Orug, at a place called Hageirat, south towards the Abyssinian border a few are still to be found. The Rhinoceros is protected under the present game laws of the Sudan, but the few that survive are more or less in danger from poaching Abyssinians. Capt. Stanley S. Flower told us at Cairo that so far as he could learn there were probably not more than ten or a dozen rhinos left on the upper Dinder, and that these are probably not breeding for the natives report no tracks of young ones.

Lydekker (Proc. Zool. soc. London, 1911, p. 958) recognizes the Black Rhino of Somaliland as distinct under the name *somaliensis*, but in the absence of specimens I cannot attempt to settle the identity of the Sudanese animals.

Elephas africanus oxyotis Matschie.

Sudanese Elephant.

Elephas africanus oxyotis Matschie, Sitzb. Ges. naturf. freunde Berlin, 1900, p. 196.

In reviewing the African elephants, Lydekker (1907, p. 398) considers that the form inhabiting the Blue Nile Valley and western Abyssinia may stand as a valid race. It is characterized by Matschie as having a very long and pointed lobe at the base of the ear. The upper border of the ear is much rounded but the value of this character is still under discussion. The tusks are rather small in this race, nardly above 60 lbs.

Elephants were formerly common over the eastern Sudan, and have been much hunted for their ivory. Sir Samuel Baker's accounts of their pursuit and capture by the Arab hunters, mounted on agile ponies and armed only with a keen-edged sword, are familiar to readers of African travel. At the present time Elephants are practically gone from the travelled region along the northeastern bank of the Blue Nile. I. C. Johnson, in 1901, hunted Elephant near the little village of Omdurman above Karkoj, and although a small herd of five was discovered, the animals were traveling and struck off toward the

Dinder. The southeasterly bank of the Blue Nile is a semireservation, where government officials only are allowed to hunt, and there is much less travel and native settlement. The same writer mentions that Elephants occasionally come to drink on this south bank at Zumurka, nearly opposite from Karkoj, and opposite Abu Tiga and Om Bared, farther up. The only place where we learned of their presence was opposite Magangani, a few miles below Roseires. Here we heard them trumpeting and blowing water about one evening in January, but were unable to see the animals. They still frequent the Dinder River. In 1901, I. C. Johnson found them at Durraba and shot one near there. On our journey up this river we first found their tracks and droppings on the dry river bed above that place at a camp site, Mesharat el Kuka. The spoor was old, however. From this point on up the river to Um Orug, our farthest camp, there was abundance of old sign, and many broken trees twisted off by the huge beasts. A poaching party of Abyssinians had killed an Elephant here two or three months before and the herd had evidently left the region; possibly they had crossed over to the Rahad, or as some of the native hunters supposed, they may have retired to a *khor* or dry water course to the south. The red-barked Acacia, whence the gum arabic is obtained, is the favorite food tree of the Elephants in this region. We constantly came upon large trees of this species, often eight inches in diameter at two or three feet from the ground and twenty-five or thirty feet high, that had been broken down and the topmost twigs eaten. They are broken in a rather characteristic manner, at about two or three feet from the ground, and the trunk partly twisted off. Others are broken over and uprooted, and the topmost twigs chewed.

Procavia butleri Wroughton.

Butler's Hyrax.

Procavia butleri Wroughton, Ann. mag. nat. hist., 1911, ser. 8, **8**, p. 461.

The type of this species was obtained by Mr. A. L. Butler at Gebel Fazogli, one of the foothills of the Abyssinian highlands on the south side of the Blue Nile. Mr. Wroughton, in describing it, records a second specimen from Gebel Ain on the White Nile. During our stay at Fazogli we obtained three specimens and saw a few others. They live in dens among huge boulders and though somewhat shy, have a curious way of appearing suddenly at the openings of their retreats, or frequently coming boldly out several feet from the entrance, where perched on a boulder they look about or give a characteristic sharp bark of two syllables at short intervals for some minutes at a time. Apparently they are much preyed upon by leopards and no doubt by other smaller Carnivora or predacious birds. Their habit of throwing aside all caution and bounding a few paces from their holes of a sudden is thus rather the more remarkable. At times, however, they show more concern for their safety, and if alarmed, will sit motionless at the opening of the den for many minutes at a time. Again they may be seen to run a long distance from rock to rock, and then dive into a crevice. When convinced that no danger is near they delight to bask in the sun during the early forenoon, but commonly retire at about 9:30 or 10 o'clock in the morning. On one occasion, however, I saw three running rapidly among the loose boulders at 1 p. m. On the rocks where they are accustomed to bask and particularly at the entrance to their dens, are usually to be seen large accumulations of their droppings. In addition to those from Gebel Fazogli, I found a considerable colony on a large isolated rock peak, Gebel Okalma. This is in appearance an old volcanic neck, projecting steeply and abruptly from the plain, several days' march from the nearest of the Abyssinian foothills from which it is separated by many miles of low country that would be utterly impassable for a Hyrax. The presence of these isolated colonies must therefore indicate that they have been long in the land, probably before the deposition of the *loess* that now covers the country. I could, nevertheless, detect no single character by which the Okalma specimens differed from those of Fazogli. No trace of these animals was to be found on a neighboring hill (Gebel Maba), which, however, was much less rocky, and afforded no suitable boulder heaps.

Arvicanthis testicularis (Sundevall).

Field Rat.

Isomys testicularis Sundevall, Kongl. Svenska vet.-acad. Handl., for 1842, 1843, p. 221.

This is the common Field Rat of the Blue Nile valley in the Sudan, and occurs generally throughout the country traversed from Sennar to Fazogli. Its favorite haunts are grassy fields, the borders of cultivated grounds, or the open scrub of bushes, weeds, and small palms. It is practically a diurnal species, and was several times seen running about in the hotter parts of the day. The specimens trapped were all taken in early morning or before evening. Hawks catch many of them.

Sundevall's description was drawn from specimens collected on the White Nile by Hedenborg, and appears to apply well to the series from Sennar. The body measurements of adults are larger than he gives, however, for the average of three adults is: — head and body 163 mm., tail 149, foot 35, ear 19. Apparently *A. abyssinicus* does not occur west of the Abyssinian border. At all events, persistent trapping failed to discover it; nor did Lord Lovat's expedition across Abyssinia find it farther west than Sellen and Goodur in the high country at the head of the Blue Nile.

ACOMYS CINERACEUS Heuglin and Fitzinger.

Gray-footed Spiny Mouse.

Acomys cineraceus Heugl. and Fitzinger, Sitzb. Kön. akad. wiss. Wien, math.-nat. cl., 1867, **54**, pt. 1, p. 573.

Two species of spiny mice were collected by the expedition. The one is a broad-footed, shorter-tailed animal, inhabiting all the low flat country of the Blue Nile Valley; the other is a slender-footed, longer-tailed species which we found only at Fazogli in the rocky hills which begin here at the Abyssinian border. The former I have referred to Heuglin's *A. cineraceus;* Heuglin's type locality is Doka, in eastern Sennar, between the Atbara and the Rahad Rivers. The original description is brief and refers to a figure previously published by Heuglin. In his "Reise" (1877), however, he gives a more detailed account, with measurements, which agree in all essentials with those of an immature specimen taken at Adreiba, a day's march above Roseires on the Blue Nile. We were fortunate in obtaining a second adult specimen, much farther down the river at El Mesharat. Apparently it is a widely distributed species but was difficult to obtain in the dry and barren plains over which we journeyed. There can be no doubt that Heuglin's type was an immature animal, having the entire dorsal area a smoky gray, paling slightly at the sides. The feet he states are marked with the same color on their outer portion. The measurements given are:—head and body 3″ 3‴ (= 82.5 mm.), tail 2″ 6‴ (= 69 mm.), ear 6‴ (= 12.6 mm.). Our immature specimen measures:— head and body 78 mm., tail 67. The ratio of tail to head and body is 83% in Heuglin's specimen, 85% in our immature individual. In the adult the tail is relatively shorter — 73%; and the measurements of the fresh specimen were:—head and body 112, tail 82, hind foot 18, ear 15. The entire dorsal region from nose to base of tail is smoke gray, becoming pale clay-color on the cheeks and sides of the body. The forearms and outer sides of the metacarpal and bases of the metatarsal areas are gray like the back, and the tail is similar above. The ventral surfaces, a spot below the eye, and at the base of the ear are white. Capt. Stanley S. Flower, of the Gizeh Zoölogical Gardens, generously presented an adult Acomys in alcohol taken June 19, 1912, at Eneikliba in Sennar Province, which is unquestionably the same animal. The short, broad hind feet and the relatively short tail (85 mm.) are equally characteristic.

In the Novitates zoologicae, (1901, **8**, p. 400) de Winton describes as new, *Acomys witherbyi*, type from Kawa, south of Khartoum. He compares it with *A. nubicus* of Heuglin, from Middle Egypt, and mentions specimens from Shendi and Gebel Auli in the Nile Valley. It seems very close to *cineraceus*, with which it appears to agree in all essential characters, so far as the description goes. Possibly the two are identical, and *cineraceus* should apply to the Acomys of the level country of this part of the Nile Valley.

Acomys hunteri deWinton.

Hunter's Spiny Mouse.

Acomys hunteri de Winton, Novitates zoologicae, 1901, **8**, p. 401, footnote.

Among the rock crevices of Gebel Fazogli, at the Abyssinian border, there occurred a second species of Acomys, which from descriptions alone, I am unable to differentiate from *hunteri*, the type of which came from the plains of Tokar, near Suakin, on the Red Sea. This is described as red fawn above, white beneath, which is practically as in an adult from Fazogli, except for the darker spines of the head and back. A younger individual is grayer dorsally, the sides pale ochraceous. The measurements given are:— head and body 105, tail 102, foot 17.5, ear 16. Our two specimens measure:— head and body 104, 101, tail 98, 96, foot 18, 19, ear 16, 16. It will be observed that the tail is about 94 or 95 (in the type 97) per cent of the length of head and body, hence much longer than in *cineraceus*. It differs strikingly also in its slenderer feet, which are pure white instead of darker.

The white spot at the base of the ear is not conspicuous. Compared with *A. kempi* from British East Africa, these specimens are only a trifle paler, and externally hardly to be distinguished. One specimen was taken in a trap placed on a leaning stump some three feet from the ground.

Mus (Leggada) tenella (Thomas).

Blue Nile Harvest Mouse.

Leggada tenella Thomas, Proc. Zool. soc. London, 1903, **1**, p. 298.

Three specimens were preserved from Magangani and El Garef, both within a few miles of Roseires, the type locality. Two of the specimens are immature and much darker over the back than the other which is an adult. The type is said to have the fore legs entirely white, but in these two youngish specimens they are buffy like the sides of the body, and very pale buffy in the adult. The white spot at the outer base of the ear is very marked, whereas in the dark *L. bella* of British East Africa this spot is practically wanting.

Several other specimens were trapped along the Blue Nile at El Garef, Magangani, Bados, among the thorn bushes and tall grass canes, but they were nowhere common. The adult female measured:— total length 116 mm., tail 54, hind foot 13, ear from meatus 10.

Epimys macrolepis (Sundevall).

Large-scaled Rat.

Mus macrolepis Sundevall, Kongl. Svenska vet.-acad. Handl., for 1842, 1843, p. 218.

The identity of Sundevall's *Mus macrolepis* is still a matter of some doubt, as indicated by Wroughton (1911, p. 460), and its author was himself uncertain whether or not it was the same as Rüppell's *Mus albipes*. The type locality of the former is Roseires, and there can be no doubt whatever, from Sundevall's careful description, that his *macrolepis* is the common ground rat which we found all along our journey from Sennar to Fazogli on the Blue Nile, and wherever we trapped on the Dinder River. The name is based on the fact that the caudal scales seemed large, five to 5 mm., but in our dried specimens there are six to 5 mm. No doubt Sundevall made the measurement from alcoholics. Until it can be shown, therefore, that *Mus* *albipes* is identical with the Blue Nile rat, Sundevall's name may stand for it.

At El Garef we found a large colony of this rat among an open scrub growth of small dhoum palms, weeds, and bushes. They make well-worn runways from one clump of palms to another, or among the weed tangles, and live in holes dug in the ground in these shelters. They are apparently for the most part nocturnal.

The measurements of an adult male of *E. macrolepis* from Gabardi, beyond Singa, are:— head and body 142, tail 149, hind foot 24, ear 19. This is a very brightly colored specimen, with a buffy suffusion over the entire upper surface, and with a buffy line in the middle of the belly. The pure buffy tips of the hairs of the sides make a distinct stripe in this species, from the nose to the ankle, bounding the white of the belly.

Of *Epimys azrek*, a species of the multimammate group, the type of which also came from Roseires, we could find nothing. It may be at once distinguished by its smaller dimensions and by its pure white belly hairs, which latter in *macrolepis* are dark gray at their bases.

Tatera robusta (Cretzschmar).

Nile Valley Tufted-tailed Gerbille.

Meriones robustus Cretzschmar, Rüppell's Atlas reise nordlichen Afrika. Säugeth., 1826, p. 75, pl. 29, fig. b.

Wroughton (1906, p. 494) in his review of the members of this genus shows that Sundevall's *Meriones murinus* is probably the same as the *M. robustus* of Cretzschmar, the type of which is still in existence and is labeled "Ambukol, Nubien." The latter name Wroughton applies to the tufted-tailed gerbilles of the Nile Valley, and includes among his list of specimens in the British Museum, a single example from the Blue Nile, at Roseires, collected by Lord Lovat's expedition. We found this the common species all along the Blue Nile. It lives in tangled growth of grass, bushes, and small palms, the shelter of which it commonly shares with the native rat (*Epimys macrolepis*).

Tatera flavipes, sp. nov.

Buff-footed Gerbille.

Type.— Skin and skull 14,491 M. C. Z., adult female, from Aradeiba, above Roseires, Blue Nile, Sudan. January 22, 1913.

General Characters.— Size large; tail as long as head and body, not tufted. Dark hairs prevailing dorsally; backs of hands and feet buff. Upper incisors grooved; pterygoids slightly expanded proximally, their bases extending forward anterior to the posterior median edge of the palate.

Description.— Top of head from nose to crown, nape, back, and dorsal surface of the tail a mixture of black and ochraceous buff, the former predominating. The individual hairs are slaty for the basal two thirds, then either black-tipped or with a subapical ring of ochraceous buff and a black tip; on the sides of the muzzle, cheeks, sides of body, forearms, and hind legs the black-tipped hairs become largely suppressed giving a nearly clear ochraceous buff (Ridgway, 1886) tone to these parts. Metacarpal and metatarsal areas clear buff, toes white. The ears are clothed with minute blackish hairs externally, and sparsely covered internally with short pale buff hairs. The entire ventral surface of the head and body (including the upper lips) and the limbs are covered with hairs white to their bases. The tail is sharply marked off by its ochraceous buff color on its basal half below; the rest of the under surface is darkened with short black hairs which predominate towards the tip. The terminal hairs are slightly the longest but do not form a tuft.

Skull.— The skull is that of a mature animal but the teeth are only slightly worn. In this condition the middle lamina of the first upper molar shows a slight central contraction marking off an inner and an outer portion. The upper incisors show a well-marked groove nearer the outer side, thus differing from the *liodon* group which this species equals in size. Anterior palatal foramina 3 mm. long, reaching from the level of the center of the first molar to the back of the second. Posterior palatal foramina reduced to two minute perforations just posterior to the level of the last molars. The conformation of the pterygoids is different from that of other species to which I have had access. Their bases are slightly divergent, and included within a notch in the palatal bones between the median projecting point and the posterolateral extensions, which are rather

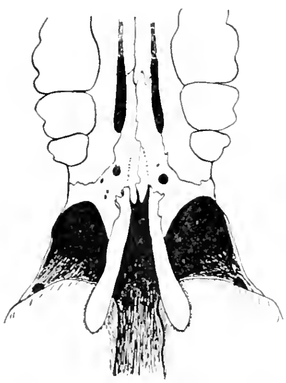

Fig. 2.— *Tatera flavipes*, palatal region. × 3.

broader than in *T. robusta*. Distally the club-shaped end of the pterygoid is strongly in contact with the large audital bulla.

Measurements.— The type measured in the flesh:— head and body 171 mm., tail 172, hind foot 40.5, ear from meatus 23. Skull:— occipitonasal length 44, basal length 37.6, palatal length 24.4, nasals 17, zygomatic breadth 22.5, incisive foramina 8, audital bulla 12.3 × 7.2; upper molar series (alveoli) 8, lower molar series (alveoli) 8, upper diastema 12.5.

Remarks.— This large species seemed rare as we obtained but the single specimen. It was trapped in grass and bushes on the edge of a native grain field. In Wroughton's key to this genus (1906), it would come under the second Section, "A. Tail not appreciably longer than head and body." It seems to show no very close relation to either *liodon* or *valida*, the two largest species of this section. Its large size, untufted tail equalling head and body, grooved upper incisors, dark dorsal area, buffy feet, and peculiar shape of the pterygoids are characteristic.

At Fazogli, on the south side of the Blue Nile we obtained a second species of Tatera with untufted tail, which likewise seems undescribed. It may be known as

Tatera soror, sp. nov.

Lesser Blue Nile Gerbille.

Type.— Skin and skull 14,492 M. C. Z., adult female, from Fazogli, Blue Nile, Sudan. January 16, 1913.

General Characters.— A smaller species, similar in general coloration to *T. flavipes* above described, but brighter ochraceous, feet white, tail longer than head and body, pterygoids narrowed basally, reaching the level of the hinder edge of the palate.

Description.— Top of head, nape, and median dorsal region the usual mixture of black and pale ochraceous buff, becoming clearer ochraceous buff on the sides where there is but slight admixture of black hairs. Compared with *flavipes* the ochraceous tint is brighter, but not so bright as in *mombasae* in which the head and nape are nearly clear, instead of being largely mixed with black. Fore and hind feet covered with short white hair. Area between the eye and ear paler, lower border of eye black. Ventral surface of head and body pure white to the roots of the hairs. Upper surface of tail thinly clothed with coarse, short, black hairs, not appreciably longer at the tip;

lower surface covered with short ochraceous buff hairs slightly paler on the distal half, and without admixture of black. Ears externally covered with black hairs, and minutely bordered with whitish.

Tail slightly longer than head and body, about 112%; hind foot shorter and stouter than in *T. mombasae.*

Skull.— The skull is that of a fully adult animal with teeth considerably worn. The anterior palatal vacuities do not extend quite to the level of the posterior edge of the second molar, and the posterior are present as rounded foramina larger than in *T. robusta,* beyond which the lateral extension of the palatal is very much more reduced. The pterygoids do not extend beyond the posterior median edge of the palate and are not expanded proximally. The nasal portion is relatively shorter than in *T. robusta.*

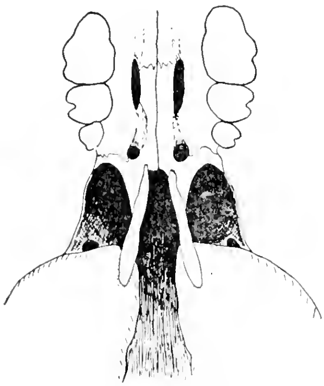

Fig. 3.— *Tatera soror,* palatal region. × 3.

Measurements.— The type measured in the flesh: — head and body 141 mm., tail 158, hind foot 34, ear from meatus 20. Skull: — occipitonasal length 38.5, basal length 32.5, palatal length 20, nasals 15.4, zygomatic breadth 20.4, incisive foramina 6.6, audital bulla 10 × 6.5, upper molar series (alveoli) 7, lower molar series (alveoli) 6.3, upper diastema 10.1.

Remarks.— This small Tatera of the Blue Nile does not seem to resemble any of its geographically near allies. From the Abyssinian *T. shoana* it differs in its untufted tail, smaller size, and proportions. Compared with *T. mombasae* it is distinguishable at a glance by its shorter hind foot, less clear ochraceous coloring, and its tail which is proportionately shorter, coarser-haired, and differently colored.

The type was brought in by the natives at Fazogli near the Abyssinian border, and was said to have been caught in the tall grass of the alluvial plains. With it were its four young, about one third grown, which differ in color from the adult in being much darker above owing to the predominance of long black hairs; the sides are only slightly tinged with pale ochraceous buff, and the tail below is clear white to the tip, not ochraceous buff as in the adult. The discovery of these two additional species is of the greatest interest, as hitherto *Tatera* *robusta*, a tufted-tailed species, was the only member of the genus known from this part of the Nile Valley.

GRAPHIURUS OROBINUS (Wagner).

Pigmy Dormouse.

Myoxus orobinus Wagner, Abh. Kön. Baier. akad. wiss., 1843, p. 149.

There is much doubt as to the identity of Wagner's *M. orobinus*, the type locality of which is Sennar. The original description is too brief to be of much avail, nor does Reuvens in his review of 1890, shed further light on the subject. The length of the body (=head and body) is given as 4″2‴ or about 107 mm. We obtained five dormice on the Blue Nile, at El Garef and Magangani in traps set at the foot of thorn trees in scattered groves with vines and undergrowth. As no other species was met with, it may be that these represent *orobinus* though the largest is smaller than Wagner's measurement indicates. They are of the group to which *G. parvus* belongs, but rather pallid,— a brownish gray above, slightly clearer on the shoulders, black eye-ring nearly obsolete, tail pale drab; below whitish, with a tinge of buff. The gray bases of the hairs show through on the abdomen. The tail is not white-fringed. The measurements of two adult females (M. C. Z. 14,483, 14,486) are: — head and body 83, 88; tail 75, 71; hind foot 15, 17; ear from meatus 13.5, 12.5; greatest length of skull 25. It is not unlikely that Wagner's specimen was one of the larger browner group of dormice, and that ours is an undescribed race of the smaller group. Dollman's *Graphiurus butleri* seems to be a larger species; it was described from Jebel Ahmed Agar, on the White Nile below Fashoda.

EUXERUS ERYTHROPUS LEUCOUMBRINUS (Rüppell).

Side-striped Ground Squirrel.

Scuirus leucoumbrinus Rüppell, Neue wirbelth. fauna Abyssinien. Säugeth., 1835, p. 38.

We first saw this Squirrel between Sennar and Singa, and it was subsequently met with all along the Blue Nile to Fazogli where we obtained a young one, not more than a third grown, in late January. Heuglin states that these animals appear in early forenoon and late afternoon foraging on the ground for food, but we found them about during the hottest hours of the day, running from clump to clump of scattered bushes or herbs, often stopping motionless to look about, and frequently making considerable journeys across open ground. Their holes were almost always found to have several openings close together, whether separate burrows or a common burrow was not ascertained. It was noticeable that the Squirrels were confined almost wholly to sandy soil, and were practically absent from the hard and sun-cracked "cotton soil." No doubt the latter is of too sticky a consistency in the wet season and so unsuitable for burrowing. Relatively fewer were seen on the Dinder than on the Blue Nile. In contrast to the ground squirrels of the genus Xerus seen in British East Africa, this species when running away in alarm or otherwise does not erect its tail at right angles to the body, but trails it inertly behind.

Paraxerus sp.

Bush Squirrel.

This is an extremely rare Squirrel in the Blue Nile valley and seems to occur sparingly near the eastern portion along the Abyssinian border. We met with it but twice and unfortunately failed to secure specimens. A pair was seen in a leafy thorn tree a few miles from Fazogli and on Gebel Fazogli a single one feeding among the branches of a white-barked fig tree with thick green leaves, whose small berry-like fruits are eagerly eaten by many species of birds and by the fruit bats.

Felis leo roosevelti Heller.

Abyssinian Lion.

Felis leo roosevelti Heller, Smithsonian misc. coll., 1913, **61**, no, 19, p. 2.

Lions are now rare on the Blue Nile. Indeed, the only place where we learned of them was at Omdurman, a small native village above Karkoj, where Dr. Phillips heard one. It was at this same place that I. C. Johnson in 1901, killed a lion; farther up at Soleil, he shot two others, and found more on the southerly bank of the river opposite Bados. Probably they have somewhat decreased in the twelve years intervening for we did not learn of their presence except at Omdurman. Possibly, also, there are more in this region during the rainy season.

On the upper Dinder River there are still a fair number of Lions, following the herds of antelope. They seem to kill a good many Giraffe as well. Shortly above Khor Galegu we once came out at midday upon the open dry river bed, and discovered an old lioness stalking a fine Waterbuck. She had crept unseen almost within striking distance by taking advantage of the slight inequalities of the sandy ground. One of her full grown cubs was only a short distance away near some sheltering bushes and nearer at hand were three others. The Lions sighted us and made off, leaving the buck unmolested. No doubt Lions are decreasing throughout this district.

Heller, in describing this race, refers to it a Sudanese specimen in the collection of the U. S. National Museum. The salient characters are the great breadth of the skull in combination with the small cheek-teeth.

Felis pardus Linné.

Leopard.

Felis pardus Linné, Syst. nat., ed. 10, 1758, **1**, p. 41.

We obtained no specimen of the Leopard, and are unable to assign the proper subspecific title to those observed. Leopards are not rare in the Blue Nile valley and on the Dinder, and their tracks were occasionally seen in the dusty trails. At Fazogli they were said to be present on the rocky hills, whence they sometimes descended by night to prowl about the native villages. No doubt they feed largely on the Hyraxes that live among the rocks. On the Dinder, Dr. Phillips came upon a company of monkeys scolding a Leopard among some thick bushes, but it bounded away at his approach. From its boldness and cunning as well as its ability to conceal itself in little cover, this will probably be about the last of the big cats to be driven from the country by the spread of settlements.

Felis capensis phillipsi, subsp. nov.

Phillips's Serval.

Type.— Adult male, skin and skeleton, 14,908 M. C. Z., from El Garef, Blue Nile, Sudan. January 10, 1913; Dr. John C. Phillips, collector.

General Characters.— A rather pale, short-tailed form, in which the body stripes are completely reduced to small spots.

Description.— General color of the dorsal surfaces "buff" (of Ridgway, 1886), a shade deeper along the middorsal line. On the forehead, cheeks, and feet are a few small black spots as usual in the servals. The nape is marked by the usual two pairs of black stripes, the outer of which is the broader (about 10 mm.) and runs from the inner base of the ear for about four fifths of the length of the neck beyond which point it breaks into a series of black spots. The inner pair is similar but one half as broad. On the shoulders all the stripes commonly present in the usual *serval* pattern are broken into elongated spots, the largest of which are some 50 mm. long by 10 wide. From the shoulders to the rump the body is uniformly spotted, without any semblance of a stripe posterior to the shoulders. These spots are arranged in more or less definite longitudinal rows, some fifteen in number at the middle region, and average about 10 to 15 mm. in diameter. The ear, as usual, is black on the terminal half with a whitish cross stripe which in the type extends practically across to the inner border. On the fore legs, a black band crosses the dorsal side below the elbow; while on their ventral surface there are two broad black bands. The ventral surface of the body and inside of the legs, chin, and upper throat are white except for the black markings. The lower throat is pale buff. A narrow black band crosses the throat between the angles of the jaws and a second about half the length of the throat. The tail is colored buff with seven black rings, the more basal of which are not quite complete ventrally; the tip is included within the seventh ring.

Measurements.— The measurements of the fresh specimen are:— head and body 792 mm., tail 290, hind foot 185, ear from meatus 90. Weight 21 pounds. The tail seems unusually short in this race, about 36% of the head-and-body length, against 46% in *hindei* and 43% in *kempi* its nearest neighbors geographically. Skull.— Basal length 102 mm., palatal length 46, zygomatic breadth 78.5, interorbital constriction 22, mastoid width 46, upper cheek teeth (front of canine to back of molar) 38, lower cheek teeth (front of canine to back of sectorial) 42, width outside upper molars 45.5.

Remarks.— Wroughton (1910, p. 205) has shown that the name *Felis serval*, based on an Asiatic cat, if not unidentifiable, is at least untenable for an African species. He proposes to ignore the name in a technical sense, and adopts in its stead *Felis capensis* of Forster (1781) based on the *serval* of the Cape of Good Hope. He recognizes as valid races, *F. c. galeopardus* of Senegal and *F. c. togoensis* of Togoland and describes three new forms:—*F. c. hindei*, type locality, Machakos, British East Africa, *F. c. kempi*, type locality, Kirui, Elgon, and *F. c. beirae*, type locality, Beira, Portuguese East Africa. I have been able to make direct comparison with specimens in the Museum representing the races *galeopardus* and *hindei* but from a study of these and of Wroughton's descriptions it is clear that the *serval* of the dry flat country of the Blue Nile Valley is distinct from them all. It appears to be very much paler than *kempi* of the Elgon district and *hindei* of British East Africa, and represents to an extreme degree the reduction of the striped pattern to one entirely of spots on the body. The shortness of the tail and its color-pattern are also noteworthy.

It is a pleasure to associate this fine cat with the name of Dr. John C. Phillips, to whose enthusiasm and generosity the present collection is due. The type specimen was trapped by him in a scattered growth of thorn trees on the outskirts of the native village of El Garef.

Lynx caracal nubica (Fitzinger).

Sudan Caracal.

Caracal nubicus Fitzinger, Sitzb. Kön. akad. wiss. Wien, math.-nat. cl., 1869, **60**, pt. 1, p. 205.

The Caracal is apparently uncommon in the region traversed. There are specimens living in the Zoölogical Gardens at Gizeh, that were caught on the Blue Nile, and we trapped an immature specimen at Magangani a few miles below Roseires. It had come to the bait in the late afternoon within a short distance of our camp.

Mungos albicaudus albescens (Geoffroy).

White-tailed Mongoose.

Herpestes albescens Geoffroy, Rev. et mag. zool., 1839, p. 16.

This was the only Mongoose we met with. Specimens were obtained on the Blue Nile and on the Dinder River. It seemed to be one of the commonest of the smaller Carnivora. Although the smaller species of mongoose are active by day, this species apparently is nocturnal. At a camp a few miles above Roseires, one came to a trap within a few yards of the tent in the early evening, doubtless the same animal that succeeded in stealing the bait from a trap even nearer the preceding evening. At Magangani, on visiting the traps shortly after dawn, one was found already dead having been bitten through the neck by a leopard whose tracks were seen in the path. On another occasion we startled one in the early afternoon, that had been ensconced in the hollow under the roots of a fallen tree, no doubt asleep.

Genetta abyssinica (Rüppell).

Abyssinian Civet-cat.

Viverra abyssinica Rüppell, Neue wirbelth. fauna Abyssinien. Säugeth. 1835, p. 33, pl. 11.

Along the Blue Nile and the Dinder River this seemed to be a common species. Specimens were trapped at Bados and Magangani on the Blue Nile and at the latter spot Dr. Phillips shot one that was clambering up the trunk of a large baobad tree in the full sunlight of noon. At Bados, one was caught in a trap and found next morning partly eaten by a large cat, apparently a Caracal, that bounded off in the dusk when surprised. Curiously, we did not succeed in trapping any in the more northern part of our journey between Sennar and Bados, where perhaps they are less common.

The extraordinary amount of color variation in this group renders the division into races a matter of much uncertainty. Professor Matschie (1902) in his review of the civet-cats, was able to examine some 240 skins in the Berlin Zoölogical Museum, and recognized no less than thirty-three forms, all of which may be considered races of two species, the one with a longer-haired, the other with a shorter-haired tail. In the latter group belong the specimens obtained by the Phillips Expedition. Although the propriety of recognizing so many local races may be questioned and the value of certain of the characters considered distinctive is yet to be shown, the four skins preserved do agree in having the light tail annulations much wider than the dark, and the feet practically of the same light gray on both the superior and the inferior surfaces, marks which Matschie finds distinctive of the civet-cats of the Red Sea coast (*G. schraderi* from Massawa) and the present species, described by Rüppell from between Kordofan and Gondar in Abyssinia. As these specimens are practically topotypes of *abyssinica*, a brief statement of the variation in color is of interest. This is mainly a matter of the relative amounts of black, rusty, and buff in the pattern, and the degree to which the rows of spots coalesce to form stripes. In two specimens, the ground color is uniformly pale buff; the two dorsal rows of spots on each side are much larger in one than in the other and prevailingly rusty in color. The median stripe is likewise more rusty than black. In the other two skins, the ground color is clearer gray, the dorsal rows of spots in one case rusty in the other more black than rusty, and the dorsal stripe black. In all, the two terminal light rings on the tail are incomplete dorsally owing to the median black portion connecting the three last dark rings. The stripes and rows of spots vary even on opposite sides of the body. The spots in the row nearest the midline on each side show a marked tendency to run together into a stripe over the hips. The outer stripe from the nape to the shoulder, in one individual is broken into a series of elongated spots. The pale annulations of the tail in all are white ventrally shading rather abruptly into buff on the dorsal side. At the ankle, posteriorly the dark spot is rather ill defined and restricted. All the three males in the series are more buff than the single female, but the latter is practically identical with one of the males. Both are from Magangani, some ten miles below Roseires on the Blue Nile, whereas the two buffer specimens, with rusty spots and median stripe are from the Dinder River at Kuka and Ereif el Dik respectively.

Hyaena hienomelas Matschie.

Nubian Striped Hyaena.

Hyaena hienomelas Matschie, Sitzb. Ges. naturf. freunde Berlin, 1900, p. 53.

The Striped Hyaena of the Atbara and neighboring region is considered distinct by Matschie in his revision of the species. He calls it *H. hienomelas*, and quotes Latreille (Sonnini's Suites de Buffon, **27**, p. 25) as the authority. Latreille, however, did not give a Latin designation to this species, but refers to a specimen in the Paris Museum as having been called by Lacépède *chien hiênomelas*. He further quotes Bruce's account of its habits in the Sudan. The Latin name must then apparently be credited to Matschie. We trapped a specimen at Magangani and several times heard them about our camps along the Blue Nile. What I took to be their cry is different from that of the Spotted Hyaena, having a more musical quality with a rising then a falling inflection.

ICTONYX ERYTHRAEA de Winton.

Red Sea Striped Weasel.

Ictonyx erythraea (sic) de Winton, Ann. mag. nat. hist., 1898, ser. 7, **1**, p. 248.

The type locality of this species is Suakin on the Red Sea coast, and its describer considers that a specimen from Somaliland represents the same form. A male collected by Mr. A. L. Butler at Roseires on the Blue Nile is also referred to this species by Wroughton (1911, p. 459). Two specimens were taken by our expedition — at Gabardi and El Garef respectively, localities between Singa and Roseires.

ERINACEUS ALBIVENTRIS PRUNERI Wagner.

White-bellied Hedgehog.

Erinaceus pruneri Wagner, Schreber's Säugeth. suppl., 1841, **2**, p. 23.

Although apparently not uncommon, Hedgehogs were hard to obtain. A live one was brought in by the natives at Fazogli who said they occasionally came upon them, or found them hidden in hollow logs or tree trunks. The dried spiny portion of the skin is sometimes found, as if left by some animal that had eaten the rest.

This species belongs to the group for which Pomel in 1848 proposed the generic name Atelerix, type species *pruneri*. Fitzinger in 1867 gave the name Peroëchinus to the same group of small hedgehogs that lack the first hind toe. In the specimen from Fazogli the toes are very short, hardly separate from the pad. The claw of posterior digit 2 is largest, curved, and flattened. The remaining claws of the hind foot are successively smaller, that of the third digit rather flattened, those of the fourth and fifth compressed laterally. The face from nose to between the eyes is thinly covered with short dark brown hairs, and in life the skin is blackish. The hair of the forehead, cheeks, and ventral surfaces is dull white, mixed on the ears, legs, and tail with brown. This coloration separates it from the Senegambian *albiventris* of which it is made a subspecies by Anderson and de Winton in their Mammalia of Egypt. The spines are blackish, with white tips, and a few along the sides are white throughout.

We found nothing of the species *senaarensis* described from Sennar Province. It belongs to the group of larger species with five well-developed claws on the hind foot. According to Anderson and de Winton the locality "Senaar" is very doubtful, and it is probable that the name is a synonym of *E. aethiopicus* of lower Egypt.

Crocidura sericea (Sundevall).

Silky Shrew.

Sorex sericeus Sundevall, ex Hedenborg MS., Kongl. Svenska vet.-acad. Handl. for 1842, 1843, p. 173.

In his essay on the genus Sorex above cited, Sundevall in 1843 described three new Crociduras from Sennar and the White Nile on the basis of specimens sent by Hedenborg, the Swedish traveller. The first of these, *Sorex* (= *Crocidura*) *hedenborgianus*, is characterized as a rather large species, head and body 140 mm., tail 52, skull 31 mm. long, of a uniform chocolate-brown above and below. We found nothing of this animal. The second species *S.* (= *C.*) *fulvaster* is said to be pale grayish brown above, ashy white below, the tail about half the length of head and body. The single specimen came from the White Nile, and measured:—head and body 90 mm., tail 44, skull 21 mm. long and 5 mm. between the orbits. The third species *S.* (= *C.*) *sericeus* is reddish brown above, beneath ashy, with a tail slightly more than half the length of head and body. The skull is 22 mm. long. For this animal the name *sericeus* is proposed, with Hedenborg as authority, but the latter merely suggested the name in a manuscript catalogue of the collection.

Two specimens taken on the Blue Nile some ten miles above Karkoj and a third from Kuka, a camp site on the Dinder River, agree very closely with Sundevall's description of *sericeus* and undoubtedly represent that animal. The measurements of the three are:—

No.	Head and body.	Tail.	Hind Foot.	Ear.
14,447	87	53	12	—
14,448	90	60	13	8
14,449	95	58	14	9.5
Type	90	49	14	

The skull of the type was 22 mm. long, interorbital breadth 4.5, breadth of rostrum 2.5. These measurements are practically the same in our specimens. *C. fulvastra* is said to have a trifle shorter but actually broader skull.

All three specimens were caught among dry grass and weeds, two at a distance of several miles from the nearest water, the third near the course of the Dinder then largely dried up. This last specimen is appreciably darker in color, less brown, than the two from the Blue Nile. The type locality is Sennar Province on the White Nile.

Epomophorus labiatus (Temminck).

Large-lipped Fruit Bat.

Pteropus labiatus Temminck, Monogr. mammalogie, 1835–41, **2**, p. 83, pl. 39, fig. 1–3.

At Fazogli on the Blue Nile, and at Um Orug on the upper Dinder River, fruit bats came nightly to feed on the berry-like fruit of a large fig tree with thick green leaves that grew by the river's brink. Numbers of them were visible in the moonlight darting about, hovering momentarily to feed, or apparently alighting here and there in order to obtain the berries. A curious hoarse squeak was frequently uttered as they flew about. Of three specimens secured, one female proves to be of this species. Wroughton has also recorded a specimen taken at Gebel Maba, 25 miles south of Roseires, and Andersen notes two males from Roseires in the British Museum. According to this author (1912, p. 531) Sennar is the type locality, not "Abyssinia" as given by Temminck.

Epomophorus anurus Heuglin.

Heuglin's Fruit Bat.

Epomophorus anurus Heuglin, Nova acta Acad. Leop. Carol., 1864, **31**, art. 7, p. 12.

An adult male and a female were taken at Fazogli. Andersen (1912) shows that in this species the males are much larger than the females, whereas in *E. labiatus* there is practically no such disparity between the sexes. The females of the two species however, in their extremes, closely approach each other. This author gives the range as from Erythrea and Abyssinia to British and German East Africa, Uganda and Bahr-el-Ghazal. Its occurrence in eastern Sennar is therefore of interest, and perhaps not unexpected.

An immature specimen of the Egyptian Rousette Bat (*Eidolon helvum*) without skull, is recorded by Wroughton (1911, p. 458) as sent to the British Museum from Roseires, by Mr. A. L. Butler. We did not meet with the species.

Lavia frons affinis Andersen and Wroughton.

Northern Big-eared Bat.

Lavia frons affinis Andersen and Wroughton, Ann. mag. nat. hist., 1907, ser. 7, **19**, p. 140.

Specimens of this bat were obtained at Singa and Abu Zor on the Blue Nile, and at El Abiad on the Dinder. De Winton (1900) records it also from Roseires. No doubt it is one of the common species and widely distributed. Compared with a series of skins from British East Africa (Guaso Nyiro) representing *L. frons frons* those from the Sudan are decidedly smaller (forearms 56–61 mm., as against 62–63) and paler in color. Two males differ from any of the East African specimens in the color of the fur on the rump which shades into olive-green and forms a distinct patch at the posterior end of the body, contrasting with the pearly gray of the rest of the coat. At Singa, December 28, 1912, two, a male and female, were found hanging in the branches of a thin mimosa tree where it was still shady in the early forenoon. They hung one atop of the other and were possibly a mated pair. At other times they are frequently disturbed among thick bushes or vines in the daytime and ever alert, fly to a new covert when approached. Their habits during their periods of activity we could never observe. None were ever identified or shot in the evening when other species were collected. At El Abiad, however, just before dawn I noticed several flying about a large thorn tree above our tent and finally coming to rest in its upper twigs as the daylight came on. The shelter was so thin, that had they been undisturbed, they would doubtless have quitted it later for some thick vines near at hand. The dull orange-yellow of the membranes soon fades out in the preserved specimen.

Rhinolophus dobsoni Thomas.

Dobson's Leaf-nosed Bat.

Rhinolophus clivosus Dobson, Cat. Chiropt. Brit. mus., 1878, p. 120 (*nec* Rüppell).

Rhinolophus dobsoni Thomas, Ann. mag. nat. hist., 1904, ser. 4, **14**, p. 156.

Thomas has shown that the alcoholic specimens from which Dobson drew his description of *R. clivosus*, were not that species but belong to the group in which the anterior upper premolar stands in the tooth-row, between the second premolar and the canine. The color as described by Dobson — "sulphur-brown above, beneath canary colour" — he considers perhaps due to faulty preservation. The type locality is Kordofan.

Four skins and eleven alcoholics from Abu Zor on the Blue Nile agree structurally in all particulars with *dobsoni* and undoubtedly are referable to that species. The slight narrowing of the vertical process of the sella at its middle and the high blunt tip of the connecting process are characteristic. The forearm measurement of the type is given as 44 mm., and in our series varies between 42 and 44.5 mm. The color is a smoky or smoky drab above and clear drab below, so that the yellowish tint observed by Dobson is doubtless, as Mr. Thomas suggests, a result of poor preservation. As no cranial measurements are published, the following are appended: — skull, (14,471 M. C. Z.) greatest length 18 mm.; palatal length 6; zygomatic breadth 9.5; mastoid breadth 9; upper tooth row to front of canine 6.8; lower tooth row to front of canine 7.

All our specimens were from a single large colony that inhabited the dark interior of a hollow baobab tree. A huge limb had broken off making a hole about two feet in diameter by means of which access was gained to the interior. The hollow trunk was about ten feet in diameter and the main colony of bats was resting in the upper part of its dark interior. Many, disturbed by my presence flew around and around within the great cavity but did not attempt to pass out into the daylight. A faint chippering note was frequently given as they flew about. All but three of the fifteen preserved proved to be females.

The British Museum has a specimen of *Rhinolophus hipposideros minimus* from Sennar, but we did not meet with the species (Andersen, Ann. mag. nat. hist., 1904, ser. 7, **14**, p. 455).

Rhinolophus acrotis Heuglin.

Sharp-eared Leaf-nosed Bat.

Rhinolophus acrotis Heuglin, Nova acta Acad. Leop. Carol., 1861, **29**, art. 15, p. 10; Andersen, Ann. mag. nat. hist., 1904, ser. 7, **14**, p. 454.

At Magangani, about ten miles below Roseires on the Blue Nile, a solitary leaf-nosed bat was found hanging inside a hollow baobab tree. It was a male and apparently represents Heuglin's species, the type of which was from Keren, Erythrea. In contrast to the tree inhabited by the Dobson's Leaf-nosed Bats, this was well lighted by two large openings in the massive trunk, and the bat hung in the shade against the inner wall. The forearm measurement is 48, which as Andersen points out, is slightly greater than in the race *andersoni* from the eastern desert region of Egypt. The skull is decidedly longer, 21.2 mm. from occiput to front of canine instead of 19, but the lower tooth row, back of last molar to front of canine, measures the same in both, 8.3 mm. In all four specimens of *R. a. andersoni* examined by Thomas, the minute anterior premolars, (considered by Andersen to be p^2 and p_3 in upper and lower jaws respectively), were quite lacking and the same is true of the type and topotype of *R. acrotis* according to Andersen. In the specimen from Magangani, however, the minute p^2 of the upper right-hand series is present as a mere spicule in the outer angle between the canine and the large premolar. In the related *R. clivosus* the small anterior premolars are said to be present.

Peters, in 1859, described a species of Rhinopoma from the Blue Nile, but no specimens seem to have been recorded in more recent times. Heuglin and Fitzinger also name a species of this genus from Sennar, but it may be that the generic reference was erroneous. We did not find the genus except in Egypt where it is well known.

Pipistrellus marginatus (Cretzschmar).

Marginated Pipistrelle.

Vespertilio marginatus Cretzschmar, Rüppell's Atlas reise nördlichen Afrika. Säugeth., 1826, p. 74, pl. 29, fig. a.

But a single Pipistrellus was obtained, an adult female at El Garef, on the Blue Nile. It was knocked down with a stick as it flew past near the ground. In general appearance it much resembles *P. kuhli* of Europe, not only in color of the fur but in having a dull whitish border to the interfemoral membrane. It is smaller, however, with a forearm of only 30 mm., against 35 in specimens of *kuhli* from Italy, with which I have compared it. In color and size it differs from *P. kuhli fuscatus* described by Thomas from Naivasha, British East Africa, but appears to be identical with Cretzschmar's *Vespertilio marginatus*, currently placed as a synonym of *P. kuhli*. The forearm of *marginatus* measures 30 mm. in Cretzschmar's plate, and so agrees with our specimen, which in lack of evidence to the contrary, may stand for the present as a full species. The subspecies *fuscatus* is described as dark smoky brown above, scarcely lighter below and without a white edging to the membrane, so is a very different animal. The inner upper incisor in *P. marginatus* is strongly bifid, and about twice the height of the outer. The first upper premolar is minute, not exceeding the cingulum of the canine, hence is invisible externally. It is not present on the left side of our specimen. The greatest length of the skull is 11.8 mm., of the tooth row, back of upper third molar to front of canine 4.

EPTESICUS PHASMA G. M. Allen.

Ghost Bat.

Eptesicus phasma G. M. Allen, Bull. Mus. comp. zoöl., 1911, **54**, p. 327.

Five specimens of this white-winged species were collected at various points along the Blue Nile (Roseires, El Garef, Magangani) where it appeared to be fairly common. It commences to fly at dusk, and usually keeps fairly low, even coming close to the ground. More than once I knocked one down with a stick as it flew near me.

I have compared the specimens with the original series from British East Africa and do not find them essentially different.

EPTESICUS MINUTUS SOMALICUS (Thomas).

Northern Little Brown Bat.

Vespertilio minutus somalicus Thomas, Ann. mag. nat. hist., 1901, ser. 7, **8**, p. 32.

A single specimen of this species was obtained at Bados on the Blue Nile, as it was flying about at the edge of a great marsh at dusk. Although in its present condition it is impossible to be certain of its color, it seems less pallid below than Thomas describes for the type from Somaliland; the interfemoral membrane is prominently edged with whitish, which is given as one of the characters separating it from typical *minutus* of South Africa.

Scoteinus schlieffeni (Peters).

Schlieffen's Bat.

Nycticejus schlieffenii Peters, Monatsb. Kön. preuss. akad. wiss., 1859, p. 224.

Dr. Phillips shot an adult male of this bat at Bados, on the Blue Nile. It was flying about at the edge of a broad marsh just at dusk. In common with Scotoecus, it has a large penial bone, 12 mm. long in this specimen, clothed with very short whitish hairs directed basally. Dobson mentions a specimen in which a minute first upper premolar was present on one side only, and another in which this tooth was found on both sides. Our specimen presents a similar anomaly in possessing this extra premolar on both sides, wedged in the angle between the canine and the large premolar. The wings seem relatively short, due apparently to the short third finger which but little exceeds the fourth.

