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NOTES ON A COLLECTION OF BIRDS FROM THE SUDAN.

By John C. Phillips.

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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.; Maganganí, 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 PTILORYNCHA (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 (Klemschmidt).

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 Mesharat, 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.

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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.

By Henry B. Bigelow.

With Nine Plates.

[Published by Permission of H. M. Smith, U. S. Fish Commissioner.]

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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.

CONTENTS.

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 midsummer 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.

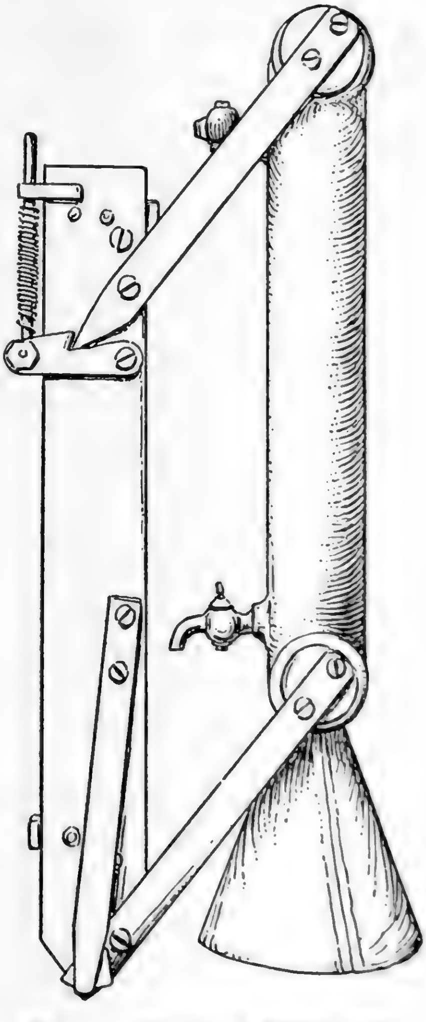

Fig. 1.— Stop-cock water bottle.

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

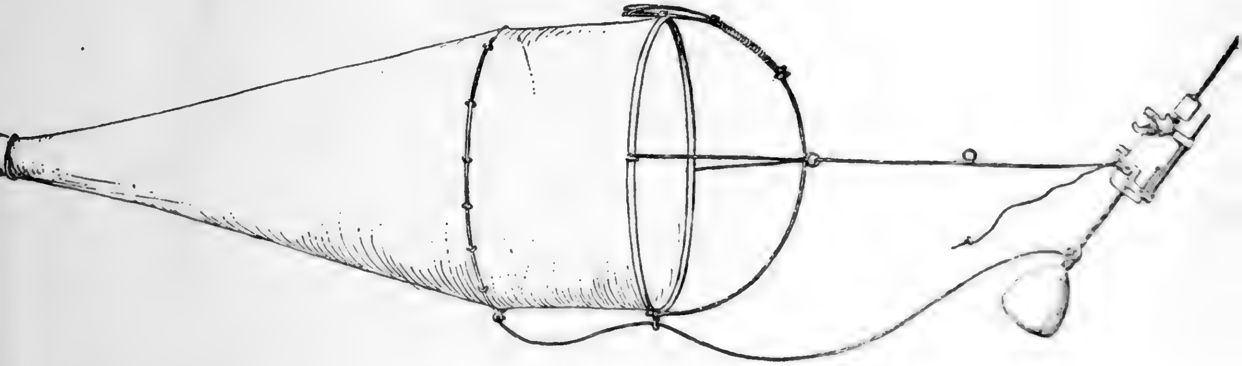

FIG. 2.— Closing net in operation.

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.

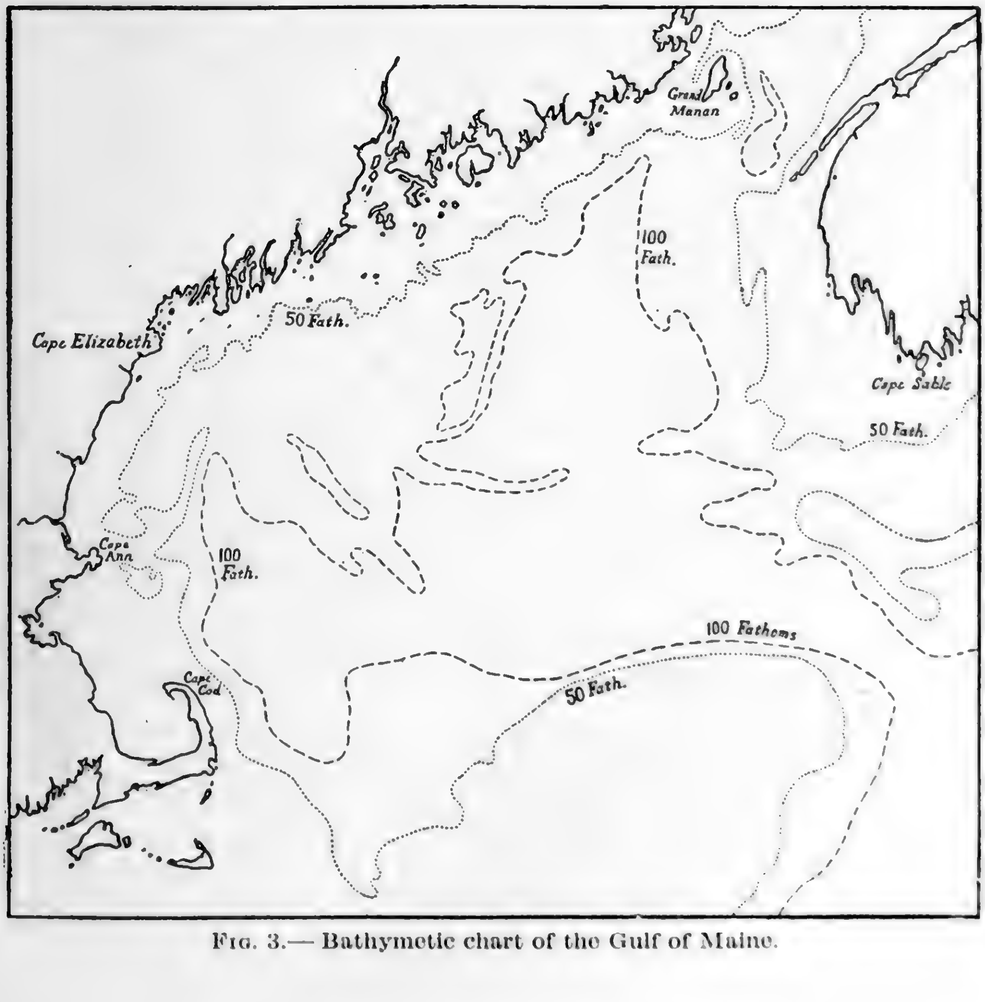

FIG. 3.— Bathymetic chart of the Gulf of Maine.

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 of Cape 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 conditions. 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

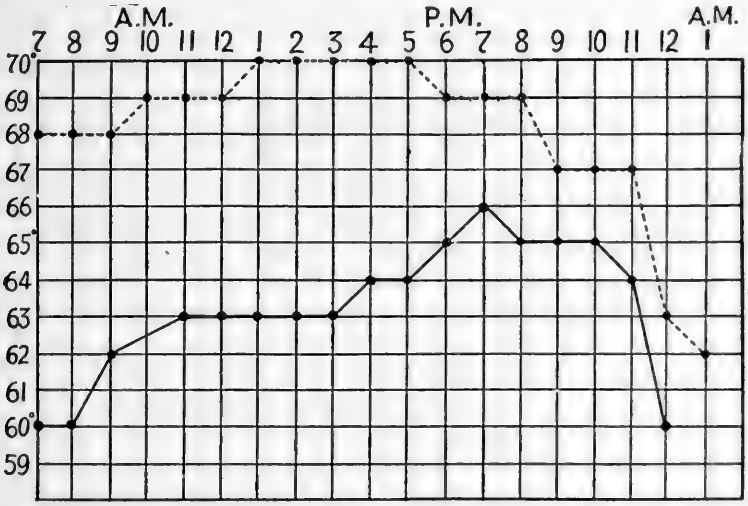

FIG. 4.— Air and surface temperatures, off Cape Ann, July 15, 1912.

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 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°.

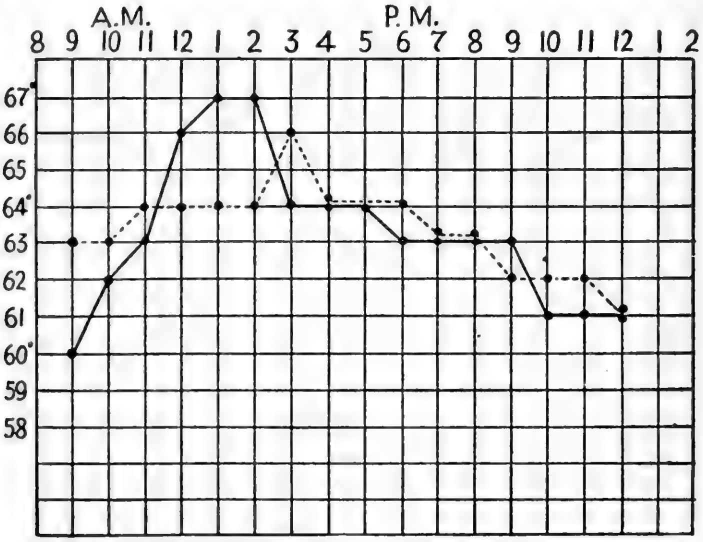

FIG. 5.— Air and surface temperatures, August 7, 1912.

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°

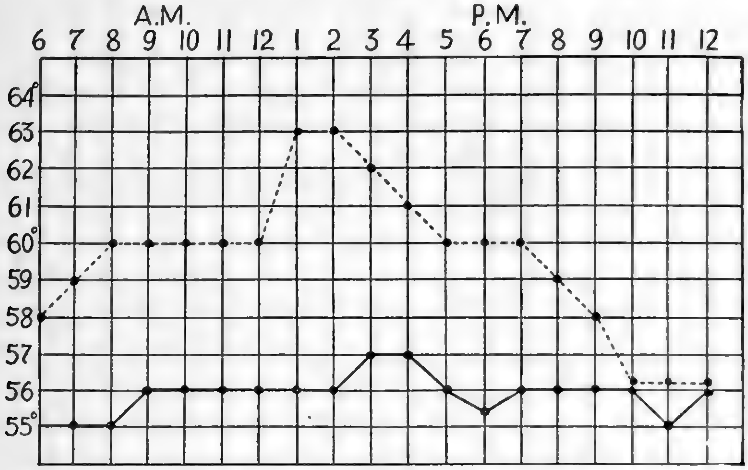

Fig. 6.— Air and surface temperatures, August 21, 1912.