The type specimen of this bat came from Cairo, Egypt. Later writers persistently misspell the specific name, by omitting an "f."

Scotophilus nigrita leucogaster (Cretzschmar).

White-bellied Brown Bat.

Nycticejus leucogaster Cretzschmar, Rüppell's Atlas reise in nördlichen Afrika. Säugeth., 1826, p. 71, pl. 28, fig. a.

This large species is common throughout most of the African continent and has been subdivided into several races. Thomas (Ann. mag. nat. hist., 1904, ser. 7, **13**, p. 208) states that Cretzschmar's name is applicable to the Abyssinian form, though Kordofan is the type locality. True *nigrita* of West Africa, Senegal, is larger, with forearm, as measured on Schreber's plate, 57 mm.

We obtained specimens at Magangani and at Fazogli on the Blue Nile. They appear shortly after sunset while it is yet light, and are among the first bats flying. Their flight is straightforward, fairly steady and not so swift as that of the Chaerephons, and they commonly are at an elevation of 30 or 40 feet. During the daytime they rest in hollow trees (Cretzschmar). Most of those obtained were excessively fat. The color above is an olive-brown, distinctly darker on the crown and nape, where in one specimen at least, there are a few minute white flecks, and the tips of the hairs are minutely white, giving a frosted appearance. This specimen has a small white spot in the middle of the lower back. The fur of the lower surface is dull white to the roots of the hairs. The forearm measurement is 51–52 mm. The extreme length of the skull (occiput to incisors) is 20.5 mm.

Scotophilus altilis, sp. nov.

Lesser Brown Bat.

Type.— Adult male, skin and skull, 14,463 M. C. Z., from Aradeiba, above Roseires, Blue Nile, Sudan. 22 January, 1913.

General Characters.— A small species, forearm 46 mm., grayish brown above; chin and throat white, chest and belly pale drab.

Description.— In contrast to the previous species, this is a grayish or yellowish brown above; crown only slightly darker, marked in the type by two fine streaks of white due to the confluence of the fine white tips which many of the hairs of the nape and crown show, and which give a slightly frosted appearance to this region. Chin practically naked, its skin dark-pigmented. Hair of the throat and groin silky white to the base; chest and abdomen pale drab to the roots of the hairs. Membranes naked above, but below a sparse covering of white hairs extends out as far on the wings as a line joining the elbow and the middle of the femur. A line of fine whitish hairs extends along the outer side of the forearm to the carpus. Postcalcaneal lobe well developed.

Skull.— The skull resembles in general that of *S. n. leucogaster* but is much smaller, with a less prominent occipital crest, the upper incisors are slightly more inturned, and the median spine at the posterior margin of the palate is relatively more developed.

Measurements.— The type measured: — total length 116 mm., tail 50, hind foot 8, ear from meatus 16, tibia 20.5, forearm 46. The skull: — greatest length (occiput to tip of incisor) 18.2, basal length (basion to tip of incisor) 15, median palatal length 6, zygomatic width 12.8, lacrymal width 7.5, mastoid width 11, upper tooth row (exclusive of incisor) 6.1, lower tooth row (exclusive of incisors) 7.

Remarks.— Throughout Africa, south of the Sahara two species of Scotophilus, a larger and a smaller, seem to occur together. The larger is *S. nigrita* represented by the following races:— *S. n. nigrita* (Schreber) from Senegal; *S. n. nux* Thomas from the Cameroons; *S. n. herero* Thomas from northern Damaraland; *S. n. dingani* (Smith) from South Africa; *S. n. planirostris* (Peters) from Mozambique; *S. n. colias* Thomas, from British East Africa; and *S. n. leucogaster* (Cretzschmar) from Northeast Africa. The status of *S. borbonicus* I do not know. In these forms the forearm is large, from 51 to 57 mm. The smaller species seems to have corresponding geographic races, but their relationships are not yet settled. To this group belong apparently *S. nigritellus* de Winton, a small species from the Gold Coast, forearm 44.5 mm.; *S. damarensis* Thomas, a larger form from Damaraland, forearm 48 mm., *S. viridis* (Peters) of Mozambique, forearm 46, olive-green above, greenish yellow below; and *S. altilis* here described, which is at once distinguished by its size and color from these.

In addition to the type, specimens were taken at Bados, El Serifa, and Fazogli along the Blue Nile. Their flight and appearance was as in the larger species, and they were similarly fat, whence the Latin designation.

Chaerephon midas (Sundevall).

Hedenborg's Free-tailed Bat.

Dysopes midas Sundevall, Kongl. Svenska vet.-acad. Handl. for 1842, 1843, p. 207, pl. 2, fig. 7, a–e.

De Winton (1901) in his review of the Nyctinomi of Africa, redescribed this species on the basis of an imperfect cotype in the British Museum. Sundevall received several specimens taken in the Acacia trees on islands of the White Nile by Hedenborg, who suggested the name in a note sent with them. The original description is clear and points out the characters separating it from "*D. cestoni*" (= *C. taeniotis*) of Europe; the skull is figured of natural size, showing the great breadth of the braincase and the narrow rostrum. We obtained a single specimen at Fazogli, near the Abyssinian border, from a native who had caught it in a hollow tree. The general color above is chocolate, with a grayish suffusion due to the pale tips of the hairs. Below, these pale tips are more extensive, giving a hoary appearance. A narrow line of whitish hairs extends from the elbow along the outer side of the forearm to the carpus. De Winton describes the skull in a male as having a "very high keel-like sagittal crest raised above the forehead from between the eyes" but in our female this crest is barely indicated. The forearm measured 61 mm.; Sundevall gives 60 mm. The skull measures:— greatest length 25.5 mm., palatal length 11, zygomatic breadth 15; breadth outside last molars 11; interorbital constriction 5; upper tooth row excluding incisors 10, lower tooth row excluding incisors 11.1.

Chaerephon emini (de Winton).

Emin's Free-tailed Bat.

Nyctinomus emini de Winton, Ann. mag. nat. hist., 1901, ser. 7, **7**, p. 40.

Wroughton (1911) has recorded this species from Roseires, on the Blue Nile, where a single male was taken by Mr. A. L. Butler. We collected a specimen not far from the same locality, at Aradeiba, which seems to be the same species, though differing from the type as described by de Winton in that the first upper premolar is crowded slightly to the exterior of the line of the tooth row instead of standing directly in it. The lower incisors *are* markedly bifurcaté in this specimen in addition. The color above is a very grayish brown rather than reddish brown; the throat hairs are pure white to their bases, and this color extends down the midventral line. The hair at the elbow and thence along the sides to the groin is not white but more like that of the sides of the body — a variation similar to that seen in this area of *C. pumilus*. The forearm measures 42 mm.; that of the type specimen from Mosambiro, 43 mm. The skull measures: — greatest length 19 mm., palatal length 8.2; width outside last molars 9.5; zygomatic width 12.7; interorbital constriction 4; upper tooth row excluding incisors 7.5; lower tooth row excluding incisors 8.5.

Chaerephon bivittatus (Heuglin).

Gray-streaked Free-tailed Bat.

Nyctinomus bivittatus Heuglin, Nova acta Acad. Leop. Carol., 1861, **29**, art. 8, p. 13.

Two large heavy-bodied bats from El Garef on the Blue Nile, seem to represent Heuglin's species, though the forearm measurement (42, 44 mm.) seems rather smaller than that given by the describer (1 inch 10 lines = 46.4 mm.). Heuglin's specimens were from Keren, in north-central Erythrea. The color above is very dark brown with a minute frosting of gray, and with scattered specks or streaks of whitish, on the nape, shoulders, and back; below, the fur is grayish, darker on the sides, and clearer on the lower throat. The two specimens were very fat and heavy bodied. They were flying shortly after sunset, going in a rather steady slow course, in comparison with the smaller species. Compared with *C. emini*, which it approximates in size, the skull is longer, with a larger rounder braincase, which is less markedly truncate at the lambdoid crest, in contrast to that of *emini* which is almost squarely truncate in posterior outline. In *C. pumilus* the lambdoid ridges are not transverse but are directed slightly forward so that they do not form the posterior boundary of the skull as in these two species, and the supraoccipital is not hidden by them in dorsal view. The skull of *C. bivittatus* (no. 14,456) measures:— greatest length 21 mm., palatal length 8.5, zygomatic breadth 12.5, width outside last molars 9.1, interorbital constriction 4.2, upper tooth row excluding incisors 7.5, lower tooth row excluding incisors 8.

In one of the two specimens, the minute first upper premolar is nearly in the tooth row, but very slightly exterior to the posterior heel of the canine; in the other the same tooth is entirely external to the tooth row and placed in the external angle between the canine and the second premolar, which are actually in contact on each side. Somewhat similar variation has just been noted in case of *C. emini*, and is evidently an expression of the tendency toward shortening the tooth row through the displacement and eventual loss of the minute first premolar.

Chaerephon pumilus (Cretzschmar).

Lesser Free-tailed Bat.

Dysopes pumilus Cretzschmar, Rüppell's Atlas reise nördlichen Afrika. Säugeth., 1826, p. 69, pl. 27, fig. a.

Several specimens of this bat were obtained along the Blue Nile at El Garef and Magangani where they seemed to be common. They appeared shortly after dusk, flew rather high and swiftly. This species is dichromatic and presents a russet and a blackish or dark chocolate-brown phase. The former condition seems to be due to a lack of the blackish pigment in the hairs; the latter to the mixture of the reddish and the blackish pigments which commonly coexist in the pelage. The extreme tips of the hairs are pale, giving a faintly hoary aspect to the back. The lower surfaces are paler than the upper and along the sides of the body from the axilla to the groin is a pale, almost whitish band of fur on the wing-membranes, that contrasts with the darker sides of the body. These details of color have not heretofore been described, no doubt because they are not very apparent in alcoholic specimens. The original description was based on a specimen from the Red Sea coast at Massowa, collected by Rüppell. The forearms of the five specimens obtained measure from 35.5 to 37.5 mm., hence a trifle smaller than what de Winton (1901) gives (38 mm.) in his review of the African Nyctinomi. Other dimensions are: — total length 87–91 mm., tail 31.5–34; hind foot 6.8–7; ear from meatus 13–15. The skull of an adult male (14,460) measures:— greatest length, 16.5 mm.; palatal length 7; zygomatic breadth 10; interorbital constriction 4; upper tooth row exclusive of incisors 6; lower tooth row exclusive of incisors 6.6.

Galago sennaariensis Lesson.

Nile Valley Galago.

Galago acaciarum var. *G. sennaariensis* Lesson, Spec. mamm., 1840, p. 248.

Elliot in his Review of the Primates considers Sundevall's *Otolincus teng* of the White Nile a synonym of this species. On the Blue Nile it appears to be rare, but this is no doubt due in part to its retiring habits. At Roseires we were shown one that had been caught by a native soldier in gathering fuel among the larger trees near there. A female from the same locality was living in the Zoölogical Gardens at Gizeh. Shortly after its arrival she had given birth to a young one.

Erythrocebus pyrrhonotus (Hemprich and Ehrenberg).

Hussar Monkey.

Cercopithecus pyrrhonotus Hempr. and Ehrenb., Symb. phys., 1838, pl. 10.

Although troops of these monkeys are said to be frequently seen on the Blue Nile and the Dinder, south of Singa, we met with them but once, near Gozar on the latter river, where Dr. Phillips came upon two companies of them near the stream at midday. They rushed off over the level ground and in a moment had disappeared among the scattered thorn trees.

It is worth noting that we met with no baboons, even among the rocky foothills of the Abyssinian border near Fazogli. In the Zoölogical Gardens at Gizeh, however, were some splendid specimens of the dark-colored Anubis Baboon said to be from the Blue Nile. At the mouth of the Dinder, where it meets the Blue Nile some forty miles to the south of Wad Medani, is said to be a favorite resort for baboons. In his book, Sport on the Blue Nile, (1903, p. 46) I. C. Johnson mentions seeing great numbers at this point, but farther south they seem to be rare or altogether absent. Rothschild calls the Blue Nile Baboon *Papio lydekkeri*, but Elliot places this as a *nomen nudum* under *P. cynocephalus*.

LASIOPYGA GRISEOVIRIDIS (Desmarest).

Grivet Monkey.

Cercopithecus griseoviridis Desmarest, Mammalogie, 1820, **1**, p. 61.

The first monkeys seen were near El Mesharat two or three days' journey up the Blue Nile from Singa. From this point to the Abyssinian border we saw them frequently, usually in small troops of old and young in the large leafy 'sont' trees near the river. At Abu Zor they were rather tame, coming freely into the great trees above the Government rest house, but elsewhere they were shy and commonly took to flight on seeing us approach. They appeared well aware of the fact that the scattered tree growth afforded no safe retreat, and usually when surprised they came at once to the ground and dashed off into the thorn scrub. On Gebel Fazogli we watched a troop of these monkeys on several mornings. They spent much time on the ground or running about among the rocks, searching for fruits of various small trees. The two specimens brought back were both old males, found singly on the Blue Nile at El Mesharat and Magangani near Roseires respectively.

On the Dinder River we saw small troops of these monkeys along the banks at several places, particularly at Kuka; on one occasion Dr. Phillips came upon a small company of them at Um Orug scolding a leopard that was crouching among thick bushes.

An old male shot on the Blue Nile at Magangani had a curiously deformed skull. One side of the braincase, orbit, and jaw had developed at a much slower rate than the other so that the long axis of the skull was turned upon itself, and much deformation of the jaw with resorption of the condyle had taken place.

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XVII.

REPORTS ON THE SCIENTIFIC RESULTS OF THE EXPEDITION TO THE EASTERN TROPICAL PACIFIC IN CHARGE OF ALEXANDER AGASSIZ, BY THE U. S. FISH COMMISSION STEAMER "ALBATROSS," FROM OCTOBER, 1904, TO MARCH, 1905, LIEUT. COMMANDER L. M. GARRETT, U. S. N., COMMANDING.

XXVIII.

ISOPODA.

By Harriet Richardson Searle.

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No. 8.— *Reports on the scientific results of the Expedition to the Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer Albatross, from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.*

XVII.

Reports on the scientific results of the Expedition to the Eastern Tropical Pacific in charge of Alexander Agassiz, by the U. S. Fish Commission Steamer Albatross from October 1904 to March, 1905, Lieut. Commander L. M. Garrett, U. S. N., Commanding.

XXVIII.

Isopoda.

By Harriet Richardson Searle.

The small number of isopods collected by the Albatross expeditions of 1899–1900, and 1904–1905 renders separate reports unnecessary. The peculiar form, *Colypurus agassizi*, was described in a preliminary paper (Bull. M. C. Z., July, 1905, **46**, p. 103–106).

CIROLANIDAE.

Cirolana latistylis Dana.

Cirolana latistylis Dana, U. S. expl. exp., 1853, **14**, Crust., **2**, p. 772.

Locality.— Two specimens from Funafuti, Ellice Islands.

Dana's type specimen was from the Straits of Balabac, north of Borneo. Whitelegge and Borradaile have recorded this species from Funafuti. Stebbing also had a specimen from Minikoi.

Alcirona maldivensis Stebbing.

Alcirona maldivensis Stebbing, Fauna & geography Maldive & Laccadive Archipelagoes, 1904, **2**, pt. 3, p. 708–709.

Locality. — Funafuti, Ellice Islands. Two specimens, a male and female.

Stebbing's specimen was from Hulule, Maldive Islands.

The drawings of the abdomen and frontal lamina are of one of the specimens from Funafuti.

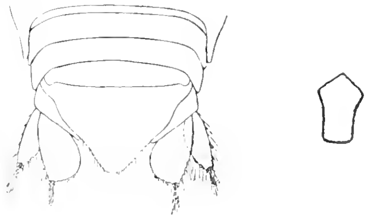

Fig. 1. Fig. 2.
Fig. 1–2.— *Alcirona maldivensis.* 1. Abdomen. 26. × 2. Frontal lamina.

AEGIDAE.

Rocinela aries Schioedte and Meinert.

Rocinela aries Schioedte & Meinert, Naturh. tidsskr., 1879–80, ser. 3, **12**, p. 401–403, pl. 13, fig. 7–8.

Locality.— Panama Harbor. One small specimen, probably immature.

Ricinela angustata Richardson.

Rocinela laticauda Richardson (not Hansen), Proc. Amer. philos. soc., 1898, **37**, p. 14–15, figs. 5–6.

Rocinela angustata Richardson, Proc. U. S. N. M., 1904, **27**, p. 33; Bull. 54, U. S. N. M., 1905, p. 206–207.

Locality.— Lat. 5° 47′ S., long. 81° 24′ W. (Station 4,653).
Depth.— 536 fathoms. One specimen.

CYMOTHOIDAE.

Anilocra meridionalis, sp. nov.

Body of female about three times longer than wide, $9\frac{1}{2}$ mm. wide: 28 mm. long. Color dark brown with terminal abdominal segment and uropoda light brown or yellow.

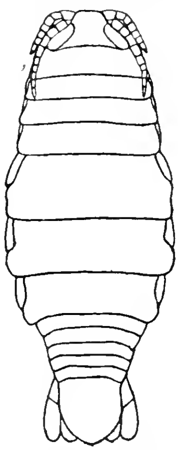

Fig. 3.— *Anilocra meridionalis.* 8. ×

Head a little wider at the base than long, 5 mm.: 4 mm., triangular in shape, with the apex produced in a process which arches over the antennae and is truncate at the extremity. Eyes small, round, composite, situated in the postlateral angles of the head and separated by a distance of $1\frac{1}{2}$ mm. Head not at all immersed in the first thoracic segment. The first pair of antennae are composed of eight articles and extend to the middle of the first thoracic segment. The second pair of antennae are composed of eleven articles and extend to the posterior margin of the second thoracic segment. The fifth article is the longest, and is the last peduncular article, although the articles of flagellum and peduncle are not clearly marked. The first and fourth segments of the thorax are a little longer than the second and third, which are about the same length. The first segment is $2\frac{1}{2}$ mm. long, the second and third each 2 mm. and the fourth 3 mm. The fifth segment is longest, being 4 mm.; the sixth is $3\frac{1}{2}$ mm. and the seventh is $2\frac{1}{2}$ mm. The epimera are small, narrow plates, extending almost the entire length of the second thoracic segment, about two thirds the length of the third segment and half the length of the fourth, fifth, and sixth segments. In the seventh segment the epimera extend two thirds the length of the segment.

The first five segments of the abdomen are subequal in length, but gradually decrease in width to the terminal segment, which is linguiform in shape. The last segment is longer than wide, being 5 mm. long.: about $3\frac{1}{2}$ mm. wide. The branches of the uropoda are subequal in width and length and extend to the extremity of the terminal abdominal segment. They are oar-like in shape.

Locality.— Only one specimen, a female, was taken between the Galapagos Islands and Manga Reva at Station 4722, in lat. 9° 31′ N., long. 106° 30′ 5″ W. at a depth of 1,923 fathoms on a rocky bottom.

Type.— Cat. No. 46,440, U. S. N. M.

This species differs from all the others of the genus in the longer second antennae, which extend to the posterior margin of the second thoracic segment.

A number of immature forms of Cymothoidae come from Stations 4,640, 4,657, 4,596, 4,730 and Butaritari, Gilbert Group Lagoon. Surface.

Nerocila excisa, sp. nov.

Body oblong-ovate.

Head broader posteriorly than anteriorly, with the front slightly excavate in the middle. Eyes irregular in shape and placed in the postlateral angles. First pair of antennae, composed of seven

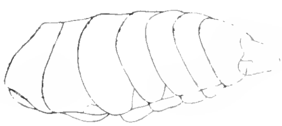

Fig. 4.— *Nerocila excisa.* Head and first three thoracic segments. 8. ×
Fig. 5.— *Nerocila excisa.* Lateral view of thorax. 8. ×

articles, extend to the anterolateral angles of the first thoracic segment. Second pair of antennae, composed of seven articles, are equal in length to the first pair. The posterior margin of the head is trilobate, the median lobe being the largest.

The first four thoracic segments are about equal in length, but increase gradually in width. The epimera of the second, third, and fourth segments extend the entire length of the lateral margin. The fifth, sixth, and seventh segments are much longer than the four anterior segments, each being about one and a half times longer than any of those preceding. Their postlateral angles are widely rounded and not produced. The epimera of these segments extend nearly the entire length of the lateral margin and are in the form of narrow, elongated lobes, attached anteriorly and free posteriorly.

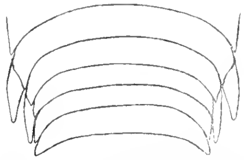

Fig. 6. — *Nerocila excisa*. First five segments of abdomen. 8. ×

The first five segments of the abdomen are about equal in length. All are furnished with distinct epimera, those of the first two segments being produced in long narrow lamellae reaching the length of two segments beyond the one to which they are attached. The epimera of the last three segments are small and almost inconspicuous on the last two. They decrease gradually in size.

All the legs are prehensile in character and none are furnished with a carina on the basis.

The terminal segment of the abdomen is linguate. In the only specimen the posterior portion is almost torn off. The uropoda are also lost.

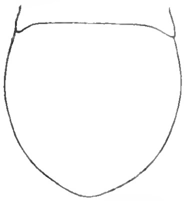

Fig. 7. — *Nerocila excisa*. Terminal segment of abdomen. 8. ×

Locality.— One specimen. Station 13. It was found in the stomach of Coryphaena sp., Sept. 5, 1899, in lat. 9° 57′ N., long. 137° 47′ W.

Type.— Cat. No. 46,435, U. S. N. M.

IDOTHEIDAE.

Pentidotea resecata (Stimpson).

Idotea resecata Stimpson, Bost. journ. nat. hist., 1857, 6, p. 504, pl. 22, fig. 7.
Pentidotea resecata Richardson, Bull. 54 U. S. N. M., 1905, p. 369–370.

Locality.— Lat. 33° 40′ N., long. 119° 35′ W. Station 4,571. Four specimens from surface.

ONISCIDAE.

PHILOSCIA AUSTRALIS, sp. nov.

Body ovate, a little more than twice as long as wide $4\frac{1}{2}$ mm.: 10 mm. (not including uropoda).

Head two and a half times wider than long, 1 mm.: $2\frac{1}{2}$ mm. Front not margined, without median or lateral lobes. Eyes rather large, composite and situated in the lateral angles of the head. First pair of antennae minute, inconspicuous. Second pair of antennae with the first article of the peduncle short; second and third articles subequal, and each about twice as long as the first article; fourth and fifth articles subequal and each twice as long as the third. The flagellum is composed of three articles, decreasing successively in length. The second pair of antennae are longer than half the body and extend to the posterior margin of the fifth thoracic segment.

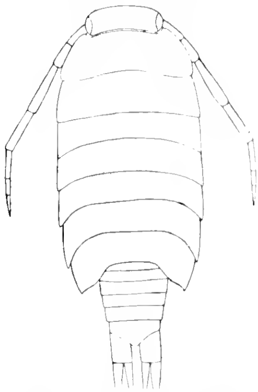

Fig. 8.— *Philoscia australis.* 16. ×

The first three segments of the thorax are each a little longer than any of the last four, which are about equal in length. The lateral margins of the segments are straight and the epimera are not separated from the dorsal portion. The postlateral angles of the seventh segment are somewhat truncate.

The abdomen is very abruptly narrower than the thorax, being just half as wide, 2 mm. while the last thoracic segment is only 4 mm. in width. The first two segments are partly covered at the sides by the seventh thoracic segment. The first five segments are about equal in length. The sixth or terminal segment is triangular with apex rounded.

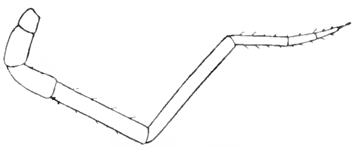

Fig. 9.— *Philoscia australis.* Second antenna. 26. ×

The uropoda are long. The peduncle is twice as long as the terminal abdominal segment (measured on the exterior margin). The inner branch is twice as long as the peduncle (measured from the inner side). The outer branch is longer than the inner branch being two and a half times as long as the peduncle (measured from the inner side).

All the legs are ambulatory. In color the specimens, six in number, are dark brown with patches of yellow, the lighter colored patches

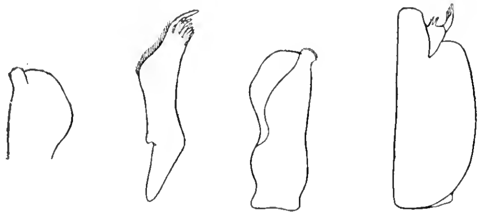

Fig. 10. *Philoscia australis*. a. Maxilliped. b. Second maxilla. c. Outer lobe of first maxilla. d. Extremity of second maxilla. 41. ×

uniting in the middle to form a longitudinal stripe, and with larger patches on the sides of the segments and on the postlateral corner of the epimera.

Locality.— Nuka Hiva, Sept. 15, 1899.

This species is probably close to *Philoscia truncata* Dollfus, which also has the postlateral angles of the seventh thoracic segment truncate.

PORCELLIO LAEVIS Latreille.

Porcellio laevis Latreille, Hist. nat. crust. et insectes, 1804, **7**, p. 46; Richardson, Bull. 54 U. S. N. M., 1905, p. 614–616.

Localities.— Easter Island, under rocks, forty-nine specimens; Tahiti, two specimens.

PORCELLIO SCABER Latreille. var. MARMORATA.

Porcellio scaber Latreille, Hist. crust. et insectes, 1804, **7**, p. 45; Richardson, Bull. 54, U. S. N. M., 1905, p. 621–624.

Locality.— Easter Island. One specimen.

PORCELLIONIDES PRUINOSUS (Brandt).

Porcellio pruinosus Brandt, Bull. Soc. imp. nat. Moscow, 1833, **6**, p. 19.
Metoponorthus pruinosus Richardson, Bull. 54, U. S. N. M., 1905, p. 627–629.
Porcellionides pruinosus Stebbing, Records Indian mus., 1911, **6**, p. 189.

Locality.— Tahiti, five specimens; Fakarava, Paumotus, one specimen.

ARMADILLIDIDAE.

ARMADILLIDIUM VULGARE (Latreille).

Armadillo vulgare Latreille, Hist. nat. crust. et insectes, 1801, **7**, p. 48; Richardson, Bull. 54, U. S. N. M., 1905, p. 666–668.

Locality.— Easter Island, under rocks. Thirty-one specimens.

CUBARIS MURINA Brandt.

Cubaris murina Brandt, Bull. Soc. imp. nat. Moscow, 1833, **6**, p. 28.
Cubaris murinus Richardson, Bull. 54, U. S. N. M., 1905, p. 645–647.

Localities.— Tahiti, one specimen; Nuka Hiva, in dry places under stones, thirty-nine specimens.

SPHERILLO TESTUDINALIS Budde-Lund.[1]

Armadillo testudinalis Budde-Lund, Crust. Isop. Terrestria, 1885, p. 29.
Spherillo testudinalis Budde-Lund, Voeltzkow's Reise in Ostafrica, 1903–1905, 1908, **2**, p. 269–270, pl. 12, fig. 17–29.

Body ovate, convex, smooth, contractile into a ball.

Head about four times wider than long, with the frontal margin straight. Eyes large, composite, composed of eighteen ocelli and placed close to the lateral margins of the head. Prosepistoma plain. First pair of antennae rudimentary, composed of three minute articles. Second pair of antennae with the first article short; the second article is about three times longer than the first; the third article is about as long as the second; the fourth is about equal in length to the third; the fifth is one and a half times longer than the fourth. The flagellum is composed of two articles, the second being three times longer than the first. The antennae are geniculate at the articulation of the second and third articles. The inner lobe of the first maxillae is furnished with two plumose processes.

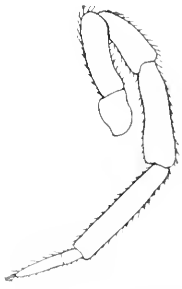

Fig. 11. — *Spherillo testudinalis.* Second antenna. 41. ×

The first segment of the thorax is the longest and is about twice as long as the head. Coxopodites present and visible on the dorsal side

[1] Budde-Lund places this genus in a subfamily, Spherilloninae, of the Oniscidae.

of the segment in the form of a small cleft on the posterior margin a short distance from the lateral margin. On the underside the coxopodite is separated only posteriorly in the form of a tooth. The six following segments of the thorax are subequal in length. The coxopodites of the second segment are small, but quite prominent on the underside, and are in the form of a sharp tooth. The coxopodites of the third and fourth segments are small and are represented on the upper part of the underside of the segments by a thickened ridge. In the last three segments the coxopodites are large and prominent and are in the form of thickened processes on the underside.

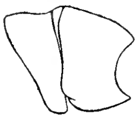

Fig. 12.

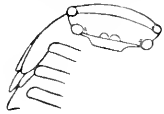

Fig. 13.

Fig. 12.— *Spherillo testudinalis.* First and second thoracic segments. (Lateral view). 16. ×

Fig. 13.— *Spherillo testudinalis.* Head and first three thoracic segments. (Ventral view). 16. ×

The first five segments of the abdomen are about equal in length. The lateral parts of the first two are covered by the last thoracic segment. The lateral parts of the third, fourth, and fifth segments are expanded and the third segment has distinct coxopodites on the underside similar to those of the preceding thoracic segments. The terminal abdominal segment is tetragonal, wider at the base than at the apex, which is truncate, and contracted in the middle. The uropoda are short, not reaching beyond the extremity of the last abdominal segment. The basal article is large, wide, truncate at the apex, and occupies all the space between the last segment of the abdomen and the lateral parts of the preceding segment. The outer branch is small, conical, and placed on the dorsal side of the basal article in a groove which extends to the middle of the dorsal side. The inner branch is small and narrow and does not quite reach the extremity of the last abdominal segment on the underside.

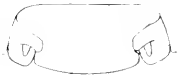

Fig. 14.

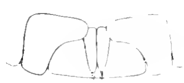

Fig. 15.

Fig. 14.— *Spherillo testudinalis.* Terminal segment of abdomen with uropoda. (Dorsal view). 41. ×

Fig. 15.— *Spherillo testudinalis.* Terminal segment of abdomen with uropoda. (Ventral view). 41. ×

In color it is dark brown with patches of light brown at the sides of the body in which are wavy lines of dark brown. A dark band extends along the median line. Patches of light brown extend also along the lateral parts of the segments.

Locality.— Fakarava, Paumotus, Tahiti, and Tipaevii Valley. About forty specimens.

Specimens of *Cubaris Armadillidium pacifica* Borradaile were sent to me from the Museum of Zoölogy, Cambridge, England for comparison with my specimens and they were found to be specifically the same. I have redescribed the species, because in the original description of *C. pacifica* (Proc. Zoöl. soc., London, 1900, p. 796, pl. 51) the uropods were not correctly interpreted.

LIGYDIDAE.

Ligyda exotica (Roux).

Ligia exotica Roux, Crust. Médit., 1828, p. 3, pl. 13, fig. 9.
Ligyda exotica Richardson, Bull. 54, U. S. N. M., 1905, p. 676–677.

Locality.— Mohican Reef. Rangiroa Island. Five imperfect specimens.

DAJIDAE.

Zonophryxus similis, sp. nov.

Body of female longer than wide, ovate, 29 mm. wide: 45 mm. long. Dorsal surface convex, swollen, and with numerous wrinkles in the integument. The three divisions of the body are not marked. The body is narrowest in the cephalic region, where the front is rounded. Two small pits or depressions mark the eyes, one on either side of the median line. The posterior part of the body is rounded. On the ventral side the oral area is large and is bounded at the sides by a border, the lateral edges of which have four or five shallow incisions which indicate the thoracic segments. This border surrounds the cephalic region extending forward as a wide margin. On either side of this border below the oral area, the inflated portions of the body extend.

a. b.

Fig. 16.— *Zonophryxus similis.* a. Dorsal view. b. Ventral view. S. ×

The antennae are widely separated and seem to be composed of three articles. The antennulae are concealed by the maxillipeds. The tips of the mandibles project between the maxillipeds.

The five pairs of legs are crowded closely together, within the oral area. There are five pairs of incubatory plates. The first and fifth pairs are the largest and overlap the other three pairs, so as to partly or entirely conceal them. By carefully lifting these the others are easily seen lying beneath. The pleopoda consist of a single pair of large plates situated on the ventral side of the body just below the last pair of incubatory plates. There are no uropoda.

On the posterior margin of the border which surrounds the pleopoda at the terminal part of the body are eleven teeth, one in the median line, and five on either side. These teeth indicate the coalesced abdominal segments.

Locality.— Only one specimen, a female was collected at Station 4,621 in latitude 6° 36′ N., long. 81° 44′ W. at a depth of 581 fathoms.

The host is unknown.

Type.— Cat. No. 46,432, U. S. N. M.

Only three other species of this genus have been described, *Zonophryxus retrodens* Richardson, *Z. trilobus* Richardson, and *Z. grimaldii* Koehler. The present species is very close to *Z. trilobus* but differs in the narrower cephalic region, which is more triangular in appearance in both a dorsal view and a ventral view, in the presence of eye pits, in the invisibility of the cephalic border in a dorsal view, in the contour of the body, and in the greater number of teeth on the posterior border.

COLYPURIDAE.

Colypurus agassizi Richardson.

Colypurus agassizi Richardson, Bull. M. C. Z., 1905, **46**, p. 105–106.

Body gradually increasing in width backward from the first to the fourth free thoracic segment. The head is 2 mm. wide, the first free thoracic segment is 3 mm. in width, and the fourth free segment measures 4 mm. The length of the body is 5 mm.

The head is produced in the middle anteriorly in a rounded lobe. The sides of the head are also expanded in rounded lobes. Four knob-like bodies are situated in a transverse series on the dorsal surface of the head, the two central ones being largest; the lateral knobs are placed one on each lateral lobe. The antennae are rudimentary, inconspicuous, composed of only a few articles, and not visible in a dorsal view. The tips of the mandibles project from the apex of the oral cone.

The first segment of the thorax is coalesced with the head and bears the first pair of legs. The following five segments are more or less subequal in length, but increase gradually in width to the fourth free segment. The last thoracic segment is longer than any of the preceding segments and is posteriorly rounded. Each thoracic segment bears a pair of prehensile legs, there being seven pairs altogether[1].

The abdomen is inserted beneath the last thoracic segment, is conically tapered, unsegmented, and devoid of appendages.

Locality.— One specimen. Station 4621. Lat. 6° 36′ N. long. 81° 44′ W. off Mariato Point.

Type.— Cat. No. 46,433, U. S. N. M.

[1] In the specimen the third leg on the right side is broken off about the middle

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LOUIS CABOT. Immature State of the Odonata. Part IV.
E. L. MARK. Studies on Lepidosteus, continued.
" On Arachnactis.
A. AGASSIZ and C. O. WHITMAN. Pelagic Fishes. Part II., with 14 Plates.
H. L. CLARK. The "Albatross" Hawaiian Echini.

Reports on the Results of Dredging Operations in 1877, 1878, 1879, and 1880, in charge of ALEXANDER AGASSIZ, by the U. S. Coast Survey Steamer "Blake," as follows:—

A. MILNE EDWARDS and E. L. BOUVIER. The Crustacea of the "Blake."
A. E. VERRILL. The Alcyonaria of the "Blake."

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieutenant Commander Z. L. TANNER, U. S. N., Commanding, in charge of ALEXANDER AGASSIZ, as follows:—

K. BRANDT. The Sagittae.
" The Thalassicolae.
O. CARLGREN. The Actinarians.
R. V. CHAMBERLIN. The Annelids.
W. R. COE. The Nemerteans.
REINHARD DOHRN. The Eyes of Deep-Sea Crustacea.
H. J. HANSEN. The Cirripeds.
H. J. HANSEN. The Schizopods.
HAROLD HEATH. Solenogaster.
W. A. HERDMAN. The Ascidians.
S. J. HICKSON. The Antipathids.
E. L. MARK. Branchiocerianthus.
JOHN MURRAY. The Bottom Specimens.
P. SCHIEMENZ. The Pteropods and Heteropods.
THEO. STUDER. The Alcyonarians.
—— The Salpidae and Doliolidae.
H. B. WARD. The Sipunculids.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of ALEXANDER AGASSIZ, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding, as follows:—

R. V. CHAMBERLIN. The Annelids.
H. L. CLARK. The Holothurians.
—— The Volcanic Rocks.
—— The Coralliferous Limestones.
S. HENSHAW. The Insects.
R. VON LENDENFELD. The Siliceous Sponges.
—— The Ophiurans.
G. W. MÜLLER. The Ostracods.
MARY J. RATHBUN. The Crustacea Decapoda.
G. O. SARS. The Copepods.
L. STEJNEGER. The Reptiles.
C. H. TOWNSEND. The Mammals, Birds, and Fishes.
T. W. VAUGHAN. The Corals, Recent and Fossil.

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MUSEUM OF COMPARATIVE ZOÖLOGY

AT HARVARD COLLEGE.

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Vols. LV. to LVIII. of the BULLETIN, and Vols. XXV., XXX., XXXV., XXXIX., XL., XLII., XLIII., XLV. to XLVIII. of the MEMOIRS, are now in course of publication.

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Reports on the Results of Dredging Operations from 1877 to 1880, in charge of Alexander Agassiz, by the U. S. Coast Survey Steamer "Blake," Lieut. Commander C. D. Sigsbee, U. S. N., and Commander J. R. Bartlett, U. S. N., Commanding.

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieut. Commander Z. L. Tanner, U. S. N., Commanding, in charge of Alexander Agassiz.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

Reports on the Scientific Results of the Expedition to the Eastern Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from October, 1904, to April, 1905, Lieut. Commander L. M. Garrett, U. S. N., Commanding.

Contributions from the Zoölogical Laboratory, Professor E. L. Mark, Director.

Contributions from the Geological Laboratory, Professor R. A. Daly, in charge.

These publications are issued in numbers at irregular intervals. Each number of the Bulletin and of the Memoirs is sold separately. A price list of the publications of the Museum will be sent on application to the Director of the Museum of Comparative Zoölogy, Cambridge, Mass.

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Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

Vol. LVIII. No. 9.

A NEW PERIPATUS FROM COLOMBIA.

By Charles T. Brues.

With Two Plates.

CAMBRIDGE, MASS., U. S. A.:

PRINTED FOR THE MUSEUM.

September, 1914.

Reports on the Scientific Results of the Expedition to the Eastern Tropical Pacific, in charge of Alexander Agassiz, by the U. S. Fish Commission Steamer "Albatross," from October, 1904, to March, 1905, Lieutenant Commander L. M. Garrett, U. S. N., Commanding, published or in preparation:—

A. AGASSIZ. V.[5] General Report on the Expedition.
A. AGASSIZ. I.[1] Three Letters to Geo. M. Bowers, U. S. Fish Com.
A. AGASSIZ and H. L. CLARK. The Echini.
H. B. BIGELOW. XVI.[16] The Medusae.
H. B. BIGELOW. XXIII.[23] The Siphonophores.
H. B. BIGELOW. XXVI.[26] The Ctenophores.
R. P. BIGELOW. The Stomatopods.
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W. E. HOYLE. The Cephalopods.
W. C. KENDALL and L. RADCLIFFE. XXV.[25]. The Fishes.
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—— The Ophiurans.
G. W. MÜLLER. The Ostracods.
JOHN MURRAY and G. V. LEE. XVII.[17] The Bottom Specimens.
MARY J. RATHBUN. X.[10] The Crustacea Decapoda.
HARRIET RICHARDSON. II.[2] The Isopods.
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B. L. ROBINSON. The Plants.
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HARRIET R. SEARLE. XXVIII.[28] Isopods.
H. R. SIMROTH. Pteropods, Heteropods.
E. C. STARKS. XIII.[13] Atelaxia.
TH. STUDER. The Alcyonaria.
JH. THIELE. XV.[15] Bathysciadium.
T. W. VAUGHAN. VI.[6] The Corals.
R. WOLTERECK. XVIII.[18] The Amphipods.

[1] Bull. M. C. Z., Vol. XLVI., No. 4, April, 1905, 22 pp.
[2] Bull. M. C. Z., Vol. XLVI., No. 6, July, 1905, 4 pp., 1 pl.
[3] Bull. M. C. Z., Vol. XLVI., No. 9, September, 1905, 5 pp., 1 pl.
[4] Bull. M. C. Z., Vol. XLVI., No. 13, January, 1906, 22 pp., 3 pls.
[5] Mem. M. C. Z., Vol. XXXIII., January, 1906, 90 pp., 96 pls.
[6] Bull. M. C. Z., Vol. L., No. 3, August, 1906, 14 pp., 10 pls.
[7] Bull. M. C. Z., Vol. L., No. 4, November, 1906, 26 pp., 4 pls.
[8] Mem. M. C. Z., Vol. XXXV., No. 1, February, 1907, 20 pp., 15 pls.
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[11] Bull. M. C. Z., Vol. LI., No. 6, November, 1907, 22 pp., 1 pl.
[12] Bull. M. C. Z., Vol. LII., No. 1, June, 1908, 14 pp., 1 pl.
[13] Bull. M. C. Z., Vol. LII., No. 2, July, 1908, 8 pp., 5 pls.
[14] Bull. M. C. Z., Vol. XLIII., No. 6, October, 1908, 285 pp., 22 pls.
[15] Bull. M. C. Z., Vol. LII., No. 5, October, 1908, 11 pp., 2 pls.
[16] Mem. M. C. Z., Vol. XXXVII., February, 1909, 243 pp., 48 pls.
[17] Mem. M. C. Z., Vol. XXXVIII., No. 1, June, 1909, 172 pp., 5 pls., 3 maps.
[18] Bull. M. C. Z., Vol. LII., No. 9, June, 1909, 26 pp., 8 pls.
[19] Bull. M. C. Z., Vol. LII., No. 11, August, 1909, 10 pp., 3 pls
[20] Bull. M. C. Z., Vol. LII., No. 13, September, 1909, 48 pp., 4 pls.
[21] Mem. M. C. Z., Vol. XLI., August, September, 1910, 323 pp., 56 pls.
[22] Bull. M. C. Z., Vol. LIV., No. 7, August, 1911, 38 pp.
[23] Mem. M. C. Z., Vol. XXXVIII., No. 2, December, 1911, 232 pp., 32 pls.
[24] Bull. M. C. Z., Vol. LIV., No. 10, February, 1912, 16 pp., 2 pls.
[25] Mem. M. C. Z., Vol. XXXV., No. 3, April, 1912, 98 pp., 8 pls.
[26] Bull. M. C. Z., Vol. LIV, No. 12, April, 1912, 38 pp., 2 pls.
[27] Mem. M. C. Z., Vol. XXXV., No. 4, July, 1912, 124 pp., 12 pls.
[28] Bull. M. C. Z., Vol. LVIII., No. 8, August, 1914, 14 pp.

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By Charles T. Brues.

With Two Plates.

CAMBRIDGE, MASS., U. S. A.:

PRINTED FOR THE MUSEUM.

September, 1914.

No. 9.— *A New Peripatus from Colombia.*[1]

By Charles T. Brues.

The Bryant Walker Expedition, of the University of Michigan, which visited the Sierra Nevada de Santa Marta in northeastern Colombia during the summer of 1913, obtained an interesting series of Onychophora. Through the kindness of Dr. A. G. Ruthven, the leader of the Expedition, I have had the opportunity of examining these specimens which were collected by himself and Prof. A. S. Pearse. Professor Pearse made some valuable field notes at the time the animals were obtained, and these are of such interest, that they are included separately at the end of the taxonomic account.

Three species are represented in the collection, *P. edwardsii* and *P. imthurmi* in addition to the one described as new. All belong to Bouvier's (Monographie des onychophores, 1907, p. 158) group of "Péripates caraïbes" which has lately been given the subgeneric name of Epiperipatus by Clark (Proc. Biol. soc. Washington, 1913, **26**, p. 17). It may be mentioned, however, that Bouvier's division of the neotropical forms into Andicolous and Caribbean species does not hold for the Colombian species as has recently been shown by Fuhrmann (Zool. anz., 1913, **42**, p. 242).

Peripatus (Epiperipatus) vespucci, sp. nov.

Plate **1**, fig. 1–4; Plate **2**, fig. 7.

A small, moderately slender species with 33 or 34 pairs of legs in the female and 30 pairs in the male. Integument similar to that of *P. brasiliensis*, but there are two incomplete folds on each body segment.

Form and dimensions. Body rather slender, considerably narrowed at each end, so that it tapers very decidedly from a broadened middle portion toward the head and posterior end. In the three specimens before me, the body measurements are as follows:—

[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 81.

TABLE 1.

Length of body	Greatest breadth	Number of legs
Type ♀ 32 mm.	5 mm.	34 pairs
Paratype ♀ 36 mm.	5 mm.	33 pairs
Paratype ♂ 21 mm.	4 mm.	30 pairs

Although there is a difference in proportions in the two females the paratype is more fully expanded and consequently appears to be of a more slender form. The type female and the male are of very similar shape (see Plate 2, fig. 11).

Coloration. All three specimens are considerably decolorized from their preservation in alcohol, but still show very distinctly the general color-pattern of the body. To the naked eye, the legs and a broad stripe directly above them are much lighter than the dorsal region, exhibiting a dull yellowish gray tint with distinct purplish cast which is much more distinct in one specimen. In all three, the legs are decidedly paler than the pleural stripe. The dorsal region, including two thirds of the animal when seen from above, is much darker than the pleurae and differentiated into a complicated color-pattern. This consists in a light-colored median dorsal broad stripe, strongly constricted between each body segment, and a narrow very dark beaded or interrupted median line, the interruptions of which coincide with the constrictions of the light stripe. Examined under a microscope it is seen that the enlargements of the dorsal light stripe are rhomboidal in form, but coalescent for about half their greatest width along the intersegmental lines, so that their margins form a continuous longitudinal serrate line. The dark color is confined to the space between the body folds and does not include the apices of the papillae, even in the darkest portions of the stripe. The median blackened line is discontinuous, passing over only five to seven folds on each segment and is much more strongly pigmented on the three or four alternate folds of each segmental group. The dorsal color-pattern fades out on the head and next segment, and [illegible]s to the posterior extremity of the body, although paler on the last two or three segments. The antennae are pale.

Integument. The integumentary folds are very narrow on the ridges with the transverse grooves between them deep. At the level of each leg two of the folds are incomplete, extending only about half-way from the median line to the legs when seen in dorsal view. Examined in surface view the papillae appear to be practically all of the same type, large and rather transverse in outline. Seen by transmitted light, accessory papillae are few in number and always appear on the extreme edges of the folds singly or in pairs between two primary papillae, which are farther apart at the points where accessory ones are interpolated. The primary papillae are short-conical in form, with the terminal cylinder poorly developed, short, nipple-shaped; their bases are usually separated by nearly transverse grooves which give the papillae a somewhat rectangular appearance when viewed from above. The accessory ones tend to project over the groove between the body folds and are thus seen more or less in profile when the integument is viewed from above. In one specimen (Plate **1**, fig. 1–2) where the skin is stretched from side to side the primary papillae are more widely separated and the accessory ones appear to be drawn up farther toward the ridges of the body folds.

Mandibles. The mandibles bear one large accessory tooth and nine denticles.

Legs. As stated above there are 33–34 pairs of legs in the females and 30 pairs in the single male examined. The legs are provided with three pedal papillae, two on the anterior face and one on the posterior face as in the Caribbean members of the genus. The creeping pads of each leg are composed of four bands. The nephridial tubercles on the fourth and fifth pairs of legs lie between the third and fourth bands of the creeping pad. They are free from the third band although lying partly in an emargination of its proximal margin, and do not disturb the continuity of the fourth band.

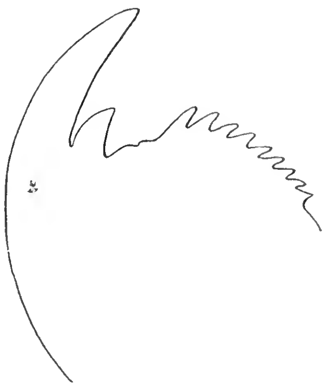


Fig. 1.— *Peripatus (Epiperipatus) vespuccii.* Outer blade of mandible.

Type:— M. C. Z., No. 239, Cincinnati Coffee Plantation, near Santa Marta, Colombia, 2,300 feet. (Field No. 92).

Paratypes: — M. C. Z., No. 240; Univ. Mich. Same locality, 2,200 feet.

Named in honor of Amerigo Vespucci whose explorations led him along the coast which has yielded so many species of Peripatus.

In Bouvier's key this species will run down to *edwardsii*, but it is quite different from that species in the form and arrangement of the tegumentary papillae, and also possesses a larger number of legs in the female (33–34 pairs), *edwardsii* having only 30–32, rarely 33 in this sex. Were it not for the presence of incomplete body folds the structure of the integument would place it close to *brasiliensis*, although the specimens of *brasiliensis* figured by Bouvier have the primary papillae placed farther apart and the accessory ones ascend to the ridges of the folds. The structure of the fourth and fifth legs is as in *brasiliensis* also, with the nephridial tubercle entirely free from the third band of the creeping pad. It appears impossible, therefore, to associate the present form closely with any described species, although it undoubtedly falls near *edwardsii* while showing a striking similarity to *brasiliensis*. *Peripatus brasiliensis* was described from Santarem, but according to Bouvier probably extends to Panama; *P. edwardsii* occurs from French Guiana to Colombia. The present species is not closely related to any of the forms recently described by Fuhrmann (Zool. anz., 1913, **42**, p. 241–248) from Colombia.

Peripatus (Epiperipatus) edwardsii Blanchard.

Ann. sci. nat. Zool., 1847, sér. 3, **8**, p. 140.

Of this widely distributed species there are nine specimens (Coll. Univ. Mich. and M. C. Z. No. 241–244), from the Cincinnati Coffee Plantation, near Santa Marta, Colombia.

As can be seen from the accompanying illustrations, there is considerable variation in the distribution of the integumentary papillae, particularly in the accessory ones. These latter vary much both in numbers and in distribution on the body folds, but the variation does not exceed that already observed by Bouvier in this species. All have the nephridial tubercles of the fourth and fifth legs free from the third creeping pad and the fourth pad is continuous. The number of legs is indicated in Table 2.

In the smaller specimens there is a marked difference in the size of the primary papillae which are alternately large with well-developed terminal cylinder and small with reduced cylinder. In these specimens the accessory papillae are sparse and restricted almost exclusively to the edges of the folds (Plate **2**, fig. 7–8). The larger examples (Plate **2**, fig. 6, 9) have the primary papillae of more nearly equal size and similar form and the accessory ones ascend more commonly on the sides of the folds although always remaining away from the ridges.

One unusually large specimen (Plate **2**, fig. 5–6) has the periphery of the papillae unusually well defined by a series of irregular non-pigmented lines which form a noticeable network along the folds. It is possible that there may be one or more varietal or subspecific forms of *edwardsii* that might be distinguished. However, a close study of the material on hand, supplemented by other specimens in the M. C. Z. and in the American Museum of Natural History does not seem to offer any characters of sufficient constancy to warrant any such division.

TABLE 2.

Field number	Length of body		Greatest breadth	Number of legs
	Alive	Preserved	Preserved	
50 (large)	72 mm.	50 mm.	5.7 mm.	30 pairs
50 (small)	42 mm.	31 mm.	3.1 mm.	29 pairs
58	76 mm.	48 mm.	6 mm.	30 pairs
171–172	———	53 mm.	4.5 mm.	32 pairs
171–172	———	43 mm.	3.7 mm.	32 pairs
171–172	———	29 mm.	2.9 mm.	30 pairs
171–172	———	30 mm.	2.8 mm.	29 pairs
171–172	———	24 mm.	2. mm.	31 pairs
179	———	74 mm.	3.7 mm.	32 pairs

PERIPATUS (EPIPERIPATUS) IMTHURMI Sclater.

Quart. journ. micros. sci., 1888, **28**, p. 474.

One specimen, No. 49 of the present collection (M. C. Z. No. 245), seems undoubtedly to belong to this species which has hitherto been reported only from Guiana. It is not very typical but agrees well in the form and disposition of the papillae as well as in the character of the nephridial tubercle on the fourth and fifth legs. There are 30 pairs of legs, a common number for this species. In color, however, the specimen before me seems to differ somewhat from the normal color of *imthurmi* for according to Professor Pearse's field notes, it evidently showed in life lozenge-shaped markings. Bouvier has found in certain individuals indications of lozenges in addition to the median dark line, however, so that this variation is perhaps of not very great importance. The specimen was fixed in Gilson's fluid and it is impossible at present to see any indications of the original color-pattern.

The present record greatly extends the range of *imthurmi*, but after a long series of comparisons I am convinced that it is either a non-typical or varietal form of *imthurmi*. The single female is from the Cincinnati Coffee Plantation, altitude about 3,000 ft., 18 miles south of Santa Marta, Colombia.

Field Notes and Observations. By A. S. Pearse. All specimens are from the Cincinnati Coffee plantation, 18 miles south of Santa Marta, Colombia. The field numbers are those referred to in the preceding taxonomic account.

49. One Peripatus, in a log 30 × $1\frac{1}{2}$ ft. on a hillside southeast of the Plantation. Altitude about 3,000 feet. July 7, 1913.

50. Two Peripatus, same as 49 per locality and date, in a small stump $1\frac{1}{2}$ ft. high and 5 inches in diameter, with borers (Passalus, etc.) imagoes, larvae, and pupae.

58. Peripatus in a rotten log with one beetle, isopods, ants, etc. Altitude about 5,300 feet. July 8, 1913.

    This log, like the others I had examined up to this time which contained Peripatus, was on an open hillside exposed to the sun, with Pteris growing all around. I found a cricket in this log which was fastened by its dorsal surface by a sticky secretion.

92. Peripatus on the trail toward Minca below the Plantation. Under bark on a live tree about $3\frac{1}{2}$ feet above the ground in a rather dry, dense forest. Altitude about 2,300 feet. July 15, 1913.

151. Small Peripatus in the forest southwest of the Plantation, under leaves. Altitude about 2,200 feet. Died before being preserved. July 21, 1913.

152. Peripatus in the centre of a very soft log which could be torn apart with the hands. Same locality and date as 151.

171. Two small Peripatus beside the trail under the bark of a rather firm log which had been bored by beetles. The bodies of these

two animals were in contact when taken. On the trail toward Minca below the Plantation in forest. Log exposed to full rays of sun. Altitude about 2,100 feet. July 24, 1913.

172. Three Peripatus, same locality as last, one under the bark of a log, two in cavities made by beetles in log.

179. Peripatus under log in forest southwest of the Plantation. Altitude about 2,200 feet. July 25, 1913.

Locomotion. They crawl backward as well as forward, and may use one, two, three, four, five, or six pairs of legs at the anterior end alternately, but may use all pairs of legs together. I placed several in a big white developing tray. They often crawled away from the light, though they frequently went toward it, or without reference to it. Often when they came to the edge of the dish, or sometimes when a card was held between them and the light, they raised the anterior end and waved it about. The last or last two pairs of legs are usually not used in walking but are held quiet above the substratum upon which the animal moves. Often the first three pairs of legs are thus held immobile.

I put Nos. 58 and 50 (large) in a vial with a beetle larva, a silver fish, and a milliped. Although these crawled over the Peripatus it did not shoot out any white threads. I pinched No. 50 (small); it turned its anterior end and shot out a colorless secretion which stuck to the forceps and fastened the myriopod to the tray so that it could not escape. I pinched No. 50 (large), and it gave out a colorless, rather viscid secretion from two ventral lateral papillae on the under side of the head. This secretion fastened the beetle larva to the bottom of the tray, but it soon hardened so that it was not sticky. I pinched it again. The head was turned back and the secretion shot out for a distance of about 2 cm. It formed a reticulate network on the back of the Peripatus and stuck it to my forceps. The Peripatus was unable to free itself from the forceps for an hour, when I released it.

On a later day I squeezed a Peripatus and induced it to throw threads from the bases of several of the legs behind the head.

Note on a Collection of Peripatus from Trinidad and Grenada. During a visit to Grenada and Trinidad during the winter of 1912-13, Prof. Roland Thaxter secured a very extensive collection of Peripatus from these islands, which he has given to the Museum of Comparative Zoölogy. Though unsuccessful in collecting further specimens of *Peripatus barbouri* Brues, a species peculiar to the high portion of Grenada, he obtained a single small specimen, (M. C. Z. No. 199), of

Peripatus collected by Mr. G. Whitfield Smith on the Island of Carriacou. This is quite different from the Grenada species, but it is impossible to identify it with certainty from the unique, evidently immature specimen. Although Carriacou is within sight of the northern coast of Grenada, it lies rather low and its comparatively dry climate is in great contrast to the very moist region in the higher mountains of Grenada where *P. barbouri* occurs.

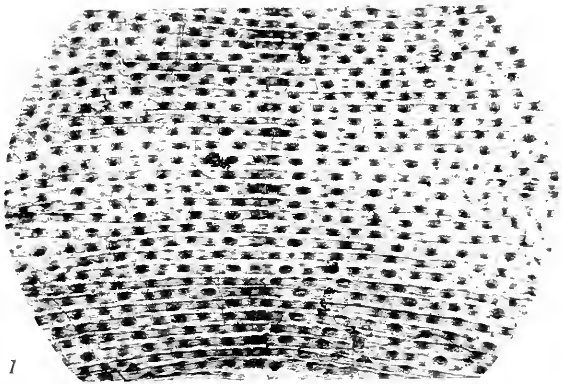
In Trinidad Professor Thaxter obtained fine series of both species hitherto known from that island; six males and seven females (M. C. Z. No. 201–208, 211–214, 217), of *P.* (*Epiperipatus*) *trinidadensis* Sedgwick, and two males and four females (M. C. Z. No. 209–210, 215–216, 218–219), of *P.* (*Macroperipatus*) *torquatus* von Kennel. In addition there is a single female (M. C. Z. No. 200), measuring 88 mm. in length with 31 pairs of legs belonging to *P.* (*Epiperipatus*) *imthurmi*, a species hitherto known only from the mainland of South America.

EXPLANATION OF PLATES.

PLATE 1.

Peripatus (Epiperipatus) vespuccii Brues.

Fig. 1. Portion of dorsal integument of paratype. (No. 150).
Fig. 2. Same, more highly magnified.
Fig. 3. Portion of dorsal integument of type. (No. 92).
Fig. 4. Same, more highly magnified.



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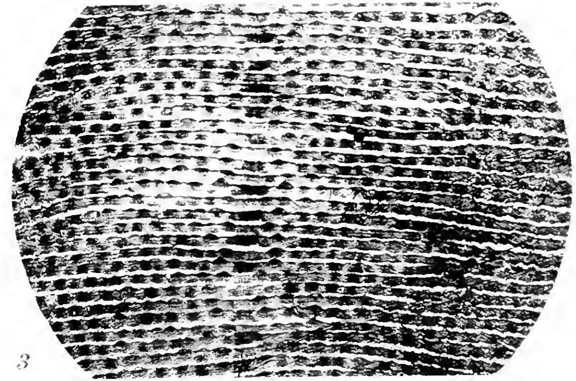

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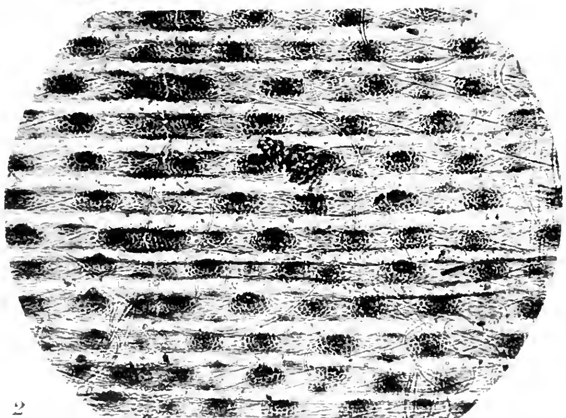

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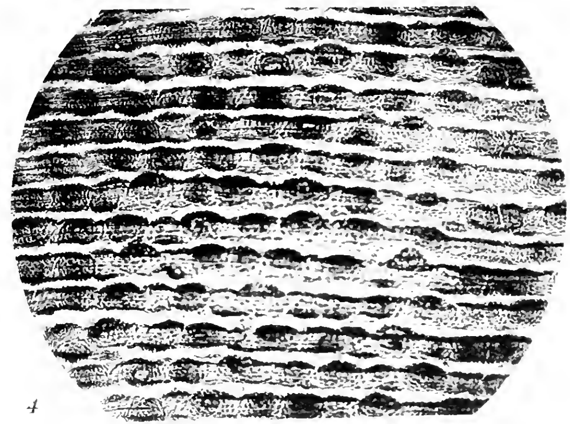

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HELIOTYPE CO., BOSTON

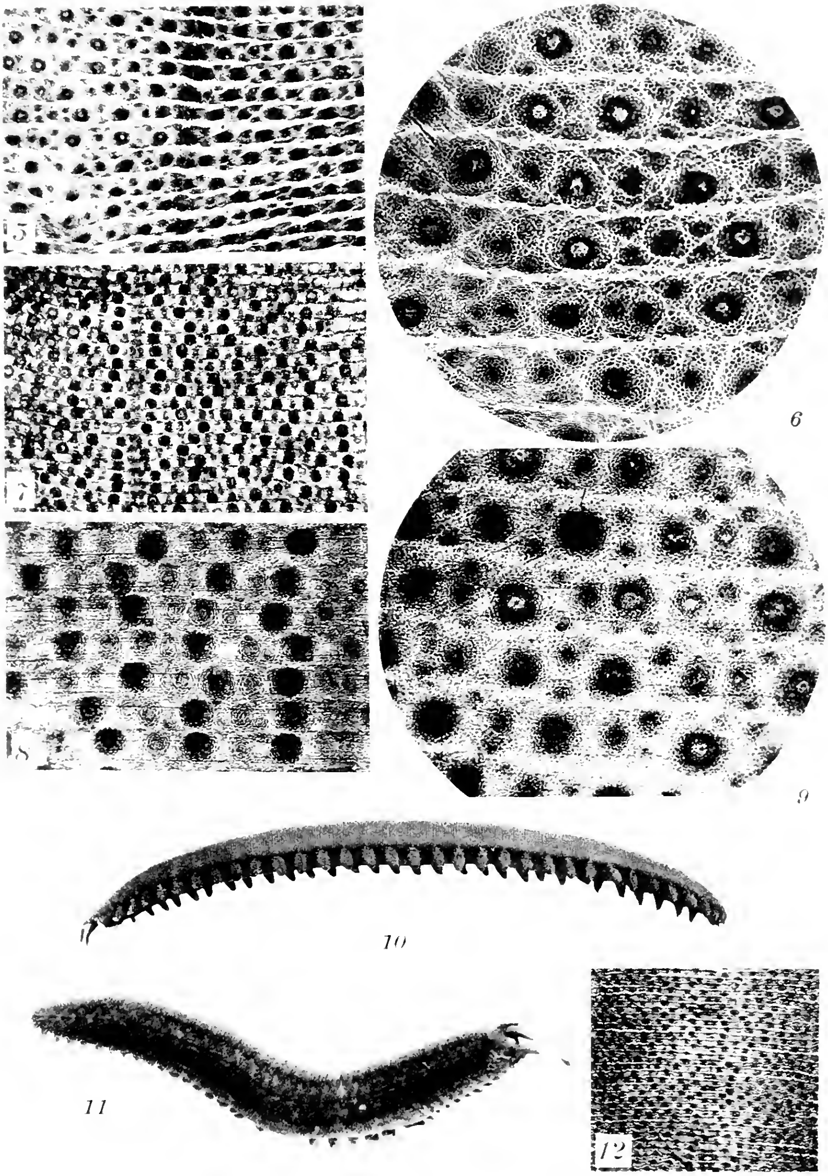
PLATE 2.

Peripatus (Epiperipatus) edwardsii Blanchard.

Fig. 5. Portion of dorsal integument. (No. 58).
Fig. 6. Same, more highly magnified.
Fig. 7. Portion of dorsal integument. (No. 50 small).
Fig. 8. Same, more highly magnified.
Fig. 9. Portion of dorsal integument. (No. 50 large).
Fig. 10. Lateral view. (Specimen from No. 171–172).

Peripatus (Epiperipatus) vespuccii Brues.

Fig. 11. Dorsal view of type. (No. 92).
Fig. 12. Portion of dorsal integument of paratype. (No. 151).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The following Publications of the Museum of Comparative Zoölogy are in preparation:—

LOUIS CABOT. Immature State of the Odonata, Part IV.
E. L. MARK. Studies on Lepidosteus, continued.
" On Arachnactis.
A. AGASSIZ and C. O. WHITMAN Pelagic Fishes. Part II., with 14 Plates.
H. L. CLARK. The "Albatross" Hawaiian Echini.

Reports on the Results of Dredging Operations in 1877, 1878, 1879, and 1880, in charge of ALEXANDER AGASSIZ, by the U. S. Coast Survey Steamer "Blake," as follows:—

A. MILNE EDWARDS and E. L. BOUVIER. The Crustacea of the "Blake."
A. E. VERRILL. The Alcyonaria of the "Blake."

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieutenant Commander Z. L. TANNER, U. S. N., Commanding, in charge of ALEXANDER AGASSIZ, as follows:—

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" The Thalassicolae.
O. CARLGREN. The Actinarians.
R. V. CHAMBERLIN. The Annelids.
W. R. COE. The Nemerteans.
REINHARD DOHRN. The Eyes of Deep-Sea Crustacea.
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H. J. HANSEN. The Schizopods.
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W. A. HERDMAN. The Ascidians.
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Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of ALEXANDER AGASSIZ, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding, as follows:—

R. V. CHAMBERLIN. The Annelids.
H. L. CLARK. The Holothurians.
—— The Volcanic Rocks.
—— The Coralliferous Limestones.
S. HENSHAW. The Insects.
R. VON LENDENFELD. The Siliceous Sponges.
—— The Ophiurans.
G. W. MÜLLER. The Ostracods.
MARY J. RATHBUN. The Crustacea Decapoda.
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L. STEJNEGER. The Reptiles.
C. H. TOWNSEND. The Mammals, Birds, and Fishes.
T. W. VAUGHAN. The Corals, Recent and Fossil.

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OF THE

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AT HARVARD COLLEGE.

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Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieut. Commander Z. L. Tanner, U. S. N., Commanding, in charge of Alexander Agassiz.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

Reports on the Scientific Results of the Expedition to the Eastern Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from October, 1904, to April, 1905, Lieut. Commander L. M. Garrett, U. S. N., Commanding.

Contributions from the Zoölogical Laboratory, Professor E. L. Mark, Director.

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Bulletin of the Museum of Comparative Zoölogy
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Vol. LVIII. No. 10.

OCEANOGRAPHY AND PLANKTON OF MASSACHUSETTS BAY AND ADJACENT WATERS, NOVEMBER, 1912–MAY, 1913.

By Henry B. Bigelow.

With One Plate.

[Published by Permission of H. M. Smith, U. S. Fish Commissioner].

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Reports on the Scientific Results of the Expedition to the Eastern Tropical Pacific, in charge of Alexander Agassiz, by the U. S. Fish Commission Steamer "Albatross," from October, 1904, to March 1905, Lieutenant Commander L. M. Garrett, U. S. N., Commanding, published or in preparation:—

A. AGASSIZ. V.[5] General Report on the Expedition.
A. AGASSIZ. I.[1] Three Letters to Geo. M. Bowers, U. S. Fish Com.
A. AGASSIZ and H. L. CLARK. The Echini.
H. B. BIGELOW. XVI.[16] The Medusae.
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[1] Bull. M. C. Z., Vol. XLVI., No. 4, April, 1905, 22 pp.
[2] Bull. M. C. Z., Vol. XLVI., No. 6, July, 1905, 4 pp., 1 pl.
[3] Bull. M. C. Z., Vol. XLVI., No. 9, September, 1905, 5 pp., 1 pl.
[4] Bull. M. C. Z., Vol. XLVI., No. 13, January, 1906, 22 pp., 3 pls.
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[16] Mem. M. C. Z., Vol. XXXVII., February, 1909, 243 pp., 48 pls.
[17] Mem. M. C. Z., Vol. XXXVIII., No. 1, June, 1909, 172 pp., 5 pls., 3 maps.
[18] Bull. M. C. Z., Vol. LII., No. 9, June, 1909, 26 pp., 8 pls.
[19] Bull. M. C. Z., Vol. LII., No. 11, August, 1909, 10 pp., 3 pls.
[20] Bull. M. C. Z., Vol. LII., No. 13, September, 1909, 48 pp., 4 pls.
[21] Mem. M. C. Z., Vol. XLI., August, September, 1910, 323 pp., 56 pls.
[22] Bull. M. C. Z., Vol. LIV., No. 7, August, 1911, 38 pp.
[23] Mem. M. C. Z., Vol. XXXVIII., No. 2, December, 1911, 232 pp., 32 pls.
[24] Bull. M. C. Z., Vol. LIV., No. 10, February, 1912, 16 pp., 2 pls.
[25] Mem. M. C. Z., Vol. XXXV., No. 3, April, 1912, 98 pp., 8 pls.
[26] Bull. M. C. Z., Vol. LIV, No. 12, April, 1912, 38 pp., 2 pls.
[27] Mem. M. C. Z., Vol. XXXV., No. 4, July, 1912, 124 pp., 12 pls.
[28] Bull. M. C. Z., Vol LVIII., No. 8, August, 1914, 14 pp.

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No. 10.—*Oceanography and Plankton of Massachusetts Bay and adjacent waters, November, 1912–May, 1913.*

By Henry B. Bigelow.

CONTENTS.

Introduction.

During the winter and early spring of 1912–1913 the Bureau of Fisheries Steamer Blue Wing carried on oceanographic investigations in Massachusetts Bay, under my supervision, continuing the work of the Grampus during the summer of 1912 (Bull. M. C. Z., 1914, **58**, p. 29–148). It was planned to make a trip every two weeks to a locality some eight miles south of Gloucester, in 35–40 fathoms; and also a few visits to Ipswich Bay, and to the waters off Cape Ann; but the frequent gales which made the season an exceptionally rough one interfered more or less with the program. This work was supplemented by Mr. W. W. Welsh, of the Bureau of Fisheries, who took temperatures, water samples, and tows at 32 stations, chiefly north of Cape Ann, during March, April, and May, while investigating the spawning habits of the coast schools of haddock. And a few temperatures, water samples, and tows were also taken on George's Bank, by Mr. W. F. Clapp, of the Museum of Comparative Zoölogy, and by Mr. Donthart, of the Bureau of Fisheries.

The subsurface temperatures were all taken with the Negretti and Zambra reversing thermometers; the water samples with the stop-cock water bottle previously described (Bull. M. C. Z., 1914, **58**, p. 37, fig. 1). The purpose of our plankton work being chiefly qualitative, we depended on horizontal tows, at different depths, with the 4 ft. net used on the GRAMPUS (Loc. cit., p. 39) beside various small nets. The salinities listed below were all obtained by titration. Each sample was tested twice, by Mr. Welsh, or myself, standard water being supplied by the International Committee for the exploration of the sea.

TEMPERATURE AND SALINITY, SOUTH OF CAPE ANN.

When we ceased work on the GRAMPUS at the end of August, 1912, the surface temperature was about 60° over the northern half of Massachusetts Bay, a noticeable cooling having already taken place from the summer maximum of 64° to 66°; and though there was a very rapid temperature decline from the surface downward to about 44.5° at 30 fathoms and 43° at 40 fathoms, the bottom temperatures in general at 30–40 fathoms were several degrees warmer than they had been at the beginning of July; the exact readings varying from place to place, consequent on tidal currents (*Loc. cit.*, p. 48). The salinity at the end of August was about 31.6 on the surface, 32.55‰ at 30 fathoms over the northern half of the Bay; 31.9‰ at the surface, 32.6‰ at 30 fathoms, 32.9‰ at 40 fathoms over its central portion, showing practically no change from the early part of July; and the water of the Bay was in stable equilibrium, the density (at the temperature *in situ*) being about 23.2 at the surface, about 25.5 at 30 fathoms.

On resuming work on November 20 (fig. 1, 3) it was found that the surface temperature had dropped to 48.5°, but the reverse change had taken place on the bottom, for while the 30 fathom temperature was 44.7° on August 31, on November 20, at nearly the same locality, it was 48° both at that level and at 25 fathoms. Thus the mean temperature for the whole column of water had fallen less than one degree, being about 49° on August 31, and 48.2° on November 20. The salinity (fig. 2), like the temperature, was nearly uniform with depth on November 20, being 32.57‰ at the surface, 32.57‰ at 25 fathoms; 32.6‰ at 30 fathoms, a degree of saltness about the same as the bottom salinity in this region at the end of August, and considerably higher than the mean salinity of the entire column of water at that time (August 31, Station 10,046, mean salinity 32.2‰). Density, for November 20, at the temperature *in situ*, disregarding pressure, was 25.24 at the surface, 25.27 at the bottom; *i. e.*, the vertical stability of the water was so slight that all that would be necessary to

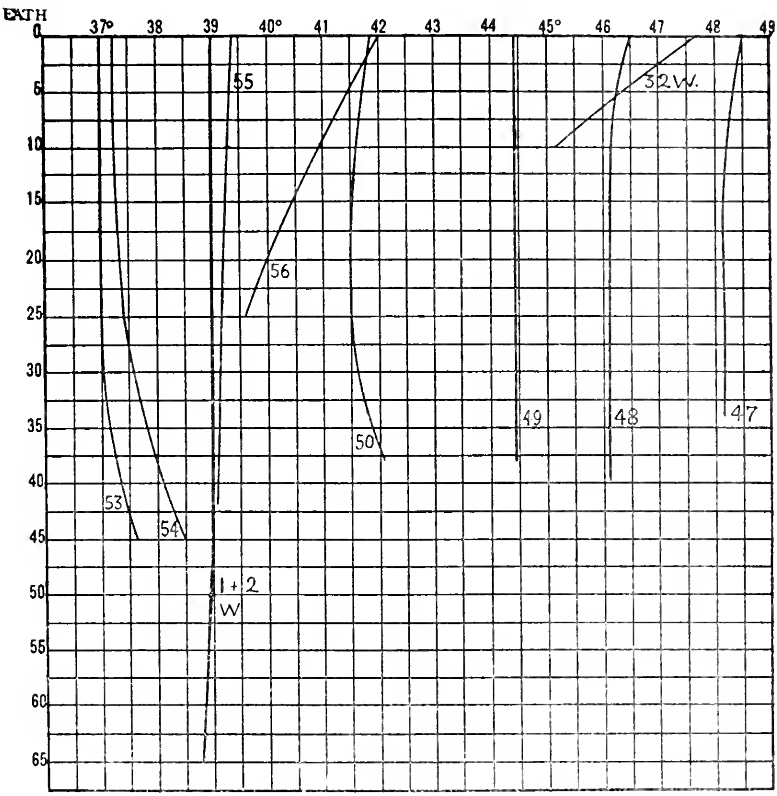


FIG. 1.—Temperature sections off Cape Ann, November 20 (Station 10,047); December 4 (Station 10,048); December 23 (Station 10,049); January 16 (Station 10,050); February 13 (Station 10,053); March 4 (Station 10,054); March 19 (Stations 1 and 2, W. W. Welsh); April 3 (Station 10,055); and off Gloucester Harbor, April 14 (Station 10,056) and May 17 (Station 32 W. W. Welsh).

cause a reversal of density, with consequent vertical circulation, would be a cooling at the surface of about 1°. Evidently then, dynamic overturning of the water might be expected to be active from this time onward as the surface became colder and colder with the advance of winter. And the data show that such was the case, for on the next visit, December 4, we found that the water was not only appreciably colder at all depths, but very nearly uniform from surface to bottom, the surface temperature having fallen to 6.6°, with 46.1° at 20 fathoms and at the bottom (30 fathoms). Probably the slight excess of heat at the surface over the deeper layers was the result of diurnal warming, the day being sunny and calm, with an air temperature at noon of 46°. The salinity was 32.56‰ on the surface and at 25 fathoms, 32.61‰ on the botton, *i. e.*, practically the same as at the preceding station (November 20). The density at the surface (at the temperature *in situ*) was 25.38, at 25 fathoms 25.39, at 38 fathoms (bottom) 25.42. The fact that the surface water was slightly less saline than the subsurface layers is no doubt to be explained as the result of recent rains.

The next station was made on December 23, on a bright sunny day, with a brisk northwest wind, and air temperature, in the shade, at noon, of 36°. Considerable cooling of the water proved to have taken place during the three weeks since our last visit, and the fact that this was the first station at which there was no change of temperature at all with depth, the reading being 4.5° from surface to bottom, shows that convectional overturning, together with tidal currents, now kept the water thoroughly mixed. The water samples proved especially interesting, for while the salinity, like the temperature, was uniform from surface to bottom, it was considerably higher than any previous reading in Massachusetts Bay, *i. e.*, 32.74‰, good evidence that there must have been an accession of salt offshore water, the origin of which is discussed (p. 400).

On January 16, 1913, at the same locality, the water had cooled to 41.7° at the surface; 41.5° at 25 fathoms; 42.1° at 38 fathoms, an instructive series for the fact that the lowest temperature was at the mid-level shows that the convectional overturning, now a constant phenomenon only interrupted by diurnal warming of the surface, was most active in the upper 25 fathoms, foreshadowing the time when cooling would be so rapid at the surface that the latter would be constantly cooler than the bottom. The slight excess of warmth (.2°) of the surface over the 25 fathom reading, was no doubt the result of diurnal warming during the preceding two or three days, which were unseasonably warm. The salinity was 32.81‰ at the surface; 32.86‰ at 25 fathoms; 32.94‰ at 38 fathoms (bottom); a considerable rise since the previous stations. The difference in salinity between surface and bottom was probably in part evidence of an inshore flow of salt bottom water from the deep basin (p. 400); but it was probably in part the result of heavy rains which fell during the preceding week.

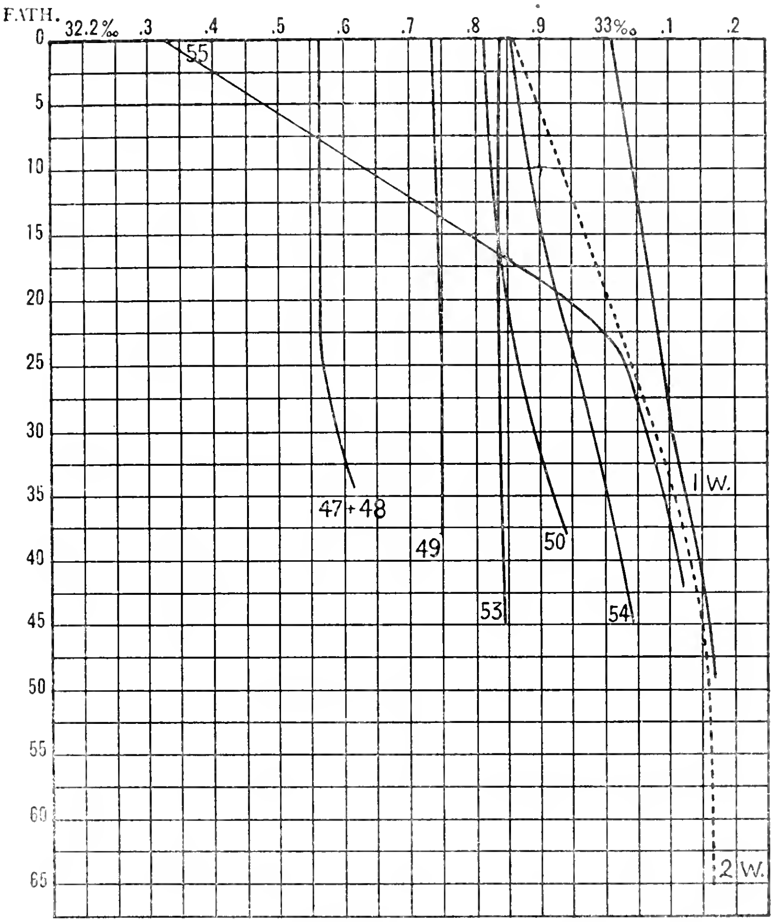


FIG. 2.— Salinity sections off Cape Ann, November 20 (Station 10,047); December 4 (Station 10,048); December 23 (Station 10,049); January 16 (Station 10,050); February 13 (Station 10,053), March 4 (Station 10,054); and March 19 (Stations 1 and 2 W. W. Welsh).

On January 30, a strong southwest wind and heavy sea made the occupation of our usual locality out of the question, though a station was occupied in 20 fathoms of water some three miles off Gloucester. The surface temperature had now dropped to 40.5° and at 19 fathoms to 41.7°, *i. e.*, we found the reversal of temperature foreshadowed on the last visit, which was to be a constant phenomenon from this time on until spring. The salinity at 19 fathoms proved to be practically the same as at the last station (32.8‰); but at the surface it had fallen to 32.56‰, no doubt as the result of a snow-fall of three inches

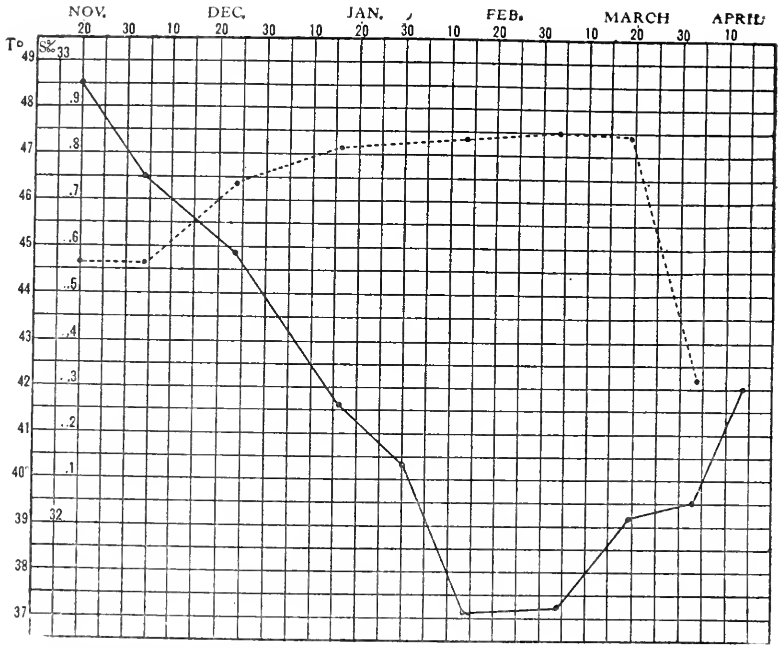


FIG. 3.— Surface Temperature ———, off Cape Ann and Gloucester, November 20 to April 13; and surface salinity . . . ., off Cape Ann, November 20 to April 3.

on the previous day. Owing to the comparatively fresh surface, the water was now temporarily in stable equilibrium, in spite of the fact that it was coldest at the surface, the density being 25.77 at the surface, 25.98 at 19 fathoms. After completing the station we ran through Squam River to Ipswich Bay, where, sheltered from the wind, we made a station for the sake of comparison with the waters on the south side of Cape Ann. The surface water proved to be considerably colder here, 40.3°, with 40.7° at 8 fathoms. But at 18 fathoms the temperature was 41.7°, practically the same as it was at the same depth on the Massachusetts Bay side of Cape Ann. The surface salinity, likewise, was much lower on the surface in Ipswich Bay, 32.20‰; but at 19 fathoms it was slightly higher, 32.9‰ as against 32.82‰. Of course it is impossible to be certain of the reasons for these differences, without any data on conditions in Ipswich Bay during the preceding three months, but the simplest, and probably the correct explanation for its low surface temperature is that the snow-fall in the recent storm was heavier there than over Massachusetts Bay, for melting snow ranks second only to melting ice as a cooling agent for surface waters; while the low surface salinity is no doubt an indication of the fresh water from the Ipswich and Merrimac rivers which empty near by.

The minimum temperatures for the winter were reached about the middle of February. Thus on February 13, at a station some five miles southeast of Cape Ann, the surface temperature was only 37.1°, with 37° at 25 fathoms, and 37.6° on the bottom in 45 fathoms: thus reflecting the wintry weather which had at last set in after an unusually mild season. At this station the air temperature was 20°, with a high northwest wind, and during the preceding night the thermometer had fallen to −2°. Salinity differed little from what was found at the last station but one in Massachusetts Bay, being 32.83‰ on the surface and at 25 fathoms, 32.84‰ on the bottom. And the fact that the difference between surface and bottom salinity was so slight is as good evidence as are the inverted temperatures, of active vertical circulation, for there had been two falls of snow since the last visit. And as a matter of fact, the water was in unstable equilibrium, the density being 26.19 at the surface, 26.18 on the bottom (pressure disregarded).

By March 4, when we made the next station some five miles east of the usual location, choosing this point because of the slightly greater depth (45 fathoms), both the weather and the water showed signs of spring warming, the surface temperature having risen by .1°, to 37.2°: at 25 fathoms by .5° to 37.5°, and at 45 fathoms by .9° to 38.5°, the air temperature being 32° with light snow falling. At the same time the water samples showed a decided rise in salinity, the surface being 32.85‰, with 32.96‰ at 25 fathoms, and 33.04‰ at the bottom, the latter a much higher salinity than any which we had previously obtained in Massachusetts Bay. In summer, water as salt as this was first found on the bottom some 35 miles east of the mouth of the Bay. The water was now once more in stable equilibrium (density at surface 26.18, at 45 fathoms, disregarding pressure, 26.30); and its stability might be expected to increase as warming of the surface progresses. Thus the process of winter cooling on the surface, with its consequent inversion of density, had come to an end by the beginning of March at the mouth of Massachusetts Bay.

It was a month before the Blue Wing resumed work; but in the meantime Mr. Welsh had commenced his haddock investigation at Gloucester, and on March 19, he occupied two hydrographic stations at very nearly the same locality as our last station, nine miles southeast from Cape Ann, in 45 and 65 fathoms of water. Mr. Welsh's temperature records show a decided rise on the surface, which had warmed to 39°, with the same temperature at 48 fathoms, the latter being unchanged from the last Blue Wing station. At 65 fathoms the temperature was 38.8°, 1.5° colder than I found it at that depth, and, indeed, generally over the bottom of the western half of the deep basin, in summer. The salinity proved to be 33.17‰ at the bottom, at both stations, a decided rise from two weeks previous; and interesting further because the deeper sample (65 fathoms) came from a circumscribed basin, the shallower one from its rim, thus repeating our experience in this same basin in July (Bull. M. C. Z., 1912, **58**, p. 65), when the bottom salinity was found to be the same as the salinity on the bottom over the enclosing shoal. At the surface, over the deep basin, the salinity was 32.84‰, precisely the same as it was when the Blue Wing last visited this region: but over the rim it was decidedly salter (33.01‰): probably an evidence of vertical stirring by tidal currents.

On April 3, the Blue Wing occupied a station some five miles southeast of Gloucester. By this time the surface temperature had risen to 39.3°, being practically uniform down to 30 fathoms, and slightly colder, 39.1° at the bottom, in 42 fathoms, the latter reading showing a rise of only .1° from Mr. Welsh's records two weeks before. And the fact that the temperature of the entire column of water had risen slightly is good proof that tidal currents still caused active vertical circulation, in spite of the increasing vertical stability of the water, the conductivity of sea water being too slight for us to suppose that the warmth of the surface had thus been propagated downward. But though the temperature had followed the expected course, the salinity had undergone a very striking change, for while the bottom and intermediate waters continued to show the progressive increase in saltness which had been taking place during the winter, with the very high readings of 33.12‰ on the bottom and 33.03‰ at 25 fathoms, (fig. 2) the surface salinity had fallen from 32.8‰ to 32.3‰ (fig. 3), which is, of course, good evidence that the influx of river water was beginning to flood the surface. And from the standpoint of dynamics this phenomenon is important, because it suddenly lowers the surface density to a marked degree, with consequent increase in vertical stability. Unfortunately only two more stations were occupied in Massachusetts Bay during the spring; but though both were so close to land that they are not strictly comparable with the data acquired further offshore, they show the advance of the general vernal hydrographic change. Thus on April 14, two miles off the mouth of Gloucester Harbor, the surface temperature had risen to 42°, the 25 fathom reading (bottom) being about the same as at the last station (39.4°). And on May 17, the surface water off Magnolia had warmed up to 47.3°, with 45.1° at 9 fathoms. Salinity meantime had fallen to 31.11‰ on the surface, 32.79‰ at 25 fathoms, on April 14: and it continued to fall, reaching 30.95‰ on the surface, 31.25‰ at 10 fathoms on May 17.

Temperature and salinity north of Cape Ann, March and April.

Mr. Welsh's oceanographic data for these months were taken chiefly in three general regions, *i. e.*, the neighborhood of the Isles of Shoals, near Boon Island, and a few miles off the coast between Cape Porpoise and Wood Island (Plate); and though his stations were chosen primarily for their fisheries interest, they proved to be well located for oceanographic purposes. The first two grounds together cover an area of some fifteen miles from northeast to southwest; but there is no important separation between the two, so far as temperatures are concerned. The salinity of the area, however, is less uniform, because subject to the immediate influence of the Piscataqua River. The Cape Porpoise ground, though nearer in actual distance to the Boon Island stations than the latter are to the Isles of Shoals, was very distinct hydrographically.

The Boon Island ground was visited on March 29, April 4, April 5, and May 14, while from April 22 to May 16 frequent observations were taken close to the Isles of Shoals and between them and the coast. On the first date the water was coldest at the surface, the readings being 38.3° at the surface, 38.7° at 17 fathoms, and 38.9° at 35 fathoms; *i. e.*, winter conditions still prevailed (fig. 4), although the surface had begun to grow warmer in Massachusetts Bay by this date (p. 391). At Boon Island, however, it was not until April 5 that the first sign of spring warming was evidenced by the equalization of temperature (39°) from surface to bottom. From this time onward, near the Isles of Shoals, there was a steady rise of temperature, which made itself felt first and most strongly at the surface, and later, to a much smaller degree, at the bottom (fig. 4). But the surface warming was very irregular, and often interrupted, and even temporarily reversed, by climatic conditions. During the winter

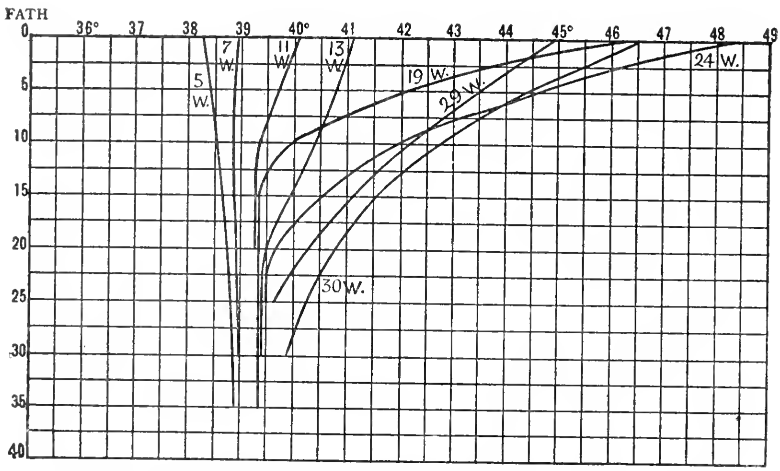


Fig. 4.— Temperature sections off Boon Island, March 29 (Station 5 W. W. Welsh); April 4 (Station 7 W. W. Welsh); and near the Isles of Shoals, April 13 (Station 11 W. W. Welsh); April 16 (Station 13 W. W. Welsh); April 26 (Station 19 W. W. Welsh); May 5 (Station 24 W. W. Welsh), May 13 (Station 29 W. W. Welsh) and May 14 (Station 30 W. W. Welsh).

when the column of water is of nearly uniform temperature from the surface downward, offshore winds have little effect on surface temperature, because although the surface water moves offshore, yet the waters which well up from below to take its place are of nearly the same temperature as those which they displace. But as soon as the surface is appreciably warmer than the underlying waters, any upwelling, or vertical mixing, is at once evidenced by a decided drop in surface temperature. Along the coast, upwelling is usually the result of northwest winds; but any gale causes more or less vertical mixing of the upper few fathoms by wave action. How active these disturbing factors were off the Isles of Shoals during the spring of 1913 is illustrated by the diagram of surface temperature (fig. 7). After a steady rise from 38.3° to 41°, a northwesterly gale cooled the surface to 40.3° by upwelling. It then warmed once more, under the influence of unseasonably warm weather, to 46.3° on April 26, when a northeasterly gale and rain, followed by high northwest wind, once more lowered the surface temperature to 44°. This was followed by another rise to 49° when a third northwesterly gale blew for several days, with the result that the surface was cooled to about 45°. When the wind changed to the south, the surface once more grew warmer, its temperature being 46.6° on May 14, when the latest observation was made. These surface irregularities are traceable down to about 5 fathoms (fig. 4) below which depth the progressive warming was comparatively regular. Until April 19 warming was limited to the upper 15 fathoms, below which depth the temperature was about 39.3° to the bottom (the deepest observations were at 30 fathoms); but by May 5 this temperature was found only below 20 fathoms, and from that time onward there was a slight rise in the bottom temperature to 39.9° on the 14th (latest station). This is about 2° colder than it was at this depth (30 fathoms) in this same region in the summer of 1912, but only about 1° lower than the water in the deeper parts of the basin between Jeffrey's Ledge and the mainland at that time.

The Boon Island stations (fig. 5) show that salinity reaches its maximum here in early spring just as it does southeast of Cape Ann. Unfortunately the observations do not show exactly what the maximum was for there is a gap in the data at the critical time from April 5 to April 13: but the fact that the salinity was 32.45‰ on the surface, 32.99‰ at 40 fathoms, March 29, with a mean of about 32.76‰ for the entire column of water, rising to 32.74‰ on the surface, 33.04‰ at 32 fathoms, on April 5, suggests that the maximum was about the same here as it is on the other side of Cape Ann. But whether or not this is the case, it is certain that in 1913 the maximum salinity was not reached off Boon Island until at least a week after surface freshening had begun to show itself in Massachusetts Bay. The numerous observations near the Isles of Shoals show a marked decline in salinity in that region from the middle of April till the middle of May, *i. e.*, from 31.43‰ to 29.54‰ followed by an irregular rise which was still in progress when the work came to an end. And a glance at the salinity curve for the surface (fig. 7) shows that it agrees closely with the temperature curve, periods of temporary cooling corresponding to a temporarily heightened salinity, surface salinity being raised as surface temperature is lowered by the upwelling of cold saline waters consequent on the several northwest gales already mentioned, or by the mixing of the upper few fathoms by wave action. An excellent example of the effect of the latter is afforded by two successive stations, April 26 and 29, a few miles outside the Isles of Shoals. On the former day the surface salinity was 30.03‰, when a northeast gale and heavy sea mixed the water sufficiently to raise the surface to 31.5‰, and to lower the 15 fathom salinity from 32.45‰ to 32.3‰, the bottom salinity remaining the same (fig. 5), the fact that the average salinity of the entire column of water had

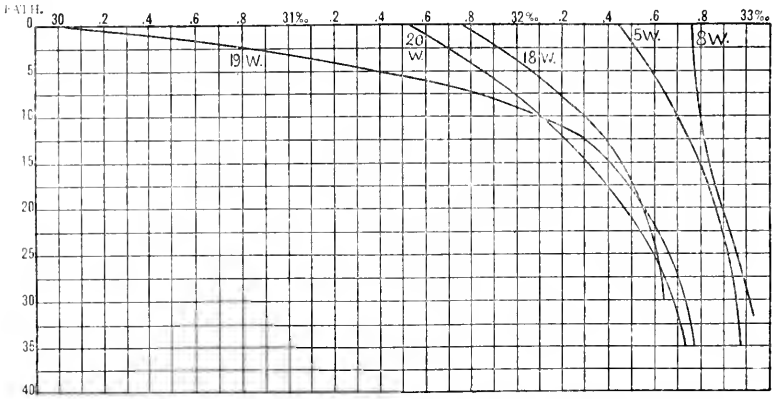


FIG. 5.— Salinity sections near Boon Island March 29 (Station 5 W. W. Welsh); April 5 (Station 8 W. W. Welsh); April 25 (Station 18 W. W. Welsh); and east of the Isles of Shoals, April 26 (Station 19 W. W. Welsh) and April 29 (Station 20 W. W. Welsh).

risen only from 32‰ on the 26th to 32.15‰ on the 29th showing that there had been very little influx of salt water from off shore.