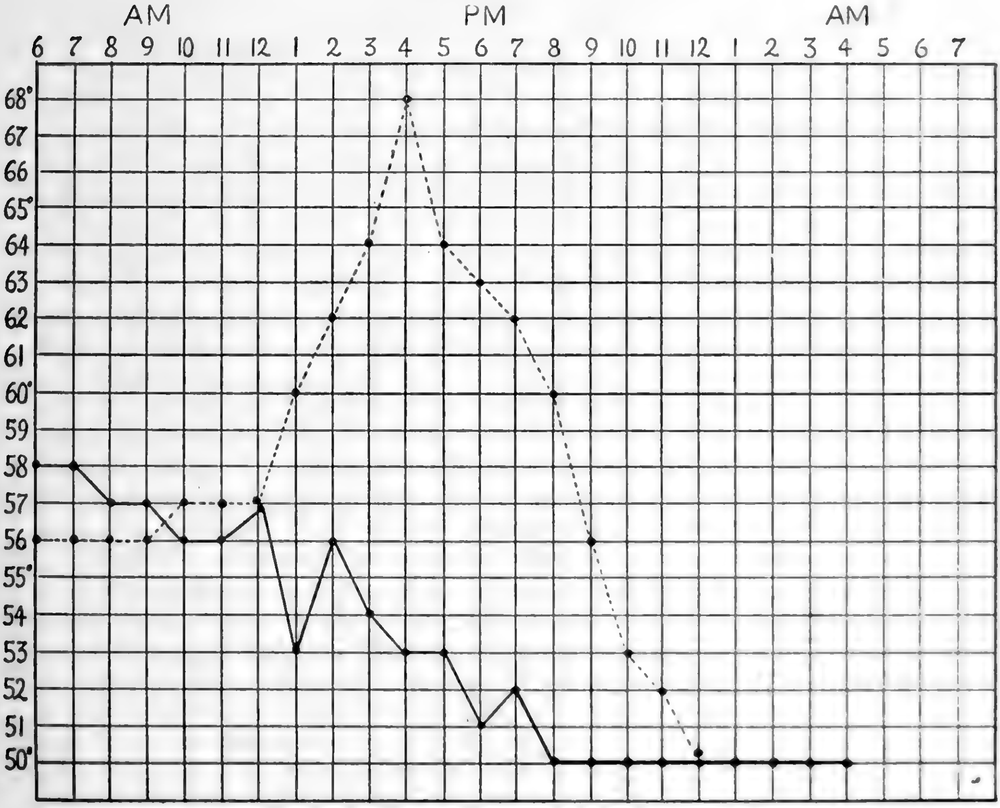

Fig. 7.— Air and surface temperatures, August 6, 1912.

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

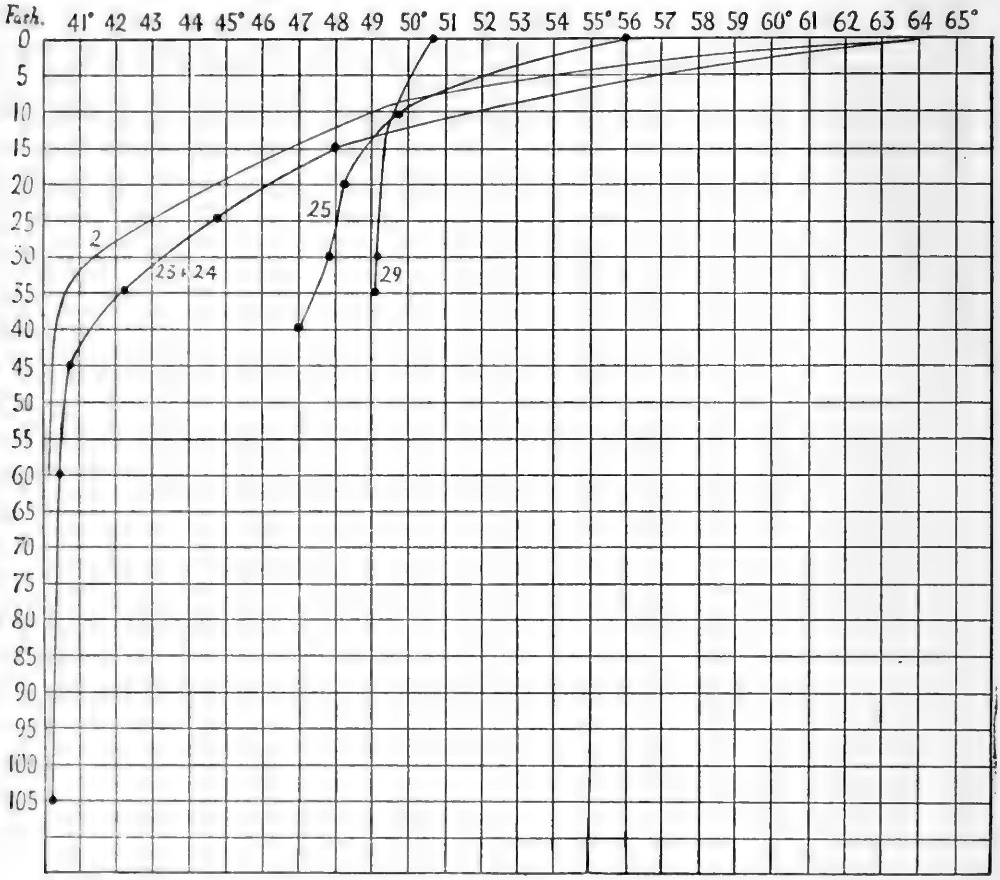

FIG. 8.— Temperature sections at Stations 2, 23, 24, 25, 29.

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-

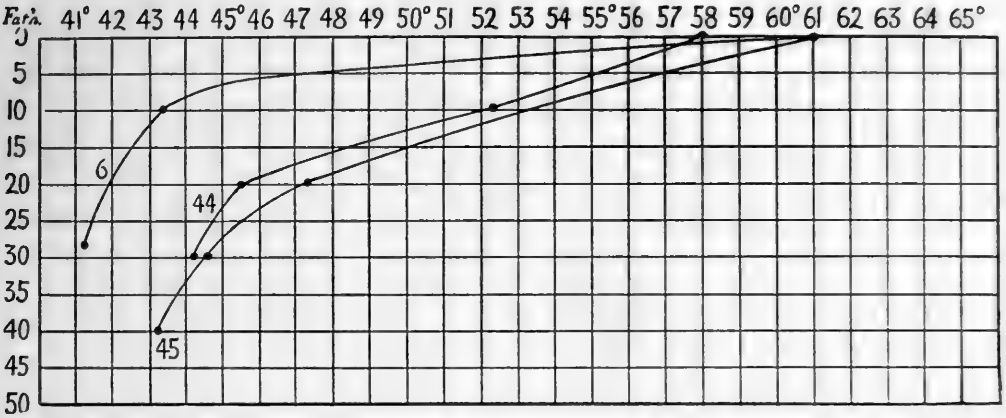

Fig. 9.— Temperature sections in Massachusetts Bay, Stations 6, 44, 45.

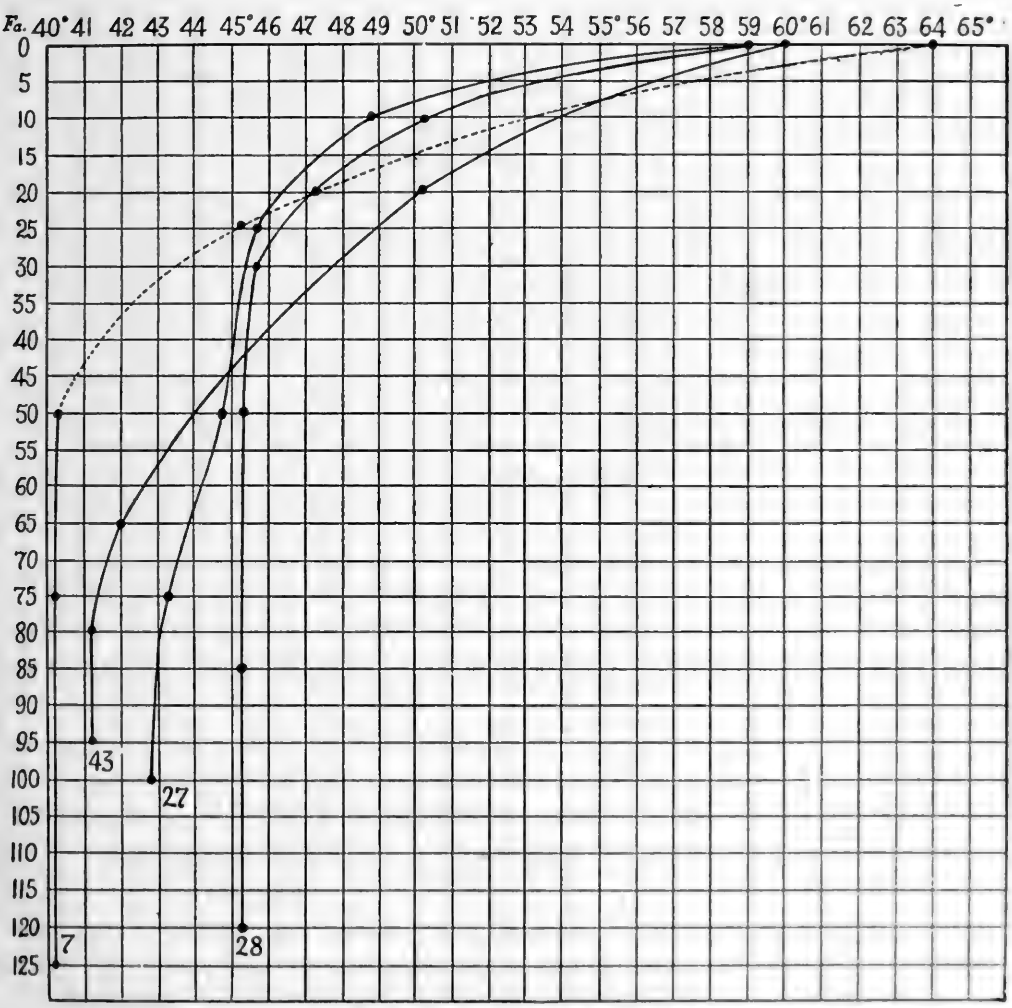

Fig. 10.— Temperature sections in the western and eastern parts of the Gulf Stations 7, 27, 28, 43.

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 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.

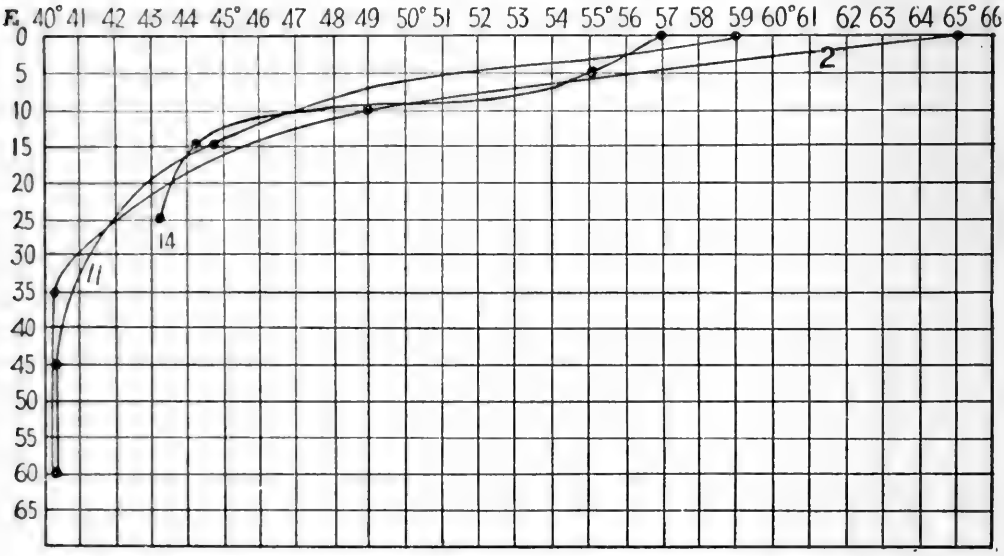

FIG. 11.— Temperature sections in the mouth of Massachusetts Bay (Station 2), and west of Jeffrey's Ledge (Stations 11, 14).