The effect of a northwest wind, with consequent upwelling of bottom water, is illustrated by the sections for April 16 and 22 (Stations 13 and 16 Welsh, fig. 6), which show how the salinity of the entire column of water was raised by this process (mean salinity, Station 13 Welsh, 31.7‰: Station 16 Welsh, 32.0‰), though most markedly near the surface. And the fact that the rise is evident at the bottom (25 fathoms) shows that the influence of the wind causes an inshore movement of bottom water from greater depths further to the east, while the next salinity section (Station 17 Welsh, fig. 6) shows that this movement continued at least a day after the surface freshening once more reestablished itself. The minimum surface salinity was reached about May 5, near the Isles of Shoals, from which time on a rise is to be expected to the summer condition.

There was no separation between the waters just outside the Isles of Shoals, and the channel between them and the mainland so far as surface salinity is concerned. But the salinity sections (fig. 5, 6) show that the progressive freshening was much more strictly a surface phenomenon outside the islands than it was nearer the mainland, as might be expected from the fact that the inshore stations lie near the mouth of the Piscataqua River. After about May 5, when the water was freshest, there followed not only a rise in surface salinity, but a progressive though slight increase in mean salinity of the whole

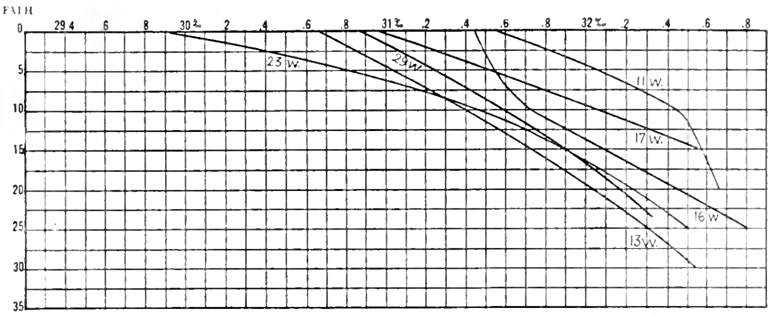


FIG. 6.— Salinity sections between the Isles of Shoals and the mainland. April 13 (Station 11 W. W. Welsh); April 16 (Station 13 W. W. Welsh); April 22 (Station 16 W. W. Welsh); April 23 (Station 17 W. W. Welsh); May 3 (Station 23 W. W. Welsh) and May 13 (Station 29 W. W. Welsh).

column (Station 25 Welsh, mean 31.1‰; Station 26 Welsh, mean about 31.2‰; Station 27 Welsh, mean about 31.4‰, Station 28 Welsh, mean about 31.4‰; Station 29 Welsh, mean 31.5‰; Station 31 Welsh, mean 32.7‰, the depths varying from 20–26 fathoms). And though the rise on the surface was once interrupted by heavy rain (Station 30 Welsh, May 16) the mean of 29 fathoms, 31.6‰, was practically unchanged from the last station. The weather was stormy during the period May 5–15, with a northwest gale on the 10th and 11th and 12th (*i. e.*, Stations 27 and 28 Welsh), which may partly explain the rising salinity. But the fact that it continued to grow salter after this, except as just noted, shows that the spring influx of river water had passed its maximum, and was gradually being absorbed by the general circulation of the Gulf.

The one station (18) made off Boon Island near the end of April (April 25, fig. 5) is especially interesting because the water proved to be considerably salter (surface 31.76‰, 15 fathoms, 32.46‰; 30 fathoms, 32.65‰) at the surface, and down to about 15 fathoms than the Isles of Shoals stations the day before or the day after, though below 15 fathoms its curve agrees almost exactly with the latter.

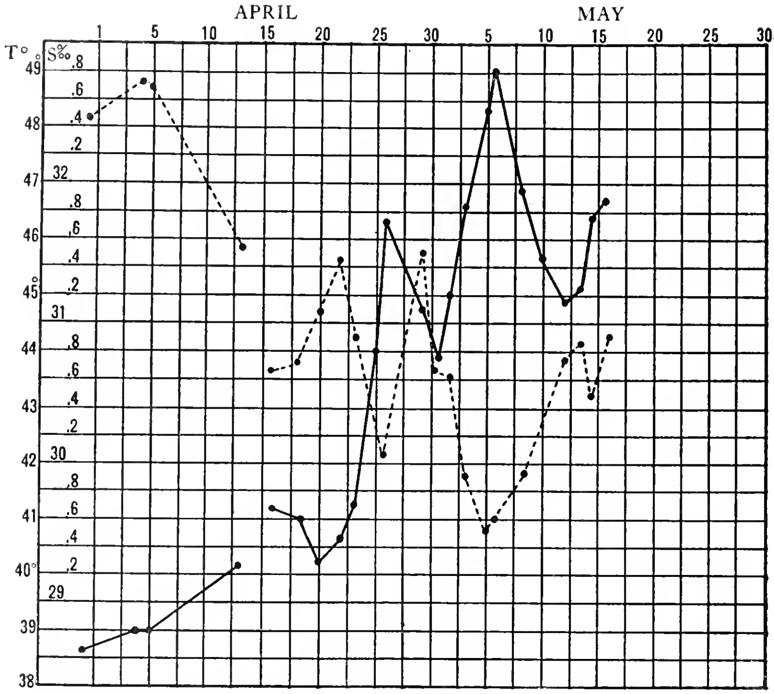


FIG. 7.— Surface temperature ——— and surface salinity, - - - - - - - -, near Boon Island, April 1–14, and near the Isles of Shoals, April 16–May 16

And inasmuch as there is no reason to assume any upwelling, the weather having been calm for the two preceding days, it is safe to conclude that the surface water was normally salter a few miles north of Boon Island than it was near the Isles of Shoals.

The Wood Island ground was visited April 9, 10, and 14. On the 9th, the temperature was practically equalized at 39° from surface to bottom, just as it had been off Boon Island four days earlier; and by the 14th, the surface had warmed up to 40.2°, though the bottom reading was still 39°. But although the water here agreed with the Boon Island region so closely in temperature, it differed widely in salinity, for on the 9th it was only 29.51‰ on the surface, with 30.79‰ at 9 fathoms, and 31.‰ at 18 fathoms: and the next day, a few miles closer to shore, the surface salinity was only 26.74‰, though the deeper readings were rather higher than before, *i. e.*, 31.8‰ at 11 fathoms and 32.52‰ at 29 fathoms. On the 14th, on the contrary, some five miles further south, off Cape Porpoise, the surface salinity was 29.13‰, with 31.92‰ at 10 fathoms, and 32.47‰ at 21 fathoms, these differences between stations so close together being probably the result of the tidal currents which were encountered in this region in the summer of 1912 (Bull. M. C. Z., 1914, **58**, p. 87).

Temperature and salinity on Georges Bank.

The data obtained from Georges Bank during the past season, is more important than its scantiness would suggest, because our knowledge of oceanographic conditions in that interesting region is extremely fragmentary. Mr. Clapp's water samples showed that in February the surface salinity was 33.04‰ on the southeastern side of the Bank (41° 10′ N, 66° 30′ W) which proves that it was not washed by the Gulf Stream, at least at that time. In the middle of April (Mr. Douthart's records, p. 419), the surface temperature, on the northern side of the Bank, was 44°; temperature at 25 fathoms (bottom), 43°; with 41.5° at 70 fathoms on its northern slope. The surface salinities varied from 33.21‰ to 33.38‰ at stations within a few miles of one another, the differences probably being due to more or less active vertical mixing which must result from the very violent tidal currents. No water samples were taken below the surface. The second set of records, April 26 to 27, is more instructive, because a series of water samples was taken from Boston Light ship to the northwestern edge of the Bank, as well as a bottom sample, and surface and bottom temperatures, on the latter. These showed an increase in salinity passing offshore, from 31.5‰ near Boston Light ship 32.29‰ off Cape Cod, and 33.13‰ half way from the latter to Georges Bank, to a maximum of 33.25‰ at Lat. 41° 34′ N, Long. 68° 45′ W, over the northwest slope of the Bank. But on its northwest part, the surface salinity was only 33.16‰, with 33.21‰ on the bottom in 35 fathoms. The surface temperature on the Bank was 46°, 2°

higher than on the last visit, the 35 fathom reading being 44°. The general increase in surface salinity from west to east, of course, was to have been expected from the previous records on the Bank, as well as from its geographic location, and from the fact that the shore water was at this time at its freshest (p. 393). But that the salinity was higher just northwest of the Bank than on the Bank itself is less easily explained. A bottom sample from the former would have shown whether the higher surface salinity was the result of the vertical mixing of a column of water nearly twice as deep, and consequently with a higher mean salinity, than the water over the Bank; and inasmuch as the tidal currents in this region are proverbially violent, it is likely that this is the explanation. But it is also possible that there was an indraught of salt water from the south, via the broad channel between Georges Bank and Nantucket shoals. Without more extensive data, it is impossible to settle the question.

General discussion.

The temperature and salinity records presented in the preceding pages, when added to the 1912 summer records, allow us to reconstruct the seasonal changes which the waters of the western side of the Gulf underwent from the summer of 1912 to the early spring of 1913. Summer conditions were marked by high surface temperature, with a rapid decline, and considerable increase in salinity, with depth. But even as early as the end of August the surface had cooled appreciably, while the bottom temperature, in 30–40 fathoms, had risen. And this process of equalization of temperature and salinity, progressed until, by the end of November, both these factors were nearly uniform from surface to bottom. Meanwhile the mean temperature of the whole column of water had fallen about 1°, while its mean salinity had risen appreciably. During the winter and early spring there was an irregular rise in salinity at all depths: the bottom water being usually saltest, in spite of the active vertical circulation. And the fact that the bottom salinity continued to rise after the surface salinity commenced to diminish, is good evidence that the rise is in general the result of an inward movement of the salt bottom water. It is evident that the thorough mixing of the water which had taken place by November must be caused by vertical circulation, which is no doubt the result of the rather strong tidal currents, growing more and more active as it is less and less strongly opposed by the vertical stability of the water. For the latter is diminished by surface cooling as the season advances, while it is, of course, progressively lessened as the column of water becomes more and more uniform in temperature and salinity, until, by the end of November, it no longer opposes any barrier to vertical currents.

After the water is practically uniform from top to bottom, a new cause for vertical currents is introduced, namely, the reversal of density consequent on further cooling at the surface. And after the beginning of December surface chilling was rapid, owing to the low temperature of the air, and to occasional falls of snow. As the winter progressed the surface temperature fell so fast that it was constantly coldest at that level, so that the water was in unstable equilibrium, aiding active vertical circulation which kept it thoroughly mixed until early March, when the first sign of spring was evidenced by a rise in surface temperature. The minimum temperature for the year was reached about the middle of February (surface 37.1°, 45 fathoms 37.6°), and though data from north of Cape Ann is lacking for this month, it is probable that it was about equally cold over the whole region studied. By the middle of March the surface was once more as warm as the bottom in Massachusetts Bay, and vertical stability thus reestablished, for the surface was rather less salt than the deeper layers. But north of Cape Ann, *i. e.*, near Boon Island and Cape Porpoise, surface warming was not apparent until about two weeks later. Up to this time dynamic overturning, together with the strong tidal currents, wave action, and the frequent upwelling of bottom water near shore, must all be active factors in reducing the inequalities of temperature and salinity over the Gulf as a whole; while there is very little influx of shore water to hinder the process. But the sudden flooding of the surface with river water acts as an effective check to vertical circulation by lowering the surface density to such a degree that the water shortly assumes a state of pronounced vertical stability, constantly increased by the progressive warming at the surface, a condition which characterizes it throughout the summer. The immediate result of this change is that surface warming goes forward more and more rapidly, while the bottom temperature, in 30–40 fathoms, rises so slowly that the difference between April and July at that level is only about 1°. And vertical movements are so much retarded that the surface freshening persists near the coast as late as August, although the river floods which cause it are at their maximum in April and May.

The fact that the spring freshening was felt first near Cape Ann and near Cape Porpoise is important as showing that there is a southwesterly long-shore movement of the river water at this season, its chief sources on this part of the coast being the Merrimac, the Kennebec, and possibly the Penobscot. And this agrees with our summer data (*Loc. cit.*, p. 91), as well as with the common report of a "spring current" flowing across the mouth of Casco Bay from northeast to southwest. The Merrimac water evidently flows around Cape Ann; but that it hardly enters Massachusetts Bay, is shown by the comparatively high salinities encountered by Mr. Douthart (p. 419), while summer salinities suggest that it must swing eastward off Cape Ann.

It is not known of course, how closely the changes outlined above are reproduced in other years; but to judge from the climate of the neighboring land mass, there is every reason to assume that they represent the normal cycle, though no doubt there are slight differences in salinity and temperature from year to year.

The Georges Bank records show that the water was considerably warmer there in April than it was close to the western coast of the Gulf at the same season; and salter than the latter is at any season. Furthermore the Bank water showed no sign of the spring freshening so evident near shore.

Our winter records do not afford any evidence that the low temperatures of winter are caused by an influx of northern water into our Gulf. On the contrary, the cooling is no more rapid, nor extreme, than can be accounted for by the winter climate of the neighboring land mass. And the data show clearly that the surface chilling depends closely on air temperature, a conclusion which is equally pertinent to the waters of Georges Bank in spring. But this does not prove that St. Lawrence water never affects the Gulf, for this source of supply may be expected to exert its greatest influence in autumn, as shown by Dickson's charts of salinities off Nova Scotia.

The salinities on Georges Bank in April are so low as to forbid the idea that the water there is chiefly Atlantic bottom water, though of course there may be some upward movement over the continental slope: and this is even more true of the Gulf itself, for nowhere does the water of the latter, at any depth, or at any season, approach the high salinity (34.9) of the abyssal water of the North Atlantic, so far as we know. The Gulf Stream certainly exerts little influence on the Gulf of Maine in winter; but plankton records show that there are irregular penetrations of its surface layers in summer.

Plankton notes.

The following general notes on the plankton may be of value, pending the appearance of the special reports on the more important groups of pelagic organisms collected during the winter.

The plankton which occupied the waters of Massachusetts Bay and the coast region between Cape Ann and Cape Elizabeth in August, 1912, consisted chiefly of copepods (*Loc. cit.*, p. 98), the most abundant species at the offshore stations being *Calanus finmarchicus*, with smaller numbers of *Pseudocalanus elongatus*, *Centropages typicus*, and *Metridia lucens*; *Anomalocera patersoni*, so conspicuous by its brilliant blue color, was often common on the surface, while the large boreal copepod *Euchaeta norvegica* occurred sparingly, though more or less regularly, in the hauls from intermediate depths. In addition to these copepods, the amphipod *Euthemisto compressa*, the schizopod *Meganyctiphanes norvegica*, the chaetognath *Sagitta elegans*, and the coelenterates *Staurophora mertensii*, Aurelia, Cyanea, *Pleurobrachia pileus*, *Bolinopsis infundibulum*, and Beroe, were regularly represented in the hauls. Other characteristic forms, less often taken, were the pteropods *Clione limacina* and *Limacina balea*; *Tomopteris helgolandica*, and *Sagitta serratodentata*. Quantitatively the macroplankton was very rich, the microplankton, on the other hand, was decidedly scanty, consisting chiefly of the peridinian, *Ceratium tripos*, with copepod eggs and nauplii, and very few diatoms.

When we resumed work at the end of November, the macroplankton was very much the same qualitatively as it had been in summer, *Calanus finmarchicus* being much the most numerous organism, with a few other copepods, *e. g.*, *Metridia lucens*, *Centropages typicus*, and *Pseudocalanus elongatus*, and notably *Euchaeta norvegica* (10–0 fathoms.) But Anomalocera, so numerous off Cape Ann in August, was noticeably absent, nor did we meet it at any time during the winter or early spring. Next in numerical importance were the chaetognaths, represented chiefly by *Sagitta elegans*, with a few *S. serratodentata*, the relative quantity in the haul with the 4 ft. net being copepods, 75 cc., Sagittae 15 cc. Considerable numbers of the amphipod *Euthemisto compressa*, a few pteropods, *Limacina balea*, many *Pleurobrachia pileus*, and fragments of Beroe, with a few crab and other decapod larvae were likewise found in the tow. The haul with the no. 20 silk net at the surface revealed a very scanty microplankton of much the same type as in summer, chiefly *Ceratium tripos*, with an occasional diatom (Rhizosolenia), and a good many copepod eggs and nauplii. Schools of pollack (*Pollachius virens*) were spawning near by, and consequently it is rather surprising that our hauls contained very few of their eggs and only two pollack fry. And throughout the spawning period, which lasted until January, the eggs were only very sparsely represented in the plankton catches; but with the haddock in spring the case was quite the contrary.

We found much the same type of plankton in early December, and though the catch, taken at its face value, would suggest a quantitative increase; the hauls are not comparable with one another though of the same length, because all were horizontal, while the speed of the vessel varied more or less. Furthermore, one might, another might not, pass through the zone of maximum richness; so that all they can be expected to yield in the way of quantitative results is whether the plankton was scanty, notably rich, or intermediate. The greater mass of the haul still consisted of *Calanus finmarchicus*, with a few *Euchaeta norvegica*. Sagittae were about one half as plenty in bulk as the copepods, chiefly *S. elegans*, with a few *S. serratodentata;* and as usual, Euthemisto was a conspicuous member of the plankton; the only coelenterates were a few *Pleurobrachia pileus*. The microplankton had not changed appreciably since November, being still very scanty, chiefly *Ceratium tripos*, with an occasional *C. fusus* and Peridinium, and very few diatoms, chiefly Chaetoceras.

As the winter advanced, and the water grew colder and colder, there was little noticeable change in the general type of the plankton. Thus on January 16th (St. 10,050) the bulk of the haul consisted of *Calanus finmarchicus* as usual, and of Sagittae, chiefly *S. elegans*. But though no Euchaeta were taken, the net yielded four specimens of the large northern copepod *Calanus hyperboreus*, a species not previously taken in the Bay, though we obtained it in other parts of the Gulf in summer (*Loc. cit.*, p. 102). The haul also contained a few *Sagitta serratodentata*, appendicularians (Oikopleura) *Tomopteris helgolandica*, and *Clione limacina*, all of which occurred more or less frequently in summer. Euthemisto, too, was plentiful. Two species of fish eggs were numerous, but no fish fry. The microplankton was still very scanty; but diatoms, chiefly Chaetoceras, with a few Coscinodiscus and *Thalassiothrix nitzschioides* now formed about one half its mass.

At the end of January, the tow in Massachusetts Bay was quantitatively about the same, with the addition of a few specimens of the large copepod Euchaeta; but Sagittae formed fully half its bulk. In Ipswich Bay, however, on the same day (St. 10,052) there were only twenty specimens of Sagitta in the haul, while we encountered a swarm of copepods, almost pure *Calanus finmarchicus*, with one *C. hyperboreus* and one *Euchaeta norvegica*, no less than 225 cc. being taken in the net. And this tow was decidedly richer, quantitatively, than any we had made since summer. Qualitatively it was extremely monotonous, the only large organisms, besides copepods and Sagittae, being a few Euthemisto, four *Tomopteris helgolandica*, unrecognizable fragments of an agalmid siphonophore, a few fish eggs, and a pycnogonid, the latter, of course, an accidental visitor from the bottom. The microplankton, likewise, was decidedly richer in bulk in Ipswich Bay than on the Massachusetts Bay side of Cape Ann, with fully as many diatoms (Chaetoceras) as Ceratium.

At our coldest Station (10,053, February 13th) Sagittae had usurped the chief importance from the copepods, there being 125 cc. of the former, and only about 50 cc. of the latter. The most abundant species was *S. elegans*; while the copepod swarm consisted chiefly of *Calanus finmarchicus*, as usual, with an occasional *Euchaeta norvegica*. The tow likewise yielded a considerable number of the boreal pteropod *Limacina balea*, besides appendicularians (*Oikopleura dioica*), *Tomopteris helgolandica*, and fragments of Beroe.

Up to this time the plankton had been decidedly uniform, the most important change being an irregular but unmistakable increase in the relative number of Sagittae. But when the water began to grow warmer, the zoöplankton decreased noticeably in quantity. Thus on March 4th, there were only 15 cc. of copepods (chiefly *Calanus finmarchicus*) in the haul, and only twelve specimens of Sagittae (*S. elegans*), nine Tomopteris, a few Euthemisto, and very little else except a considerable number of haddock eggs. On the other hand, the no. 20 net haul showed that there had been an appreciable increase of diatoms, chiefly Chaetoceras, with a few Coscinodiscus, and Thalassiothrix, these forms combined far outnumbering the few Ceratium (*C. tripos* and *C. fusus*). Later stations showed that this haul foreshadowed the vernal diatom swarm, a phenomenon now well known for the North Sea and for other parts of the eastern side of the north Atlantic. Thus on April 3d (Station 10,055) the water was visibly cloudy, and the nets were soon clogged with a slimy brown mass of diatoms. However, it was not a Chaetoceras plankton, as might have been expected from our earlier work; but was almost exclusively composed of two species of Thalassiosira, *T. gravida*, and *T. nordenskioldi*, with occasional specimens of *Chaetoceras decipiens*, *C. densum*, *C. atlanticum*, *C. contortum*, *Biddulphia aurita*, *Coscinosira polychorda*, *Thalassiothrix nitzschioides*, and *Rhizosolenia semispina*.

It is interesting to note that the diatom swarm was not uniformly distributed. On the contrary, while the net was towing near the surface, we could see it pass through clear bands, as well as through bands of diatoms, which gave it a brown color. This observation shows, too, how erroneous an idea of the quantitative richness of diatoms in the waters of Massachusetts Bay would have been afforded by a single vertical haul with a quantitative net.

At this same station the zoöplankton was as poor as the diatom plankton was rich, the only large organisms yielded by the nets being a few dozen copepods, one Euthemisto, two *Clione limacina* and a few unrecognizable bells of some agalmid siphonophore, besides a few barnacle (Balanus) nauplii, and, to my surprise, a considerable number of tests of Foraminifera. This was the first haul in which there were no Sagittae.

The diatom swarm continued at its height during the first half of April, hauls on the 14th (St. 10,056) yielding the same rich Thalassiosira plankton just described, and the zoöplankton still proved to be very scanty, the catch being only a few Calanus, one Tomopteris, one *Sagitta elegans*, one fragmentary Beroe, and one young Staurophora. But there were considerably more Balanus nauplii than before.

No plankton hauls were made north of Cape Ann, except the one station in Ipswich Bay noted above, previous to March 29th. But from that date onward, Mr. Welsh's stations show that the Thalassiosira swarm filled the coast water very generally from Cape Ann to Cape Porpoise during the whole of April, often being so dense as to discolor the water. Thus on May 2, he writes "the water yesterday and today full of green slime," and on the 3d, "the water is full of the greenish brown algae." Microscopic examination of his catches showed that the plankton was extremely uniform qualitatively, consisting almost altogether of Thalassiosira, with an occasional specimen of the other species noted for Stations 10,055 and 10,056 (p. 405). The catches were very clean up to about the first of May, but about that date, they began to contain noticeable amounts of diatom debris, and as the season progressed the relative amounts of dead specimens, and variously fragmented remnants, grew progressively greater until by the 25th of the month there were very few living diatoms, contrasted with large amounts of debris, among which the various genera which formed the swarm (particularly Chaetoceras and Thalassiosira) could be distinguished. In the latest hauls there were hardly any living specimens, though the nets yielded masses of fragments in various stages of decay.

During all this time the microplankton was extremely uniform qualitatively over all the area studied; but instead of being evenly distributed, it was streaky; and occasionally the hauls missed these streaks, and yielded hardly anything.

Mr. Welsh's hauls could not be expected to give as satisfactory an idea of the macro- as of the microplankton, because all of them were made on the surface in the day time, and previous experience has shown that it is only occasionally that daylight hauls at that level yield a representative sample. But they show that the larger organisms were usually scanty in April and May, just as they were in Massachusetts Bay early in April, and consisted of the same components, except that Euthemisto was lacking. However, off Wood Island, April 10th, he made a rich haul of Calanus, with many haddock and sand-dab eggs, Clione, Euthemisto, and Sagittae. And again, off the Isles of Shoals, on April 26th, the haul contained hardly any diatoms, but instead, great numbers of copepods, *Calanus finmarchicus* and Eurytemora in roughly equal proportions, though in each of these instances a haul the next day at almost the same locality yielded swarms of diatoms, chiefly Thalassiosira, with almost no macroplankton except fish eggs, and larval Balanus. And on May 14–16, when diatoms were diminishing, there was a decided increase in small copepods (chiefly Calanus) which probably foreshadows the time when the latter once more form the bulk of the plankton. This apparently takes place by the middle of May in Massachusetts Bay, for on the 3rd, Mr. Welsh found the water in Gloucester Harbor "reddened for areas of about a square yard several yards apart" with what proved to be swarms of copepod nauplii and young copepods. And on the 17th, hauls off Magnolia, Mass., yielded great numbers of small copepods, chiefly *Calanus finmarchicus*, with a few Eurytemora, besides many crab zoaeae, but no large organisms, and almost no diatoms.

The haul in Gloucester Harbor, just mentioned, was also notable for the number of Medusae which it contained, the list including swarms of *Sarsia tubulosa*, a few *Bougainvillea superciliaris*, *Rhathkea blumenbachi*, in both budding and sexual phases, half-grown *Tiaropsis diademata*, many very young stages of *Staurophora mertensii*, Obelia, young Aequorea, a very young Cyanea, and an agalmid bell. The fact that the Tiaropsis, Staurophora, Aequorea, and Cyanea were all very young, suggests that they must have passed through the fixed stage in the near neighborhood, as the Sarsia and Bougainvillea undoubtedly did. And in the case of the Staurophora this is especially important, because this Medusa has often been classed as an Arctic form. As a matter of fact, however, the available data show that it is a constant inhabitant of the Gulf of Maine. On May 17th, several specimens about two inches in diameter were taken; and I have seen it adult in Massachusetts Bay at the beginning of June.

Other animals, the young of which occurred in notable numbers were crabs (Cancer) as noted above, and especially the common barnacle (Balanus). In the case of the latter, the whole reproductive period was covered by the hauls near Boon Island and the Isles of Shoals, for its eggs were taken in large numbers on March 29th and April 4th off Boon Island, the nauplii at the same locality April 5th. By the 9th, the nets yielded large numbers of the "Cypris" stage with a few nauplii, and by the 19th, Cyprids only were taken. These reached their maximum abundance April 25th to 30th, when they formed the bulk of the macroplankton, from which time onward they diminished, though they were constantly present in small numbers until the middle of May, when they had practically disappeared.

The most interesting feature of the spring macroplankton, from the fisheries standpoint, was the sudden appearance of great swarms of the schizopod *Thysanoessa raschii.* A few specimens were taken in the nets on April 22, and on the 23d, when none chanced to be caught Mr. Welsh noted the "pollack schools feeding on shrimps which were also in dense schools," near the Isles of Shoals. On the 25th many were taken off Boon Island, and Mr. Welsh noted "the feed (shrimps) breaking water trying to get away from the pollack which are after them. The feed occurs in dense swarms, apparently 6 inches to a foot below the surface." Evidently they were an important food for surface-schooling fish. Early in May they were no longer in schools though from this time on occasional specimens were taken; and they again appeared in considerable numbers in the hauls near the Isles of Shoals on the 12th and 13th.

Mr. Welsh's work covered the spawning period of the haddock, and several of the hauls yielded great numbers of eggs, notably on April 23 (Station 17), May 6 (Station 25).

LIST OF COPEPODS. By *C. O. Esterly.*

The numbers indicate proportional, not absolute, numbers of the various species in each haul, except those in italics, which are the actual numbers of individuals. The symbol 00 indicates that the copepod component of the haul was composed almost exclusively of the species in question. The list includes the material taken at the BLUE WING stations and on Georges Banks.

Stations	Calanus finmarchicus	Calanus hyperboreus	Pseudocalanus elongatus	Euchaeta norvegica	Metridia lucens	Temora longicornis	Centropages typicus	Tortanus discaudatus
10,047	50		1		1		10	
10,048	20						2	1
10,049	40			*3*	10			
10,050	00	*6*						
10,051	00	*1*		*1*				
10,052	200	*2*	4	*2*				
10,053	200		1		4			1
10,054	80		6					
10,055	15		2					
41°, 37′ N. 67° 18′ W.	125					5		

List of hyperiid amphipods.

The numbers denote the relative abundance of the various species in the Plankton hauls, November, 1912–May, 1913, except those in italics, which give the absolute numbers of individuals in the hauls in question.

Stations	Euthemisto compressa	Euthemisto bispinosa	Hyperoche abyssorum	Hyperia medusarum
10,047	20	12	*1*	
10,048	15	25	*1*	
10,049	15	12		*1*
10,050	30	2	*1*	
10,051	*4*			
10,052	25	3	*1*	
10,053	30	5	*1*	
10,054	20		*2*	
10,055				*1*

No hyperiids were taken in any of the hauls made by Mr. Welsh.

List of euphausiids, identified by *H. J. Hansen.*

The Euphausiacea collected in the Gulf of Maine, during the summer of 1912 and winter of 1912–1913, have been identified by Dr. H. J. Hansen. They belong to six species:— *Meganyctiphanes norvegica* Sars, *Thysanoessa inermis* Kröyer, *Thysanoessa raschii* Sars, *Thysanoessa longicaudata* Kröyer, *Thysanoessa gregaria* G. O. Sars, and *Nematoscelis megalops* G. O. Sars, all so well known that only the geographic aspect of their occurrence need be touched on here. But this is considerable, because, so far as I can learn, only two euphausiids *Thysanoessa inermis*, and *Meganyctiphanes norvegica*, had been recorded from the Gulf previous to the cruise of the GRAMPUS in 1912.[1]

Thysanoessa raschii was not taken during the summer. The occurrence of the other species, for July and August, is shown on the accompanying table.

Stations	Meganyctiphanes norvegica	Thysanoessa inermis	Thysanoessa longicaudata	Thysanoessa gregaria	Nematoscelis megalops
10,002		×			
10,003	×				
10,007	×	×			
10,011		×			
10,019	×	×	×	×	
10,022		×			
10,023		×		×	
10,025	×				
10,026a	×				
10,027	×	×	×	×	
10,028			×		
10,029	×				
10,030		×			
10,031		×			
10,032	×	×	×	×	×
10,035	×	×			
10,036		×	×		
10,038		×			
10,041	×				
10,043	×	×	×	×	
10,049				×	
Eastport	×	×			

Thysanoessa inermis was very generally distributed over the Gulf, both in its central portion (Station 10,027) and near shore both east

[1] M. J. Rathbun. Fauna of New England. 5. List of the Crustacea. Occasional papers, Boston soc. nat. hist., 1905, **7**, p. 26.

and west, from Cape Cod to German Bank; the stations of capture being so located that it can not be said to have been absent from any considerable part of the Gulf. And it was even found in water as barren of plankton as the Grand Manan Channel (Station 10,035) and Eastport Harbor (*Loc. cit.*, p. 104). Few animals, except the copepod Calanus, were more consistent in their occurrence than *T. inermis.* It was most abundant north of Cape Ann in early July (Station 10,011), and on German Bank in August (Station 10,030); with minor centres of abundance off Penobscot Bay in August (Station 10,038) and in the northeast corner of the gulf (Station 10,036).

Meganyctiphanes norvegica was taken at nearly as many localities as *T. inermis* (12, as against 14); and its distribution over the Gulf was practically the same, except that we did not find it so regularly. However, its occurrences are too uniformly distributed to suggest any important local restriction further than that it, like *T. inermis*, was apparently not living in Massachusetts Bay. Meganyctiphanes was most abundant on German Bank (Station 10,029) and in Eastport Harbor, where it swarmed on the surface (*Loc. cit.*, p. 104). Elsewhere it was represented by a few specimens.

Thysanoessa longicaudata was taken less often than either of the preceding species, *i. e.*, at six stations (10,019, 10,027, 10,028, 10,032, 10,036, 10,043), thus being widely distributed over the shore parts of the Gulf, from Cape Cod to German Bank. But it was absent, so far as our hauls show, from the water close to the coast, in striking contrast to the abundance of Meganyctiphanes and *Thysanoessa inermis* near land. The only place where we found it in numbers was in the centre of the Gulf (Station 10,027), far from land. Elsewhere it was represented by occasional specimens only.

Thysanoessa gregaria was taken at the same number of stations (10,019, 10,023, 10,027, 10,032, 10,043, 10,049), and usually in the haul with *T. longicaudata*, the only station where the former was found and not the latter being on Platt's Bank (Station 10,023). But it was most numerous near Mt. Desert Rock (Station 10,032) instead of further off shore. In the other hauls there were only a few specimens.

Nematoscelis megalops occurred in only one haul, off Mt. Desert rock (Station 10,032 surface, a single specimen).

When work was resumed in autumn, off Cape Ann, schizopods were wholly absent, though the plankton was decidedly rich otherwise (p. 403). And the only euphausiid taken all winter was a single specimen of *Thysanoessa longicaudata* off Cape Ann, December 23. But, as pointed out above (p. 408) swarms of euphausiids appeared on the surface between Cape Ann and Boon Island, during the last half of April and continued more or less abundant until the middle of May. To my surprise the great majority of specimens in these hauls proved to be a species, *Thysanoessa raschii,* not taken in the Gulf in the summer. A few *T. inermis* were also taken on April 22, May 12, and May 13. But there were no *T. longicaudata, T. gregaria,* or Meganyctiphanes in the hauls.

The captures of *T. raschii* being from the surface, it is easy to establish salinity and temperature: — the former ranges from 30.6‰ to 31.7‰, the latter from 40.7° to 46.7°. Thus the species was living in extremely uniform water, with a combination of physical characters, low temperature coupled with low salinity, not paralleled anywhere in the Gulf, at any depth, in summer.

There is nothing surprising in the occurrence of any of these euphausiids in our Gulf, considering their distribution elsewhere.[1] In fact all might have been expected there. Thus Meganyctiphanes is widely distributed in Boreal waters near land. *Thysanoessa inermis, raschii,* and *longicaudata,* though cold water species, all extend as far south as the northern part of the North Sea [2]; *inermis* to Vineyard Sound (Rathbun, *Loc. cit.*). *Nematoscelis megalops* is a wide ranging oceanic species. *Thysanoessa gregaria,* according to Zimmer, (*Loc. cit.*, p. 21) is a southern form of very wide distribution in the warmer parts of the Atlantic. Its appearance in the Gulf of Maine is caused by the Gulf Stream water, which is its oceanic constituent. But the details of the occurrence of these various species in the Gulf are less easily understood. For example, it was surprising to find *Thysanoessa longicaudata* and *T. gregaria,* a cold water and warm water species, side by side, instead of finding the latter side by side with other warm water organisms, *e. g.* Salpa and Physophora (Bull. M. C. Z., 1914, **58**, p. 103). Equally hard to explain is the fact that the occurrence of *T. raschii,* absent in summer, abundant in early spring, is exactly the opposite of that of *T. inermis* (abundant in summer, absent in winter and early spring), although both are northern species, finding their southern limit near Cape Cod. Possibly the seasonal influence of the St. Lawrence water may give the clue, *T. raschii* being rather the more northern of the two species; but this seems hardly likely, inasmuch as both are widely distributed in the Arctic Ocean. Other possible factors are salinity and food supply.

[1] Zimmer, C. Schizopoden. Nordisches Plankton, 1909, **6**.

[2] Kramp, P. L. Cons. Int. Expl. de la Mer. Bull. Trimestr. 1913, **3**. p. 539, Schizopoda.

Finally, a phenomenon of some interest is the apparent absence of *Meganyctiphanes norvegica* from Massachusetts Bay at all seasons. There seems to be nothing in temperature or salinity to bar it from the waters of the Bay, for in summer, at some depth, the Bay closely reproduces the combination of temperature and salinity in which we found it swarming in Eastport Bay in August (salinity about 32.4‰ to 32.6‰, temperature 52°); and in winter the Bay is very little colder than the northern part of the North Sea, where Meganyctiphanes is common at that season. Its absence or rarity in the Bay is perhaps analogous to its absence in the southern part of the North Sea, where, as Kramp points out, both salinity and temperature would allow its existence. His explanation is that it is prevented from spreading southward in the North Sea by the shallow water, Meganyctiphanes being, according to his view, chiefly an inhabitant of the deeper water layers. But it can hardly be shallow water which bars it from Massachusetts Bay because many of our records for the species were from hauls no deeper than the deeper parts of the Bay, and because it was found in swarms on the surface at Eastport, in water of almost precisely the same temperature and salinity as the surface water off Cape Ann in November. Food supply, not hydrographic conditions, may be the factor which determines the local occurrence of Meganyctiphanes in the Gulf.

Plankton from Georges Bank.

The data for the season is limited to the few hauls made by Mr. Douthart during two trips, April 14th and 26th–27th, which, being taken at the surface with a small net, cannot be expected to give so complete a survey of the plankton as the work carried on in Massachusetts Bay. There must have been a fairly abundant macroplankton on his first visit, for the samples contained a considerable number of copepods, chiefly *Calanus finmarchicus* and *Temora longicornis* in the proportion of about 5–2; *Sagitta elegans*, and many specimens of the small Anthomedusa *Hybocodon prolifer*, with a few young *Staurophora mertensii*. The list also includes occasional specimens of *Oikopleura dioica* and *Tomopteris helgolandica*, besides many Arachnactis larvae; but the most interesting find is a large number of small colonies of two species of campanularian hydroids which were evidently living under pelagic conditions at the time, because the stems present no broken ends, but are growing actively in all directions. No doubt the strong tides and currents which flow over the Bank keep them afloat. They were submitted to Prof. S. F. Clarke for identification, and will be described more fully elsewhere. Large numbers of haddock eggs, nearly ready to hatch, were likewise found in the haul. The microplankton was decidely more abundant than the larger organisms, so much so, that, according to Mr. Douthart's accounts, the nets were soon clogged, although of large mesh. And he further noted that it was in streaks, not uniformly distributed. On microscopic examination, the mass proved to consist of diatoms; but qualitatively it was far more complex than the diatom swarm near shore, while the chief role was played by various species of Chaetoceras, especially *C. densum*, *C. atlanticum*, and *C. decipiens*, instead of by Thalassiosira, although *T. nordenskioldi* and *T. gravida* were both abundant. Other conspicuous species are *Ditylum brightwellii*, *Rhizosolenia obtusa*, *R. styliformis*, *R. semispina*, *Thalassiothrix nitzschioides*, Coscinodiscus, Coscinosira *Asterionella japonica*, with large numbers of Pleurosigma.

A little more than a week later, Mr. Douthart made a second series of tows on the western side of the Bank (p. 419), which showed that the macroplankton was apparently less abundant; and though it was of the same general type as before, Temora was about as abundant as Calanus. But the fact that the hauls were restricted to the surface makes it doubtful whether apparent variations in the relative numbers of different organisms have any real meaning. Other characteristic members of the plankton were *Sagitta elegans*, Oikopleura, the campanularian hydroids noted above, Actinian larvae, Hybocodon, *Pleurobrachia pileus*, and many haddock eggs. The microplankton was quantitatively as rich as on the last visit; but it had undergone a decided change qualitatively, its most important component, numerically, now being *Rhizosolenia styliformis*. In the last haul, this form was represented by occasional examples only; now it formed the greater part of the mass; and many of the specimens were so large (1.1 mm.) as to be easily visible with the naked eye.

Temperatures and salinities at Blue Wing Stations.

The numbers are consecutive with the Grampus stations of 1912. (Bull. M. C. Z., 1914, **58**, p. 135).

No.	Date	Position Lat.	Position Long.	Depth	Temp.	Sal. ‰
10,047	Nov. 20	42° 27′	70° 40′	0	48.5°	32.57
				25	48.2	32.57
				34	48.2	32.66
10,048	Dec. 4	42° 26′	70° 40′	0	46.6°	32.56
				25	46.1	32.56
				38	46.1	32.61
10,049	Dec. 23	42° 26′	70° 40′	0	44.5°	32.74
				23	44.5	32.75
				38	44.5	32.75
10,050	Jan. 16	42° 26′	70° 40′	0	41.7°	32.81
				25	41.5	32.86
				38	42.1	32.94
10,051	Jan. 30	42° 33′	70° 41′	0	40.5°	32.56
				10	40.7	
				19	41.7	32.82
10,052	Jan. 30	42° 43′	70° 39′	0	40.3°	32.20
				8	40.7	
				18	41.6	32.90
10,053	Feb. 13	42° 37′	70° 30′	0	37.1°	32.83
				25	37	32.83
				45	37.6	32.84
10,054	Mar. 4	42° 33′ 30″	70° 30′	0	37.2°	32.85
				25	37.5	32.96
				45	38.5	33.04
10,055	April 3	42° 33′	70° 30′	0	39.3°	32.32
				10	39.3°	
				20	39.3	
				25		33.03
				30	39.2°	
				42	39.1°	33.12
10,056	April 14	42° 33′	70° 39′ 30″	0	42°	31.11
				25	39.4	32.79

Temperatures and salinities at stations occupied by W. W. Welsh.

The deepest record depth at each station is at the bottom.

No.	Date		Position Lat.	Long.	Depth	Temp.	Sal. ‰
1	March	19	42° 31′	70° 29′	0	39°	33.01
					48	39	33.17
2	"	19	42° 35′	70° 28′	0	39.1°	32.84
					65	38.8	33.17
4	"	27	42° 51′	70° 20′	0	39.2°	32.61
5	"	29	43° 12′	70° 25′	0	38.3°	32.45
					17	38.7°	32.83
					35	38.9	32.99
7	April	4	43° 13′	70° 24′	0	39°	32.77
8	"	5	43° 10′	70° 28′	0	39°	32.74
					14	38.8	32.81
					28	39	
					32		33.04
9	"	9	43° 24′	70° 20′	0	38.9°	29.51
					9	39.1	30.79
					18	39.3	31.00
10	"	10	43° 23′	70° 21′	0	38.2°	26.74
					10	39.3	31.80
					21	39.2	32.52
11	"	13	42° 57′	70° 39′	0	40.1°	31.56
					10	39.4	32.43
					20	39.3	32.66
12	"	14	43° 18′	70° 26′	0	40.2°	29.13
					10	39.5	31.92
					20	39	32.47
13	"	16	42° 55′	70° 41′	0	41.1°	30.66
					11	40.4	31.47
					30	39.3	32.52

No.	Date		Position Lat.	Long.	Depth	Temp.	Sal. ‰
14	April	18	42° 56′	70° 41′	0	41°	30.79
					10	40.5	30.97
					24	39.3	32.47
15	"	20	42° 55′	70° 45′	0	40.4	31.11
16	"	22	42° 55′	70° 37′	0	40.7	31.43
					10	40	31.71
					25	39.3	32.80
17	"	23	42° 59′	70° 39′	0	41.2°	30.93
					6	40.4	31.53
					15	39.3	32.56
18	"	25	43° 12′	70° 27′	0	44°	31.76
					15	39.3	32.46
					30	39.2	32.65
19		26	43°	70° 35′	0	46.3°	30.03
					15	39.2	32.45
					35	39.2	32.74
20	"	29	43° 02′	70° 35′	0	44.8°	31.51
					15	39.3°	32.33
					35	39.2	32.72
21	May	1	42° 57′	70° 38′	0	43.8°	30.66
					26	39.3	32.48
22	"	2	42° 57′	70° 40′	0	45°	30.64
23	"	3	42° 54′	70° 42′	0	46.6°	29.92
					11	42.8	31.56
					25	39.3	32.49
24	"	5	42° 54′	70° 42′	0	48.3°	29.54
					12	41.3	31.95
					26	39.4	32.50
25	"	6	42° 56′	70° 41′	0	49.6°	29.60
					25	39.4	32.52
26	"	8	42° 56′	70° 41′	0	46.8°	29.93
					5	45.2	
					10	41.8	
					24	39.5	32.30

No.	Date	Position Lat.	Position Long.	Depth	Temp.	Sal. ‰
27	May 10	42° 56′	70° 44′	0	45.6°	30.44
				11	42	
				22	39.4	32.46
28	" 12	42° 56′	70° 45′	0	44.9°	30.73
				10	42.2	
				20		32.48
29	" 13	42° 56′	70° 44′	0	45.1°	30.88
				12	41.6	
				24	39.6	32.33
30	" 14	42° 58′	70° 35′	0	46.6°	30.50
				15	41.5	
				29	39.9	32.62
31	" 16	42° 56′	70° 42′	0	46.7°	30.94
				26	42.8?	32.39
32	" 17	42° 32′	70° 44′	0	47.3°	30.95
				9	45.1	31.25

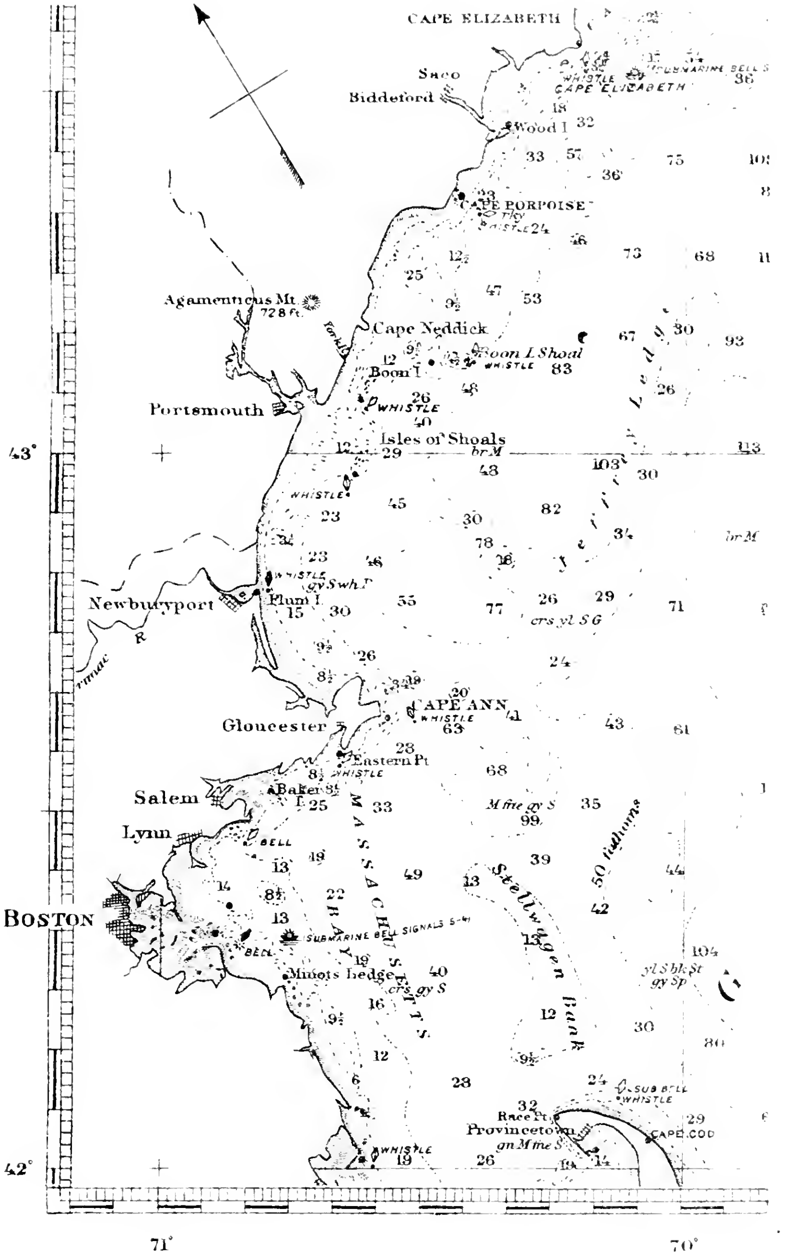
Temperatures and salinities, Massachusetts Bay to Georges Bank.

Location		Date	Surface temp.	Bottom temp.	Depth Fath.	Surface salinity	Bottom salinity
41°47′N	67°18′W	April 11				33.22	
41°37′N	67°18′W	" 14	44°	43°	25	33.21	
41°52′N	66°45′W	" 15				33.33	
42° 3′N	67° 1′W	" 15				33.22	
42° 8′N	67°12′W	" 15				33.38	
42°14′N	67°28′W	" 15	44°	41.5	70		
42°20′N	70°45′W	" 26				31.51	
42° 8′N	70°10′W	" 26				32.29	
41°48′N	69°21′W	" 27				33.13	
41°34′N	68°45′W	" 27				33.25	
41°27′N	68°20′W	" 27	46°	44°	35	33.16	33.21

EXPLANATION OF PLATE.

EXPLANATION OF PLATE.

Chart of the Coast, from Cape Elizabeth to Cape Cod. Reduced from the U. S. Coast Pilot.


CAPE ELIZABETH
Saco
Biddeford
Wood I
CAPE PORPOISE
Agamenticus Mt.
728 ft.
Cape Neddick
Boon I
Boon I. Shoal
Portsmouth
Isles of Shoals
Newburyport
Plum I.
CAPE ANN
Gloucester
Eastern Pt
Salem
Baker I.
Lynn
BOSTON
Minots Ledge
MASSACHUSETTS BAY
Stellwagen Bank
SUBMARINE BELL SIGNALS
Race Pt
Provincetown
CAPE COD
43°
42°
71°
70°

The following Publications of the Museum of Comparative Zoölogy are in preparation:—

LOUIS CABOT. Immature State of the Odonata, Part IV.
E. L. MARK. Studies on Lepidosteus, continued.
E. L. MARK. On Arachnactis.
A. AGASSIZ and C. O. WHITMAN. Pelagic Fishes. Part II., with 14 Plates.
H. L. CLARK. The "Albatross" Hawaiian Echini.

Reports on the Results of Dredging Operations in 1877, 1878, 1879, and 1880, in charge of ALEXANDER AGASSIZ, by the U. S. Coast Survey Steamer "Blake," as follows:—

A. MILNE EDWARDS and E. L. BOUVIER. The Crustacea of the "Blake."
A. E. VERRILL. The Alcyonaria of the "Blake."

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieutenant Commander Z. L. TANNER, U. S. N., Commanding, in charge of ALEXANDER AGASSIZ, as follows:—

K. BRANDT. The Sagittae.
K. BRANDT. The Thalassicolae.
O. CARLGREN. The Actinarians.
R. V. CHAMBERLIN. The Annelids.
W. R. COE. The Nemerteans.
REINHARD DOHRN. The Eyes of Deep-Sea Crustacea.
H. J. HANSEN. The Cirripeds.
H. J. HANSEN. The Schizopods.
HAROLD HEATH. Solenogaster.
W. A. HERDMAN. The Ascidians.
S. J. HICKSON. The Antipathids.
E. L. MARK. Branchiocerianthus.
JOHN MURRAY. The Bottom Specimens.
P. SCHIEMENZ. The Pteropods and Heteropods.
THEO. STUDER. The Alcyonarians.
—— The Salpidae and Doliolidae.
H. B. WARD. The Sipunculids.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of ALEXANDER AGASSIZ, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding, as follows:—

R. V. CHAMBERLIN. The Annelids.
H. L. CLARK. The Holothurians.
H. L. CLARK. The Ophiurans.
—— The Volcanic Rocks.
—— The Coralliferous Limestones.
S. HENSHAW. The Insects.
R. VON LENDENFELD. The Siliceous Sponges.
G. W. MÜLLER. The Ostracods.
MARY J. RATHBUN. The Crustacea Decapoda.
G. O. SARS. The Copepods.
L. STEJNEGER. The Reptiles.
C. H. TOWNSEND. The Mammals, Birds, and Fishes.
T. W. VAUGHAN. The Corals, Recent and Fossil.

PUBLICATIONS

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY

AT HARVARD COLLEGE.

There have been published of the BULLETIN Vols. I. to LIV.; of the MEMOIRS, Vols. I. to XXIV., and also Vols. XXVI. to XXIX., XXXI. to XXXIV., XXXVI. to XXXVIII., XLI., and XLIV.

Vols. LV. to LVIII. of the BULLETIN, and Vols. XXV., XXX., XXXV., XXXIX., XL., XLII., XLIII., XLV. to XLVIII. of the MEMOIRS, are now in course of publication.

The BULLETIN and MEMOIRS are devoted to the publication of original work by the Officers of the Museum, of investigations carried on by students and others in the different Laboratories of Natural History, and of work by specialists based upon the Museum Collections and Explorations.

The following publications are in preparation:—

Reports on the Results of Dredging Operations from 1877 to 1880, in charge of Alexander Agassiz, by the U. S. Coast Survey Steamer "Blake," Lieut. Commander C. D. Sigsbee, U. S. N., and Commander J. R. Bartlett, U. S. N., Commanding.

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieut. Commander Z. L. Tanner, U. S. N., Commanding, in charge of Alexander Agassiz.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

Reports on the Scientific Results of the Expedition to the Eastern Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from October, 1904, to April, 1905, Lieut. Commander L. M. Garrett, U. S. N., Commanding.

Contributions from the Zoölogical Laboratory, Professor E. L. Mark, Director.

Contributions from the Geological Laboratory, Professor R. A. Daly, in charge.

These publications are issued in numbers at irregular intervals. Each number of the Bulletin and of the Memoirs is sold separately. A price list of the publications of the Museum will be sent on application to the Director of the Museum of Comparative Zoölogy, Cambridge, Mass.

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Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

Vol. LVIII. No. 11.

NEW MIOCENE COLEOPTERA FROM FLORISSANT.

By H. F. Wickham.

With Sixteen Plates.

CAMBRIDGE, MASS., U. S. A.:

PRINTED FOR THE MUSEUM.

December, 1914.

Reports on the Scientific Results of the Expedition to the Eastern Tropical Pacific, in charge of Alexander Agassiz, by the U. S. Fish Commission Steamer "Albatross," from October, 1904, to March, 1905, Lieutenant Commander L. M. Garrett, U. S. N., Commanding, published or in preparation:—

A. AGASSIZ. V.[5] General Report on the Expedition.
A. AGASSIZ. I.[1] Three Letters to Geo. M. Bowers, U. S. Fish Com.
A. AGASSIZ and H. L. CLARK. The Echini.
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R. WOLTERECK. XVIII.[18] The Amphipods.

[1] Bull. M. C. Z., Vol. XLVI., No. 4, April, 1905, 22 pp.
[2] Bull. M. C. Z., Vol. XLVI., No. 6, July, 1905, 4 pp., 1 pl.
[3] Bull. M. C. Z., Vol. XLVI., No. 9, September, 1905, 5 pp., 1 pl.
[4] Bull. M. C. Z., Vol. XLVI., No. 13, January, 1906, 22 pp., 3 pls.
[5] Mem. M. C. Z., Vol. XXXIII., January, 1906, 90 pp., 96 pls.
[6] Bull. M. C. Z., Vol. L., No. 3, August, 1906, 14 pp., 10 pls.
[7] Bull. M. C. Z., Vol. L., No. 4, November, 1906, 26 pp., 4 pls.
[8] Mem. M. C. Z., Vol. XXXV., No. 1, February, 1907, 20 pp., 15 pls.
[9] Bull. M. C. Z., Vol. L., No. 6, February, 1907, 48 pp., 18 pls.
[10] Mem. M. C. Z., Vol. XXXV, No. 2, August, 1907, 56 pp., 9 pls.
[11] Bull. M. C. Z., Vol. LI., No. 6, November, 1907, 22 pp., 1 pl.
[12] Bull. M. C. Z., Vol. LII., No. 1, June, 1908, 14 pp., 1 pl.
[13] Bull. M. C. Z., Vol. LII., No. 2, July, 1908, 8 pp., 5 pls.
[14] Bull. M. C. Z., Vol. XLIII., No. 6, October, 1908, 285 pp., 22 pls.
[15] Bull. M. C. Z., Vol. LII., No. 5, October, 1908, 11 pp., 2 pls.
[16] Mem. M. C. Z., Vol. XXXVII., February, 1909, 243 pp., 48 pls.
[17] Mem. M. C. Z., Vol. XXXVIII., No. 1, June, 1909, 172 pp., 5 pls., 3 maps.
[18] Bull. M. C. Z., Vol. LII., No. 9, June, 1909, 26 pp., 8 pls.
[19] Bull. M. C. Z., Vol. LII., No. 11, August, 1909, 10 pp., 3 pls.
[20] Bull. M. C. Z., Vol. LII., No. 13, September, 1909, 48 pp., 4 pls.
[21] Mem. M. C. Z., Vol. XLI., August, September, 1910, 323 pp., 56 pls.
[22] Bull. M. C. Z., Vol. LIV., No. 7, August, 1911, 38 pp.
[23] Mem. M. C. Z., Vol. XXXVIII., No. 2, December, 1911, 232 pp., 32 pls.
[24] Bull. M. C. Z., Vol. LIV., No. 10, February, 1912, 16 pp., 2 pls.
[25] Mem. M. C. Z., Vol. XXXV., No. 3, April, 1912, 98 pp., 8 pls.
[26] Bull. M. C. Z., Vol. LIV, No. 12, April, 1912, 38 pp., 2 pls.
[27] Mem. M. C. Z., Vol. XXXV., No. 4, July, 1912, 124 pp., 12 pls.
[28] Bull. M. C. Z., Vol. LVIII., No. 8, August, 1914, 14 pp.

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AT HARVARD COLLEGE.

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NEW MIOCENE COLEOPTERA FROM FLORISSANT.

BY H. F. WICKHAM.

WITH SIXTEEN PLATES.

CAMBRIDGE, MASS., U. S. A.:

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DECEMBER, 1914.

No. 11. — *New Miocene Coleoptera from Florissant.*

By H. F. Wickham.

The very rich Coleopterous fauna of the Florissant shales was first studied by Dr. S. H. Scudder. He monographed the Rhynchophora as long ago as 1893 and seven years later published descriptions of the Adephaga and Clavicornia, with a few scattering members of other groups, expressing at the time his hope of completing the history at some later date. Illness and death intervened to prevent the fulfilment of this hope and general interest in the subject was so small that, with the exception of the description of half a dozen species by Cockerell and Beutenmueller, no more of the beetles were characterized for nearly a decade. Meanwhile several expeditions to the field had been made by various parties under Professor Cockerell which proved so productive that, upon the Coleoptera being submitted to me for examination, I was led to undertake a study not only of this material but also of that in the United States National Museum and the Princeton Geological Museum in the attempt to make the mass of specimens available for comparative statistical research in palaeontology. Later, I was able to make two trips to Florissant and to secure many additional species, especially those of small size. The combined results, so far as published, allowed my description of 172 new forms, which, with the 210 already made known by Scudder and the 6 described by Cockerell and Beutenmueller, raised the total number of species from these shales to 388. The present paper includes 86 novelties, while another, now in press, adds 20 more, thus giving a known fauna of 494 Coleoptera from this one locality. Perhaps sixty or eighty more remain in my hands for study and it is hoped that the investigation may be completed within a reasonable time. When the descriptive work is finished and the check list compiled, we shall have a basis for detailed comparisons with ancient and modern faunae sufficiently extensive to promise a fair degree of accuracy in our conclusions.

In this paper, I have confined myself, as far as descriptive work is concerned, to material from the S. H. Scudder collections, now the property of the Museum of Comparative Zoölogy. This is very rich in beautiful specimens representing over a hundred undescribed species and was very kindly thrown open to me by the Museum authorities. At the time of my visit, it was tentatively arranged in drawers according to families. In some cases, a study of the specimens showed the need of another assignment and in consequence the finished result of the examination does not exactly agree with the provisional numerical list of species by families of Dr. Scudder. For instance, there are no Histeridae in the lot, though he speaks of having two. Some other groups run considerably below his estimate while certain families that he had not recognized at all are represented. I do not care to give out complete figures in advance of working over the still unstudied material that I have from other sources, but it will be worth while to make some remarks based upon what has been done.

An examination of the Florissant species included in the three Phytophagous families, Cerambycidae, Chrysomelidae, and Bruchidae, shows a curious state of affairs when compared with coincident assemblages in North America of today. For the sake of showing this readily, I have compiled a table from published lists which will indicate, roughly at least, the relative specific differentiation in these families in several widely separated areas. I have given also the corresponding figures of the Florissant fossil fauna.

	Actual numbers			Relative frequency		
	Chrys.	Ceramb.	Bruch.	Chrys.	Ceramb.	Bruch.
Iowa.	193	122	10	100	63+	5+
Cincinnati.	161	142	8	100	88+	5−
Dist. Columbia.	233	174	23	100	75−	10−
Indiana.	265	147	15	100	55+	6−
Colorado.	205	113	10	100	55+	5−
Bayfield, Wis.	50	59	0	100	118	0
Alaska.	12	17	0	100	142−	0
Florissant.	26	25	16	100	96+	62−

This table has to do with species, not with specimens. In the section devoted to relative frequencies, I have taken that of the Chrysomelidae to be 100 in order to get a uniform standard of comparison. It will be noted at once that the Florissant ratio between the Chrysomelidae and Cerambycidae is, relatively speaking, not strikingly out of proportion with that shown between these families in Ohio and the

District of Columbia. It diverges more widely from the percentages shown in Iowa, Indiana, and Colorado, while compared with Alaska and the southern shore of Lake Superior the Chrysomelidae are better represented at Lake Florissant. The Bruchidae show such a marked disparity as to call for instant comment — for while in the modern lists cited they constitute at the most less than ten per cent as great a number of species as the Chrysomelidae, in the Florissant fauna they reach nearly sixty-two per cent. Unfortunately no good or relatively complete lists of all three families exist for localities in the southwestern states, but it is well known that the Bruchidae are more abundantly differentiated specifically in that district. The combined lists of Schaeffer and Snow comprise 24 Bruchidae from Brownsville, Texas, while Schaeffer records 15 species of this family from the Huachuca Mountains of Arizona. In neither locality is there any pronounced poverty of Chrysomelidae, however, so that the relative development of the two families is totally different from that seen at Florissant. It seems that the Bruchidae, like the Rhynchophora, were relatively more abundantly represented by specific forms than was the case with most of our modern families.

Another striking discrepancy in specific representation is found in the Byrrhidae. Eight species are recognized from Florissant, all of good size and none belonging to the Limnichini. If we exclude Limnichus from consideration, none of the recent lists cited contains so many, though we may assume that the faunae of their respective regions are much better known than that of the ancient lake.

From these considerations, we are justified in believing that the proportional development of the various coleopterous families during the Miocene times differed, sometimes very decidedly, from that obtaining today. Consequently we should be conservative in using data derived from comparison of these lists with recent ones as bases of conclusions as to probable climatic conditions.

Regarding the citation of catalogue numbers, I have followed Dr. Scudder's plan of joining by "and" those which belong to a single individual with its counterpart. The drawings of the new species are all made by myself with a camera lucida and are intended to show the form, the outlines of the principal sclerites and the courses of the chief lines of sculpture. Restoration has been avoided. In a few cases, where the members of different sides were unlike through distortion both have been drawn in enlarged detail without special comment.

CARABIDAE.

Bembidium obductum Scudder.

One poor specimen, No. 2,426 M. C. Z. (No. 6,529 S. H. Scudder Coll.) seems to belong here.

Amara revocata Scudder.

Two examples, No. 2,427 M. C. Z. (No. 3,233 S. H. Scudder Coll.); No. 2,428 M. C. Z. (No. 5,580 S. H. Scudder Coll.) are referred to this species though neither is in good condition.

Amara powellii Scudder.

One specimen, No. 2,429 M. C. Z. (No. 264 S. H. Scudder Coll.).

Amara cockerelli Wickham.

A single specimen, No. 2,430 M. C. Z. (No. 7,008 S. H. Scudder Coll.) referred here without much doubt.

DYTISCIDAE.

Bidessus laminarum, sp. nov.

Plate 1, fig. 1.

Form similar to that of the recent *B. affinis*. The specimen shows either a ventral view or the dorsal aspect of an insect from which the elytra have been lost and gives no sculptural characters of any value. The prosternum is like that of recent Bidessus, but the sutures between the proximal abdominal segments are more distinct than in the living form with which I have compared it. Length, 2.25 mm.

Described from a single specimen.

Type.— No. 2,431 M. C. Z. Florissant, Col. (No. 11,166 S. H. Scudder Coll.). The stone carries a small parasitic Hymenopteron on the same side as the Bidessus, while on the opposite face is Dr. Scudder's number, cited above, and the insect to which it originally referred.

The beetle is surely a small dytiscid and since it bears so close a resemblance to recent species of Bidessus it seems well to refer it here. Considering the small size, it is fairly well preserved. It is one of the smallest insects known from the Florissant shales.

Coelambus miocenus Wickham.

One specimen, No. 2,432 M. C. Z. (No. 5,859 S. H. Scudder Coll.) in poorer preservation than the type.

Hydroporus sedimentorum, sp. nov.

Plate 1, fig. 2.

Form short and stout, something like that of the recent *H. rivalis* and allied species. Head large. Prothorax distorted, but evidently nearly three times as broad as long. Coxal plates strongly and coarsely punctured, the punctures more or less confluent. Sternum between the plates similarly but hardly as strongly or thickly punctate, abdominal sculpture much finer. Hind leg stout. Length, as preserved, 3.25 mm.

Described from one specimen.

Type.— No. 2,433 M. C. Z. Florissant, Col. (No. 2,905 S. H. Scudder Coll.).

Distinguishable at first sight from *Coelambus miocenus* by the different form of the coxal plates as well as by that of the body. The state of preservation is not very satisfactory but I think that the outlines of the structures of the underside are properly delineated. None of the characters of the upper surface can be made out. I use the term Hydroporus in a broad sense, not being able to determine which of the genera of Hydroporini this insect should enter.

HYDROPHILIDAE.

Tropisternus limitatus Scudder.

One specimen, No. 2,434 (No. 3,807 S. H. Scudder Coll.).

Tropisternus vanus Scudder.

The only specimen No. 2,435 M. C. Z. is without original number and is evidently the counterpart of the one figured by Scudder.

Philhydrus scudderi Wickham.

Represented by one specimen, No. 2,436 M. C. Z. (No. 9,712 S. H. Scudder Coll.), slightly smaller than my type but exhibiting almost exactly the same proportions in length and breadth. It measures 4.50 mm. in length and 2.25 mm. in width.

Hydrobius titan Wickham.

One specimen, No. 2,437 M. C. Z. (No. 10,411 S. H. Scudder Coll.).

SILPHIDAE.

Silpha beutenmuelleri, sp. nov.

Plate 1, fig. 3.

Described from an elytron only, which is apparently a little broken at apex and much more so at base, but judging from the costae is approximately of its full original length. Sutural margin with well-defined bead, disk sharply tricostate, the costae nearly straight, slightly convergent apically, subequidistant, the inner separated from the suture by a distance markedly greater than the intercostal width. The outer costa, at middle, is about three fourths as far from the outer margin as from the suture, while exterior to it and separated from it by a space about equal to that between the suture and the inner costa is a deep groove extending the entire elytral length. Apex probably bluntly rounded. Punctuation well defined over nearly the entire surface, the punctures sharp and rather distant, finer at apex and (possibly on account of the state of preservation) not distinguishable exteriorly to the lateral groove. Length a trifle over 10 mm.

The single specimen is without counterpart.

Type.— No. 2,438 M. C. Z. Florissant, Col. (No. 5,111 S. H. Scudder Coll.).

At first, I had intended to refer this elytron to *Necrodes primaevus* from these shales. In length, the elytra of the two differ only about 1 mm., but the description of *N. primaevus* states that "except for the much shorter elytra it is difficult to separate this species by any tangible characters from the living *N. surinamensis.*" It seems unlikely that the two authors, Beutenmueller and Cockerell, would have overlooked so striking a difference as the spacing of the costae, which, in *N. surinamensis*, are about equidistant from each other and from the suture as well, while the distance from the exterior costa to the margin is relatively much less than in *S. beutenmuelleri*. The last species seems to have almost exactly the same arrangement of costae and groove as the recent European *S. tyrolensis* but the punctuation is finer and much better separated in the fossil. In this character it closely approaches the recent North American *S. noveboracensis*.

The insect is named for Mr. William Beutenmueller of New York.

STAPHYLINIDAE.

PHILONTHUS MARCIDULUS Scudder.

One good specimen, No. 2,439 M. C. Z. (No. 10,294 S. H. Scudder Coll.).

LAASBIUM AGASSIZII Scudder.

One example, No. 2,440 M. C. Z. (No. 1,229 S. H. Scudder Coll.).

COCCINELLIDAE.

COCCINELLA FLORISSANTENSIS, sp. nov.

Plate 1, fig. 4.

Form a little more elongate than in most of the recent North American species. Head in poor preservation, the outline broken. Prothorax short, sides not very well preserved but evidently arcuate and convergent anteriorly, apex much narrower than the base. Scutellum minute. Elytra without distinguishable maculation, estriate, outer edge margined but imperfect in the specimen. Upper surface extremely minutely alutaceous as in many recent Coccinellidae. Legs wanting. Length, 5.95 mm.

Described from one specimen.

Type.— No. 2,441 M. C. Z. Florissant, Col. (No. 8,884 S. H. Scudder Coll.).

The strongest reasons for placing this insect in the Coccinellidae are found in the form and particularly in the sculpture. My first impression was that it belonged in Hippodamia but the pronotum is much more like that of Coccinella and it seems better to place it in the latter genus for the present. The outline was probably similar to that of the recent *C. trifasciata* and less rotund than in the Florissant fossil *C. sodoma*. The generic reference must be understood in the broad sense, as it is not likely that the insect was a true Coccinella.

EROTYLIDAE.

Tritoma diluviana, sp. nov.

Plate 1, fig. 5–6.

Form elongate, much like the recent *T. festiva*. Under surface of head closely, and, relatively to the size of the insect, moderately coarsely punctured at the sides. Eyes elliptical as seen from below, of normal size. Antennae about equal in length to two thirds of the prothoracic basal width, club composed of three subequal joints. Prothoracic length at middle about four sevenths of the basal width, sides convergent anteriorly and nearly straight in the type, apex about one fifth narrower than the base, front angles prominent, punctuation finer than that of the head. Meso- and metasternal areas obscurely punctate. Abdominal punctuation moderately coarse but shallow and well separated. Legs not preserved. Length, 5.25 mm., in life a little less.

Described from one specimen showing the underside.

Type.— No. 2,442 M. C. Z. Florissant, Col. (No. 4,512 S. H. Scudder Coll.). No. 2,443 M. C. Z. (No. 9,097 S. H. Scudder Coll.) is evidently the same species though not the counterpart of the type.

In the second specimen, the sides of the prothorax are well preserved and are seen to be regularly but gently rounded from the base similarly to the recent *T. thoracica* or *T. flavicollis*. This species is easily distinguished from the Florissant fossils *T. materna* and *T. submersa* by its greater size and more elongate form.

COLYDIIDAE.

Rhagoderidea, gen. nov.

General outline of Rhagodera, but with the margins entire or nearly so. Elytral sculpture weaker than in Rhagodera, striatopunctate.

Antennae apparently 9-jointed, the basal (visible) joint stouter than the apparent second, the third, fourth, fifth, and sixth subequal but only about half the length of the second. Club 3-jointed, gradually formed. It is possible that the true basal joint is concealed in which case each of those noted above should be moved up one number in the series.

Type.— *R. striata*, sp. nov.

Rhagoderidea striata, sp. nov.

Plate 1, fig. 7–9.

Form moderately elongate, subparallel. Head of good size, roughly punctate, not so wide as the prothorax. Eyes not defined. Antennae rather short, reaching only slightly beyond the middle of the prothorax. Pronotum with only one side well preserved, but the length is evidently much less than the width, base and apex apparently subequal, side margin not or scarcely crenulate, a little reflexed, sculpture a rough punctuation similar to that of the head. Elytra about three and one half times as long as the prothorax, each with something more than eight fine but moderately deep punctate striae, the strial punctures of the same row close together. Interspaces apparently transversely wrinkled, somewhat cancellate near the elytral margins. Legs wanting. Length, 5.60 mm.

Described from one specimen.

Type.— No. 2,444 M. C. Z. Florissant, Col. (No. 7,006 S. H. Scudder Coll.).

While this beetle seems to be a colydiid, it disagrees in important characters with all the genera known to me. It is not at all surprising that insects like the Colydiidae become extinct, since they are highly specialized forms and are frequently very closely adapted to some particular habitat. This one is of large size for the family. It has something the appearance of Rhagodera but is not closely allied in any of the visible characters, even the sculpture being different.

CUCUJIDAE.

Pediacus periclitans Scudder.

One specimen, No. 2,445 M. C. Z. (No. 8,135 S. H. Scudder Coll.) It is like the type figure except that the antennal club is a trifle more pronounced.

CRYPTOPHAGIDAE.

Cryptophagus scudderi, sp. nov.

Plate 2, fig. 1–2.

Form stout. Head moderately large, closely and deeply sculptured with circular punctures. Eyes not definable. Antennae with the first joint much enlarged and thickened, intermediate ones submoniliform, club fairly strong and three jointed. Prothorax nearly twice as wide as long, base a little narrower than the apex, sides nearly straight posteriorly, broadly arcuate in front of the middle, surface punctate very similarly to the head. Elytra broader than the prothorax, apices rounded, surface rather finely scabropunctate. Legs not preserved. Length, 3 mm.

Described from one specimen with counterpart.

Type.— No. 2,446, 2,447 M. C. Z. Florissant, Col. (No. 3,334 and 5,880 S. H. Scudder Coll.).

Differs from *C. bassleri* in being larger and of more elongate form. There is also some difference in the proportions of the antennal joints but these are none too clear in the present specimen so I do not like to lay too much stress upon this character. The detail sketch is made from the reverse of the specimen which served for the outline of the entire insect.

Cryptophagus bassleri Wickham.

One specimen, No. 2,448 M. C. Z. (No. — ? S. H. Scudder Coll.).

DERMESTIDAE.

Dermestes tertiarius Wickham.

Two specimens, No. 2,449, 2,450 M. C. Z. (No. 7,683, 12,054 S. H. Scudder Coll.). The latter is a little smaller but otherwise is similar.

LATHRIDIIDAE.

Corticaria occlusa, sp. nov.

Plate 2, fig. 3.

Form moderately elongate. Head large, finely punctured, nearly as wide as the prothorax and not much shorter though the anterior margin is not well defined and is probably somewhat extended in apparent length by confusion with the crushed mouthparts. Eyes and antennae not definable. Prothorax about one half broader than long, sides moderately arcuate, disk punctured somewhat more coarsely than the head. Elytra rather coarsely, closely, but not deeply punctured, with no sign of strial arrangement. Legs wanting. Length, to abdominal apex, 3.10 mm.

Described from a single specimen.

Type.— No. 2,451 M. C. Z. Florissant, Col. (No. 7,109 S. H. Scudder Coll.).

This is smaller and rather more evidently punctured than *C. petrefacta.* In life, with the abdomen in normal position, it would be of about the same size as the recent *C. pubescens.*

Corticaria petrefacta Wickham.

Two specimens, one with counterpart, No. 2,452 – 2,454 M. C. Z. (No. 7,711, 520 and 1,020 S. H. Scudder Coll.).

Corticaria egregia, sp. nov.

Plate 2, fig. 4.

Form moderately elongate. Head about equal in length to the prothorax, finely, evenly and very closely punctate. Prothorax about one and one half times as broad as long, the apparently unbroken side nearly straight, apex not much narrowed, surface extremely closely punctate, more strongly and coarsely than the head. Elytra, taken conjointly, about one and one half times the prothoracic width, punctuation confused, much sparser and apparently a trifle coarser than that of the prothorax. Legs wanting. Length, to abdominal apex, 4.25 mm.

Described from one specimen.

Type.— No. 2,455 M. C. Z. Florissant, Col. (No. 7,305 S. H. Scudder Coll.).

Probably not a true Corticaria, but having the form of that genus it will be sought for in this place. There is no evidence of hairs, even under high power. The large size will separate it from similar Florissant species.

BYRRHIDAE.

Nosotetocus vespertinus Scudder.

One specimen, with counterpart, No. 2,456, 2,457 M. C. Z. (No. 8,196 and 9,054 S. H. Scudder Coll.).

Nosotetocus debilis Scudder.

Two specimens, No. 2,458, 2,459 M. C. Z. (No. 7,687, 11,246 S. H. Scudder Coll.).

Byrrhus romingeri Scudder.

One specimen, No. 2,460 M. C. Z. (No. 6,389 S. H. Scudder Coll.).

Chelonarium montanum, sp. nov.

Plate 2, fig. 5.

Form roughly elliptical. Head projecting slightly beyond the anterior prothoracic margin but showing no characters of interest. Pronotum subtriangular, very broad at the base which is lobed at middle and sinuate laterally, apex rounded, sides strongly convergent anteriorly. Along the basal margin is a series of strong punctures giving a crimped effect. Elytra broader behind the humeri, rapidly narrowing posteriorly, rounded at apex. Legs wanting. Length, from front margin of prothorax to elytral tip, 5.55 mm.

Described from one specimen.

Type.— No. 2,461 M. C. Z. Florissant, Col. (No. 2,975 S. H. Scudder Coll.).

This beetle has something the aspect of a Brachys, but the thoracic front margin seems to have nearly or quite concealed the head during life. The sculpture is very fine throughout but in places the elytra show traces of punctulate striae. The pronotum is margined at the sides. While I have no specimens of recent Chelonarium for comparison, I think that the reference to this genus is fairly safe, since, in all visible characters, the agreement is close to the description of LeConte and the figure of Lacordaire (Genera des Coléoptères, Atlas, Plate 24, fig. 4.). This correspondence extends even to the crimping of the pronotal base as will be seen by examining the cited figure with a magnifying glass. Chelonarium is found in Florida and Central America and the occurrence of this fossil adds another distinctively southern form to the Florissant fauna.

PARNIDAE.

Psephenus lutulentus Scudder.

One specimen, No. 2,462 M. C. Z. (No. 11,659 S. H. Scudder Coll.), evidently the counterpart of the one figured by Scudder.

Dryops eruptus Wickham.

Two specimens, No. 2,463, 2,464 (No. 6, 8,329 S. H. Scudder Coll.), appear to belong here.

Dryops tenuior Wickham.

A single specimen, No. 2,465 M. C. Z. (No. 3,756 S. H. Scudder Coll.) is in fairly good condition. It does not show the lines of elytral punctures which are faintly indicated in the type, but agrees in other characters.

DASCYLLIDAE.

Protacnaeus, gen. nov.

Form similar to that of Acnaeus or Ectopria, short, oblong ovate. Head of rather large size, antennae, in one sex at least, filiform. Anterior coxae contiguous. Middle coxae rather small, oblique, distinctly but not widely separated. Hind coxae oval, transverse, contiguous or nearly so. Abdominal segments subequal except the first and last which are longer.

Type.— *P. tenuicornis*, sp. nov.

Protacnaeus tenuicornis, sp. nov.

Plate 4, fig. 5.

Form short, stout. Head incompletely preserved but of large size. Eye large, rounded. Antennae probably broken and with the joints of the proximal half not distinguishable as such, those of the distal half slender and about twice as long as wide. Prothorax broad at base, narrowed to apex the sides poorly preserved. Elytron, seen from beneath, showing traces of strial punctures, neither deep nor coarse, the striae moderately distant, punctures round, those of each row separated by about their own diameters. Underside of trunk not visibly sculptured. Legs wanting. Length, to tip of abdomen, 4.60 mm.

Described from one specimen.

Type.— No. 2,466 M. C. Z. Florissant, Col. (No. 9,227 S. H. Scudder Coll.).

Like the other Florissant Dascyllidae, this species fails to agree very well with the living forms. It seems to require a new genus for its reception. It belongs to the Eubriini near Acnaeus which occurs today on our Pacific coast.

Miocyphon, gen. nov.

Body form similar to that of the elongate species of Cyphon. Antennae widely separated at base, 11-jointed, basal joint obscured, second smaller than the third, third to seventh subequal, scarcely serrate, distinctly longer than wide, eighth to eleventh longer, though not excessively so, a little wider than those preceding. Coxae not well defined on account of portions of the legs remaining in place, obscuring the view, but the front pair were approximate or contiguous, the middle well separated, the posterior nearly or quite contiguous.

Type.— *M. punctulatus*, sp. nov.

Miocyphon punctulatus, sp. nov.

Plate 2, fig. 6–8.

Form elongate, oblong-elliptical. Head of moderate size, eye large, rounded, antennae slender, scarcely serrate, in life reaching only about to the base of the elytra. Prothorax broad, sides arcuate, base evidently much broader than the apex. Elytron broad, subtruncate at tip, the surface finely, irregularly, and sparsely punctulate, the punctures showing in places some disposition to form rows. Legs in too poor condition for description. Length, 8 mm.

Described from one specimen.

Type.— No. 2,467 M. C. Z. Florissant, Col. (No. 454 S. H. Scudder Coll.).

Although of a puzzling nature, it seems that the family Dascyllidae may be utilized as a place for this insect. The characters which have led me to this assignment are to be found in the form, texture, and punctuation, the coxal structure, and the length of the distal antennal joints. This last feature is not truly characteristic of the Dascyllidae but occurs there, while in most of the other families to which the fossil might at first sight be referred the distal joints are shortened. I do not find any characters sufficiently suggestive to give a clue as to which tribe the insect should enter.

ELATERIDAE.

Eucnemis antiquatus, sp. nov.

Plate 2, fig. 9.

Form subparallel, not very slender. Head crushed too badly for description. Antennae with the intermediate joints strongly serrate, approximately one half broader than long. Prothorax distorted, sculpture obscure. Elytra separately somewhat rounded at apices, the sculpture poorly defined and showing only faint traces of striation. Length, to elytral apices, 7 mm.

Described from one specimen.

Type.— No. 2,468 M. C. Z. Florissant, Col. (No. 10,997 S. H. Scudder Coll.).

This seems to be a member of the Eucneminae and I have chosen the name of the typical genus to indicate the place of the species since there are no characters shown by the fossil which will serve as a basis for separation. The sculpture, though obscure, seems to have been rough like that of Sarpedon or Hylochares but the antenna is more like that of Eucnemis.

BUPRESTIDAE.

Dicerca eurydice, sp. nov.

Plate 3, fig. 1.

Form fairly slender for this genus but a little less so than would be inferred from the figure, the left margin of the prothorax and elytron being broken off in the fossil. Head of normal size and aspect, surface rather finely granulate, eye, viewed from above, oblique. Pronotum narrowed posteriorly, sides imperfect, surface scabrous, roughened with ill-defined longitudinal ridges and grooves. Elytra scabropunctate and granulate with scattered irregular indications of raised lines and striae, giving the normal appearance of rough sculpture found in most of the modern species of Dicerca. The elytral apices are sharply pointed. Length, to abdominal tip, 16.20 mm.; of elytron, 10.40 mm.

Described from one specimen.

Type.— No. 2,469 M. C. Z. Florissant, Col. (No. 11,649 S. H. Scudder Coll.).

The aspect of this fossil is that of Dicerca but the pointed elytra are foreign to my experience with modern species of the genus. In the lack of other characters for separation I prefer to leave it here. The form and general features, aside from the one noted, seem much like those of the living *D. spreta*. The specimen is in reverse, so that the granules described represent punctures.

Buprestis florissantensis, sp. nov.

Plate 3, fig. 2.

Form moderately stout, probably about as in the recent *B. aurulenta*. Head unnaturally extended, suborbicular, truncate behind, surface rather finely roughened. Antennae too poorly preserved for description. Prothorax much wider than the head, tapering from base to apex, the sides too badly damaged to allow of their shape being determined, surface roughened but without definable sculpture. Elytra simply rounded at apices, surface with very poorly preserved sculpture of striae which are moderately coarsely and closely punctured in single series. Legs partly displaced and nowhere fully displayed but what can be seen indicates that they are moderately stout for this genus. Length, as preserved, 23.60 mm., in life undoubtedly a little less since the body of the fossil had been distended by maceration.

Described from one specimen.

Type.— No. 2,470 M. C. Z. Florissant, Col. (No. 8,890 S. H. Scudder Coll.).

My chief reason for referring this fossil to Buprestis rather than to Chalcophora or Dicerca is to be found in the nature of the elytral sculpture, since true generic characters are wanting. It is the largest of the Buprestidae from the Florissant shales, but unfortunately is not at all well preserved. Nevertheless it is easily recognizable at sight as a member of this family. Most likely it lived upon the pines which abounded on the shores of Lake Florissant.

Buprestis scudderi, sp. nov.

Plate **3**, fig. 3.

Form only moderately elongate or even somewhat stout. Head large, front with a deep indentation having a raised center, the remainder of the surface with fine crowded granules in fairly high relief. Prothorax about one and one half times as wide as long, sides apparently imperfect but, as preserved, nearly straight as if the thoracic apex and base were about equal. Basal margin sinuate each side. Pronotum covered with moderately closely set granules, more crowded towards the sides, rounded like those of the head but a little coarser and less in relief. Longitudinal median line present, not deep and possibly adventitious. Elytra sinuate along the exterior margin, truncate at apex, surface with very fine, sharp, crenulate raised lines representing punctured striae, the intervening spaces granulate in more than one series. Legs wanting. Length, to elytral tip, 18.50 mm., in life about 2 mm. less; of elytron, 10.75 mm. Width of prothorax, 5.50 mm.

Described from one specimen.

Type.— No. 2,471 M. C. Z. Florissant, Col. (No. 11,663 S. H. Scudder Coll.).

Since the specimen is in reverse, the granules and raised lines noted in the description represent corresponding punctures and striae. It does not seem to be very closely related to any of the recent North American species of the genus although these furnish among themselves such a variety of sculpture on the upper surface of the body.

MELANOPHILA HANDLIRSCHI Wickham.

This seems to be the most common buprestid of the Florissant shales. The present collection contains six specimens, one with counterpart, No. 2,476–2,482 M. C. Z. (No. 406, 502, 6,388, 8,404, 12,488, 16,356 and 16,357 S. H. Scudder Coll.). The first noted example is remarkable for its beauty and the perfection of preservation.

MELANOPHILA COCKERELLAE Wickham.

Represented by two specimens, one of which, No. 2,474 M. C. Z. (No. 15,077 S. H. Scudder Coll.), is 2 mm. longer than the type, while the other, No. 2,475 M. C. Z. (No. 5,727 S. H. Scudder Coll.), exceeds the original measurement by less than 1 mm.

ANTHAXIA EXHUMATA Wickham.

One poor specimen, No. 2,472 M. C. Z. (No. 1,855 S. H. Scudder Coll.).

CHRYSOBOTHRIS SUPPRESSA, sp. nov.

Plate 3, fig. 4.

Preserved in ventral aspect and therefore not displaying important features of sculpture. Outline similar to that of the recent *C. floricola*. Prothorax hardly differing in width at base and apex, sides almost straight, flanks with moderately large, rounded, shallow, often confluent punctures, the prosternum with the punctuation so strongly confluent as to form transverse grooves. Meso- and metasternal side-pieces sculptured about like the prothoracic flanks, the abdominal punctures finer and more widely separated. Margin of last ventral not serrulate. Anterior tibia curved but not visibly enlarged at apex though the preservation is not good enough to be sure. Length, exclusive of the extruded sex organ, 9.20 mm.; of the elytra, about 6.50 mm. Width of prothorax, 3.25 mm.

Described from one specimen.

Type.—No. 2,483 M. C. Z. Florissant, Col. (No. 6,898 S. H. Scudder Coll.).

Very much smaller than the Florissant fossil *C. haydeni* and with relatively shorter elytra than *C. gahani*. I think there is no doubt of its being a true Chrysobothris, but am unable to suggest its affinities with any of the numerous living North American species.

Chrysobothris coloradensis, sp. nov.

Plate 3, fig. 5.

Form stout. Head wanting. Pronotum not in very good condition but apparently broadest near the base, finely and rather closely but not deeply punctate, without the reticulate effect of Anthaxia. Elytra bluntly pointed at apex, outer edges not serrate, punctuation fine and quite sparse though not well preserved. Front femur moderately stout, not visibly toothed, tibia, though broken at tip, evidently a little curved. Middle tibia distinctly arcuate, the tarsal joints longer than normal in recent Chrysobothris but their articulations are not certainly definable. Length, from front margin of prothorax to elytral apex, 4.75 mm.

Described from one specimen.

Type.—No. 2,484 M. C. Z. Florissant, Col. (No. 3,733 S. H. Scudder Coll.).

Evidently a buprestid and probably a Chrysobothris with the facies of the recent *C. atrifasciata* or *C. ulkei*. It is small for the genus but several of the recent species are of practically the same size.

Ptosima silvatica, sp. nov.

Plate 3, fig. 6.

Form not very elongate. Head damaged so as not to exhibit its true shape. Prothorax very short, base bisinuate, punctuation fine and sparse on the disk, stronger and crowded on the sides, everywhere shallow. Elytra broken at apex, finely and regularly striatopunctate, the striae impressed, strial punctures elliptical or elongate, well separated, interspaces broad, flat or nearly so. Legs wanting. Length, as preserved, 5.60 mm., in life somewhat greater.

Described from one specimen.

Type.— No. 2,473 M. C. Z. Florissant, Col. (No. 11,731 S. H. Scudder Coll.).

At first sight, this insect resembles an Acmaeodera, but cannot enter that genus on account of the distinct mesoscutellum and separate elytra. Behind the mesoscutellum is a narrow wedge-like sclerite, probably equivalent to the "second scutellum" of Chlamys, but there is no way of determining whether it was visible during life of the fossil, when the elytra were closed. A similar structure is seen in the Florissant fossil which I described some time ago under the name *Acmaeodera schaefferi*, but my figure of that species does not show the line of division between the two parts. *Ptosima gibbicollis*, our common North American representative of the genus, exhibits the same arrangement in about the same proportions, but it is necessary to open the elytra to see it. Since the size, form and sculpture of *P. silvatica* are similar to those of *P. gibbicollis*, I have assumed them to be congeneric if the lines are not too closely drawn. It will be better to consider that both of the Florissant insects which I have described under Acmaeodera (*A. schaefferi* and *A. abyssa*) belong rather to Ptosima, though they differ in sculpture of the elytra.

Agrilus praepolitus, sp. nov.

Plate 3, fig. 7.

Form only moderately elongate, less so as a fossil than in life on account of crushing by pressure. Head large, transversely suborbicular, longitudinally finely striate anteriorly, occipital region minutely closely punctulate. Antennae moderately serrate but very poorly preserved. Pronotum, as preserved, flattened so as to increase the apparent width which is equal to twice the length, apex broader than the base which is distinctly bisinuate, sides rather weakly arcuate, front angles prominent, the left hind one with a strong arcuate carina. Surface not very coarsely but deeply punctured, the punctuation close and transversely confluent so as to form a reticulate pattern of intervening raised lines. Scutellum broader than long, not triangular but with a narrow posterior lobe, distinctly transversely carinate. Elytra not or scarcely sinuate along the outer margin, apices merely bluntly pointed, sculpture a distinct but not coarse scabrous punctuation, vestiture fine. Legs not preserved. Length, 7 mm.

Described from one specimen.

Type.— No. 2,485 M. C. Z. Florissant, Col. (No. 5,359 S. H. Scudder Coll.).

Very few of the Florissant fossils are so well preserved as this little buprestid. It is a remarkably satisfactory agrilid type and exhibits many of the characters used in our tables for the separation of recent species of this genus. By comparison with specimens of the common living North American *Agrilus politus*, the fossil is so nearly identical as to be separable with difficulty. It is entirely within the bounds of possibility that *A. praepolitus* infested the willows of the ancient lake shore.

LAMPYRIDAE.

Miocaenia, gen. nov.

Form of Caenia but the pectinations of the antennae are apical in origin instead of basal.

Type.— *M. pectinicornis*, sp. nov.

Miocaenia pectinicornis, sp. nov.

Plate 5, fig. 1–2.

Body elongate, subparallel. Head small, eyes destroyed. Antennae two thirds the length of the entire body, the joints external to the second rather strongly pectinate except the last which is simple. Prothorax small, not projecting over the head. Elytra long, sculpture obscure. Legs wanting. Length, 6.15 mm.

Described from one specimen.

Type.— No. 2,486 M. C. Z. Florissant, Col. (No. 6,994 S. H. Scudder Coll.).

Superficially this insect looks very much like *Caenia dimidiata* of our eastern and northern states, but the structure of the antennae is different. The European genus Drilus approaches it in this respect, but has a different body form. In the lack of knowledge of a recent genus which will acceptably receive the fossil, I have proposed a new name.

Podabrus fragmentatus, sp. nov.

Plate 4, fig. 1.

Form elongate. Head of moderate size, rather strongly narrowed behind the eyes which are of good size and apparently shortly elliptical, muzzle projecting. Antennae long, slender, if extended backward they would reach a point three fifths from the elytral base, joints not at all serrate, those near the middle nearly three times as long as broad. Prothorax crushed but evidently not very wide. Elytra long, tips bluntly rounded, sculpture fine and obscure. Legs poorly preserved but the pieces remaining show them to have been slender. Length, as preserved, 12.75 mm.; to elytral apices, 9.85 mm.; of elytron, 6.85 mm.

Described from one specimen with counterpart.

Type.— No. 2,487, 2,488 M. C. Z. Florissant, Col. (No. 4,218 and 4,638 S. H. Scudder Coll.). Two other specimens, No. 2,489, 2,490 M. C. Z. (No. 69, 2,546 S. H. Scudder Coll.) also belong here.

It is hard to find any very definite characters to separate this species from *P. florissantensis* but the latter has a larger head, longer elytra, and shorter antennal joints.

Podabrus wheeleri Wickham.

Three specimens No. 2,491, 2,492, 2,493 M. C. Z. (No. 5,946,—? —? S. H. Scudder Coll.) belong here. It is probable that the example No. 2,494 M. C. Z. (No. 11,165 S. H. Scudder Coll.) also belongs here.

Podabrus florissantensis, sp. nov.