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-

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[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 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.

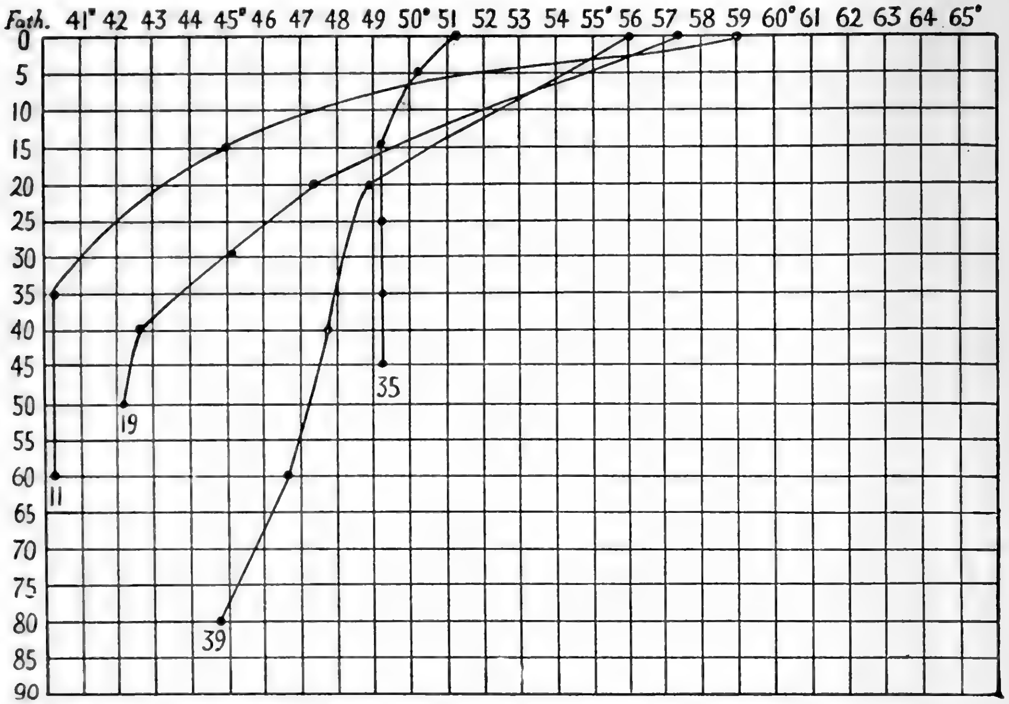

FIG. 12.— Temperature sections, Cape Ann to the Bay of Fundy, Stations 11, 19, 39, 35.

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° 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

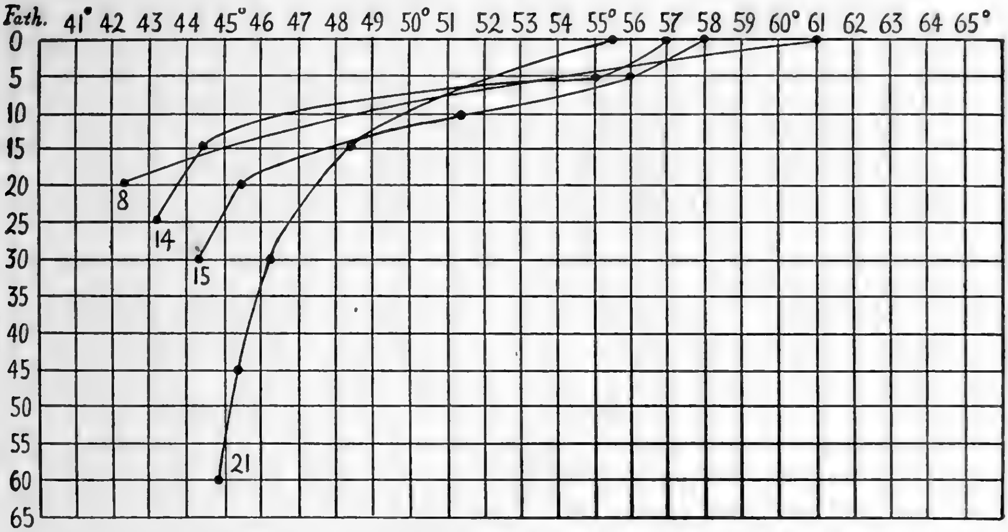

FIG. 13.—Temperature sections in Ipswich Bay (Station 8), off Cape Porpoise (Station 14); off the mouth of Casco Bay (Station 15), and off Monhegan (Station 21).

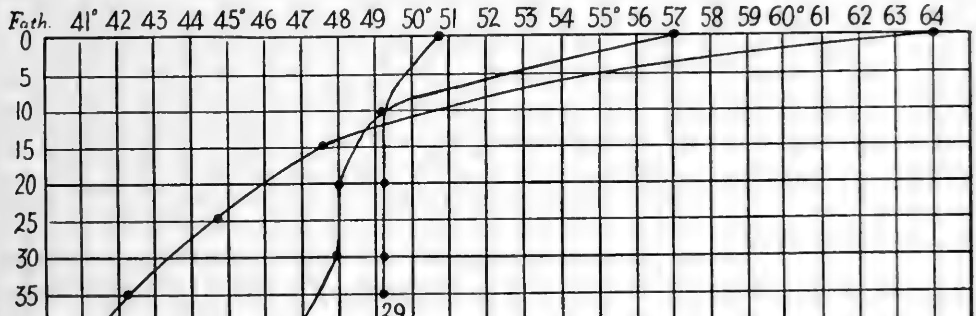

FIG. 14.— Temperature sections on Platt's Bank (Station 23), Jeffrey's Bank (Station 25) and German Bank (Station 29).

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 interesting 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.

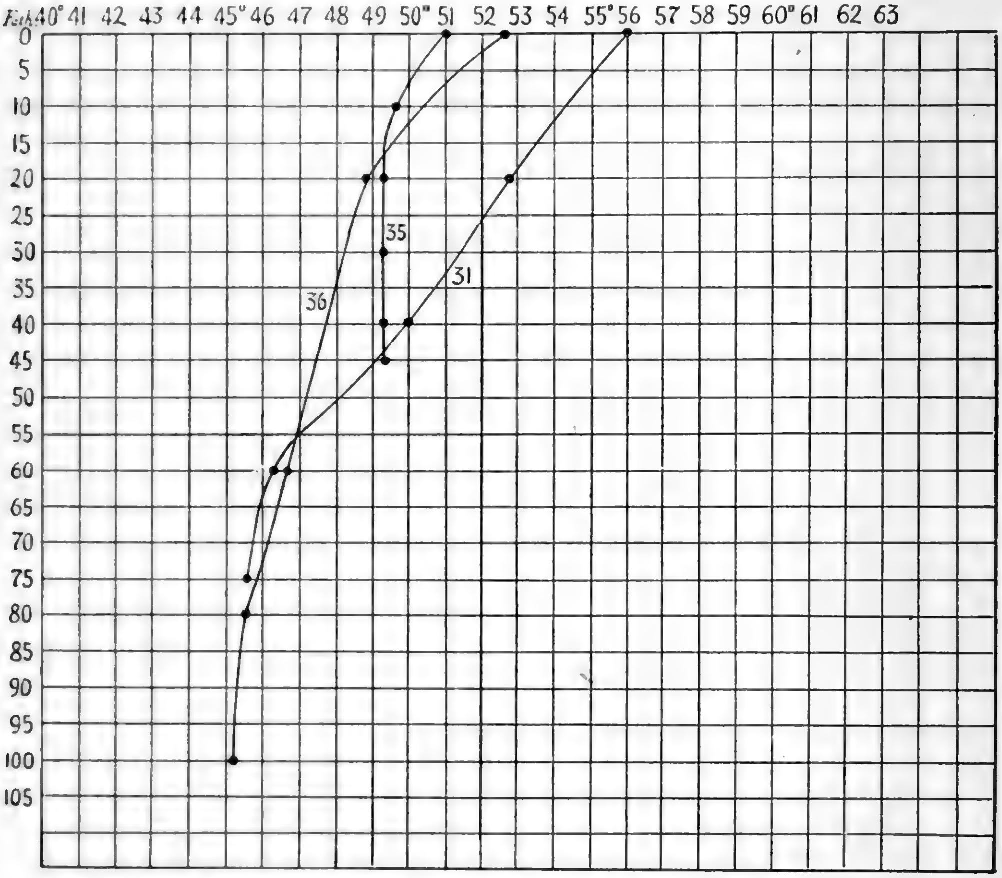

FIG. 15.— Temperature sections in the Grand Manan Channel (Station 35); in the northeast end of the Deep basin (Station 36), and near Lurcher Shoal (Station 31).

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

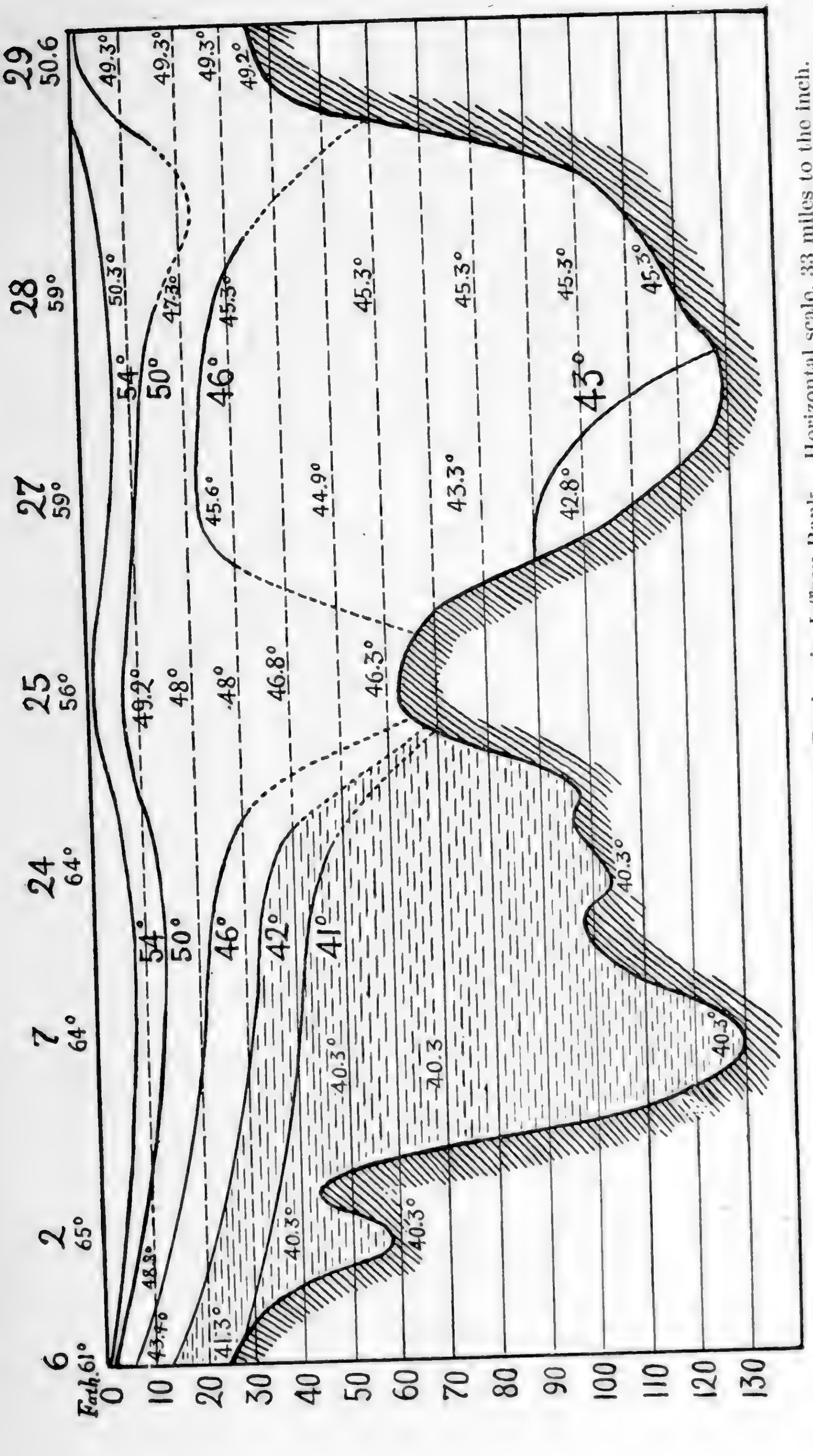

Fig. 16.— Temperature profile from Boston to German Bank, via Jeffrey Bank. Horizontal scale, 33 miles to the inch.