Plate 4, fig. 2.

Form fairly stout. Head rather long in front of the eye which is slightly elliptical, the greater axis nearly longitudinal. Prothorax crushed but evidently much wider than long, the front margin straight. Elytra long, quite narrow, apices rounded, surface finely scabrous with traces of narrow costae. Legs too poorly preserved for description. Length, to elytral apices, assuming the head to be brought into its normal position, 10.10 mm.; of elytra, 7.35 mm.

Described from one specimen.

Type.—No. 2,495 M. C. Z. Florissant, Col. (No. 8,947 S. H. Scudder Coll.).

At first I had taken this insect to be an Epicauta, but that reference is invalidated by the form of the eye. Further examination indicates that it is allied to Podabrus and for the present I have placed it in that genus.

Telephorus hesperus, sp. nov.

Plate 4, fig. 3.

Form moderately elongate. Color apparently yellowish, the sides and sutural region of the elytra darker. Head of normal size. Eyes (not shown in the type) rather small, rounded. Antennae slender, long, not reaching the elytral tips, the joints not at all serrate. Prothorax rounded at the sides and apex, broader than long. Elytra subparallel, apices rounded, surface sculpture fine, about obliterated, without visible costae. Legs slender. Length of type, to apex of elytra, 4.50 mm.; of other specimens, ranging to a little over 5 mm.

Described from six specimens.

Type.—No. 2,496 M. C. Z. Florissant, Col. (No. 9,376 S. H. Scudder Coll.). Other specimens are No. 2,497–2,501 M. C. Z. (No. 2,243, 5,065, 5,515, 6,048, 12,769 S. H. Scudder Coll.).

A small species not unlike the recent North American *T. scitulus* but probably with the elytral markings more distinct. In some of the specimens of the fossil the elytral stripe is poorly defined, the one chosen as the type and serving for the figure being the best marked.

Polemius crassicornis, sp. nov.

Plate 4, fig. 4.

Form fairly stout. Head nearly concealed. Antennae stout but scarcely serrate, not quite reaching the middle of the elytra. Prothorax rounded at sides and apex and slightly at the base. Elytra covering the abdomen, apices rounded, sculpture obscure but with faint signs of costae. Legs rather long and slender. Length, 8.40 mm.

Described from one specimen.

Type.— No. 2,502 M. C. Z. Florissant, Col. (No. 930 S. H. Scudder Coll.).

I have placed this fossil in Polemius rather than in Telephorus chiefly on account of the heavy antennae. The posterior half of the elytra is darker than the anterior but I am not at all sure that this is due to any difference in color in the living insect, it seems more likely the result of scaling off of a portion of the metamorphosed chitin when the stone was split.

Trypherus aboriginalis Wickham.

Two specimens, one with counterpart, No. 2,503–2,505 M. C. Z. No. 8,586, 8,499 and 8,651 S. H. Scudder Coll.). They show no important characters not brought out in the original description.

MALACHIIDAE.

Collops priscus, sp. nov.

Plate 5, fig. 3–4.

Form, in life, apparently similar to that of the recent *C. bipunctatus* but as preserved the abdomen is greatly distended, presumably by maceration. Head with rather indistinct outline, sculpture not discernible, antennae short, stout, first joint elongate, second much longer and distorted by the production of the inner apical angle, the third, fourth, fifth, sixth, and seventh, subtriangular, moderately serrate, eighth damaged, remainder not definable. Prothorax about as long as the head, no defined sculpture. Elytron nearly smooth but with a sparse covering of rather long black hairs. Legs slender. Length, as preserved, 5.70 mm.; of elytron, 3.60 mm.

Described from one specimen with counterpart.

Type.— No. 2,506, 2,507 M. C. Z. Florissant, Col. (No. 8,140 and 9,307 S. H. Scudder Coll.).

The form, vestiture, antennae, and abdominal segmentation all point to the above generic reference. Measured from the front of the head to the elytral apex, this insect about equals in size the living North American *C. hirtellus* which occurs from New Mexico to Nevada, Washington, and the Saskatchewan.

Collops desuetus, sp. nov.

Plate 5, fig. 5.

Smaller than *C. priscus*. The specimen is too poorly preserved to make out much besides the proportions of the head, prothorax, and elytra, which are about as in the recent *C. vittatus*. Eye rounded. Antennae and legs wanting. The elytra are scabrous and with a subsulcate effect such as is faintly indicated in several of the recent North American species of this genus. Length, from front of head to tip of abdomen, 4.45 mm.; to tip of elytra, 4.10 mm.

Described from one specimen, with counterpart.

Type.— No. 2,508, 2,509 M. C. Z. Florissant, Col. (No. 12,020 and 12,021 S. H. Scudder Coll.).

In general appearance, this insect is so much like a Collops that I feel fairly confident of the generic reference. It is likely that No. 2,510 M. C. Z. (No. 11,273 S. H. Scudder Coll.) represents the same species.

Collops extrusus, sp. nov.

Plate 5, fig. 6–7.

Of the usual subovate form, broader posteriorly. Head relatively rather small, rounded, antennae weakly serrate and without much modification of the basal joints. Prothorax wider than the head but too much crushed for description. Elytra broader behind, surface not well preserved but showing no sulcations and apparently with traces of hairs. Legs, so far as shown, slender. Abdomen distended, probably abnormally, so as to reach far beyond the elytra, the segments banded with brownish as shown in the figure. Length, to tip of abdomen, 8.15 mm.; of elytra, 4.60 mm.

Described from one specimen, with counterpart poorly preserved.

Type.— No. 2,511, 2,512 M. C. Z. Florissant, Col. (No. 13,620 and 13,642 S. H. Scudder Coll.).

Not so well preserved as the specimen of *Collops priscus*, but apparently a female of this genus or of one nearly related. The antenna is unfortunately not well preserved at base, and I am not sure whether the appearance of a short second joint is due to erosion of what shows as the third in the figure. In recent species of Collops the second joint is very small and frequently needs careful examination for detection. Quite possibly the fossil represents a genus in a transition stage, where the reduction of this joint and the increase in size of the third is not yet pronounced, but I do not care to separate it from Collops upon this rather dubious character. Compared with *C. priscus,* the present species is considerably larger, the elytra being 1 mm. longer, and apparently much less hairy. The lines on the elytra are probably wing veins showing through. Three other specimens, assigned here after the above description was written, all have the upper surface of the body better preserved, although the appendages are poor. These additional examples, No. 2,513–2,515 M. C. Z. (No. 8,503, 10,710, 14,319 S. H. Scudder Coll.), indicate that the head and prothorax are rather shining, the elytra more strongly so, elytral surface finely irregularly punctate and distinctly hairy.

CLERIDAE.

Enoclerus florissantensis, sp. nov.

Plate 5, fig. 8.

Form moderately elongate. Head large, as wide as the pronotum, sculpture nearly effaced but what remains indicates it to have consisted of a fine punctuation. Prothorax broader at apex than at base, widest well in front of the middle, sides, judging by the better preserved one, gently arcuate, base with a fairly well-defined collar or constriction, surface with poorly defined punctuation and with traces of hairs. Elytra narrow in the humeral region, humeri rounded, surface obscurely punctate and hairy with a few traces of fine lineation, apices broken off. Legs only fairly stout. Length of fragment, 9 mm.; in life probably about .75 mm. more.

Described from one specimen in somewhat unsatisfactory preservation.

Type.— No. 2,516 M. C. Z. Florissant, Col. (No. 9,889 S. H. Scudder Coll.).

The relatively narrow humeri give this insect somewhat the aspect of the recent *E. rosmarus* but the fossil is much greater in size. The clothing of hair is poorly preserved and visible only in spots. The punctuation is not well enough defined for accurate description.

Exoclerus pristinus, sp. nov.

Plate 5, fig. 9.

Form moderately elongate, subparallel. Head large, apparently greater in size than the prothorax, minutely scabrous and with a few rather long blackish hairs, probably the remains of a much more thickly disposed vestiture. Eyes of good size. Only one antenna is shown, and that in poor preservation, but the external joints are seen to be moderately thickened forming a gradual club. Prothorax strongly transverse, not very much narrowed posteriorly, sides feebly arcuate, anterior impressed line distinct. The sculpture is poorly preserved but what remains indicates a fine reticulation or scabrosity. Elytra a little more than twice the combined length of the head and prothorax, apices bluntly rounded, sculpture obscure but traces are to be seen of vague sulcations or costae. Legs not very long and rather slender. Length, as preserved, 8.15 mm.; to elytral apices, 6.85 mm.

Described from one specimen.

Type.— No. 2,517 M. C. Z. Florissant, Col. (No. 12,245 S. H. Scudder Coll.).

The characters shown are hardly sufficient to allow of comparison with recent American forms but I think that the fossil represents an insect of about the build of small specimens of *E. moestus*. It is only about two thirds as long as *E. florissantensis* and has a differently proportioned head and prothorax.

Hydnocera wolcotti Wickham.

One specimen, No. 2,518 M. C. Z. (No. 6,385 S. H. Scudder Coll.), less perfect than the type.

Necrobia divinatoria, sp. nov.

Plate 5, fig. 10–11.

Preserved in ventral view and showing scarcely any sculptural characters except those of the under surface. Outline similar to that of the recent *N. rufipes*. Antennae with a three-jointed club, similar to that of recent North American species but with the two joints preceding a little larger in the fossil. Under surface of meso- and metathorax with shallow, rather fine punctures, visible only in certain lights, abdominal segments more finely punctulate and with short hairs. Legs wanting. Length as preserved, to tip of abdomen, 7 mm., in life somewhat less since the body is abnormally distended.

Described from one specimen.

Type.— No. 2,519 M. C. Z. Florissant, Col. (No. 7,651 S. H. Scudder Coll.)

There seems to be no way of separating this insect from Necrobia except on the basis of the less pronounced antennal club and I do not feel justified in founding a new genus on this one character. The coxal and abdominal structures, as well as the size and facies, agree with Necrobia. The punctuation of the underside is less conspicuous in the fossil. The exposed elytral epipleura shows fairly strong punctures.

PTINIDAE.

Ernobius effetus, sp. nov.

Plate 6, fig. 1.

Form moderately elongate, subparallel in side view. Head fairly large, eye elliptical, antennae wanting. Prothorax probably damaged along the back but as preserved the dorsal surface is not arched, the apex projects over the head but not sufficiently to entirely conceal it from above. Elytra with only very faint signs of shallow striae visible in certain lights. Legs short and fairly slender. Length, from front of pronotum to elytral apex, 4 mm.

Described from one specimen.

Type.— No. 2,520 M. C. Z. Florissant, Col. (No. 2,647 S. H. Scudder Coll.). It is probable that No. 2,521 M. C. Z. (No. 9,440 S. H. Scudder Coll.), is the same species.

The sculpture of the surface of this insect is extremely fine and visible only under high power. It consists of a minute but close and sometimes confluent punctuation, stronger on the prothorax, the meso- and metasternal side-pieces and the base of the elytra. In size, the present species is about equal to the recent *E. mollis* which is similar in form and sculpture. These characters offer the only basis for the generic reference.

Xestobium alutaceum Wickham.

One good specimen, No. 2,522 M. C. Z. (No. 7,500 S. H. Scudder Coll.), about .25 mm. shorter than the type.

Oligomerus florissantensis, sp. nov.

Plate 6, fig. 2.

Form elongate, rather slender. Head of moderate size, minutely and closely punctulate, eye not defined, antennae wanting. Pronotum, in side view, subcuneiform, finely punctulate. Elytron long, very finely sculptured but with well-defined, sharp though narrow punctate striae, the punctures small, well impressed, longitudinally elliptical, those of the same row separated individually by something less than their own long diameters. Leg (only one being at all well shown), short and rather slender. Length, from front margin of pronotum to elytral apex, 4 mm.

Described from one specimen.

Type.— No. 2,523 M. C. Z. Florissant, Col. (No. 5,921 S. H. Scudder Coll.).

In size and outline, this beetle is about like *Ernobius effetus*, so similar in fact that allowing for the difference in thoracic outline which might be due to distortion I should have considered them as representing one species if it were not for the well-defined punctate striae of the elytra of the present insect. The nearly semicircular structure projecting on to the head near the anterior prothoracic margin seems to be not an eye but probably due to some imperfection in the stone. Of course the generic reference cannot be made with any great degree of certainty, but the fossil is not unlike the modern *O. obtusus* of eastern North America.

Oligomerus (?) duratus, sp. nov.

Plate 6, fig. 3.

Form elongate. Head large, minutely punctulate and rugulose. Eye of moderate size, elliptical. Antennae wanting. Prothorax short, subcuneiform in side view, back scarcely arched, front margin apparently but little or not at all projecting, surface finely punctate but somewhat more coarsely than the head. Elytron long, the outer edge broken so that the relative proportions of length and breadth cannot be determined with exactitude, surface with faint evidence of obtuse costation or striation, punctuation very fine and confused. Underside of body minutely punctulate, more strongly on the thorax than on the abdomen. Legs short and slender. Length, 4.25 mm.

Described from one specimen.

Type.— No. 2,526 M. C. Z. Florissant, Col. (No. 7,646 S. H. Scudder Coll.).

Probably not a true Oligomerus since the head is larger and the prothorax shorter and higher than in the modern species. For the present, I prefer to leave it here rather than erect a new genus for its reception.

ANOBIUM DURESCENS Scudder.

I have referred to this species a specimen, No. 2,527 M. C. Z. (No. 12,026 S. H. Scudder Coll.). It differs from the type in being 1 mm. longer, (length 4.50 mm., as compared with 3.50 mm. in the original), but I can find no other tangible difference.

BOSTRICHIDAE.

AMPHICERUS SUBLAEVIS, sp. nov.

Plate 6, fig. 4.

Form stout. Head large. Prothorax, in side view, subcuneiform, the back not much arched, surface comparatively smooth and without defined asperities. Elytron a little more than twice the prothoracic length, faintly substriate, otherwise nearly smooth, without teeth on the declivity. The only leg showing is one of the hind pair, which is very small and relatively weak. Length, from front of pronotum to apex of elytra, 5.85 mm.

Described from one specimen.

Type.— No. 2,524 M. C. Z. Florissant, Col. (No. 14,250 S. H. Scudder Coll.).

This is a little larger than *Xylobiops lacustre* and is much smoother. The fossil *Dinoderus cuneicollis* is much smaller. I have placed it in Amphicerus in spite of the lack of prothoracic armature because of the general likeness to the New Mexican *A. brevicollis,* which, judging from material received from Prof. D. E. Merrill, is the female of *A. grandicollis.*

XYLOBIOPS LACUSTRE Wickham.

One specimen, No. 2,525 M. C. Z. (No. 14,247 S. H. Scudder Coll.).

SCARABAEIDAE.

Oxyomus nearcticus, sp. nov.

Plate 7, fig. 1.

Form oblong-oval, moderately stout. Head roughly and coarsely punctured, clypeus broadly arcuate, not angled nor emarginate. Prothorax broader than long, sides arcuate but not sufficiently well preserved to admit of exact description, disk with coarse, close, deep, cribrate punctures which are circular or elliptical in outline and leave a well-defined, nearly straight but narrow, almost cariniform median longitudinal line. Scutellum triangular. Elytra broader behind the middle, conjointly rounded at tip, strongly costate, the costae narrow, alternate ones better defined, the intervening grooves, which represent the striae, each with a row of strong, deep, transversely elliptical punctures. The stronger costae appear to reach the elytral tips, while the weaker are somewhat abbreviated apically. Legs moderately stout, but none are sufficiently perfect for description. Length, 3.20 mm.

Described from a single specimen.

Type.— No. 2,528 M. C. Z. Florissant, Col. (No. 222 S. H. Scudder Coll.).

The small size, coarse cephalic and thoracic sculpture, and costate elytra lead me to place this pretty aphodiide in Oxyomus. The genus is now known in North America only from the introduced European *O. porcatus.* I have compared the fossil with European specimens of *O. silvestris*, received years ago from Dr. Natterer, and find that the former differs in having a more strongly punctate head, the median thoracic line not sulcate, and the elytral costae much more distinctly alternating in height. Both agree in the possession of a vague antemedian lateral pronotal impression. The coarse sculpture distinguishes *O. nearcticus* at once from all of the other Florissant Aphodiini.

Ataenius patescens Scudder.

Seven specimens are assigned here, bearing the No. 2,529–2,535 M. C. Z. (No. 8,411, 8,571, 10,160, 10,408, 11,796 S. H. Scudder Coll., and two in which the numbers are illegible or wanting). I have included under this name all the aphodiids of a little over 4 mm.

in length with distinct, simple, impunctate striae. It is possible that more than one species is included in the material but there seems to be no sure means of separation with the specimens at hand.

Ataenius restructus Wickham.

Three specimens, No. 2,536–2,538 M. C. Z. (No. 2,471, 2,502, 11,298 S. H. Scudder Coll.). They agree with my type in size and form and I think it best to assume their identity, although in some lights the elytral striae seem to show signs of punctures. The specimen bearing Scudder's number 2,502 exhibits the hind tibiae very nicely and from the slender structure of these parts and the lack of distinct transverse ridges it seems wise to assign the species to Ataenius, though I had first described it as an Aphodius.

Aphodius Illiger.

The removal of my *A. restructus* to the genus Ataenius leaves six described species of Aphodius from the Florissant shales. Two new ones are found in the present collection, both readily distinguishable from those previously known. While mammal remains are practically unknown at Florissant, it is probable that the region adjacent to the old lake was well populated with the numerous ungulate and other types of mammals known to abound during the Tertiary times. It is a matter of common knowledge that some of the species of recent coprophagous Scarabaeidae select the dung of one or more species of mammal as food, in place of promiscuous feeding. Putting together the known abundance of ungulates in the Tertiary period and the selective habit of dung-eating beetles, it is reasonable to assume that the great specific development in Aphodius at Florissant was correlated with a plentiful supply of mammalian dung of different kinds. It appears to me likely that a good many of these old Aphodii became extinct along with the mammals that formed the sources of their food supply. All of these Florissant fossil Aphodii belong to the division of the genus with short scutellum — the same section that is most abundant in North America today. None of them are especially peculiar in any way, though their specific characters are well marked. Some of them must have occurred in considerable numbers if we may judge by the frequency of their remains in the shales.

Aphodius shoshonis Wickham.

This is represented by one specimen, No. 2,549 M. C. Z. (No. 7,720 S. H. Scudder Coll.). It agrees with my type.

Aphodius aboriginalis Wickham.

A fine specimen with counterpart, No. 2,551, 2,552 M. C. Z. (No. 13,611 and 13,645 S. H. Scudder Coll.). This corresponds to the type. Several others are too poor for certain determination, or else show only undersides, but belong to either the present species or to *A. granarioides*. They bear the No. 2,553–2,558 M. C. Z. (No. 8,032, 8,335, 8,369, 9,164, 10,334, 12,437 S. H. Scudder Coll.).

Aphodius mediaevus, sp. nov.

Plate 6, fig. 5–7.

Form very short and stout for this genus, as much so as in the recent *A. hamatus*. Head poorly preserved, not showing the shape nor the sculpture sufficiently well for certain description but the clypeus appears to have been subtruncate anteriorly and there is no visible cephalic punctuation. Prothorax very broad, about twice as wide as long, sides arcuate, surface indistinctly and not coarsely punctured. Scutellum short. Elytra rather finely and very distinctly striate, the striae with well-marked punctures which are smaller and circular in the basal region, becoming larger and slightly transverse on the disk as indicated by the figure. Legs stout but not well preserved excepting one belonging to the front pair which shows the sharp and strong tibial teeth very nicely. Length, as preserved, 4.15 mm.

Described from a single specimen with counterpart.

Type.— No. 2,539, 2,540 M. C. Z. Florissant, Col. (No. 4,901 and 5,395 S. H. Scudder Coll.).

A very easily recognized species, at once differentiated from any of the other Florissant forms by the moderate size, the broad outline, the indistinct thoracic punctuation and the well-marked punctures of the simple elytral striae.

Aphodius praeemptor Wickham.

Several specimens are contained in the collection, No. 2,541–2,546 M. C. Z. (No. 433, 494, 8,523 and 9,616, 13,605 and 13,666 S. H. Scudder Coll.). These agree well with the type. It is probable that No. 2,547, 2,548 M. C. Z. (No. 2,328, 7,785 S. H. Scudder Coll.), also belong here.

Aphodius senex, sp. nov.

Plate 6, fig. 8.

Form moderately stout, similar to that of the modern *A. fimetarius*. Clypeus broadly rounded, not emarginate anteriorly. Head moderately coarsely and confluently but not strongly punctate at sides, the sculpture of the front either weak or not defined. Prothorax about one and three fifths times as broad as long, sides almost regularly arcuate, a fairly well-defined median line, punctuation not close, but the condition of the stone is such that a sparse punctuation would not be distinguishable. Scutellum short, punctured closely and confluently somewhat like the sides of the head. Elytra with broad distinct striae in which the sides are deeper than the middle, giving each stria a duplicate appearance, strial punctures visible, but weak. Legs wanting except one defective fore tibia which is omitted from the drawing and shows nothing beyond the fact that it is toothed. Length, 8 mm.

Described from a single specimen.

Type.— No. 2,550 M. C. Z. Florissant, Col. (No. 9,432 S. H. Scudder Coll.).

Differs from all the other Florissant Aphodii except *A. florissantensis* by the duplicate striae and from that species in being very much larger. In size it is surpassed only by *A. laminicola*, which has simple striae.

Aphodius laminicola Wickham.

This large species seems to have been not at all uncommon. It is represented by seven specimens, one with counterpart, No. 2,559–2,566 M. C. Z. (No. 6,118, 7,735, 8,028 and 8,474, 8,490, 11,287, 11,786, 14,403 S. H. Scudder Coll.).

HOPLIA STRIATIPENNIS, sp. nov.

Plate 7, fig. 2.

Form similar to that of most of the recent North American species. Head of moderate size, the clypeus truncate anteriorly and with rounded angles as in *H. trifasciata*. Prothorax much broader than long, widest about the middle, narrowing to the apex and less strongly to the base, sculpture not definable. Elytra, conjointly, distinctly broader than long, the apices subtruncate, disk with rather ill-defined longitudinal sublateral striae which do not show punctures. Abdominal segments subequal except the last which is longer. Length 9.75 mm.

Described from a single specimen.

Type.— No. 2,567 M. C. Z. Florissant, Col. (No. 8,001 S. H. Scudder Coll.).

The form of the head and thorax corresponds very well with our modern species of the genus and so does that of the elytra if due allowance is made for the flattening of the humeral deflexed region. The striation is about the same (though better marked in the fossil) as that shown by specimens of *H. trifasciata* var. *tristis*. Some of the other recent species have similar striation. In order to account for the abdominal segmentation it is necessary to assume that the sutures of the underside show through — a suggestion which is not in the least improbable since those of the meso- and metathoracic regions appear dimly through the elytra. Unfortunately the legs are entirely wanting.

SERICA ANTEDILUVIANA Wickham.

Plate 6, fig. 9.

A beautiful specimen of a small Serica, preserved in dorsal view, is contained in this series. It is only a quarter of a millimeter shorter than my type of *S. antediluviana*, which was preserved in side view, and agrees with it in all the visible characters. In the Scudder specimen the punctuation is better exhibited and is seen to be of the subrugose transverse type shown in the recent *S. trociformis*. The spurs of the hind tibiae are long and slender but the limits of the tarsal joints, excepting the first, are not clear enough to admit of description. I give a figure of this specimen to supplement that of the type. No. 2,568 M. C. Z. Florissant, Col. (No. 11,797 S. H. Scudder Coll.).

Miolachnosterna, gen. nov.

Body outline resembling that of Anomala. Pronotum short, the base broadly, squarely truncate. Scutellum distinct, small. Sculpture fine, body hairy above. Pygidium uncovered. Legs moderately stout, hind tarsus, including the claws, nearly as long as the tibia, the first four joints subequal, rather slender, claws simple.

Type.— *M. tristoides*, sp. nov.

Miolachnosterna tristoides, sp. nov.

Plate **8**, fig. 1–3.

Outline, as preserved, ovate, somewhat pointed behind. Head not well displayed, apparently rather small, the vertex moderately, finely, and sparsely punctured. Prothorax finely, sparsely, and rather regularly punctate, clothed with long light colored hairs which do not interfere with a clear view of the sculpture. Basal truncation wide, equal to about three fifths of the greatest pronotal width. Scutellum punctured like the pronotum. Elytra strongly narrowed posteriorly, confusedly, and a little more coarsely, and much less deeply punctured than the prothorax, similarly clothed with hairs, the punctures spaced about as on the pronotum. Exposed pygidial surface obscurely punctate. Hind tibia hairy. Length, to tip of elytra, 7.50 mm.

Described from one specimen.

Type.— No. 2,569 M. C. Z. Florissant, Col. (No. 13,668 S. H. Scudder Coll.).

In sculpture and vestiture this insect is not very different from the recent *Lachnosterna tristis*, but the absolutely simple claws preclude the reference to this genus. The basal pronotal truncation is much more pronounced than in Lachnosterna. The safe course seems to lie in the erection of a new genus. The only point not alluded to in the description, which calls for remark, is the appearance of a long rather stout spine on the poorly preserved front tibia, and while I have shown this in the figure and detail I am by no means certain of its being a true character. I have presumed this species to be a melolonthide and suggest that it be placed near Lachnosterna for the present.

LISTROCHELUS PUERILIS, sp. nov.

Plate 6, fig. 10.

Form elongate and quite slender. Surface of body weakly sculptured, the elytra without the strong rows of punctures and costiform interspaces characteristic of Diplotaxis, which this insect somewhat resembles in outline. Legs long and slender but not sufficiently well preserved to show details of the tibial dentation nor the structure of the claws. Length, 10.65 mm.

Described from one specimen.

Type.— No. 2,570 M. C. Z. Florissant, Col. The original number of the S. H. Scudder collection is illegible.

About all that can be said of the affinities of this insect is that it is a lachnosternoid type of small size, the shape reminding one of *Lachnosterna longitarsis* or of a slender Listrochelus. I think it a little more likely to have belonged to the latter genus and have so placed it, recognizing that the two genera are frequently almost indistinguishable, even in recent specimens. Listrochelus occurs today in the southern and western United States and in Mexico.

ANOMALA Koeppe.

Two species apparently belonging to this genus are found in the collection. While not very numerously represented in the United States at the present day, the genus Anomala is of great extent and wide distribution. It is also rather polymorphic.

ANOMALA EXTERRANEA, sp. nov.

Plate 7, fig. 3.

Form moderately elongate. Head strongly and closely punctured across the vertex, less so upon the occiput. Clypeus rounding in front, moderately punctate. Prothorax nearly twice as broad as long, a little narrower anteriorly, sides broadly arcuate, surface distinctly but sparsely punctate, a well-marked longitudinal median line (possibly due to a crack). Elytra moderately finely and closely punctate, the punctures subseriately arranged, some of the interstitial lines faintly costiform. Legs wanting in the type, and too poorly preserved in the other specimen to warrant description. Length of type, from front of clypeus to the abdominal apex, 16.85 mm.; of elytron, 10 mm.

Described from two specimens, one with, the other without counterpart.

Type.— No. 2,571 M. C. Z. Florissant, Col. (No. 13,610 S. H. Scudder Coll.). Paratype, No. 2,572, 2,573 M. C. Z. (No. 8,162 and 8,279 S. H. Scudder Coll.).

A good-sized species apparently belonging in the group with the elongate forms which are rather abundant in Mexico and the southwestern United States. In the paratype the sides of the prothorax are more divergent posteriorly and the elytral punctuation is better shown, but I think there is no doubt of its specific identity with the type.

Anomala scudderi, sp. nov.

Plate 8, fig. 4–6.

Form elongate, the abdomen probably unnaturally extended in the specimen at hand. As only the ventral view is shown, the characters of the head and prothorax are obscured. Elytron, (only one being preserved), nearly two and a half times as long as wide, apex broadly rounded, surface sculpture not showing through on to the underside and for that reason probably not strong. Legs moderately elongate and not very heavy, the tarsal joints rather stout and short, the claws simple or nearly so except that one of the middle pair is toothed near the base. Length, from front of head to abdominal apex, 9.25 mm.; of elytron, 5.30 mm.

Described from one specimen.

Type.— No. 2,574 M. C. Z. Florissant, Col. (No. 5,125 S. H. Scudder Coll.).

Though lacking any very characteristic features, the leg and elytral structures have led me to place this fossil in Anomala. The form, if we assume that the abdomen is unnaturally distended, was not unlike that of the modern *A. semilivida.*

Ligyrus Burmeister.

This genus is represented by several species in North America at the present day, and the Scudder collection of Florissant fossils contains two. One of these has already been described, the other is undoubtedly new.

Ligyrus effetus, sp. nov.

Plate **6**, fig. 11.

Preserved lying partly on the back, so as to give a view of the side and a portion of each of the dorsal and ventral surfaces, but the condition is too poor to allow the sculpture to be described. Head small, as usual in this genus. Prothorax short and wide. Elytra exhibiting faint traces of striae, whether punctate or not it is impossible to say. Legs very short and stout, the hind tibiae broad, middle ones less so. Tarsal articulation not well defined, but the hind tarsus is at least as long as the tibia. Length, 13.75 mm.

Described from a single specimen with its counterpart.

Type.— No. 2,576,2, 577 M. C. Z. Florissant, Col. (No. 12,025 and 12,031 S. H. Scudder Coll.).

By the facies, this should belong with Ligyrus. It is a smaller species than *L. compositus* of these shales, being about equal in length to undersized examples of the recent *L. gibbosus.* Most probably, though not certainly, it differed from either of the above in having finer sculpture.

Ligyrus compositus Wickham.

Two specimens, No. 2,578, 2,579 M. C. Z. (No. 953, 13,614 S. H. Scudder Coll.) both poor, probably belong to this species.

Strategus cessatus, sp. nov.

Plate **7**, fig. 4.

Elytron castaneous, finely, sparsely, and irregularly punctate. There is a fine sutural bead, a similar exteromarginal one which is slightly less pronounced, and about nine fine discal striae, one of which is paired with the sutural bead while the others form four double series as shown in the figure. These striae are finely and distantly punctate. Length 17 mm. Width 8.80 mm.

Described from a single specimen, an elytron only.

Type.— No. 2,575 M. C. Z. Florissant, Col. (No. 9,047 S. H. Scudder Coll.).

After comparing this elytron with those of a great number of recent American and foreign genera, I have placed it in Strategus since it corresponds more closely with *S. cessus* of our western states and Mexico than with anything else I have seen. The size of the two is almost identical and the nature of the sculpture, as well as the arrangement of the duplicate series is very similar. On account of the fineness and indistinctness of the punctuation of the striae and interstices I have not attempted to trace it in detail with the camera lucida except in one or two areas where it is particularly well preserved. The courses of the striae are, for the most part, shown on the figure in solid lines. The surface is alutaceous throughout, but this minute sculpture may be due to the texture of the stone.

CERAMBYCIDAE.

Phymatodes Mulsant.

A species of this genus (*Phymatodes volans*) has been described from the Florissant shales by Cockerell and Beutenmueller. The one which follows is almost too large for a Phymatodes and the reference is to be considered entirely provisional.

Phymatodes miocenicus, sp. nov.

Plate 9, fig. 1.

Represented by an elytron and a portion of a leg, the structure of the latter indicating that the insect does not belong to the Buprestidae, where similar elytral color patterns are not uncommon. Elytron elongate, in comparison with its width, the humeral region somewhat prominent, the outer margin sinuate behind the humerus, narrowing the elytron to about the middle whence it broadens for a short distance before narrowing again to the truncate unarmed apex. The surface is finely punctate or scabrous, the color dark, (brownish on the stone) crossed by two well-defined whitish bands, nearly at right angles to the suture, which divide the elytron into three almost equal parts. No hairs are visible upon the wing cover, but they show upon the tibia which is the only well-preserved portion of the leg. Length of elytron 10.50 mm. Width across posterior band 2.30 mm.

Described from one specimen with counterpart.

Type.— No. 2,580, 2,581 M. C. Z. Florissant, Col. (No. 431 and 1,454 S. H. Scudder Coll.).

The specimen indicates a longicorn beetle of a rather uncommon type of coloration, though approached more or less closely by recent species of various tribes. It seems worth while to give a specific name to the insect on account of its colorational interest. The pattern is almost a copy of that of the recent African *Ceroplesis bicincta*.

ELAPHIDION EXTINCTUM, sp. nov.

Plate 8, fig. 7.

Form stout. Head smaller than the prothorax, the jaws fairly strongly projecting, front finely, transversely, subrugosely punctulate. Eyes not defined. Antennae only obscurely exhibiting the proximal joints, the first stout, second apparently short, third long. Prothorax strongly transverse, sides not perfect but apparently moderately arcuate, surface rather finely but very closely and fairly deeply punctate, the punctures in front of the middle more or less confluent with a tendency to form transverse rugae, an impunctate area, probably a callosity, on each side. Elytra bluntly rounded at apex, more finely and sparsely punctate than the prothorax and with scattered, short, blackish hairs. The only leg shown is fairly slender. Length, from apex of jaws to that of abdomen, 11.35 mm.; of head and prothorax, 3.75 mm.; of the right elytron, 6.45 mm.

Described from one specimen with counterpart.

Type.— No. 2,582, 2,583 M. C. Z. Florissant, Col. (No. 11,780 and 12,034 S. H. Scudder Coll.).

By allowing some latitude of definition, this may have been an Elaphidion-like form of the same general appearance as the recent *E. moestum* but with callosities similar to those of the more typical species of the genus. Too little is shown to make the generic reference at all certain.

STENOSPHENUS PRISTINUS, sp. nov.

Plate 9, fig. 2.

Form elongate. Head large, longer than the prothorax. Antennae about as long as the entire body, basal joint large, second small, third longer than the fourth which is subequal to the fifth and to the sixth, remainder not definable. The sixth joint seems to show an apical spine but the margins of all the articles are poorly preserved, so that this character is in doubt. Prothorax broader than long, arcuate at sides. Elytra long and narrow, apex without defined spine, but the stone is too rough to allow of certain judgment. Legs slender, thighs but little clavate. Length, 10.50 mm.

Described from one specimen.

Type.— No. 2,584 M. C. Z. Florissant, Col. (No. 11,289 S. H. Scudder Coll.).

The generic determination rests upon the facies. The form is that of the North American species of Stenosphenus, in fact the resemblance is so striking as to be manifest at the first glance. The stone on which the insect is shown is of such rough texture that the margins of the impression are all more or less blurred and it is impossible to be sure of the presence or absence of spines upon the antennae, knees, or elytra. The sculpture is entirely effaced. Because of the characteristic form of the beetle, I have thought it worth figuring and naming.

Clytus florissantensis, sp. nov.

Plate 10, fig. 1.

Form stout for this group. Head decidedly narrower than the prothorax, and, including the projecting mandibles, as long as wide. Mandibles subtriangular in outline, the external margins moderately strongly and regularly arcuate, their length equal to about one half that of the head. Cephalic sculpture rather weak, consisting of a not very close granulation and rugosity. Antennae incompletely preserved, but in life evidently reaching beyond the elytral tips, though not far, if at all, past the end of the abdomen, the first joint clavate, not very elongate, the second small, third distinctly longer than the fourth which is somewhat shorter than the fifth or sixth, the remainder incomplete or wanting, though a detached distal joint lying across one wing-cover indicates that those near the apex were somewhat greater in length. The third, fourth, and sixth joints, each show a strong inner apical spine. Eyes not definable. Prothorax much broader than the head, distinctly wider than long, and, owing to the strongly rounded sides without lateral spines, roughly transversely suborbicular in outline as is commonly the case in this group. Surface more strongly sculptured than the head, the sides with closely set regular circular granules of moderate size which become sparser and smaller on the disk and pronouncedly so on the anteromedian area. There is evidence of a longitudinal medial callosity or raised line, stronger near the base. Elytra rather short, moderately tapering, apex truncate with a strong, sharp, external spine and a short sutural denticle. Surface rather finely punctate and granulate, this sculpture showing best in a light colored transverse band of irregular shape which extends across in the neighborhood of the basal third, this band having arcuate fore and hind margins which converge so as to make it narrower at the suture. In this light area are seen moderately long scattered black hairs. Abdomen, as preserved, long enough to extend beyond the elytral tips but perhaps unnaturally distended. Legs wanting, excepting one belonging to the posterior pair which is of only moderate length, the femur not strongly clavate, tarsal joints not expanded, the first scarcely equal to the next two. Length, from apex of mandibles to that of abdomen, 19 mm.; of elytron, excluding spine, 9.60 mm.; of seven proximal joints of antenna 8.40 mm. Width of elytron at middle of band, 3 mm.

Described from a single specimen with counterpart.

Type.— No. 2,585, 2,586 M. C. Z. Florissant, Col. (No. 11,795 and 12,419 S. H. Scudder Coll.).

In this specimen, the elytra and hind wings are both spread but the secondaries are not clear enough to make a description feasible. The drawing does not show the latter. The generic reference is to be understood as applying broadly but the insect shows so many features that are common in the Clytini as to make the assignment plausible at any rate. These characters are the large rounded prothorax, the shape of the head and mandibles, the rather short, spinose antennae, the short elytra, armed at apex and with transverse maculation, and the long abdomen. On the whole, I am inclined to place it near Cyllene rather than with any of the other genera that I know, though the hind tarsi are more like those of Clytus (for example the recent *C. lanifer*), but have chosen the term Clytus as being, in its broad sense, more inclusive. The anterior coxae are well separated and the prosternum is fairly broad.

Gaurotes striatopunctatus, sp. nov.

Plate 9, fig. 3.

Form rather robust. Head small, eyes not prominent. Antennae well over half the length of the entire body, not specially modified in any way, the joints beyond the second subequal as far as can be seen.

Prothorax broad at base, finely and inconspicuously punctured. Elytra wide at base, rather rapidly tapering to their apices which are conjointly rounded, disk with about ten to twelve striae of fine but sharp regularly spaced elliptical punctures, their long axes following the strial line, these punctures separated by about their own lengths. Interspaces relatively broad, flat, and smooth. Legs showing the femora of the hind pair and one of those of the front, not much thickened. Length, from front of head to abdominal apex, 9.25 mm.

Described from one specimen.

Type.— No. 2,587 M. C. Z. Florissant, Col. (No. 9,165 S. H. Scudder Coll.).

The best place for this beetle appears to be in Gaurotes with which it agrees in form and antennal structure and fairly well in sculpture which seems to be of a type rather uncommon in the Lepturoides. The recent *G. cyanipennis* has striatopunctate elytra but the punctures are finer and the striae more numerous than in the fossil.

Leptura nanella, sp. nov.

Plate 9, fig. 4.

Form elongate, fairly slender. Head of moderate size, eye elliptical, the outline hardly well enough preserved to show whether or not it is emarginate. Antenna a little longer than the head and prothorax, slender, not serrate, the joints rather indistinctly set off so as not to allow of separate description. Prothorax, in side view, campanulate, punctuation fine and poorly preserved. Elytron obtuse at tip, strongly and deeply but rather sparsely punctate, the punctures circular, separated on the basal region by about once or twice their own diameters but becoming much finer and more widely spaced apically. Sternal side-pieces nearly smooth. Abdomen finely and sparsely punctate, each puncture carrying a short fine hair. Legs apparently moderately stout. Length, 4.10 mm.

Described from one specimen.

Type.— No. 2,588 M. C. Z. Florissant, Col. (No. 9,682 S. H. Scudder Coll.).

A small species, about the size of the recent *L. haematites* and *L. molybdica*. It is smaller than any of the described Florissant forms of this genus, the nearest approach in this respect being *L. leidyi* which reaches a length of 7.50 mm.

LEPTURA ANTECURRENS Wickham.

One specimen with counterpart, No. 2,589, 2,590 M. C. Z. (No. 13,624 and 13,672 S. H. Scudder Coll.). The condition is inferior to that of the type and no additional characters can be made out except that the present example is a very little larger.

LEPTURA PETRORUM Wickham.

Three specimens showing but one side, No. 2,591–2,593 M. C. Z., and another with counterpart, No. 2,594, 2,595 M. C. Z. (No. 8,985, 12,434, 14,164, 9,187 and 9,719 S. H. Scudder Coll.). Only the last is in good enough preservation to show the characteristic sharp elytral tip.

LEPTURA INGENUA, sp. nov.

Plate 10, fig. 2.

Form moderately stout. Head badly crushed but evidently rather large. Eyes not definable. Antennae slender, and, as preserved, reaching well behind the middle of the elytra. Prothorax also badly damaged by crushing, of a lighter color than the head, apparently reddish or yellowish. Elytra hardly at all tapering behind, surface coarsely and deeply, moderately closely punctured at base, the sculpture becoming finer posteriorly, fading out near the apices which are separately rounded, each with a longitudinal slightly oblique pale vitta showing on the darker background. Legs wanting. Length, 7.60 mm.

Described from one specimen.

Type.— No. 2,596 M. C. Z. Florissant, Col. (No. 6,382 S. H. Scudder Coll.).

Judging from the remains, this is a lepturid beetle of rather broad build. The elytral coloration is like that of the recent *Leptura vibex* of the eastern United States. Probably the antennae were pale or reddish like the prothorax, or perhaps a little darker.

PROTIPOCHUS, gen. nov.

Form approaching that of Ipochus. Head nearly as large as the prothorax. Antennae (with only ten joints preserved) reaching about to the elytral tips, first joint stout, oval, longer than the third, second about two thirds the length of the third which is about two thirds as long as the fourth, fifth a little longer, sixth, seventh, and eighth a little shorter, ninth and tenth subequal to each other but not quite as long as the eighth. Pronotum without lateral spines. Elytra with rounded humeri, hind wings probably wanting or not functional.

Type.— *P. vandykei*, sp. nov.

PROTIPOCHUS VANDYKEI, sp. nov.

Plate **9**, fig. 5: Plate **10**, fig. 3–4.

Form resembling that of Ipochus or Parmena, surface finely transversely wrinkled on head and pronotum and with vestiture of rather short fine hairs. Head, including the jaws, a trifle longer than wide, eyes not definable but probably not prominent in life. Antenna moderately slender. Pronotum subequal at base and apex, sides regularly rounded without spine or tubercle, the greatest width near the middle where it exceeds the length by more than one-half. Scutellum moderate. Elytra nearly smooth, and, as preserved, not quite covering the abdomen, which, however, is probably somewhat abnormally distended by maceration. Femora clavate, stout, tibiae straight, finely hairy. Length, 5.70 mm.

Described from one specimen.

Type.— No. 2,597 M. C. Z. Florissant, Col. (No. 10,870 S. H. Scudder Coll.).

This is a very interesting and puzzling little longhorn. From the size of the head and the general facies, it would appear to belong to the Lamiinae. The antennae are hard to match, however, and on comparison with specimens, figures, and descriptions of numerous foreign and domestic genera I find nothing to agree exactly with them. They differ from those of most of the genera in this vicinity by the short third and long fifth joint and by the distal articles not decreasing rapidly in length. They seem to resemble those of Michthysoma in many respects, but the body form, thoracic armature, and coarse sculpture of that genus are entirely foreign to the fossil. I have finally concluded that Protipochus may go into Thomson's group Parmenitae of his subtribe Dorcadionitae. This group comprises genera from all of the continents and in North America is represented by the Californian genus Ipochus. Our fossil, while resembling Ipochus in outline, differs in the proportions of the antennal joints, which, in Ipochus, decrease rapidly in length from the third to the fifth. The legs of Protipochus are rather short, the thighs strongly clavate, but owing to their showing through the specimen they are not represented in the gross figure. The detail will give an idea of the appearance of the middle leg.

I take pleasure in giving this species the name of Dr. Edwin C. Van Dyke of San Francisco.

Leptostylus scudderi, sp. nov.

Plate 10, fig. 5.

Form moderately elongate. Head with prominent jaws. Antennae slender, about one and three fifths times the length of the body, first joint long, subcylindrical, second short, third barely longer than the first, fourth subequal to the third, fifth, and sixth a little shorter, the remainder not distinctly separable. There is no visible antennal vestiture. Prothorax nearly twice as broad as long, sides arcuate with no defined spine nor tubercle. Elytra long, four and a half times the prothoracic length, strongly tapering from about the middle to the apices which are moderately sharply pointed but unarmed. Legs lacking except one which probably belongs to the middle pair; this is of moderate length and stoutness, tarsal joints ill defined. Length, from front of head to tip of abdcmen, 11.35 mm.

Described from a single specimen.

Type.— No. 2,598 M. C. Z. Florissant, Col. (No. 929 S. H. Scudder Coll.).

The facies of this insect is entirely that of a Leptostylus, with which genus it agrees in the antennal and thoracic structures. The long antennae are in accord with those of the recent *L. biustus* and *L. terraecolor*. The coloration seems to have been a mottling, arranged in irregular transverse bands, the best marked of which are in the form of two rather broad postmedian fasciae. It will be noted that the thoracic sides, as preserved, are not symmetrical, the left one showing about the same shape as in *L. biustus*, while the other is simply rounded.

Protoncideres primus Wickham.

A specimen of a lamiide in this collection, No. 2,599 M. C. Z. (No. 13,594 S. H. Scudder Coll.), differs from my type of *P. primus* in just the manner which frequently characterizes the sexes in recent species. The type of *P. primus* is presumed to be a male, and the specimen before me shows the following divergencies:— size larger, build a little heavier, antennae somewhat thicker, basal joints smoother, third relatively shorter. I find no characters upon which to base specific separation and therefore prefer to consider it the female of *P. primus*. The length is about 26.50 mm., but since the elytral apex is not quite perfect it cannot be ascertained exactly.

CHRYSOMELIDAE.

Donacia primaeva Wickham.

Two specimens, one with counterpart (No. 2,601–2,603 M. C. Z. No. 8,853 and 10,177, 11,989 S. H. Scudder Coll.), belong to a species of Donacia and are similar in all respects to my type of *D. primaeva* except that the latter is a little smaller and has the punctuation better defined. I do not think these differences give sufficient basis for specific separation and therefore include all the material under the above name.

Lema evanescens Wickham.

Represented by many specimens, the best of which are No. 2,604–2,611 M. C. Z. (No. 811, 897, 1,985, 3,593, 4,956, 8,693, 8,919, 9,595 S. H. Scudder Coll.).

Lema fortior, sp. nov.

Plate 13, fig. 1.

Form moderately stout but distorted by being much crushed. Antennae stout, eyes prominent. Prothorax with no defined sculpture. Elytra with rows of strong circular punctures, those in any one row separated by about their own diameters, the intervening spaces varying a little more or less. Legs wanting. Length, from front of head to elytral tip, 5.75 mm.

Described from one specimen.

Type.— No. 2,612 M. C. Z. Florissant, Col. (No. 8,116 S. H. Scudder Coll.). It is likely that No. 2,613 M. C. Z. (No. 7,762 S. H. Scudder Coll.) also belongs here. I have provisionally considered

No. 2,614 M. C. Z. (No. 3,375 S. H. Scudder Coll.) as representing the same species, although the punctuation is less pronounced.

With some hesitation, I have separated this from *L. evanescens* on account of the much stronger punctuation of the present insect. This is particularly noticeable towards the elytral apices since in *L. evanescens* the strial rows are scarcely visible beyond the middle while in *L. fortior* they continue distinct to near the tip.

Crioceridea dubia Wickham.

Not uncommon. Represented by good specimens, No. 2,615–2,619 M. C. Z. (No. 7,977, 9,577, 11,242, 4,458 and 11,737 S. H. Scudder Coll.). Poorer examples, No. 2,620–2,623 M. C. Z. (No. 438, 8,644, 9,110, 11,791 S. H. Scudder Coll.) probably belong here.

Colaspis diluvialis, sp. nov.