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,

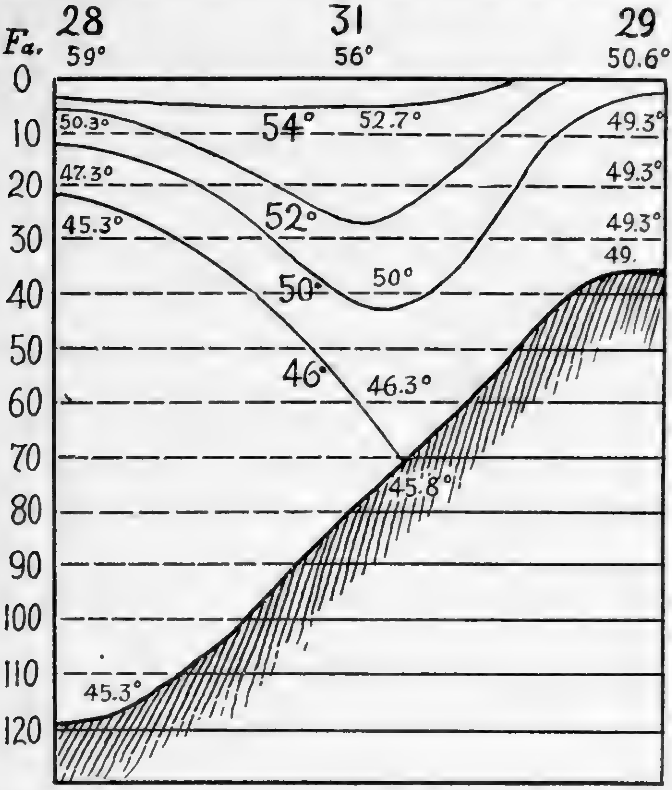

Fig. 17.— Temperature profile from the eastern basin (Station 28) to German Bank (Station 29) passing through Station 31.

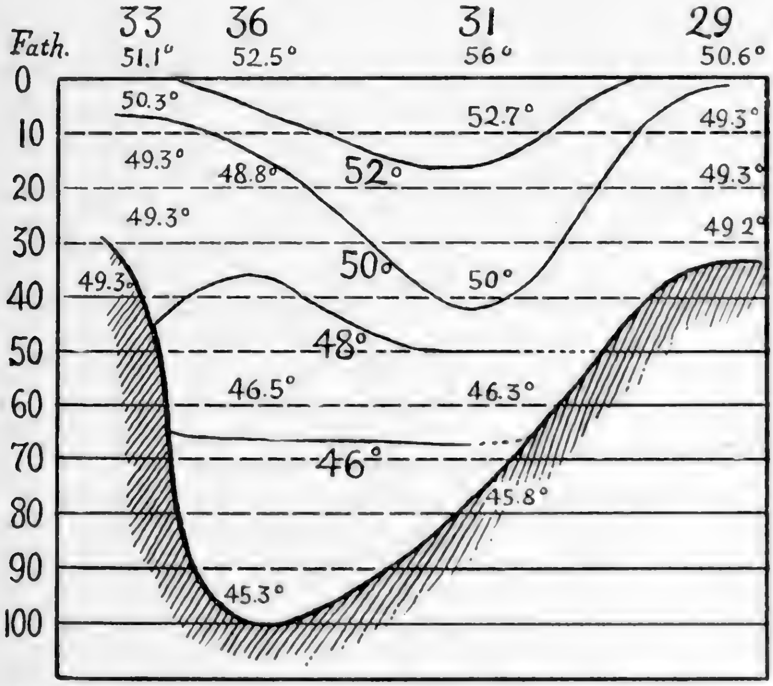

Fig. 18.— Temperature profile across the mouth of the Bay of Fundy to German Bank.

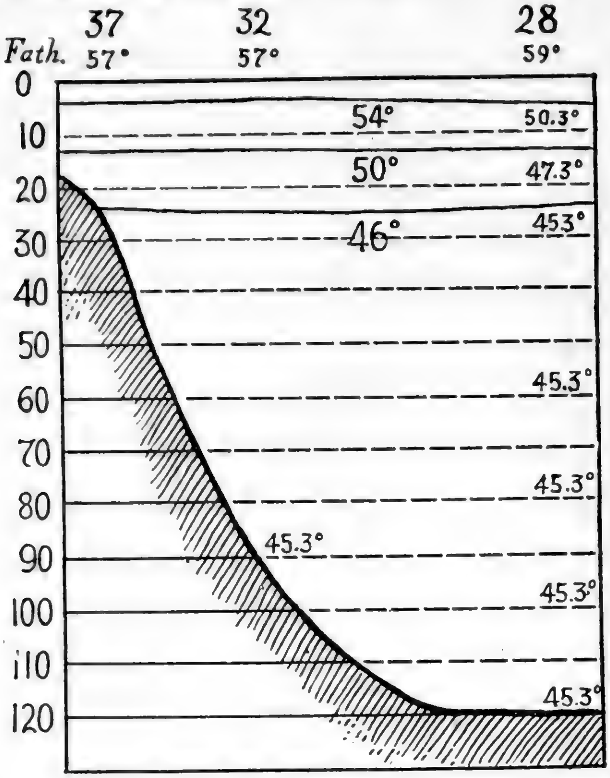

FIG. 19.— Temperature profile running southeasterly from Mt. Desert to Station 28.

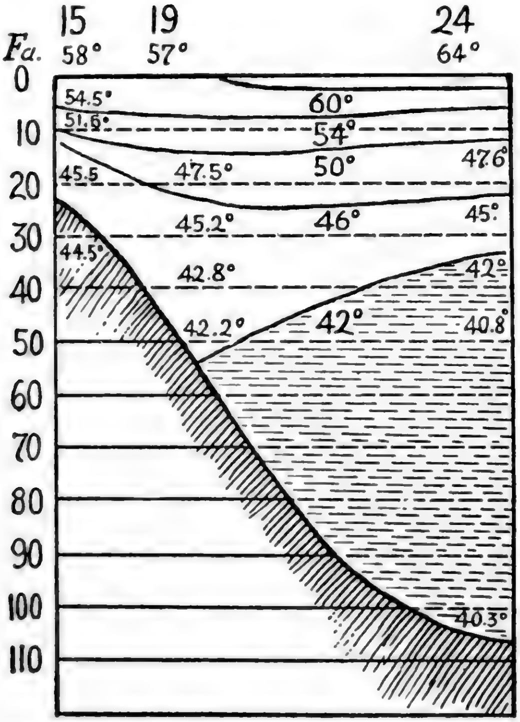

FIG. 20.— Temperature profile from the mouth of Casco Bay (Station 15) to Station 24.

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.*, 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

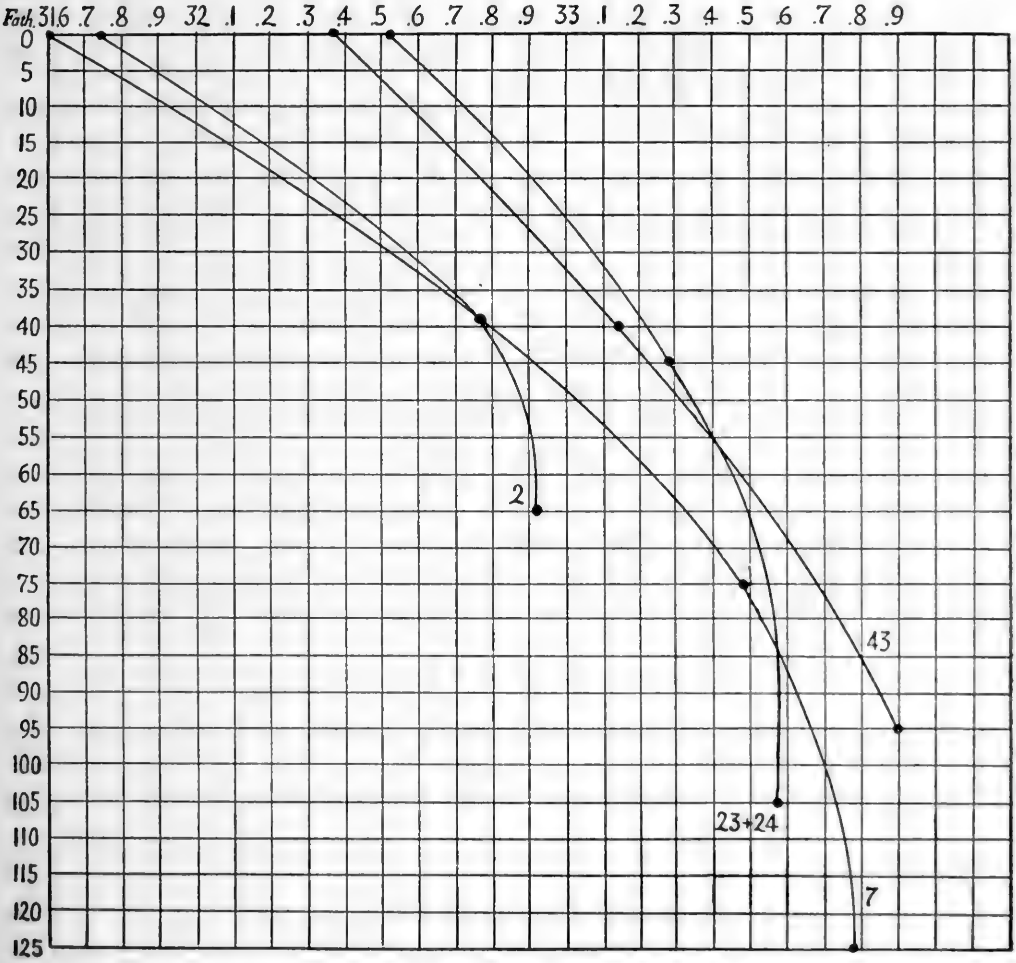

FIG. 21.— **Salinity sections at Stations 2, 7, 23, 24, 43.**

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 intermediate 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

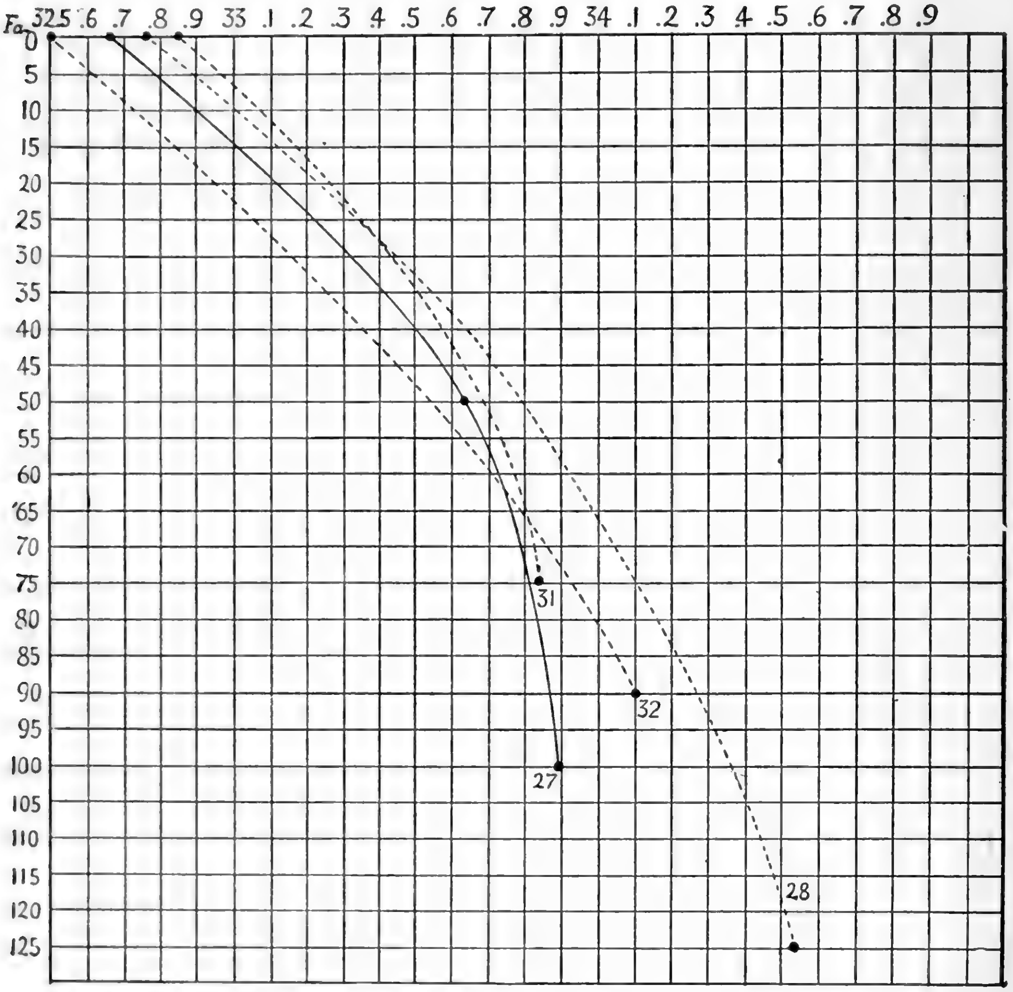

FIG. 22.— Salinity sections at Stations 27, 28, 31, 32. Curves are dotted when the surface and bottom salinities alone are known.

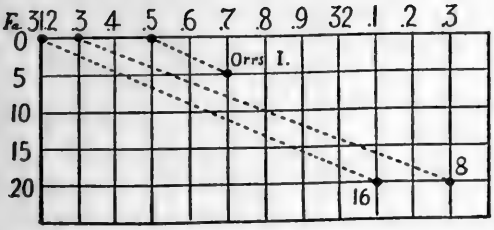

Fig. 23.

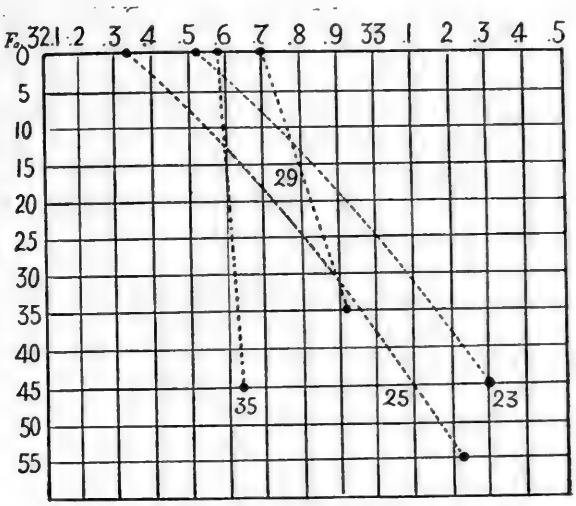

Fig. 24.

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).

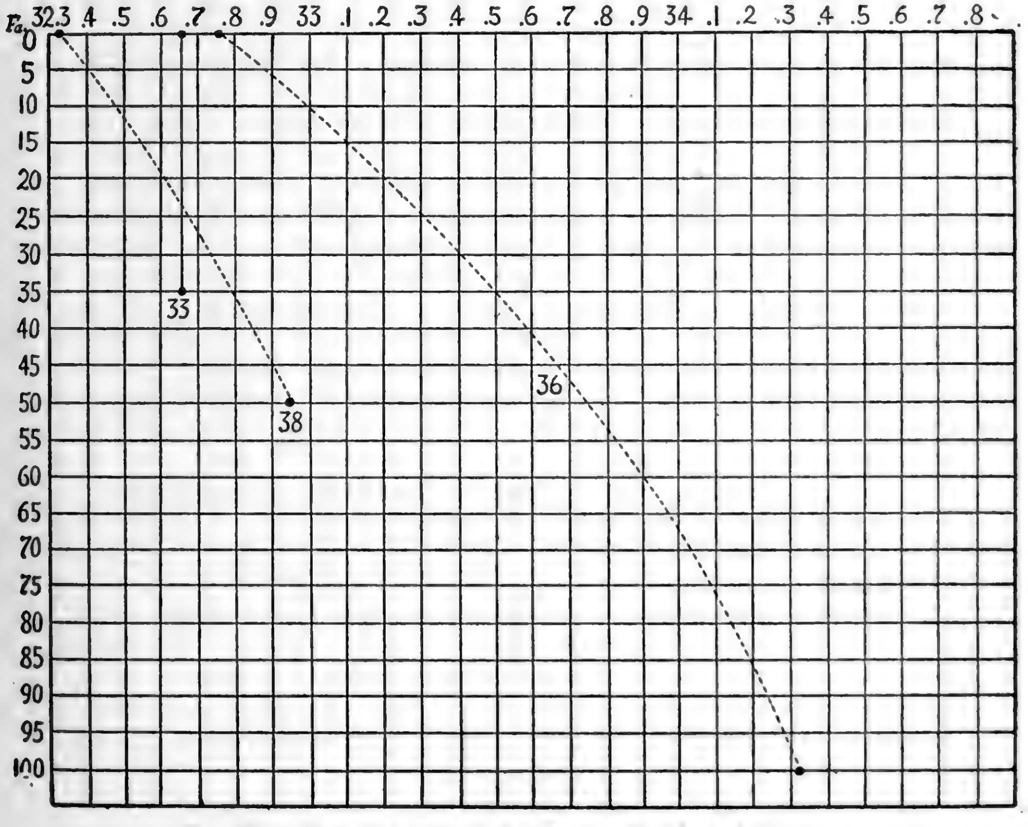

Fig. 25.— Salinity sections at Stations 33, 36, and 38.

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

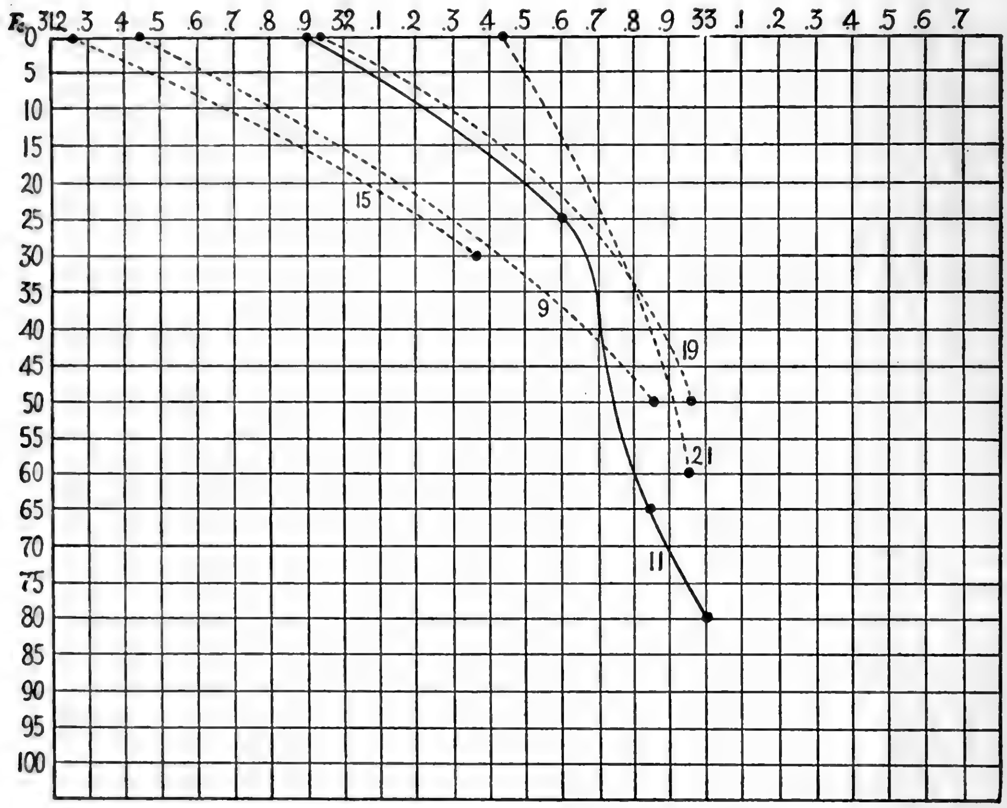

Fig. 26.— Salinity sections at Stations 9, 11, 15, 19, 21, from Ipswich Bay to Monhegan.

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 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

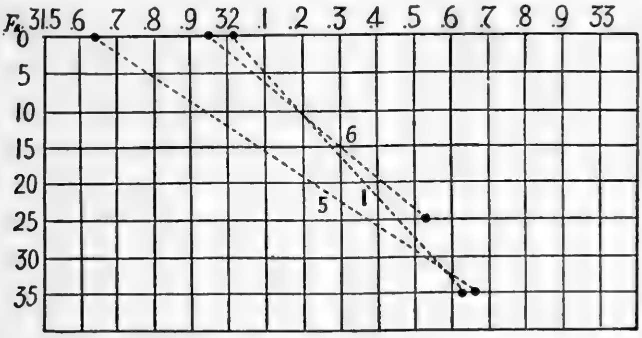

Fig. 27.— Salinity sections in Massachusetts Bay, Stations 1, 5, 6.