Plate **11**, fig. 1.

Form rather elongate. Head too much damaged to show the shape. Antennae incomplete but displaying several of the proximal joints which are slender though somewhat thicker than in recent species. Prothorax poorly defined, flanks beneath moderately coarsely and quite closely though not very deeply punctured. Meso- and metathorax more finely punctate and transversely or obliquely subrugose beneath. Elytra showing only a portion of one side upon which the sculpture is displayed in the form of nearly regular striae of circular or slightly transversely elliptical deep punctures, those of the same row separated by spaces usually much less than the diameters of the punctures. The sculpture is much finer towards the apex, and, on account of poor preservation, is nearly effaced near the base. Abdomen nearly smooth but showing traces of shallow punctuation. Legs wanting. Length, from front of head to abdominal apex, 4.50 mm.

Described from one specimen.

Type.— No. 2,626 M. C. Z. Florissant, Col. (No. 6,872 S. H. Scudder Coll.).

Most likely this insect is not a true Colaspis though it may be received in that genus in its broad interpretation. It is more like Rhabdopterus in the nature of the elytral sculpture, this being more regular than in the recent North American species of Colaspis. By description, the present species is close to Scudder's *C. luti* but has relatively a much shorter prothorax. The figure of *C. luti* represents the abdomen as having six segments.

Colaspis proserpina, sp. nov.

Plate **11**, fig. 2.

Form moderately elongate. Head without definable sculpture, eye elliptical, antenna poorly preserved but evidently long, about half the length of the body. Prothorax simply roughened, the separate punctures not distinguishable. Meso- and metasternum, their side-pieces and abdomen nearly smooth. Elytron roughened as if sculptured with partly obliterated irregular punctures after the manner of the recent *C. chrysis*, though less deeply. Legs too poorly preserved for description. Length, 6.10 mm.

Described from one specimen with counterpart.

Type.— No. 2,624, 2,625 M. C. Z. Florissant, Col. (No. 9,006 and 9,103 S. H. Scudder Coll.).

The generic reference is open to doubt. The insect seems to belong to the Eumolpini and near Colaspis but the sculpture is not matched in my series of recent forms. Most of the upper surface seems to be rough as in *C. chrysis* while the smooth side-pieces of the meso- and metasternum are like Rhabdopterus. True generic characters are lacking. It differs from the other Florissant spécies described as Colaspis in the combination of size and sculpture.

Chrysomela vesperalis Scudder.

The specimen with counterpart, No. 2,627, 2,628 M. C. Z. (No. 11,264 and 13,649 S. H. Scudder Coll.), referred here, is shown in side view. It has altogether the form of Chrysomela and answers the details of the original description. The elytral punctuation in the present specimen is fine, a point not specified by Scudder though naturally inferable from his figure.

Diabrotica bowditchiana, sp. nov.

Plate 11, fig. 4.

Form moderately elongate, broader posteriorly. Head, inclusive of jaws, about as long as the pronotum but not equalling it in breadth. Eyes rather large, rounded, very black and strongly outlined in the specimen, the remainder of the head being pale. Antennae slender, so far as shown, but only their basal portions are preserved. Pronotum about one and one half times as broad as long, sides weakly rounded, apex and base subequal. Elytra a little more than four times as long as the pronotum, finely punctate but with no signs of striae. Legs wanting. Length, 7 mm.

Described from one specimen.

Type.— No. 2,600 M. C. Z. Florissant, Col. (No. 3,467 S. H. Scudder Coll.).

The form was evidently not unlike that of the recent *D. 12-punctata*, though probably more slender. What remains of the elytral sculpture indicates a type more like that of Trirhabda than of any of the North American species of Diabrotica known to me though possibly it may be paralleled in some of the numerous South American representatives of the latter genus to which I have not access. The marmorate appearance seems due to the mode of preservation and not to the presence of any definite pattern. The prothorax is pale like the head. The present species is considerably larger than the Florissant fossil *D. excesa.*

It is named for Mr. Frederick C. Bowditch of Brookline, Massachusetts.

Diabrotica uteana, sp. nov.

Plate 11, fig. 5.

Form similar to that of *D. bowditchiana* but a little more robust. Head rather large, antennae shorter and stouter than in most of the recent North American species. Pronotum damaged on one side, the other appears to be but slightly arcuate, the base broader than the apex. Elytra four and one half times as long as the pronotum, punctuation not distinct, but with some signs of striation near the outer margin. Legs wanting. Length, 4.35 mm.

Described from a single specimen.

Type.— No. 2,629 M. C. Z. Florissant, Col. (No. 507 S. H. Scudder Coll.).

Intermediate in size between *D. exesa* and *D. bowditchiana*, both from these shales.

Diabrotica florissantella, sp. nov.

Plate 11, fig. 3.

Form similar to that of the living *D. longicornis*. Head of moderate size, the antennae showing only nine joints but these, if straightened out, would reach fully two thirds of the distance to the abdominal apex. Prothorax short, the form too much distorted for description. Elytra distinctly but finely longitudinally striate, the striae apparently not punctured. Legs normally slender. Length, 6 mm.

Described from one specimen.

Type.— No. 2,630 M. C. Z. Florissant, Col. (No. 9,566 S. H. Scudder Coll.).

While the species of Florissant fossils assigned to Diabrotica do not offer any very striking characters, it seems worth while to give this one a name since if fairly well preserved it will usually be separable from the other three by the long antennae and the distinct elytral striae.

Diabrotica exesa Wickham.

One specimen, No. 2,631 M. C. Z. (No. 9,193 S. H. Scudder Coll.).

Trirhabda sepulta, sp. nov.

Plate 11, fig. 6.

Form about like that of the recent *T. canadensis*. Head finely punctate, the punctures extensively confluent forming rugae. Antennae (possibly not preserved to the extreme tip) not quite as long as the elytra, the basal five joints proportioned about as in *T. convergens*. Prothorax with the disk scarcely visibly punctulate, sides only feebly arcuate. Elytra not at all striate, sculpture very minute. The entire upper surface of the body, including the antennal joints, is clothed with fine hairs, quite close-set on the elytra but less so on the head and pronotum. Legs wanting. Length, 7.70 mm.; of elytron, 5 mm.

Described from one specimen.

Type.— No. 2,632 M. C. Z. Florissant, Col. (No. 3,931 S. H. Scudder Coll.).

The characters shown are those of Trirhabda, though at first sight the specimen does not give the impression of belonging to that genus which is well represented in North America today. The size is about equal to that of *T. convergens* or *T. attenuata*.

Trirhabda megacephala, sp. nov.

Plate 12, fig. 2.

Form elongate, parallel. Head large but not so wide as the prothorax. Eyes not well defined. Antennae damaged but showing six of the intermediate joints which are slender, not serrate, subequal, each a little more than twice as long as wide. In life, the antennae must have reached at least to the middle of the elytra and probably beyond that point. Prothorax badly injured but what remains shows it to have been not far from twice as broad as long. Scutellum small. Elytra four times as long as the prothorax, apices rounded. Abdomen showing five nearly equal segments which can be seen through the elytra. Legs wanting. Length, to elytral apices, 8.70 mm.; of the elytra 5.80 mm.

Described from one specimen.

Type.— No. 2,633 M. C. Z. Florissant, Col. (No. 3,166 S. H. Scudder Coll.).

The entire upper surface is minutely punctulate and finely hairy. The size and form are those of Trirhabda and it seems proper to place it here provisionally.

Trirhabda majuscula, sp. nov.

Plate 12, fig. 1.

Form moderately elongate. Head abnormally exserted, rounded, minutely punctulate and clothed with fine, dark, short, close hair. Eyes rounded, widely distant on the vertex. Antennae slender, not serrate, the individual joints too poorly preserved for description. Prothorax about one and one third times as broad as long, sides rounded, apex and base more or less truncate, surface minutely punctured and clothed similarly to the head. Scutellum broad.

Elytra nearly four times as long as the prothorax, minutely punctulate and clothed like the rest of the upper surface, apices bluntly pointed. Legs in very poor condition but apparently of normal thickness for the genus. Length, to elytral apices, 10.15 mm.; of elytron, 7.50 mm.

Described from one specimen.

Type.— No. 2,634 M. C. Z. Florissant, Col. (No. 11,266 S. H. Scudder Coll.).

Easily distinguished from either of the other two Florissant species by the much greater size which slightly exceeds that of the average specimen of the recent *T. canadensis*.

Haltica renovata, sp. nov.

Plate **13**, fig. 2.

Form oblong-ovate, moderately stout. Head showing no characters except those exhibited by one antenna which is incompletely preserved but the five joints that remain, with the less defined remnants of two more, are slender as in recent species of the genus. The entire upper side is hidden in the type, but the elytral epipleural margin does not indicate striation nor heavy punctuation, and from this fact and the lack of sculpture showing through the body we may infer that the surface was merely finely punctulate or smooth. Anterior coxae large, probably not separated for their full length by the prosternum. Under surface of the trunk, including the abdomen, with no conspicuous sculpture. Hind legs with strongly swollen femora, the tarsi crossed so as to hide their articulations. Length, 5.25 mm.

Described from one specimen.

Type.— No. 2,635 M. C. Z. Florissant, Col. (No. 7,296 S. H. Scudder Coll.). Probably the same species is represented by No. 2,636, 2,637 M. C. Z. (No. 7,736, 3,507 S. H. Scudder Coll.).

It is possible that this is not a true Haltica but the general agreement is sufficiently close.

Systena florissantensis Wickham.

To this species probably belong four specimens, No. 2,638–2,641 M. C. Z. (No. 413, 3,430, 8,933, 9,615 S. H. Scudder Coll.). Like the type, they show the underside only.

Plectrotetrophanes, gen. nov.

General outline similar to that of Plectrotetra with which it agrees also in the open front coxal cavities, the distinctly striatopunctate elytra and the relatively slender hind femora. It differs especially in the short antennae and the much more abbreviated prosternum which allows the front coxal cavities to become widely confluent.

Type.— *P. hageni*, sp. nov.

Plectrotetrophanes hageni, sp. nov.

Plate **12**, fig. 4.

Form moderately elongate but probably less so than would be inferred from the figure since the specimen is preserved lying on its back but somewhat askew. Head of moderate size, eyes rather large. Antennae short for the Halticini, second joint more than half as long as the third which is a little shorter than the first, the fourth to seventh subequal and of nearly the same size as the third. Prothorax much broader than long, the exact proportions not ascertainable since only a ventral view is shown and the sides are badly damaged. Prosternum short and pointed between the coxae, rugose in front of them and not visibly carinate. The prothoracic flanks are distinctly but finely and sparsely punctate. Mesosternum rather narrowly separating the middle coxae, side-pieces nearly smooth. Metasternum very finely punctulate. Elytra showing through the abdominal segments, strongly striatopunctate, the punctures circular and well separated, the striae subequidistant. Hind femur rather slender though possibly shown on edge. Abdomen finely punctulate. Length, 4.50 mm.

Described from one specimen.

Type.— No. 2,642 M. C. Z. Florissant, Col. (No. 8,125 S. H. Scudder Coll.).

While the nature of the preservation of this insect obscures many important features, it seems to be related to the Mexican genus Plectrotetra in the chief characters shown. None of our North American Halticini with striatopunctate elytra approach it nearly so closely. Compared with *P. dohrnii* from Jalapa, the fossil is more coarsely sculptured and the striae of punctures are much better marked. Most unfortunately the antennae are poorly shown, the joints beyond the seventh all being lacking or mutilated, but what remains of these organs indicates that they were much shorter than in Plectrotetra. The left antenna of the fossil (supposing the insect to be in its natural position instead of upon its back) is taken to show the true structure, the other being very evidently distorted. The courses of the elytral striae, as they show through, are indicated on the figure by dotted lines except in a few places where the punctuation is set up strongly so as to allow of the delineation of the separate points with a camera lucida.

The specific name is given for the late Dr. Hermann A. Hagen, for many years in charge of the entomological department of the Museum of Comparative Zoölogy.

Prochaetocnema, gen. nov.

Form similar to that of the recent genus Chaetocnema, particularly the shorter species like *C. confinis*. Head large, antennae slightly thickened, 11-jointed, decidedly less than half as long as the body. Front coxae well separated by the strongly punctate prosternum, which is expanded at tip. Middle and hind coxae well separated, intercoxal process of first ventral blunt at tip. Ventral segments, as preserved, very unequal, the first extremely long, the three following short, the last nearly as long as the first. Hind femur much thickened, posterior tibia long, expanded apically and with a notch before the tip.

Type.— *P. florissantella*, sp. nov.

Prochaetocnema florissantella, sp. nov.

Plate **12**, fig. 3.

Form robust. Head moderately large; antennae shorter and thicker than in the recent species of Halticini with which I have been able to compare it, joints beyond the first subequal. Prosternum moderately broad between the coxae and expanded at tip behind them, strongly punctured. Meso- and metasternal regions more finely punctate. Abdomen moderately strongly punctured at base, less so apically, an arcuate row behind each posterior coxa. Hind leg stout, the tibia strongly expanded apically, grooved on one face. Elytra punctatostriate, probably strongly, since the sculpture shows fairly well near the margin where it is usually more or less obscured if weak. Length, in somewhat bent attitude as preserved, 2.35 mm., in life probably not far from 2.50 mm.

Described from a single specimen in somewhat oblique ventral view.

Type.— No. 2,643 M. C. Z. Florissant, Col. (No. 9,430 S. H. Scudder Coll.).

At first sight, I referred this beetle to Chaetoenema, but it differs in many points from that genus and from all others known to me. The broad punctured prosternum is like that of Chaetocnema but the antennae are more like those of Crepidodera, though shorter and thicker than in recent species. It is not possible to determine with certainty whether the front coxal cavities were open or closed, but, judging from the prosternum, probably the latter. The abdominal segmentation, if natural, is remarkable, but I think likely it is disarranged, to some extent at least, by telescoping. None of the North American genera have hind tibiae of this type and in the absence of knowledge as to the point of tarsal articulation this structure gives us no good clue to the location of the species though the groove reminds one of similar sculpture in Dibolia. On the whole, I should, for the present, place the genus in the neighborhood of Chaetoenema.

ODONTOTA Chevrolat.

This genus is the only one of the Hispini known from the Florissant shales. Today the group is not very strongly represented in temperate North America, our fauna comprising about thirty-five species, twelve of which belong to Odontota.

ODONTOTA AMERICANA, sp. nov.

Plate **11**, fig. 7–9.

Form rather short for this genus. Head and prothorax rough but the sculpture is not well defined. Elytra with deep wide striae, coarsely punctate at bottom. The exact shape of the punctures cannot be made out as the specimen is preserved in ventral aspect and only those which show through can be distinguished. Length, 3.85 mm.

Described from a single specimen.

Type.— No. 2,644 M. C. Z. Florissant, Col. (No. 7,176 S. H. Scudder Coll.). A second specimen, No. 2,645 M. C. Z. (No. 10,506 S. H. Scudder Coll.), is most likely the same species.

No doubt need attach to the generic identification, the form, sculpture, and structure of the 11-jointed antennae are those of Odontota.

BRUCHIDAE.

SPERMOPHAGUS PLUTO, sp. nov.

Plate **13**, fig. 3–4.

Form stout. Head small. Antennae short, not serrate, the joints of the middle portion, at least, squarish. Prothorax showing moderately coarse and deep, closely placed punctures on the flanks, sculpture of the remainder of the underside not defined. Legs of moderate length for the family, the hind femora slightly thickened, hind tibia carinate, straight, with two unequal but fairly long spurs at the apex. Hind coxae not much dilated and scarcely narrowing the basal abdominal segment. Length, 4.75 mm.; to elytral tips, 4 mm.

Described from one specimen showing the underside.

Type.— No. 2,646 M. C. Z. Florissant, Col. (No. 8,843 S. H. Scudder Coll.).

The rounded tips of the elytra show through and at first sight give the impression of being enlarged coxal plates. While the aspect of this insect is decidedly bruchid, I have not been able to assign it to Bruchus because of the distinct spurs on the posterior tibia and have therefore given it the above generic position rather than erect a new genus upon the basis of the difference in form of body and in development of the legs. The short antennae will separate it at once from *S. vivificatus* and the form of the hind legs will distinguish it from any of the Florissant species of Bruchus with which it might otherwise be confused.

BRUCHUS PRIMOTICUS, sp. nov.

Plate **13**, fig. 6; Plate **14**, fig. 1–2.

Form robust. Head rather large, closely and minutely punctulate. Antennae moderately stout, distinctly but not very strongly serrate. Prothorax minutely punctulate in similar fashion to the head but more strongly and having in addition a moderately coarse and very close punctuation of medium depth, more pronounced at sides and base. Elytra distinctly but rather finely striate, the striae with rows of moderately small, approximate, elongate punctures, interstitial spaces minutely transversely rugose. Hind tibia curved and carinate or grooved, the femur enlarged, with a rather small tooth and a row of four sharp subequal denticles. Sternal pieces and first abdominal segment finely and closely punctured, the remainder of the abdomen less distinctly. Length, to apex of abdomen, 5.50 mm.; to elytral apex, 5 mm.

Described from one specimen with counterpart.

Type.— No. 2,647, 2,648 M. C. Z. Florissant, Col. (No. 11,269 and 13,031 S. H. Scudder Coll.). The same species is represented by No. 2,649 M. C. Z. (No. 8,428 S. H. Scudder Coll.).

A fine species belonging, by its antennal characters, with *B. exhumatus* and *B. scudderi* from these shales, though larger than either and differing in punctuation from both of them. An interesting feature is shown by the exposure of the hind femur which exhibits an arrangement of tooth and denticles similar to that seen in many recent forms.

Bruchus submersus, sp. nov.

Plate 13, fig. 7.

Form stout, but the body is so much crushed as to obscure the exact outline. Head minutely punctulate. Antennae long and slender, not serrate. Pronotum with moderate sized round punctures, rather crowded near the base and sides, much finer anteriorly. Elytra with very large epipleural lobe, strongly striate on the disk and sides, the striae becoming evanescent apically, strial punctures hardly wider than the striae, those of each row near together. Interstitial spaces broad and flat, minutely roughened and finely hairy. Sternal pieces and abdomen almost smooth. Hind femur strongly swollen and not visibly toothed, the tibia curved, with a sharp apical spine. Fore and middle legs moderately slender, hairy. Length, as preserved, 5.15 mm.

Described from one specimen.

Type.—No. 2,650 M. C. Z. Florissant, Col. (No. 11,279 S. H. Scudder Coll.).

Probably the best place for this is next to *B. henshawi* with which it agrees in the stout form and rounded elytral strial punctures but the present species is larger, the strial punctures are relatively smaller and less conspicuous and the hind femur is very much more expanded. The great development of the epipleural lobe is noteworthy.

Bruchus carpophiloides, sp. nov.

Plate 13, fig. 8.

Form slightly elongate. Head too poorly preserved for description. Antennae showing only a few of the intermediate joints which are not serrate but are quite broad. Prothorax produced at the middle of the base into an obtuse lobe, the disk rather finely and sparsely, not deeply punctate, the sides more strongly and closely. Scutellum not visible. Elytra strongly truncate at the apices, punctatostriate, the striae not deep but rather broad, the punctures about as wide as the striae, very slightly elongate, those of the same row practically contiguous. Interstitial areas flat, well clothed with short dark hair. Pygidium with fine and shallow but close punctuation. Legs wanting. Length, as preserved, 3.90 mm.; to elytral tips, 3 mm.

Described from one specimen.

Type.— No. 2,651 M. C. Z. Florissant, Col. (No. 7,555 S. H. Scudder Coll.). It is likely that No. 2,653 M. C. Z. (No. 5,393 S. H. Scudder Coll.) represents the same species, while No. 2,652 (No. 7,332 S. H. Scudder Coll.) certainly belongs here.

Related in most of its characters to *B. henshawi*, but is smaller and relatively more slender, the prothorax shining, with finer and sparser punctuation. In *B. henshawi*, the strial punctures of the elytra are not in the least elongate but under high power appear a trifle transverse and are stronger and more clearly cut than in the present species.

Bruchus aboriginalis, sp. nov.

Plate 13, fig. 5.

Form elongate, much broader behind. Head covered by the projecting front margin of the prothorax. Antennae of moderate length, the joints rather strongly serrate, the intermediate ones longer than wide, the remainder not well defined. Pronotum with the front margin strongly arcuate, sides divergent posteriorly to the hind angles, base arcuate but much less than the apex, forming an obtuse lobe. Entire pronotal surface closely, moderately coarsely and distinctly punctured, clothed with short dark hairs. Elytra short, truncate apically, striae not deep nor distinct though rather broad, indistinctly punctate. Interstitial spaces at base punctured like the pronotum, less coarsely towards the apex. Pubescence short, dark and moderately sparse. Middle legs slender, tibiae straight. Hind femur not shown, the tibia not elongate nor curved, the right one showing the apical spine, first tarsal joint very long and a little curved, the remainder poorly shown. Pygidium minutely alutaceous and hairy. Length, to tip of abdomen, 4.20 mm.; to elytral apex, 2.80 mm.

Described from one specimen.

Type.— No. 2,654 M. C. Z. Florissant, Col. (No. 14,017 S. H. Scudder Coll.).

Entirely different from any of the other Florissant fossil species in the combination of antennal and sculptural characters. At first sight it looks a little like *B. carpophiloides*.

Bruchus bowditchi Wickham.

Four specimens, No. 2,655–2,658 M. C. Z. (No. 2,969, 3,119, 8,610, 9,151 S. H. Scudder Coll.).

Bruchus henshawi Wickham.

Five examples, No. 2,659–2,663 M. C. Z. (No. 8,397, 8,657, 8,834, 8,841, 8,851 S. H. Scudder Coll.).

Bruchus haywardi Wickham.

Represented by two specimens. No. 2,664, 2,665 M. C. Z. (No. 435, 13,585 S. H. Scudder Coll.).

Bruchus scudderi Wickham.

One specimen, No. 2,666 M. C. Z. (No. 8,332 S. H. Scudder Coll.).

Bruchus wilsoni Wickham.

Three specimens, No. 2,667–2,669 M. C. Z. (No. 4,826, 5,917, 9,569 S. H. Scudder Coll.).

BRUCHUS EXHUMATUS Wickham.

Five specimens No. 2,670–2,674 M. C. Z. (No. 446, 1,154, 5,766, 7,237, 10,920 S. H. Scudder Coll.).

BRUCHUS FLORISSANTENSIS Wickham.

Three examples, No. 2,675–2,677 M. C. Z. (No. 2,150, 8,744, 11,272 S. H. Scudder Coll.).

TENEBRIONIDAE.

PROTOPLATYCERA, gen. nov.

Aspect tenebrionoid. Integuments heavy. Form probably moderately slender, the prothorax narrower than the elytra. Sculpture light. Head rather small, eyes nearly circular, separated on the vertex by about the width of one. Antenna with the two (or possibly three, since the second may be small and inconspicuous) basal joints slender, the remainder broad and flat, proportioned as shown in the figure.

Type.— *P. laticornis*, sp. nov.

PROTOPLATYCERA LATICORNIS, sp. nov.

Plate **14**, fig. 3–4.

Moderately elongate, as preserved, in life probably less so. Head narrow, longer than wide. Eyes small, suborbicular. Antennae, if extended backward, reaching slightly beyond the elytral bases. Prothorax apparently only about as wide as the head, with subparallel sides, but not in very good condition. Elytra rather short, a little more than two and one half times as long as wide, apices bluntly rounded. Legs poorly preserved but evidently moderately stout. Length, in position on the stone, from front of head to abdominal apex, 7.10 mm.; of elytron, 3.80 mm.

Described from one specimen.

Type.— No. 2,678 M. C. Z. Florissant, Col. (No. 13,070 S. H. Scudder Coll.).

A remarkable insect which I have placed for the present in the Tenebrionidae, without being able to suggest any tribal affinities. I have been entirely unable to find any modern insect with antennae of the type shown by the fossil. The sculpture is obscure but there is no sign of striation or heavy punctuation on any part of the body.

Ephalus adumbratus Scudder.

The reverse of the specimen which served as the type for Scudder's figure is in the series transmitted to me. It is No. 2,679 M. C. Z. (No. 6,469 S. H. Scudder Coll.).

CISTELIDAE.

Cistela vulcanica, sp. nov.

Plate **14**, fig. 5.

Form elongate oval. Head exposed, projecting, a little wider than long, mandibles only slightly prominent. Eyes not well defined but what remains indicates that they were rather small and widely separated on the vertex. Antennae long and slender, only very feebly serrate basally, reaching nearly to the middle of the elytra, the second joint short, those following the third subequal in length, each more than twice as long as wide. Prothorax, as preserved, considerably more than twice as wide as long, sides in rather poor condition but the better preserved one indicates that they were gradually rounded from the broad base to the much narrower apex. Scutellum subcordiform, small. Elytra a little less than four times the prothoracic length, rounded at apices. Legs not displayed. Length, to elytral tip, 14 mm.; of elytron, 10.35 mm.

Described from one specimen with counterpart.

Type.— No. 2,680, 2,681 M. C. Z. Florissant, Col. (No. 416 and 418 S. H. Scudder Coll.).

The entire upper surface is finely sculptured and clothed with rather close short hairs. The insect looks a good deal like the Florissant fossil *C. antiqua* but has longer and more slender antennae. It seems that the two are probably congeneric and may possibly represent the two sexes of a single species.

Isomira florissantensis, sp. nov.

Plate 14, fig. 6–7.

Form elongate oval. Head rather small, eyes not prominent. Antennae long enough to reach slightly beyond the elytral bases, relatively a little stouter than in the recent species known to me and with the third joint proportionately shorter. They are scarcely serrate and the distal joints are a little shortened. Prothorax about one and two thirds times as broad as long, sides regularly rounding to the apex which is much narrower than the base. Elytra each about three times as long as wide, subparallel anteriorly to behind the middle, apices conjointly rounded. Legs wanting except one of the anterior pair which is of normal build. Length, from front of head to elytral apex, 8.35 mm.

Described from one specimen.

Type.— No. 2,682 M. C. Z. Florissant, Col. (No. 510 S. H. Scudder Coll.).

This is strikingly like our common recent *I. sericea*, (*Cistela sericea* Say) in appearance, but is larger. The weak sculpture of this genus is not preserved in the fossil.

Hymenorus haydeni, sp. nov.

Plate 14, fig. 8.

Form moderately elongate and apparently subparallel although the insect is preserved lying partly upon one side and the exact shape is thus obscured. Head rather large, though neither as long nor as wide as the prothorax, eyes of good size, somewhat narrowly separated, surface sculpture obliterated. Antennae slender, the joints following the third subequal in length, as far as shown, and fully twice as long as wide. If extended backward, the apex of the seventh joint would reach about to the basal prothoracic margin. Prothorax, as preserved, somewhat less than one and one half times as wide as long. Elytra approximately three times as long as the prothorax, fairly sharply pointed at apex, surface very obscurely striate but without visible punctuation. The entire insect appears to be scabrous, but this is probably due to the texture of the stone and the rather soft consistency of the integuments before fossilization. Length, 7.15 mm.

Described from one specimen.

Type.— No. 2,683 M. C. Z. Florissant, Col. (No. 4,412 S. H. Scudder Coll.).

This has all the appearance of a cistelid of the general type of Hymenorus. It is easily distinguished from *Isomira florissantensis* by the different antennae.

The name is given in memory of the late Dr. F. V. Hayden.

OEDEMERIDAE.

Copidita miocenica, sp. nov.

Plate 15, fig. 1–2.

Form elongate and rather slender. Head long, muzzle strongly projecting. Eye not shown in entirety. Antennae rather short, the distal joints visibly shorter than the subbasal ones, serration slight. Prothorax, as preserved, distinctly longer than broad, the sides not in good enough condition to be certain of their form. Elytra about four and two thirds times as long as the prothorax, sides parallel, apices bluntly rounded. Legs slender but not very long. Length, to elytral apices, 11.90 mm.; of elytron, 8.35 mm.

Described from one specimen.

Type.— No. 2,684 M. C. Z. Florissant, Col. (No. 12,481 S. H. Scudder Coll.).

This insect must have been of about the same build as the recent Colorado species, *C. bicolor* and *C. obscura*. The entire upper surface of the body was clothed with short hairs, sparsely preserved but perhaps more numerous in life. The antennae and legs are covered with much finer and closer hairs. The similarity of antennal structure in the recent and fossil species is quite pronounced, as far as the joints can be definitely made out but unfortunately the entire base is poorly exhibited upon the stone. The sculpture was evidently faint as nothing but the merest traces of fine punctuation can be distinguished.

Paloedemera, gen. nov.

Form stout. Mandibles prominent. Elytra apparently not much if at all narrowed apically. Legs stout, posterior with strongly thickened and toothed femur, tibia curved and produced at apex, tarsus moderately broad, first and fourth joints longer, the latter of greater length and more slender.

Type.— *P. crassipes*, sp. nov.

Paloedemera crassipes, sp. nov.

Plate **15**, fig. 3–4.

Body of heavy build. Head prominent, mandibles projecting. Eye elliptical or nearly so, rather large. Antenna showing only the four proximal joints, which are stout, the third shorter than the fourth. Prothorax, in side view, not arched along the back, finely scabrous. Elytron long, tip obtusely rounded, sculpture fine and scabrous, about like that of the prothorax. Fore leg moderately stout, tibia straight, tarsus not expanded, hind leg as described in the generic diagnosis. Length, to elytral tip, 16.90 mm.; of elytron, 13 mm.

Described from one specimen with counterpart.

Type.— No. 2,685, 2,686 M. C. Z. Florissant, Col. (No. 1,000 and 1,001 S. H. Scudder Coll.).

This assignment to the Oedemeridae must be taken with caution. There is very little to go upon aside from the texture of the body and the thickening of the hind femur. The latter character has chiefly influenced my decision. While the family position must be considered purely provisional, the insect seems sufficiently remarkable to deserve a name. The hind femur is detached and at a slightly lower level in the stone, but I think it belongs with the rest of the specimen.

MORDELLIDAE.

Tomoxia inundata, sp. nov.

Plate **15**, fig. 5.

Preserved in profile. Form somewhat more than usually elongate. Head small, antenna long and slender, about equal to the thoracic height. Prothorax strongly arched. Elytra bluntly rounded at apex, surface with very fine and weak indications of striae. Legs in a rather hazy state of preservation and evidently somewhat shifted but the hind pair is shown to be of normal form with long tarsi. Abdomen projecting far beyond the elytral apex. Length, to abdominal tip, 8.75 mm.; of elytron, 6.50 mm.

Described from one specimen with counterpart.

Type.— No. 2,687, 2,688 M. C. Z. Florissant, Col. (No. 7,972 and 7,976 S. H. Scudder Coll.).

This is very easily separable from the other Florissant species of the family by the much greater size and more elongate form. It looks like the recent *T. hilaris*, found in our eastern states.

Mordella stygia, sp. nov.

Plate **15**, fig. 6.

Form stout. Head mutilated. Antennae slender, the nine joints which are visible subequal in length and hardly incrassate distally. Pronotum rather strongly arched, minutely and closely punctulate, too finely for definition under a hand lens. Elytron rounded at tip, relatively long, sculpture of the same nature as that of the prothorax but even less pronounced. Under surface of body somewhat rugosely punctulate on the meso- and metasternal flanks, less strongly and a little less closely on the abdomen. Anal style short and stout. Legs small, not very stout. Length, to elytral apex, 4.35 mm.; of elytron, 3.20 mm.

Described from one specimen.

Type.— No. 2,689 M. C. Z. Florissant, Col. (No. 9,968 S. H. Scudder Coll.).

There should be no difficulty in recognizing this species. It is considerably smaller than the Florissant fossil *Mordella lapidicola* and much larger than either of the two species of Mordellistena described from these shales. I have placed it in the former genus, in preference to the latter, on account of its size and rather heavy build.

Mordellistena scudderiana Wickham.

Four specimens, No. 2,690–2,693 M. C. Z. (No. 5,425, 6,269, 10,241, 11,186 S. H. Scudder Coll.), none with counterparts.

ANTHICIDAE.

Lithomacratria, gen. nov.

Form similar to Corphyra. Antennae, in general, of the type seen in the modern genus Macratria but more highly differentiated, the distal three joints much longer than all of the remainder, slightly incrassate. Prothorax short, transverse, not elongate as in Macratria.

Type.— *L. mirabilis*, sp. nov.

Lithomacratria mirabilis, sp. nov.

Plate **16**, fig. 1–2.

Form moderately stout. Head not enlarged, tempora rounded, surface nearly smooth but with a visible alutaceous sculpture. Palpus, probably maxillary, enlarged apically. Antennae moderately long, reaching, in life, about to the base of the elytra, joints two to eight short, subequal, not serrate, ninth and tenth each about equal to the sixth, seventh, and eighth united, eleventh more than four fifths as long as the combined ninth and tenth, these distal three joints only a little broader than the others. Prothorax about as long as the head, sculpture minute. Elytra about three and one half times as long as the prothorax, finely punctulate and moderately closely clothed with brownish hairs which do not at all conceal the surface. Abdomen alutaceous. Legs not very well preserved, fairly slender. Length, as preserved, 7.30 mm.; of elytron, 4.60 mm.

Described from one specimen with counterpart.

Type.— No. 2,694, 2,695 M. C. Z. Florissant, Col. (No. 11,257 and 13,655 S. H. Scudder Coll.).

My idea is that this fossil should belong near Macratria, but the basis for this opinion rests mostly upon the type of antennal structure. The aspect is decidedly more that of Corphyra and the size also corresponds better with the latter genus. It seems, by description, to differ from *M. gigantea* in being smaller and having a different prothorax and antennae, but the type of *M. gigantea* is not now at hand for comparison.

CORPHYRA CALYPSO, sp. nov.

Plate 16, fig. 3–4.

Form moderately robust. Head small, eyes destroyed but the orbits indicate that they were of good size. Antenna only slightly serrate, slender but not very long, the basal joints in poor condition, the intermediate ones about one and one half times as long as wide. Prothorax suborbicular, sculpture obliterated. Elytra four times as long as the prothorax, sides subparallel, apices bluntly rounded, sculpture very obscure, apparently a confused close punctuation or rugosity, two or three longitudinal lines showing on each which are probably due, in part at least, to underlying wing veins. Fore leg, the only one showing, rather short and quite stout. Length, as preserved, 8.50 mm.; to elytral apex, 8.40 mm.; of elytron, 5.70 mm.

Described from one specimen.

Type.— No. 2,696 M. C. Z. Florissant, Col. (No. 8,706 S. H. Scudder Coll.).

The form, size, and, as far as shown, the sculpture, are those of Corphyra. The antennae agree very well if we assume that the third joint is broken off in the middle and that the break immediately preceding the first of these sections represents the place of the second joint. The small head makes it unlikely that the insect is a meloide.

MELOIDAE.

TETRAONYX MINUSCULA, sp. nov.

Plate 16, fig. 5.

Preserved in profile. Form moderately stout. Head large, finely punctate and clothed with sparse blackish hairs. Antennae showing the distal six joints which increase in length apically and are submoniliform. Prothorax higher than long, surface shining like that of the head, punctuation fine and sparse, giving rise to long dark hairs of greater length than those on the head. Elytron finely, sparsely punctured and hairy, the hairs shorter than those of the prothorax or less well preserved. Legs rather stout and clothed with sparse dark hairs. Abdomen and side-pieces of the meso- and metasternum obscurely punctate and nearly smooth except that a few hairs may be seen in places. Length, to abdominal apex, 7.75 mm. If the head were in the presumed natural position, instead of being deflexed, the length would be about 1 mm. greater.

Described from one specimen, with counterpart.

Type.— No. 2,697, 2,698 M. C. Z. Florissant, Col. (No. 8,312 and 8,317 S. H. Scudder Coll.). No. 2,699 M. C. Z. (No. 1,526 S. H. Scudder Coll.) is probably a poorly preserved example of the same species.

While this insect is a little smaller than the recent *T. fulva* of New Mexico, it resembles it quite closely in form and has similar vestiture. The relative size of the head is about the same in the two species and except that the joints are shorter in the fossil the antennae are not unlike. No true generic characters are to be made out, but the general resemblance to Tetraonyx is very well marked.

EPICAUTA SUBNEGLECTA, sp. nov.

Plate **16**, fig. 6.

Preserved in side view. Form quite stout. Head very poorly outlined and not showing the shape of the eyes but it is only of moderate size and without definite sculpture though appearing subrugose under high power. Antennae showing only a few of the proximal joints which are strongly hairy. Prothorax nearly smooth but with many rather long hairs. Elytra similarly clothed and not visibly punctate. Legs rather slender. Length, to abdominal apex, 6.50 mm.; of elytron, 4.30 mm.

Described from one specimen with counterpart.

Type.— No. 2,700, 2,701 M. C. Z. Florissant, Col. (No. 478 and 4,278 S. H. Scudder Coll.).

This is rather small for an Epicauta. It has the shaggy look of the recent North American *E. puncticollis*. The generic reference may have to be changed if more perfect material becomes available.

CANTHARIS LITHOPHILUS, sp. nov.

Plate **16**, fig. 7.

Form slender. Head small for the genus roughly suborbicular. Eyes not well defined. Antennae short and stout as in several recent species of the genus, reaching but little beyond the prothoracic base. Prothorax rounded, base a little narrower than the apex. Elytra elongate, finely scabrous with a faint costulate effect. The entire upper surface of the body is sprinkled with fairly long blackish hairs, most likely the remains of a closer covering. Legs poorly preserved, rather slender, hairy. Length, as preserved, 10.40 mm.; to elytral apices, 8.85 mm.; of elytron, 6.30 mm.

Described from one specimen.

Type.— No. 2,702 M. C. Z. Florissant, Col. (No. 10,420 S. H. Scudder Coll.). No. 2,703, 2,704 M. C. Z. (No. 6,608, 10,917 S. H. Scudder Coll.), represent the same species.

I think there is but little doubt of this being a meloid, and it seems placed better in Cantharis than elsewhere. The short antennae and costulate elytra are seen in *C. sphaericollis*, common today in the vicinity of Florissant, but the fossil has a somewhat differently shaped head and prothorax, finer sculpture, and apparently coarser vestiture.

OTIORHYNCHIDAE.

Cyphus florissantensis, sp. nov.

Plate 16, fig. 8.

Form moderately stout. Beak short without basal constriction of any kind but merging gradually into the head, marked by a fine median line which extends back to a point about even with the hind margin of the small round eyes. Antennae long, the scape slender, passing the middle of the eye, funicular joints much longer than wide, club oval, pointed. Prothorax broader than the head, base and apex about equal, sides regularly but not strongly arcuate, surface finely granulose. Elytra broken at apices but evidently narrowed behind the middle, each with about eight series of small, sharp, rounded punctures, arranged in regular striae, those in each row separated ordinarily by a little less than their own diameters. Interspaces broad, flat and nearly smooth. Legs poorly preserved but stout. Length of fragment, 9 mm.; in life about 9.75 mm.

Described from one specimen.

Type.— No. 2,705 M. C. Z. Florissant, Col. (No. 8,029 S. H. Scudder Coll.).

Resembles Cyphus in the form of the body but differs from recent species of that genus in the long, slender antennae. Compared with the otiorhynchids described by Dr. Scudder, it seems to be nearest *Eropes veneratus* but the present species is larger, more finely and closely punctured on the elytra and with straight instead of geniculate antennae.

ANTHRIBIDAE.

BRACHYTARSUS (?) DUBIUS Wickham.

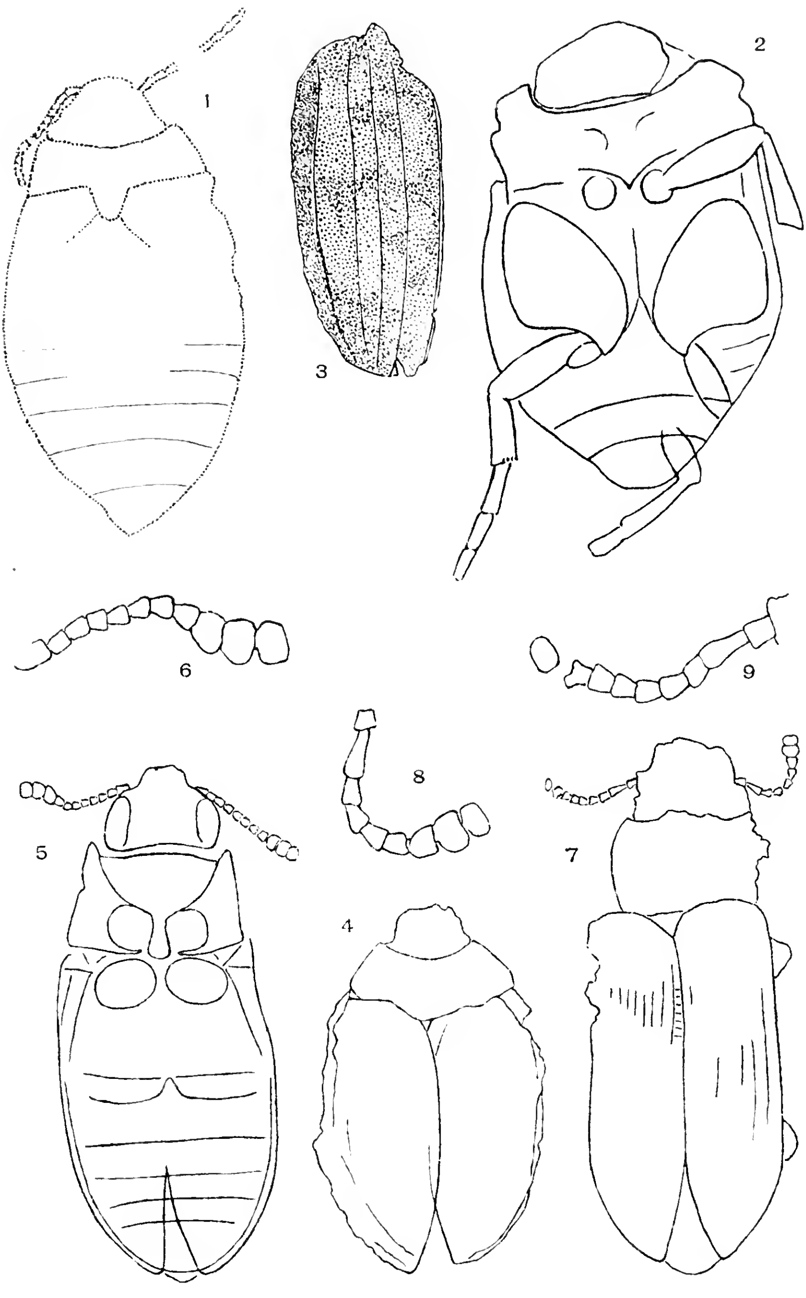
A single specimen, No. 2,706 M. C. Z. (No. 3,425 S. H. Scudder Coll.), is contained in the series. It is a little smaller than my type.

EXPLANATION OF PLATES.

PLATE 1.

PLATE 1.

Fig. 1. Bidessus laminarum.
Fig. 2. Hydroporus sedimentorum.
Fig. 3. Silpha beutenmuelleri.
Fig. 4. Coccinella florissantensis.
Fig. 5. Tritoma diluviana.
Fig. 6. Tritoma diluviana, antenna.
Fig. 7. Rhagoderidea striata.
Fig. 8. Rhagoderidea striata, right antenna.
Fig. 9. Rhagoderidea striata, left antenna.

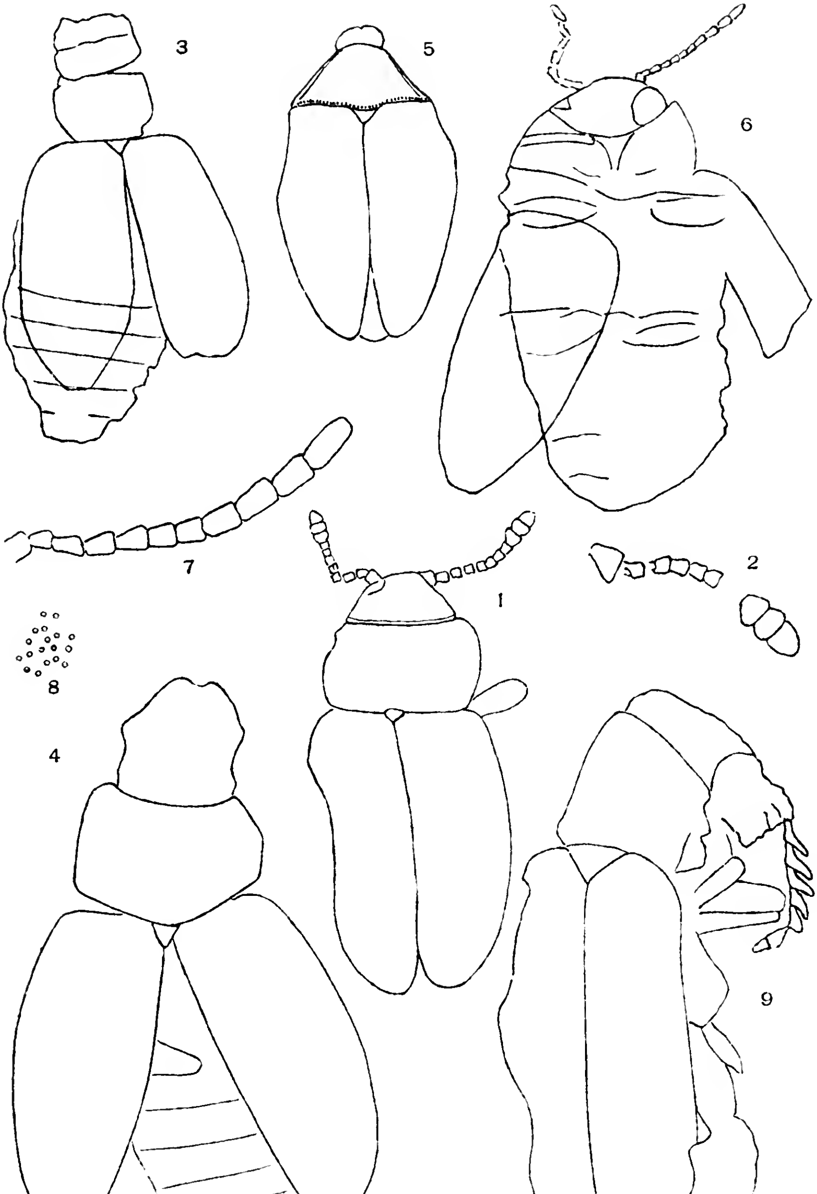


HELIOTYPE CO., BOSTON

PLATE 2.

PLATE 2.

Fig. 1. Cryptophagus scudderi.
Fig. 2. Cryptophagus scudderi, antenna.
Fig. 3. Corticaria occlusa.
Fig. 4. Corticaria egregia.
Fig. 5. Chelonarium montanum.
Fig. 6. Miocyphon punctulatus.
Fig. 7. Miocyphon punctulatus, antenna.
Fig. 8. Miocyphon punctulatus, elytral punctuation.
Fig. 9. Eucnemis antiquatus.



HELIOTYPE CO., BOSTON

PLATE 3.

Fig. 1. Dicerca eurydice.
Fig. 2. Buprestis florissantensis.
Fig. 3. Buprestis scudderi.
Fig. 4. Chrysobothris suppressa.
Fig. 5. Chrysobothris coloradensis.
Fig. 6. Ptosima silvatica.
Fig. 7. Agrilus praepolitus.