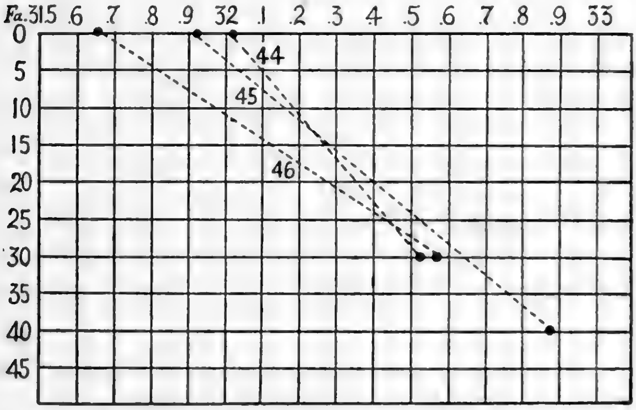

Fig. 28.— Salinity sections in Massachusetts Bay, Stations 44, 45, 46.

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.

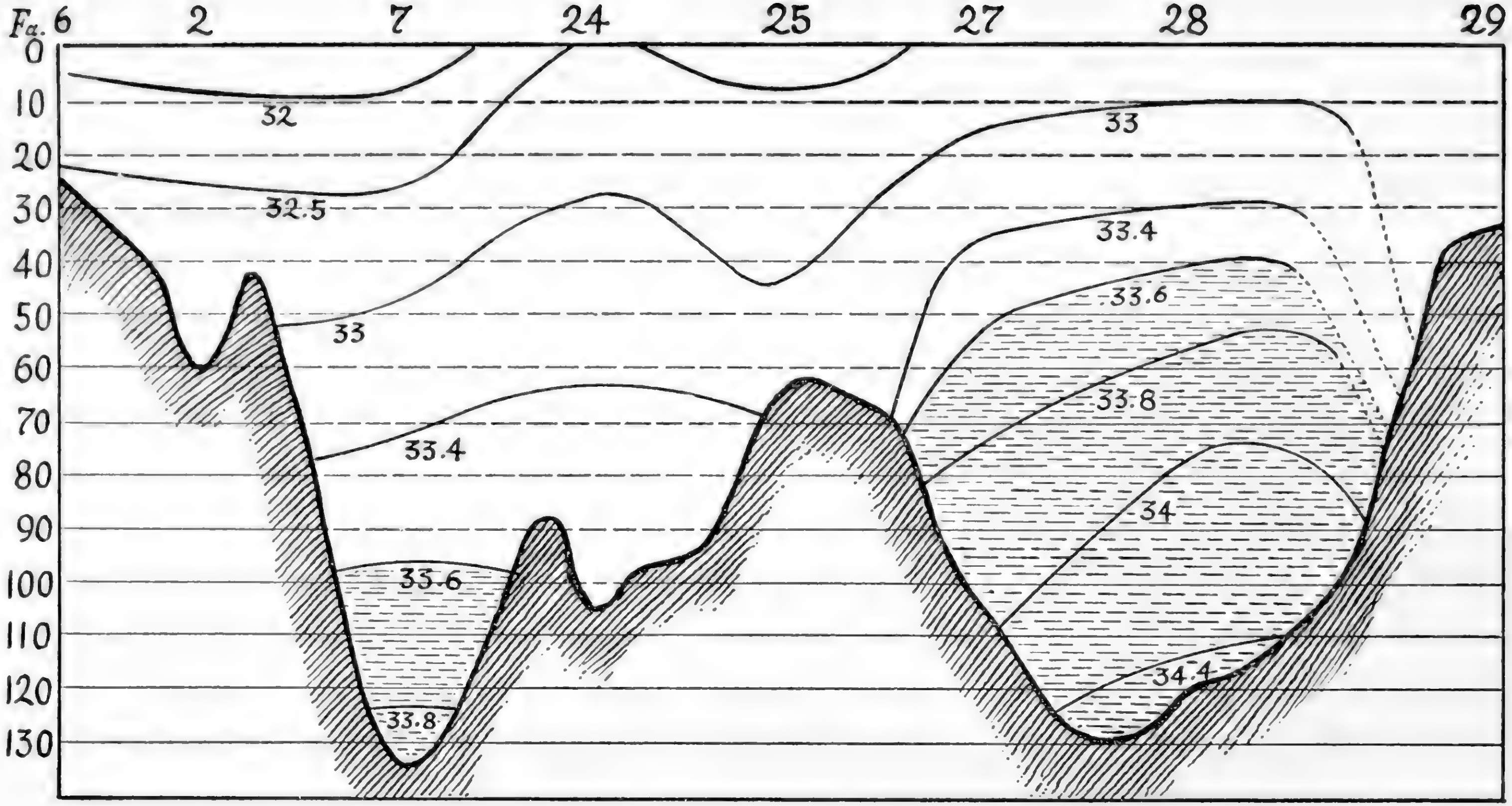

Fig. 29.— Salinity profile from Boston Light-ship (Station 6) to German Bank (Station 29), via Jeffrey Bank. Horizontal scale 33 miles per inch.

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

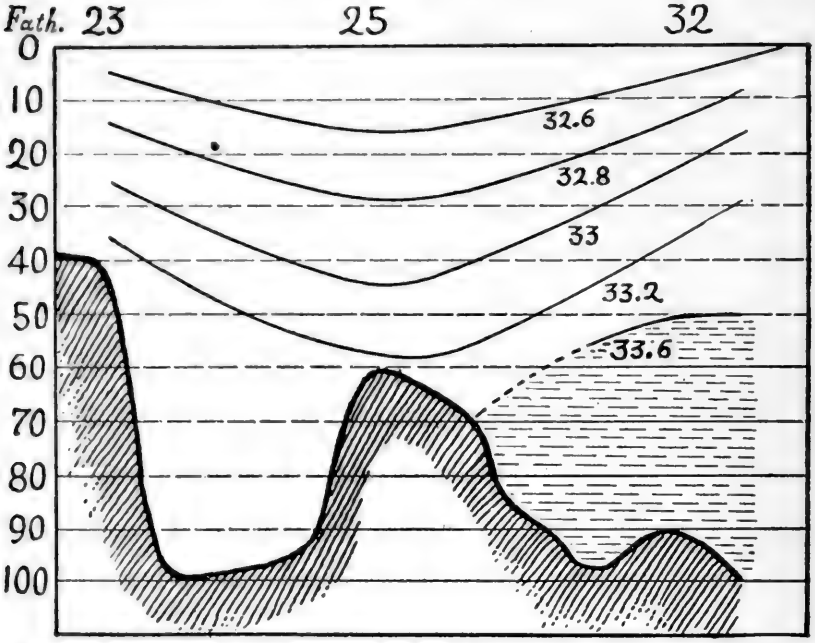

FIG. 30.— Salinity profile from Platt's Bank (Station 23) toward Mt. Desert Rock (Station 32) crossing Jeffrey's Bank (Station 25).

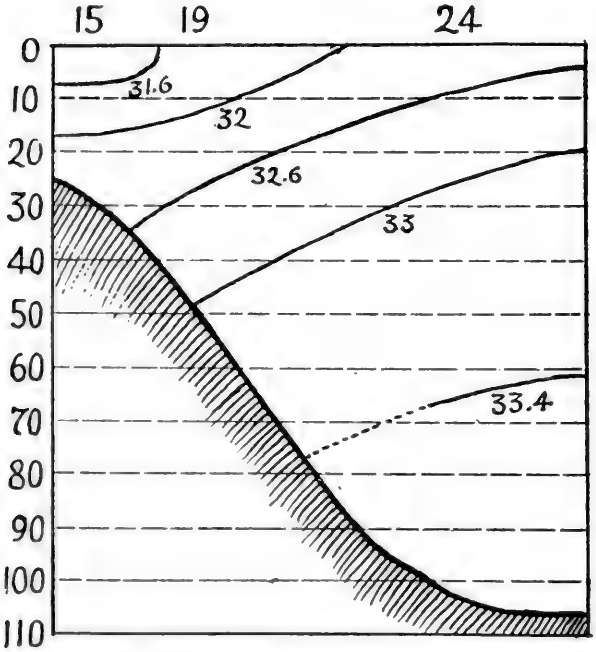

FIG. 31.— Salinity profile from the mouth of Casco Bay to Station 24.

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.

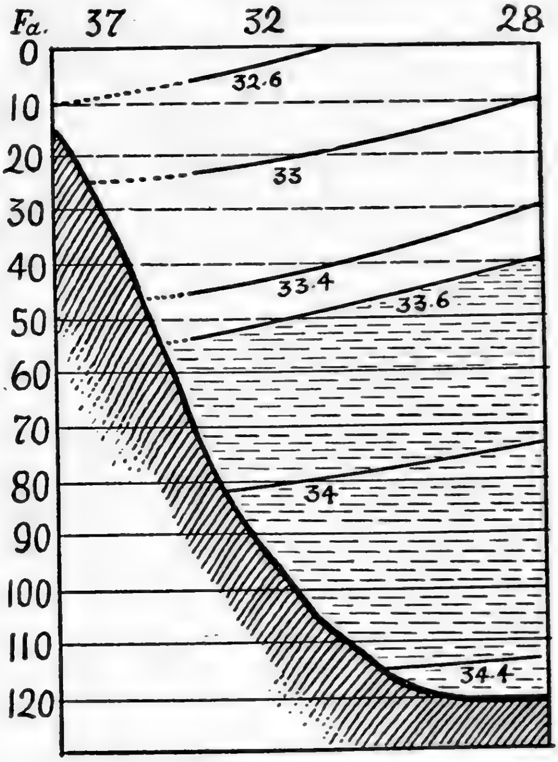

FIG. 32.— Salinity profile from near Mt. Desert (Station 37) to Station 28.

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 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.

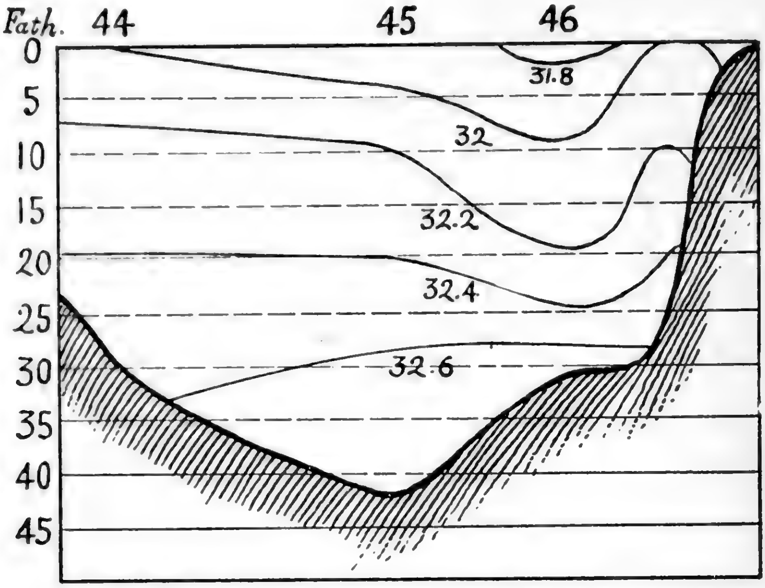

Fig. 33.— Salinity profile across Massachusetts Bay, August 13 (Stations 44, 45, 46).

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.

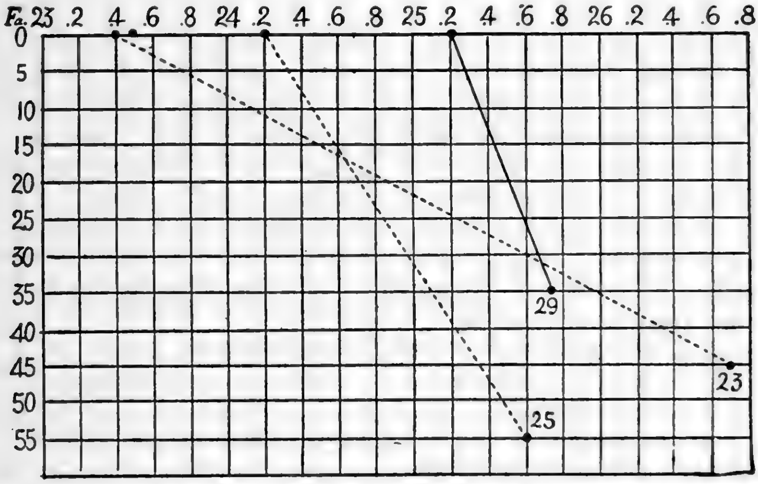

FIG. 34.— Curve of density *in situ* at Platt's Bank (Station 23); Jeffrey's Bank (Station 25) and German Bank (Station 29).

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 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

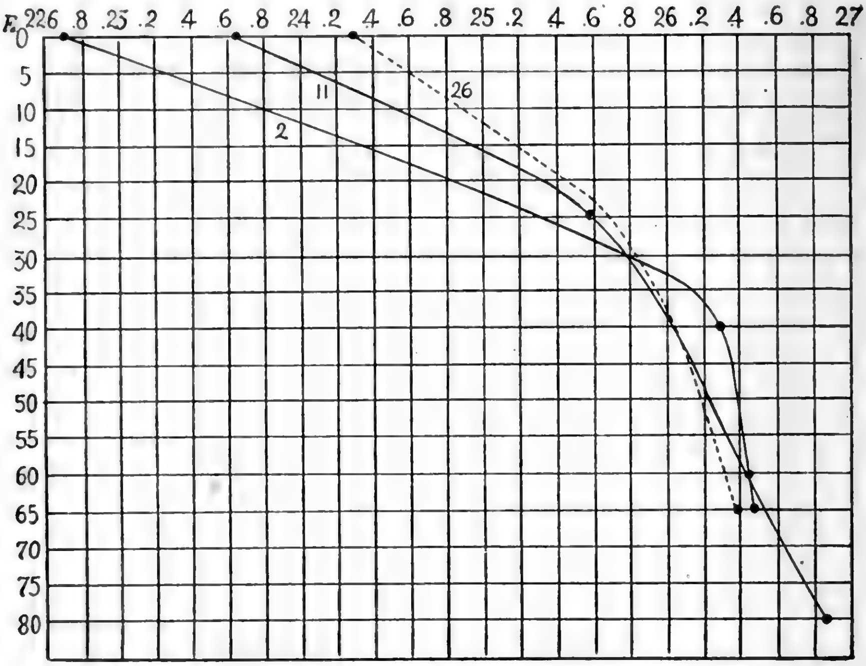

FIG. 35.— Curves of density *in situ* at Stations 2, 11, 26.

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 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-

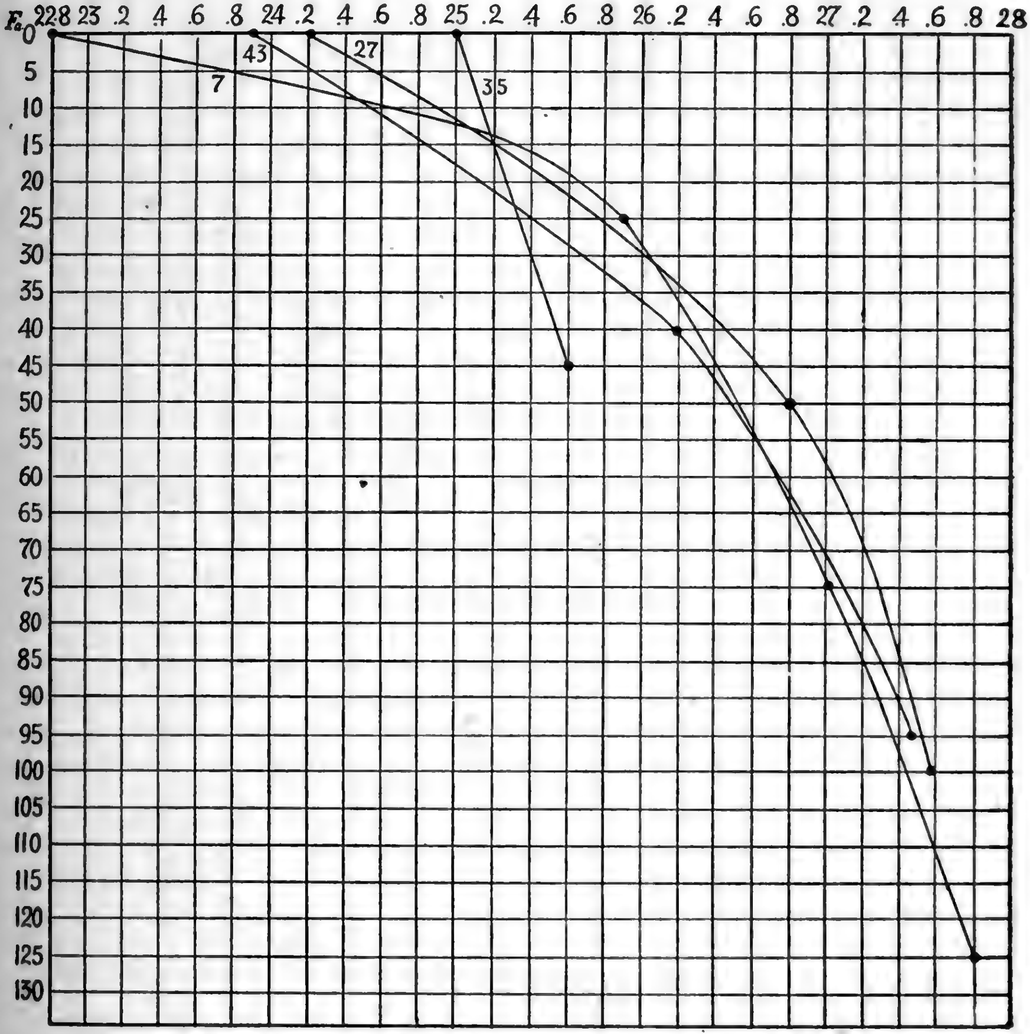

FIG. 36.— Curves of density *in situ* at Stations 7, 27, 35, 43.

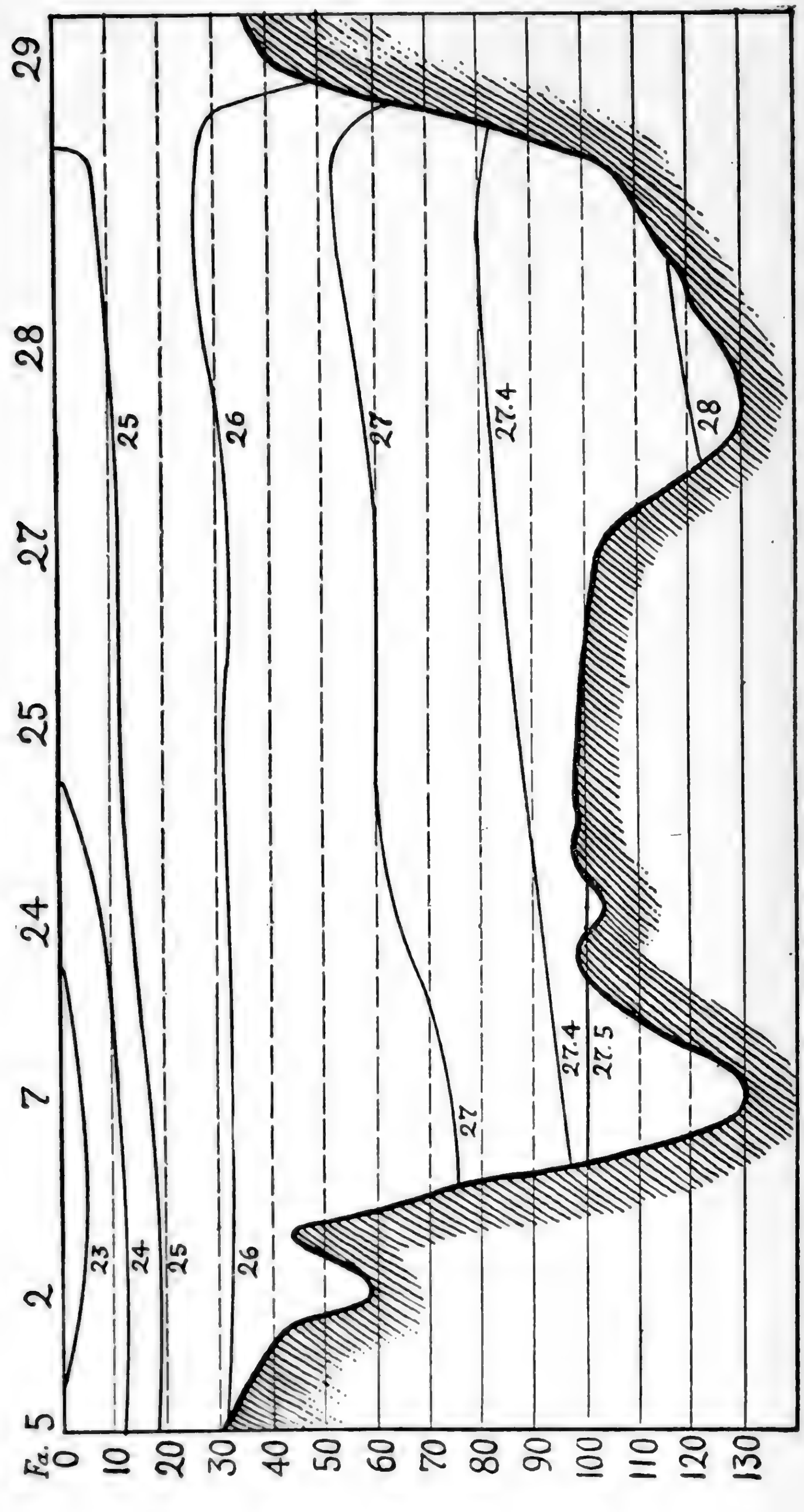

FIG. 37.— Profile from Massachusetts Bay to German Bank, passing between Platt's Bank and Cashe's Ledge, and south of Jeffrey's Bank, to show density *in situ*.