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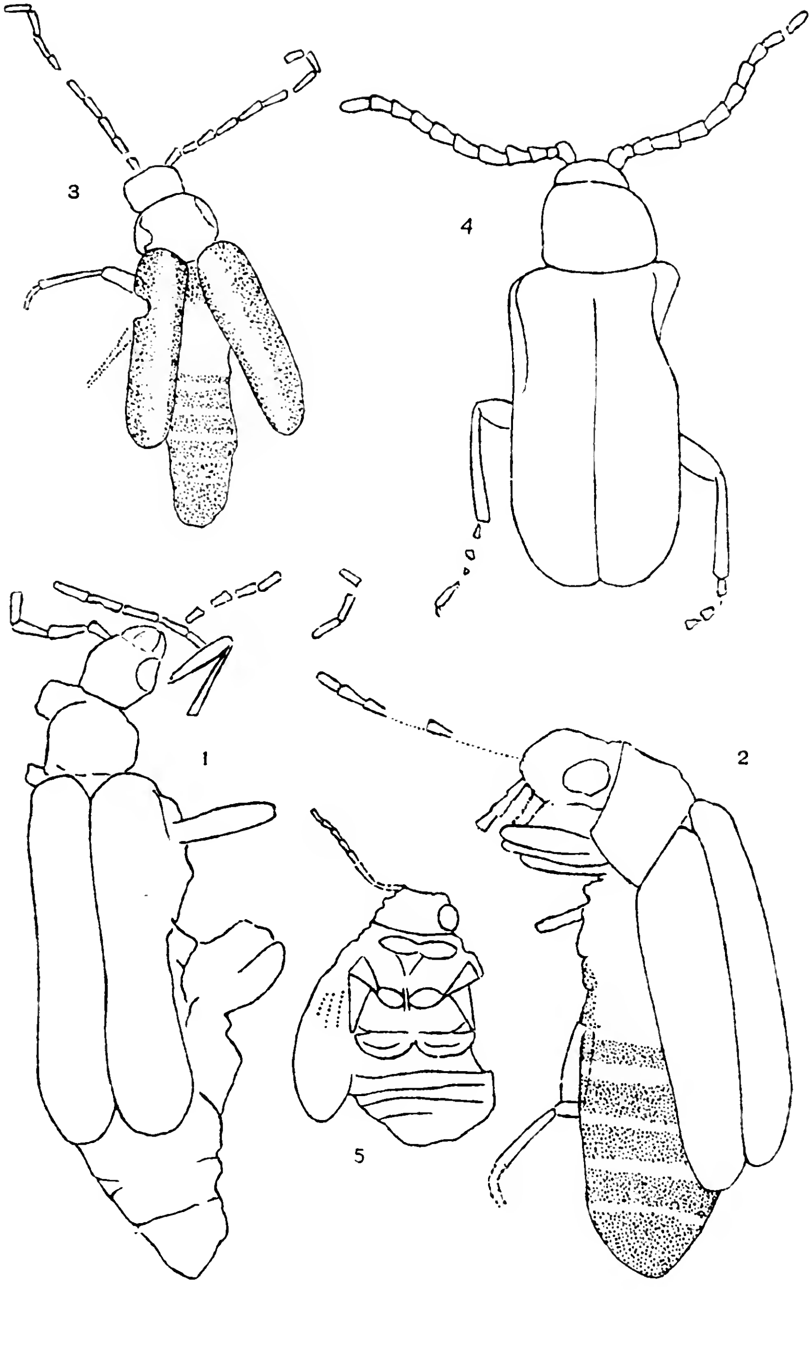
PLATE 4.

PLATE 4.

Fig. 1. Podabrus fragmentatus.
Fig. 2. Podabrus florissantensis.
Fig. 3. Telephorus hesperus.
Fig. 4. Polemius crassicornis.
Fig. 5. Protaenaeus tenuicornis.



HELIOTYPE CO., BOSTON

PLATE 5

PLATE 5.

Fig. 1. Miocaenia pectinicornis.
Fig. 2. Miocaenia pectinicornis, tip of antenna.
Fig. 3. Collops priscus.
Fig. 4. Collops priscus, antenna.
Fig. 5. Collops desuetus.
Fig. 6. Collops extrusus.
Fig. 7. Collops extrusus, antenna.
Fig. 8. Enoclerus florissantensis.
Fig. 9. Enoclerus pristinus.
Fig. 10. Necrobia divinatoria.
Fig. 11. Necrobia divinatoria, antennal apex.

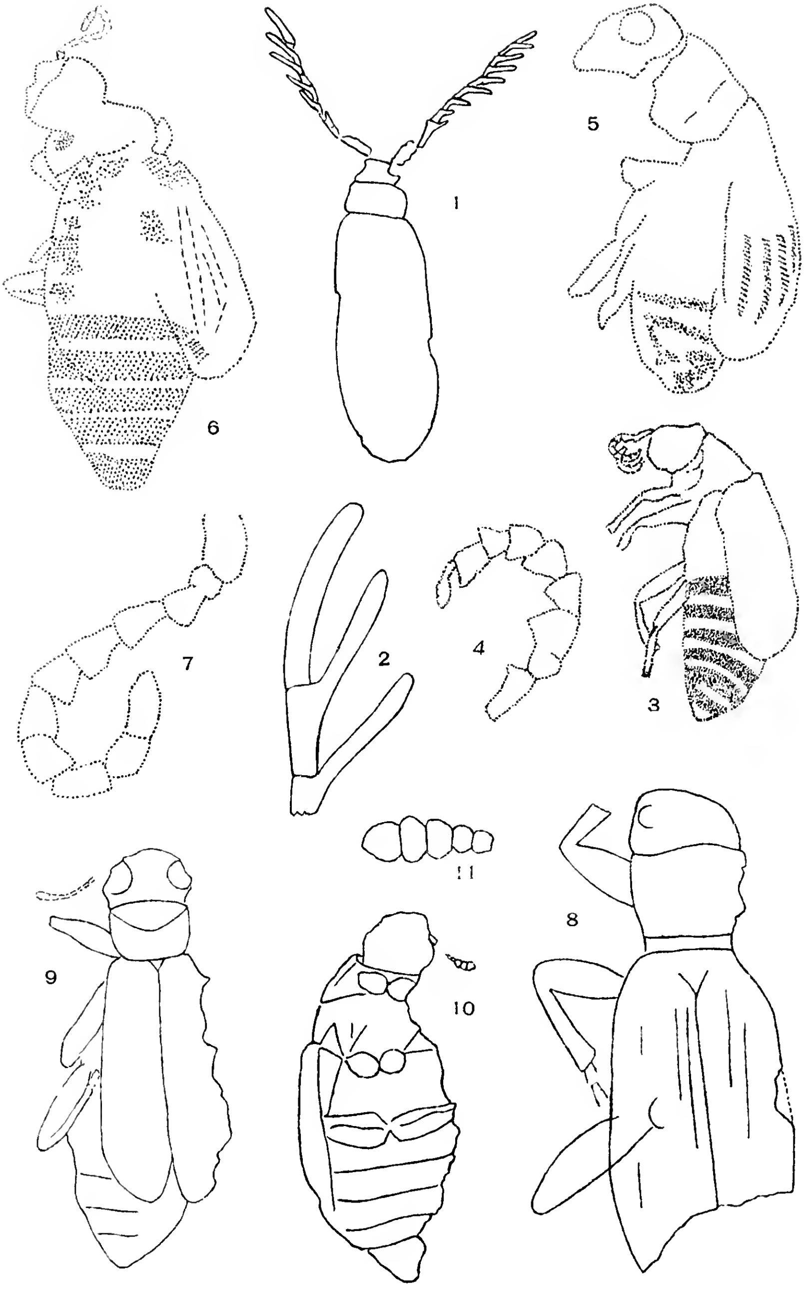

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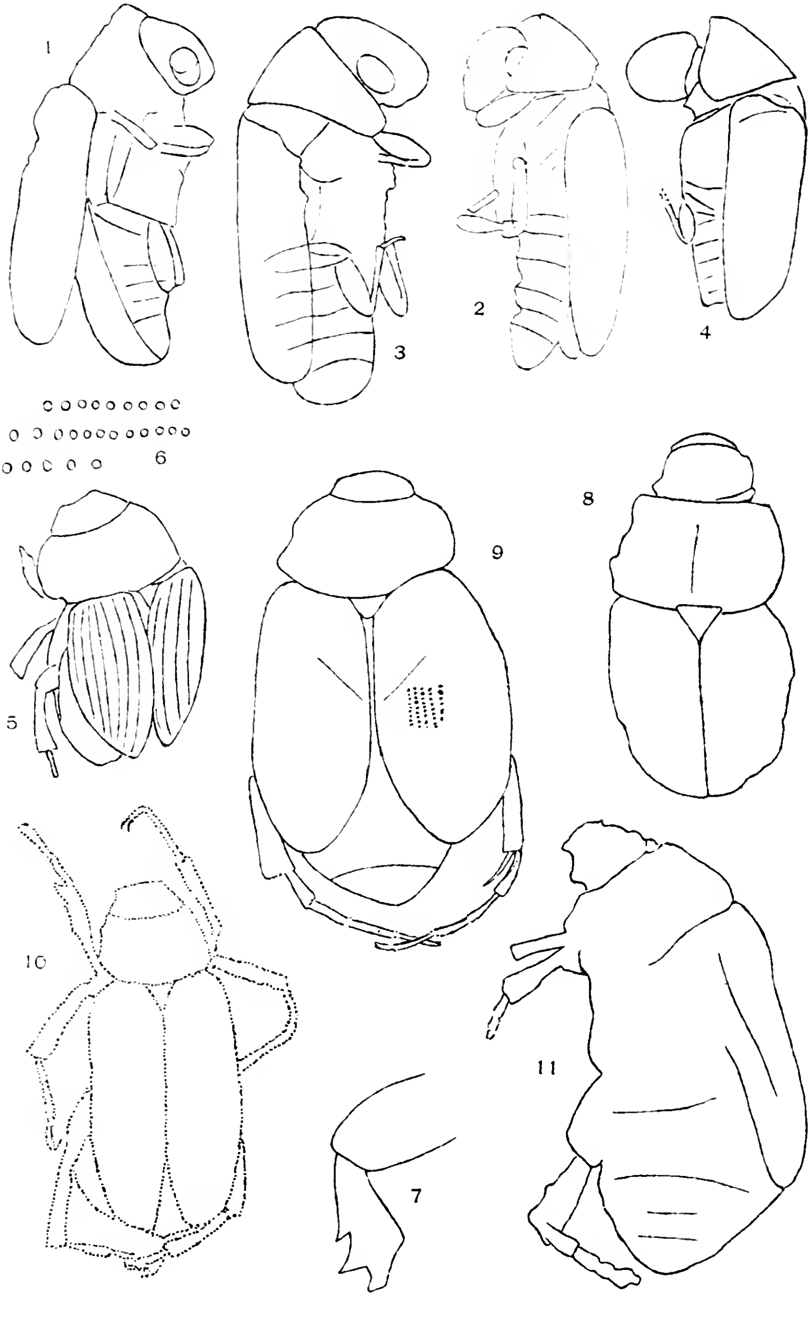
PLATE 6.

PLATE 6.

Fig. 1. Ernobius effetus.
Fig. 2. Oligomerus florissantensis.
Fig. 3. Oligomerus (?) duratus.
Fig. 4. Amphicerus sublaevis.
Fig. 5. Aphodius mediaevus.
Fig. 6. Aphodius mediaevus, elytral punctuation.
Fig. 7. Aphodius mediaevus, fore leg.
Fig. 8. Aphodius senex.
Fig. 9. Serica antediluviana.
Fig. 10. Listrochelus puerilis.
Fig. 11. Ligyrus effetus.

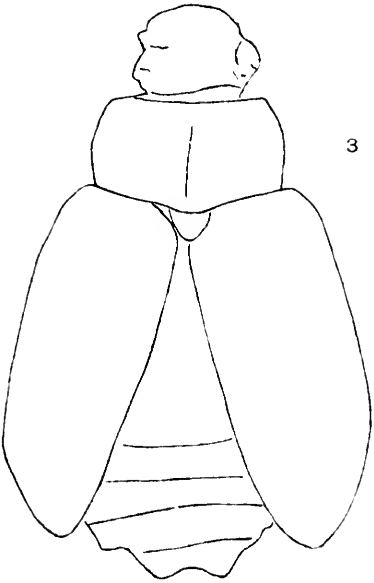


HELIOTYPE CO., BOSTON

PLATE 7.

PLATE 7.

Fig. 1. Oxyomus nearcticus.
Fig. 2. Hoplia striatipennis.
Fig. 3. Anomala exterranea.
Fig. 4. Strategus cessatus.



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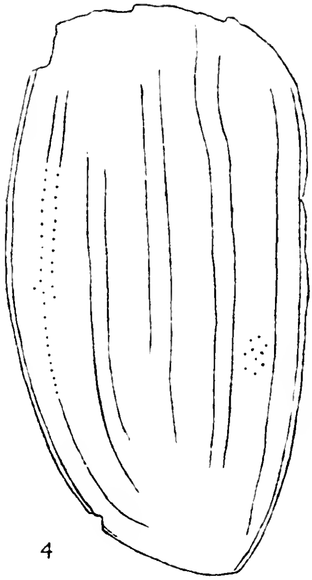

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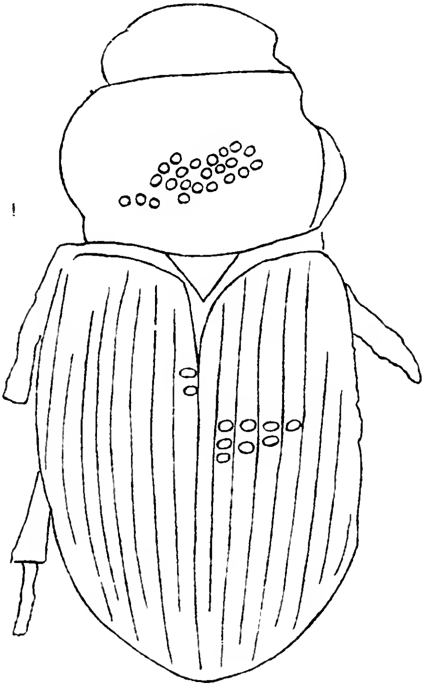

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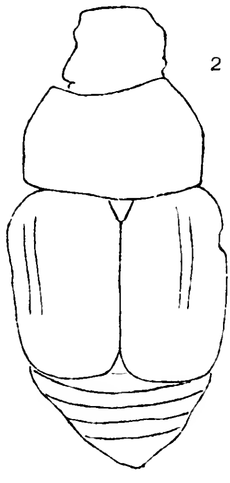

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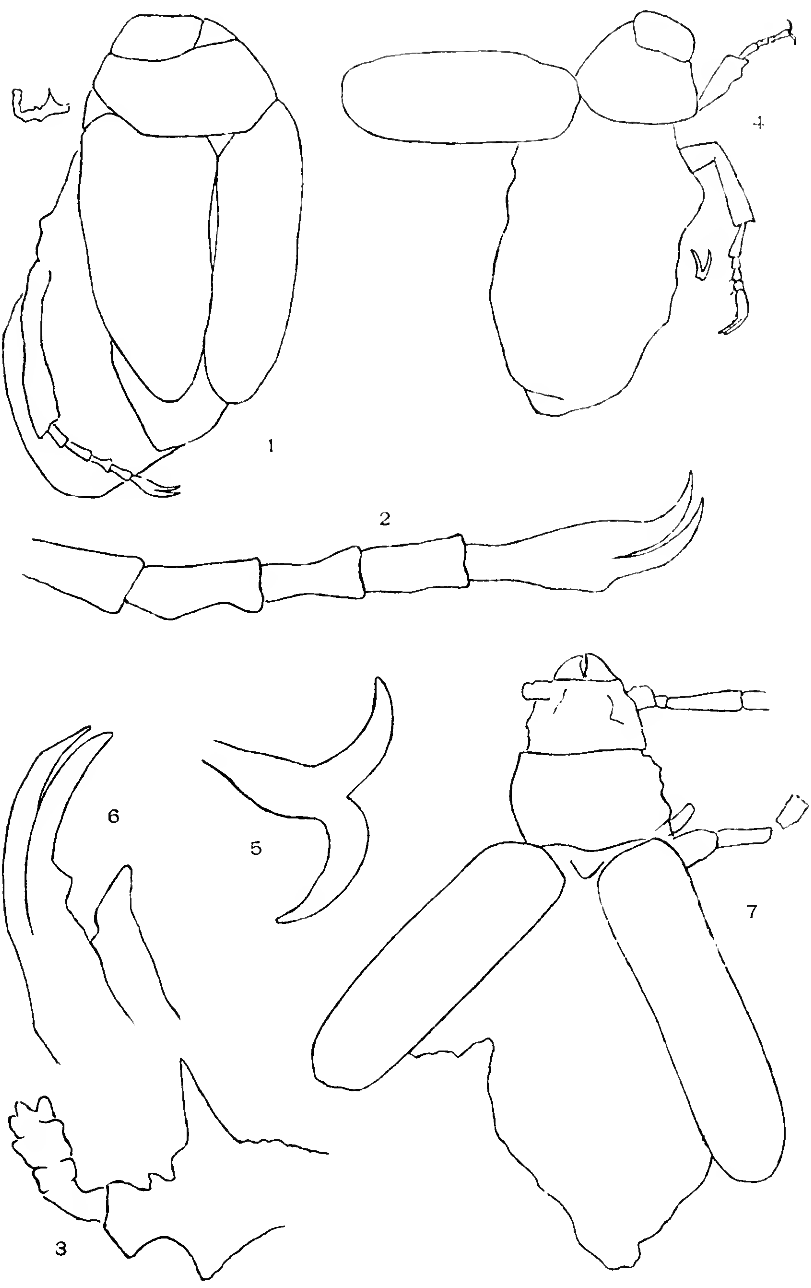
HELIOTYPE CO., BOSTON

PLATE 8.

PLATE 8.

Fig. 1. Miolachnosterna tristoides.
Fig. 2. Miolachnosterna tristoides, hind tarsus.
Fig. 3. Miolachnosterna tristoides, fore tibia.
Fig. 4. Anomala scudderi.
Fig. 5. Anomala scudderi, claws of fore tarsus.
Fig. 6. Anomala scudderi, claws of middle tarsus.
Fig. 7. Elaphidion extinctum.



HELIOTYPE CO., BOSTON

PLATE 9.

PLATE 9.

Fig. 1. Phymatodes (?) miocenicus
Fig. 2. Stenosphenus pristinus.
Fig. 3. Gaurotes striatopunctatus.
Fig. 4. Leptura nanella.
Fig. 5. Protipochus vandykei, antenna

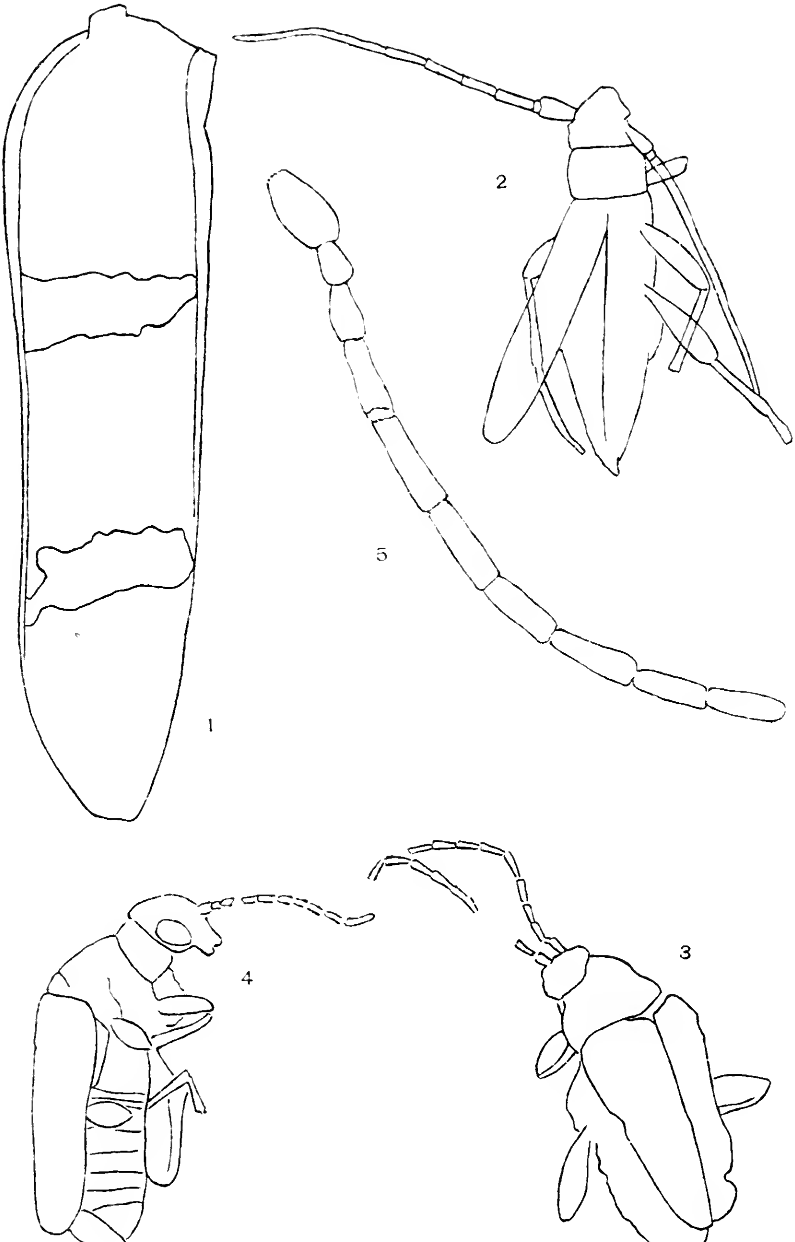

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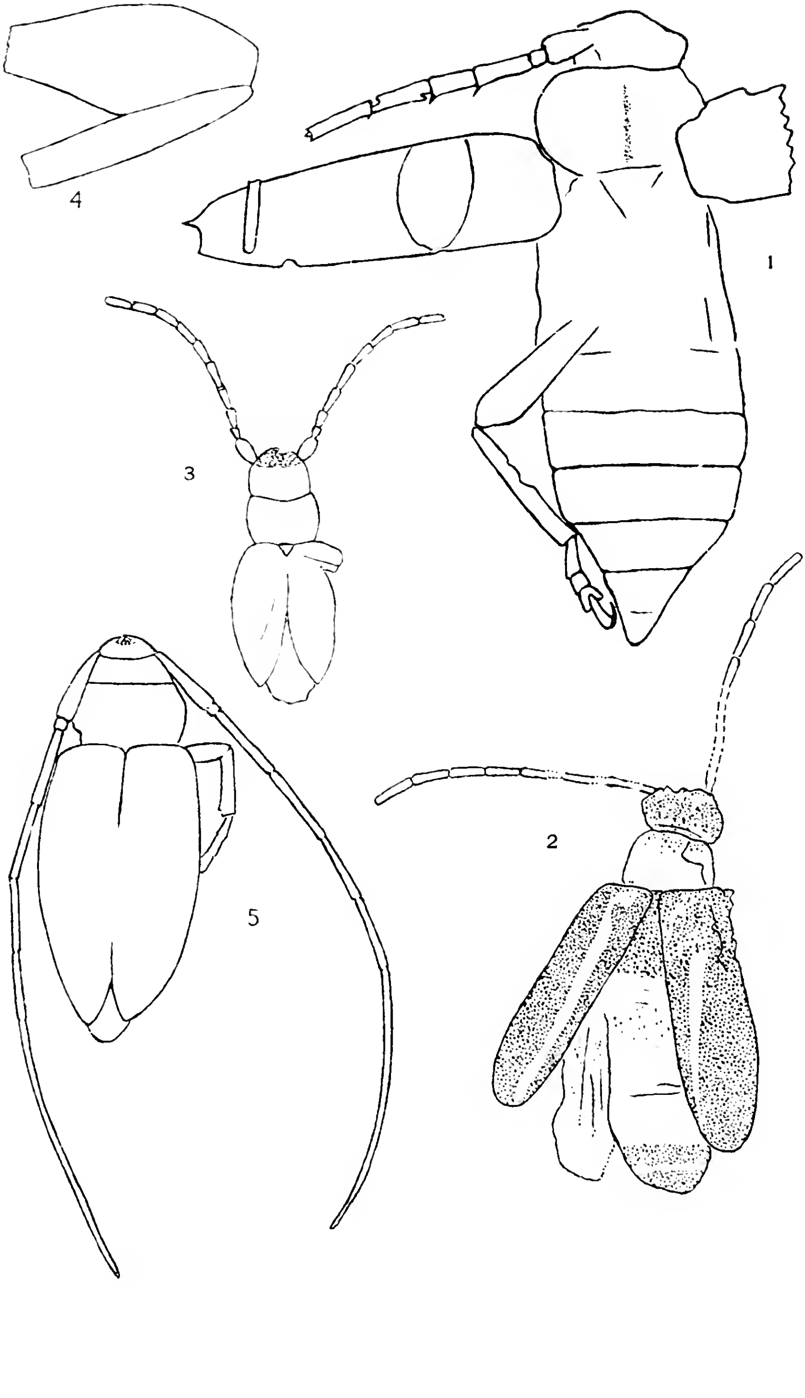
PLATE 10.

PLATE 10.

Fig. 1. Clytus florissantensis.
Fig. 2. Leptura ingenua.
Fig. 3. Protipochus vandykei.
Fig. 4. Protipochus vandykei, middle leg.
Fig. 5. Leptostylus scudderi.

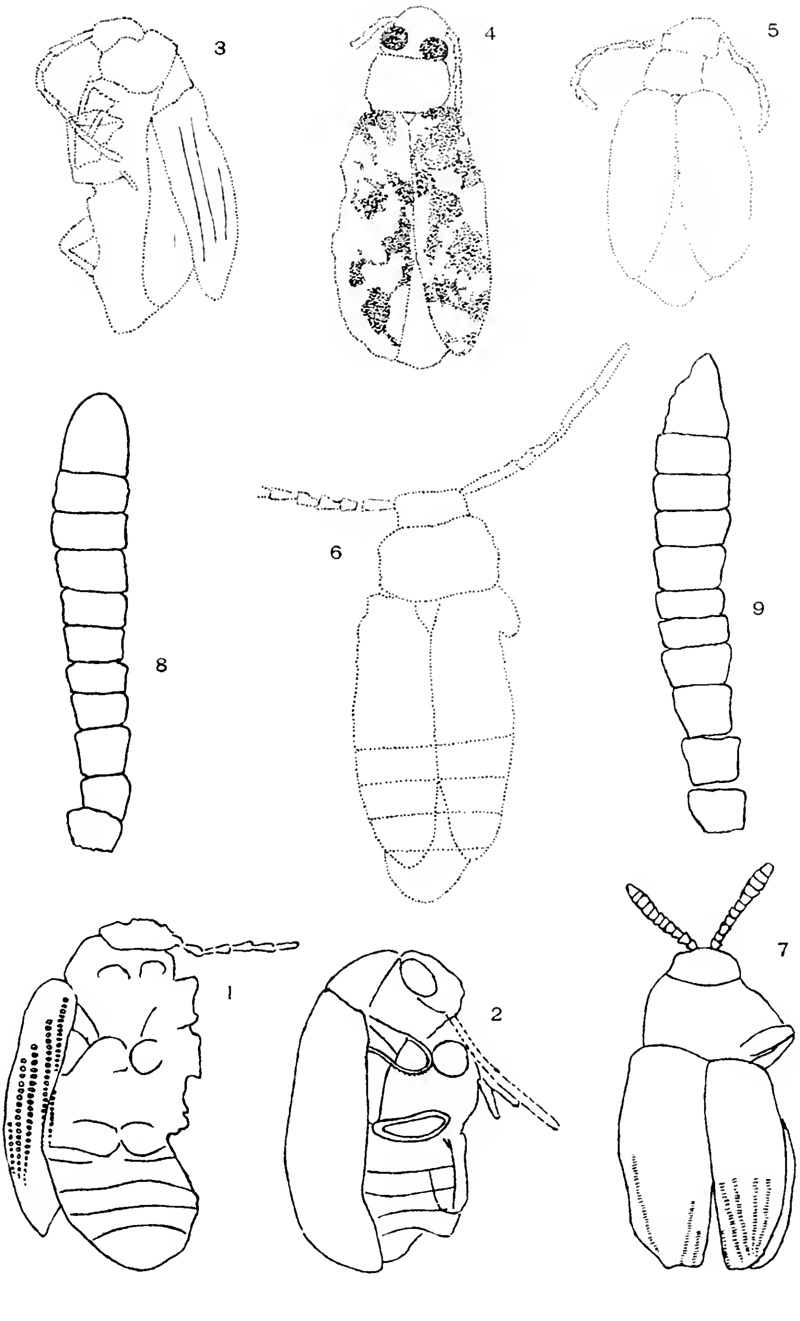


HELIOTYPE CO., BOSTON

PLATE 11.

PLATE 11.

Fig. 1. Colaspis diluvialis.
Fig. 2. Colaspis proserpina.
Fig. 3. Diabrotica florissantella.
Fig. 4. Diabrotica bowditchiana.
Fig. 5. Diabrotica uteana.
Fig. 6. Trirhabda sepulta.
Fig. 7. Odontota americana.
Fig. 8. Odontota americana, antenna.
Fig. 9. Odontota americana, antenna.

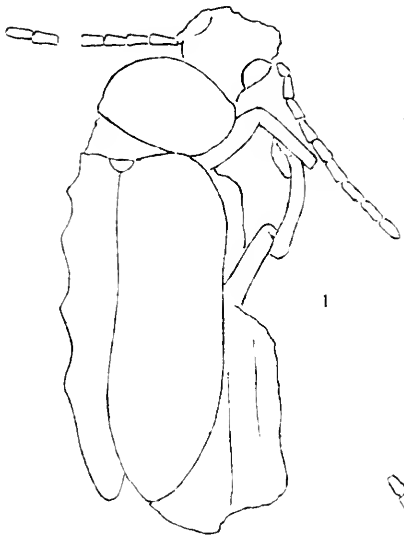


HELIOTYPE CO., BOSTON

PLATE **12**.

PLATE **12.**

Fig. 1. Trirhabda majuscula.
Fig. 2. Trirhabda megacephala.
Fig. 3. Prochaetocnema florissantella.
Fig. 4. Plectrotetrophanes hageni.



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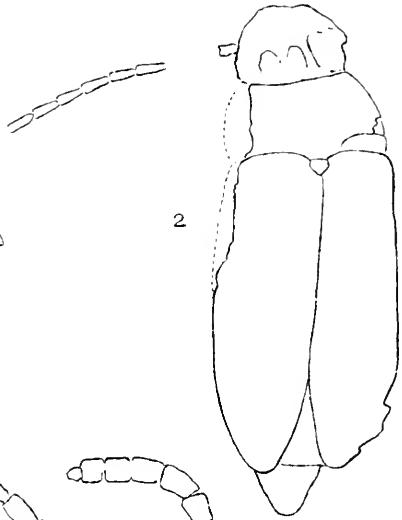

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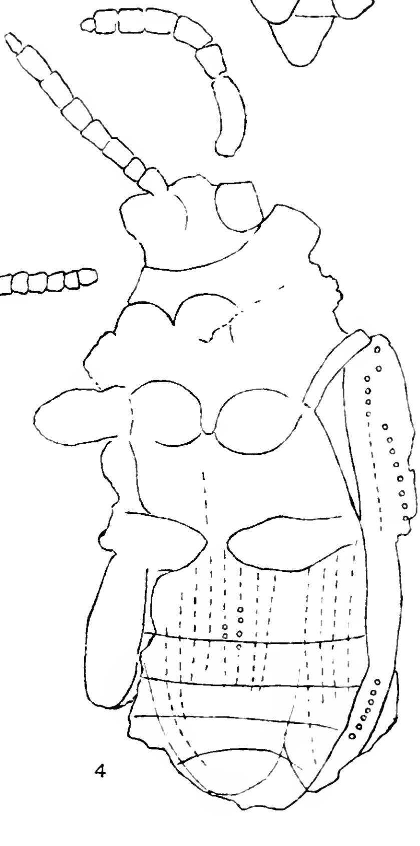

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HELIOTYPE CO., BOSTON

PLATE **13**.

PLATE 13

Fig. 1. Lema fortior.
Fig. 2. Haltica renovata.
Fig. 3. Spermophagus pluto.
Fig. 4. Spermophagus pluto, antenna.
Fig. 5. Bruchus aboriginalis.
Fig. 6. Bruchus primoticus.
Fig. 7. Bruchus submersus.
Fig. 8. Bruchus carpophiloides.

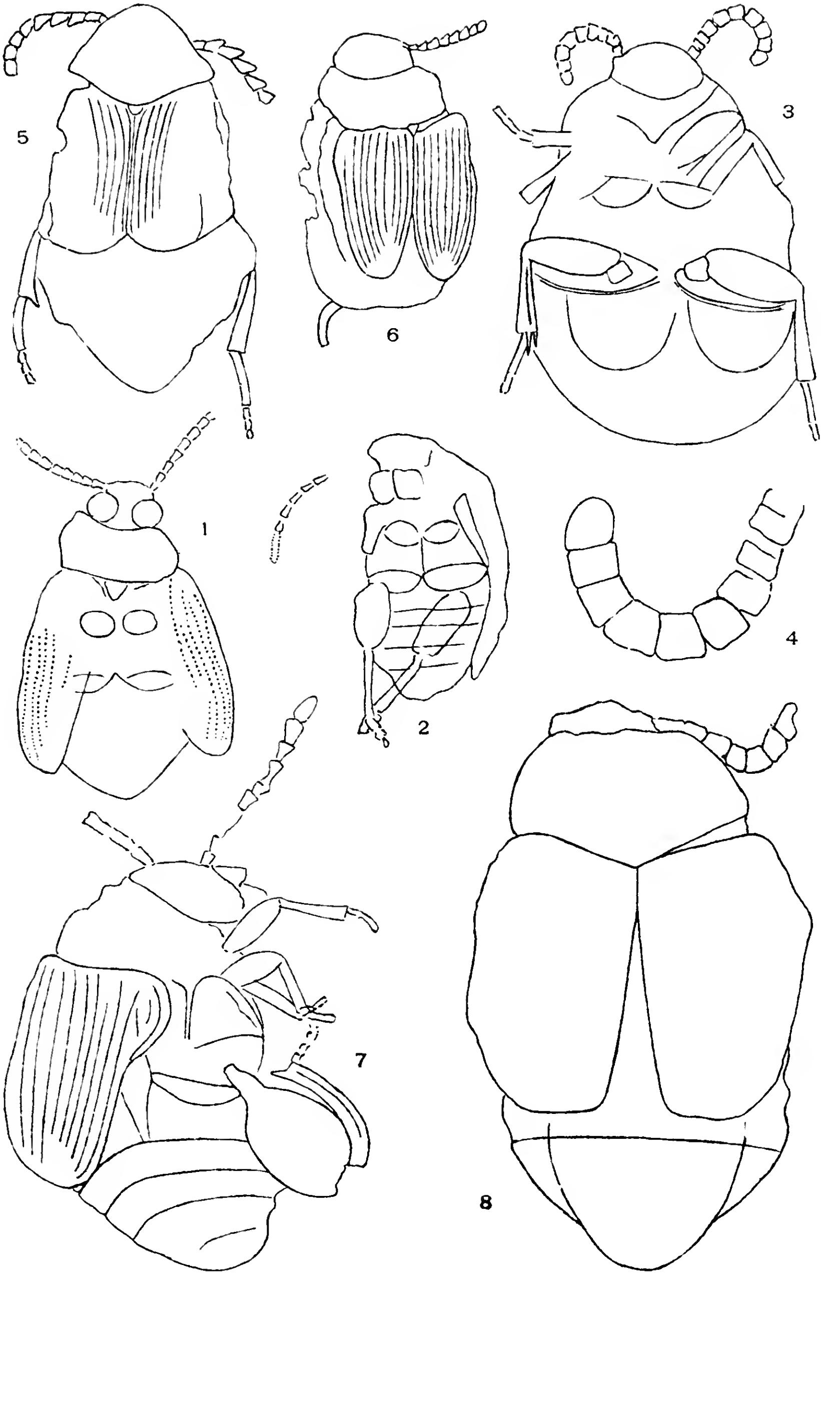
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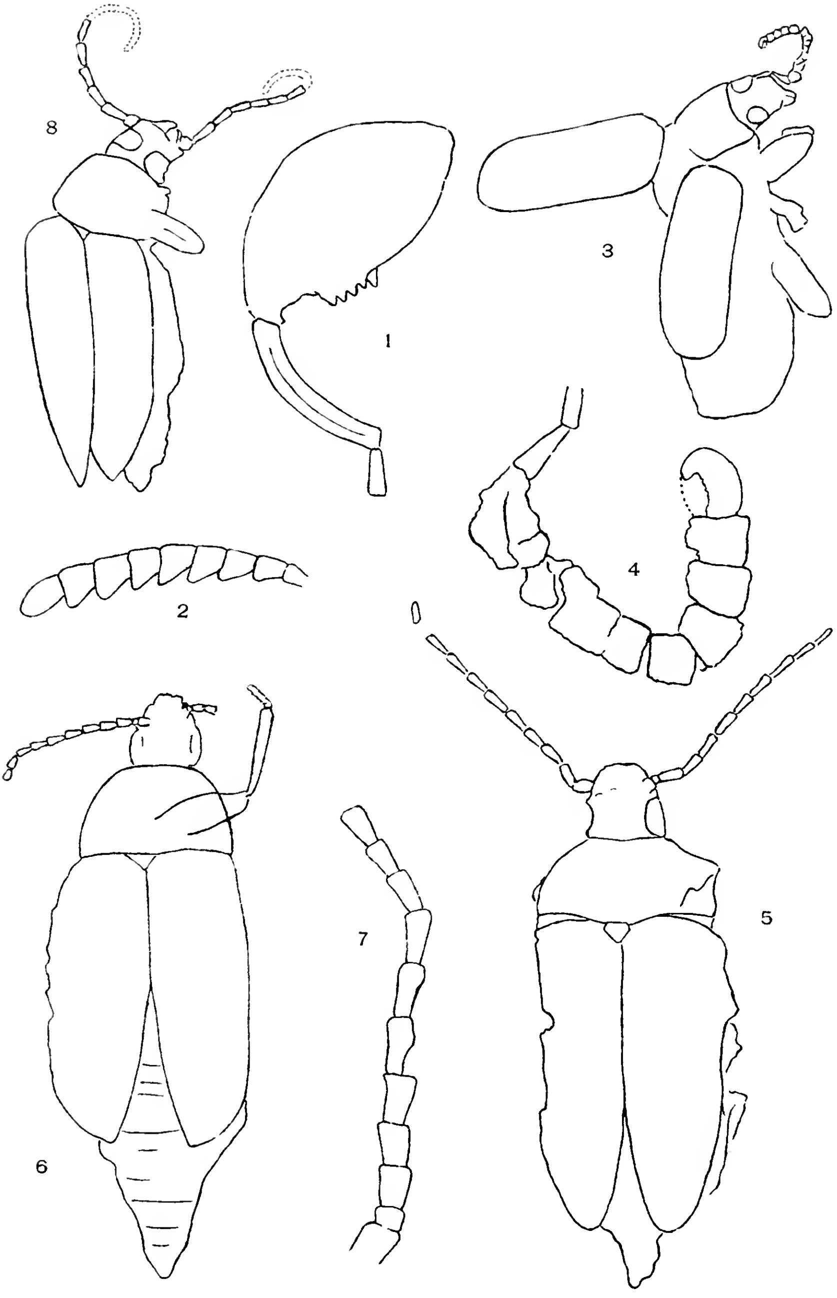
PLATE **14**.

PLATE 14.

Fig. 1. Bruchus primoticus, hind leg.
Fig. 2. Bruchus primoticus, antenna.
Fig. 3. Protoplatycera laticornis.
Fig. 4. Protoplatycera laticornis, antenna.
Fig. 5. Cistela vulcanica.
Fig. 6. Isomira florissantensis.
Fig. 7. Isomira florissantensis, antenna.
Fig. 8. Hymenorus haydeni.

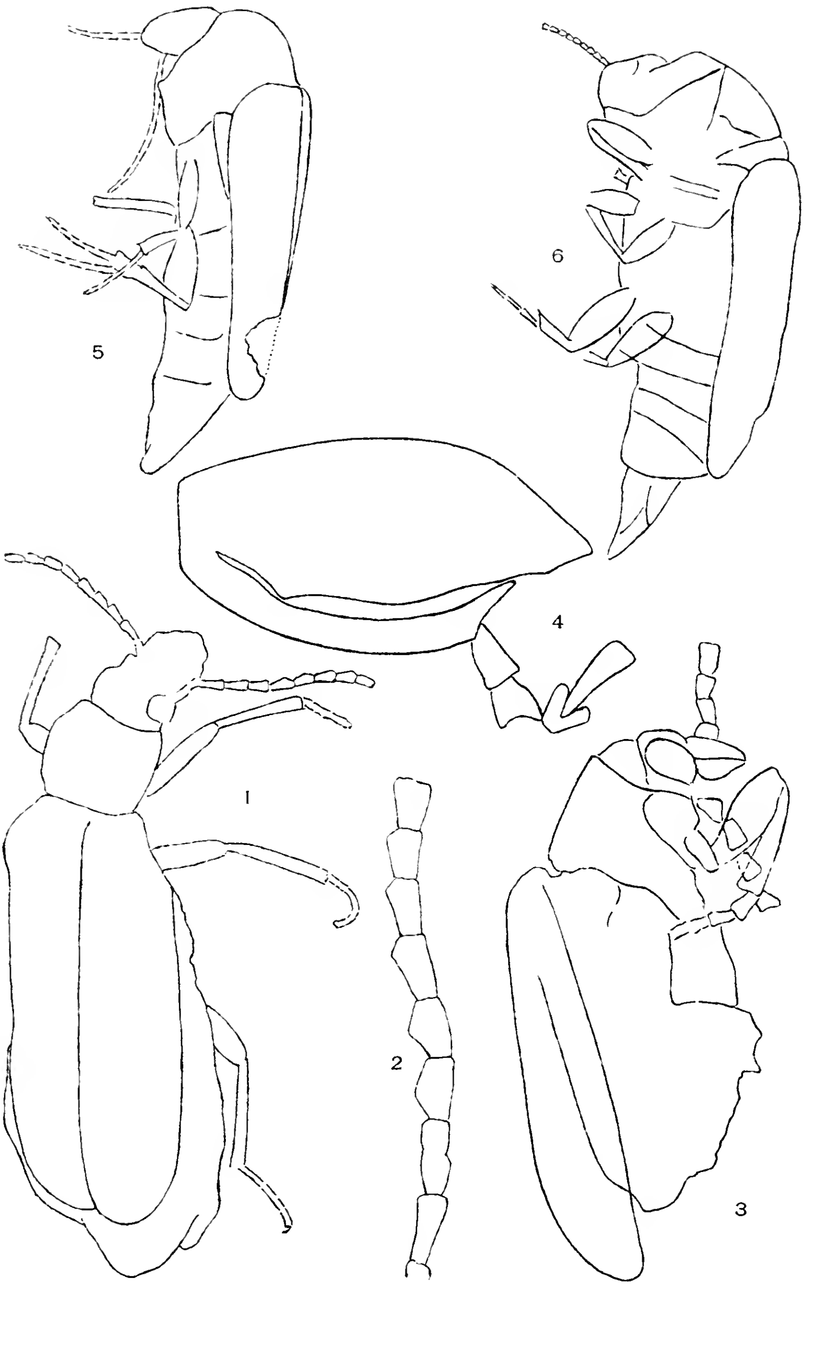


HELIOTYPE CO., BOSTON

PLATE 15.

PLATE 15.

Fig. 1. Copidita miocenica.
Fig. 2. Copidita miocenica, antenna.
Fig. 3. Paloedemera crassipes
Fig. 4. Paloedemera crassipes, hind leg.
Fig. 5. Tomoxia inundata.
Fig. 6. Mordella stygia.



HELIOTYPE CO., BOSTON

PLATE 16.

PLATE 16.

Fig. 1. Lithomacratria mirabilis.
Fig. 2. Lithomacratria mirabilis, antenna.
Fig. 3. Corphyra calypso.
Fig. 4. Corphyra calypso, antenna.
Fig. 5. Tetraonyx minuscula.
Fig. 6. Epicauta subneglecta.
Fig. 7. Cantharis lithophilus.
Fig. 8. Cyphus florissantensis.

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The following Publications of the Museum of Comparative Zoölogy are in preparation:—

LOUIS CABOT. Immature State of the Odonata, Part IV.
E. L. MARK. Studies on Lepidosteus, continued.
E. L. MARK. On Arachnactis.
A. AGASSIZ and C. O. WHITMAN. Pelagic Fishes. Part II., with 14 Plates.
H. L. CLARK. The "Albatross" Hawaiian Echini.

Reports on the Results of Dredging Operations in 1877, 1878, 1879, and 1880, in charge of ALEXANDER AGASSIZ, by the U. S. Coast Survey Steamer "Blake," as follows:—

A. MILNE EDWARDS and E. L. BOUVIER. The Crustacea of the "Blake."
A. E. VERRILL. The Alcyonaria of the "Blake."

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieutenant Commander Z. L. TANNER, U. S. N., Commanding, in charge of ALEXANDER AGASSIZ, as follows:—

K. BRANDT. The Sagittae.
K. BRANDT. The Thalassicolae.
O. CARLGREN. The Actinarians.
R. V. CHAMBERLIN. The Annelids.
W. R. COE. The Nemerteans.
REINHARD DOHRN. The Eyes of Deep-Sea Crustacea.
H. J. HANSEN. The Cirripeds.
H. J. HANSEN. The Schizopods.
HAROLD HEATH. Solenogaster.
W. A. HERDMAN. The Ascidians.
S. J. HICKSON. The Antipathids.
E. L. MARK. Branchiocerianthus.
JOHN MURRAY. The Bottom Specimens.
P. SCHIEMENZ. The Pteropods and Heteropods.
THEO. STUDER. The Alcyonarians.
—— The Salpidae and Doliolidae.
H. B. WARD. The Sipunculids.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of ALEXANDER AGASSIZ, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding, as follows:—

R. V. CHAMBERLIN. The Annelids.
H. L. CLARK. The Holothurians.
H. L. CLARK. The Ophiurans.
—— The Volcanic Rocks.
—— The Coralliferous Limestones.
S. HENSHAW. The Insects.
R. VON LENDENFELD. The Siliceous Sponges.
G. W. MÜLLER. The Ostracods.
MARY J. RATHBUN. The Crustacea Decapoda.
G. O. SARS. The Copepods.
L. STEJNEGER. The Reptiles.
C. H. TOWNSEND. The Mammals, Birds, and Fishes.
T. W. VAUGHAN. The Corals, Recent and Fossil.

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OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY

AT HARVARD COLLEGE.

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Vols. LV. to LVIII. of the BULLETIN, and Vols. XXV., XXX., XXXV., XXXIX., XL., XLII., XLIII., XLV. to XLVIII. of the MEMOIRS, are now in course of publication.

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Reports on the Results of Dredging Operations from 1877 to 1880, in charge of Alexander Agassiz, by the U. S. Coast Survey Steamer "Blake," Lieut. Commander C. D. Sigsbee, U. S. N., and Commander J. R. Bartlett, U. S. N., Commanding.

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieut. Commander Z. L. Tanner, U. S. N., Commanding, in charge of Alexander Agassiz.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

Reports on the Scientific Results of the Expedition to the Eastern Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from October, 1904, to April, 1905, Lieut. Commander L. M. Garrett, U. S. N., Commanding.

Contributions from the Zoölogical Laboratory, Professor E. L. Mark, Director.

Contributions from the Geological Laboratory, Professor R. A. Daly, in charge.

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