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 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

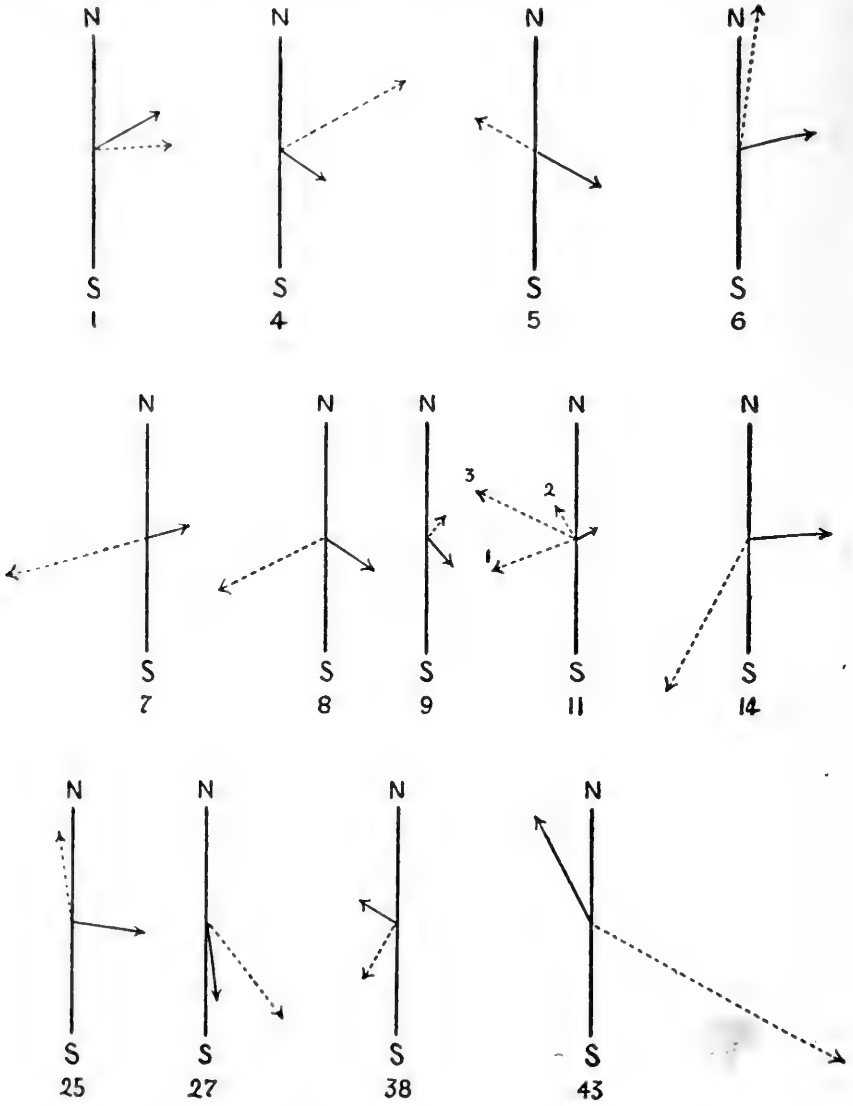

FIG. 38.— Currents, Stations 1, 4, 5, 6, 7, 8, 9, 11, 14, 25, 27, 38, 43. Surface current··········>; bottom current ————>. The strength of the current is represented by the length of the arrows, 3 cm. = 1 knot per hour.

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 extraördinary 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 60-69° 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 callarius*), 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 monopterygias,* 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 ferrugnea*), 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 helgolandica. 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 ½ 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 ½ 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		

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[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. D = No. 20 silk net H = Hensen quantitative net. Dr = Dredge
C = horizontal closing net. E = Scrim net. T = 8 ft. Beam trawl. 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 H₂O 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°30′	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°30′		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
0	64	65	66	56	61.3	61	64	61	67.5	61	59	60	57
5													
10		49.2				43.3							
15											44.9		
20								42.4					
25			41.1		41.3	41.3	45.3						
30											41.3		
35	41	40.3											
40													
45											40.3		
50							40.3		40.				
55													
60		40.3									40.3		
65													
70													
75							40.3						
80													
85													
90													
95													
100													
105													
110													
115													
120													
125								40.3					
Depths													

Stations	13	14	15	16	17	18	19	20	21	21a	22	23	24	25	26
0	57	57	58	57	57	57	57	55	55.5	56.3	62	64	61	56	57
5		55.2	54.5	53.6											
10			51.4	51.4										49.2	
15		44.4		47.7					48.6			47.5			
20			45.5	45.4			47.3							49.2	
25		43.3										45.2			
30			44.4				45.6		46.7					48.1	
35												42.1			
40							42.6							46.8	
45									45.5		46.3	40.8			
50							42.2								
55														46.2	
60									45						
65															45.8
70															
75															
80	39.4														
85															
90															
95															
100															
105														40.3	
110															
115															
120															
125															
Depths															

Stations	26a	26b	27	28	29	30	31	32	33	34	35
0	57	61	59	59	50.6	52	56	57	51.1	50	51
5									50.7		
10				50.7	49.7					49.7	49.6
15									49.7		
20				47.7	49.4		52.7				49.6
25			46						49.4	49.7	
30				45.6	49.4						49.6
35					49.3				49.3		
40							50.4			49.3	
45											49.5
50			45								
55				45.3						49.2	
60							46.7				
65											
70											
75			43.3				45.8				
80				45.3							
85											
90											
95											
100			42.8	45.3							
105											
110											
115											
120				45.3							
125											
Depths											

Stations	36	37	38	39	40	41	42	43	44	45	46
0	52.5	55	55.5	56	58	61	61	60	58	61	61
5											
10		50.9							52.7		
15											
20	49.2	49.8	49.9	49.				50.9	45.9	47.7	
25											
30			48.7						44.3	44.9	44.3
35											
40			48.3	48.				46.5		43.1	
45											
50			48.3								
55											
60	46.8			47.				42.			
65											
70											
75											
80	45.7			44.8		40.3		41.3			
85											
90											
95								41.3			
100	45.4										
105											
110											
115											
120											
125											
Depths											

TABLE OF SALINITIES.

Stations	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	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	......	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						32.39						32.1[illegible]																									
25				32.52				32.61																													
30			32.57								32.38																								32.52		32.56
35	32.65																							32.92			32.68										
40		32.77																																33.15		32.89	
45																	32.74	33.30											32.65								
50							32.84						32.97									33.64									32.95						
55																				33.22								32.56									
60								32.85							32.94																						
65		32.92																			33.13																
70																																					
75					33.49																				33.82												
80								33.04																								33.37					
85																																					
90																										34.13											
95																																		33.69			
100																						33.89								34.31							
105																			33.57																		
110																																					
115																																					
120																							34.54														
125					33.78																																
Depths																																					

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[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	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 48											
95																																		27 45			
100																						27 55								27 69							
105																			27 49																		
110																																					
115																																					
120																							28 03														
125					27 84																																
Depth																																					

[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	21	23
Flow toward	E by S	S S E	E by N	NW	N N E	W	W by S	NE by E	W	N by W	N W	S W	S	N E	0
Vel; cm. per sec.	10.2	12.7	20.7	11.7	21.9	20 7	14 8	1 8	13 2	3 3	17.7	24	22 1	10 4	0
Knot per hour	.25	.30	.5	.25	.5	.5	.37	05	.3	12	.45	62	.5	.25	0

STATIONS	25	26	27	28	29	31–32	35 Flood	35 Ebb	36	37	38	41	43	44
Flow toward	N by E	N N W	S S E	E S E	S	W by S	E	S W	NW by W	0	S W	W	S E	N E
Vel; cm. per sec.	13 2	Trace	17 4	12 7					33	0	8 4		39.4	
Knot per hour	.3	Traco	.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

2		37	38	41	43	44
S S 12 5	W	0 0 0	S W 8 4 2	W	S E 30 4 1	N E 75

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EXPLANATION OF PLATES.

PLATE 1.

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

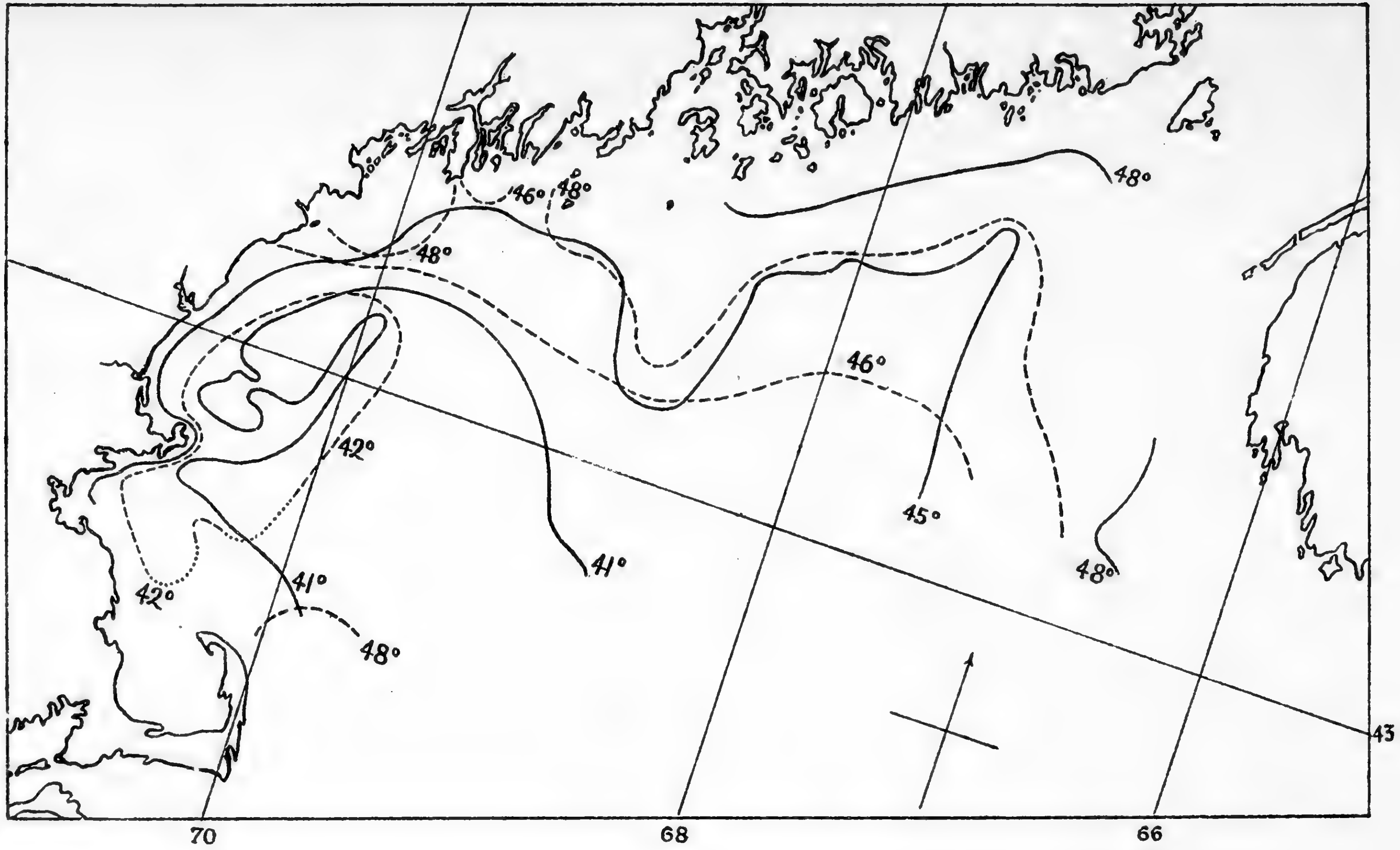

46°
48°
48°
48°
46°
42°
45°
41°
48°
42°
41°
48°
43
70
68
66

PLATE 2.

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

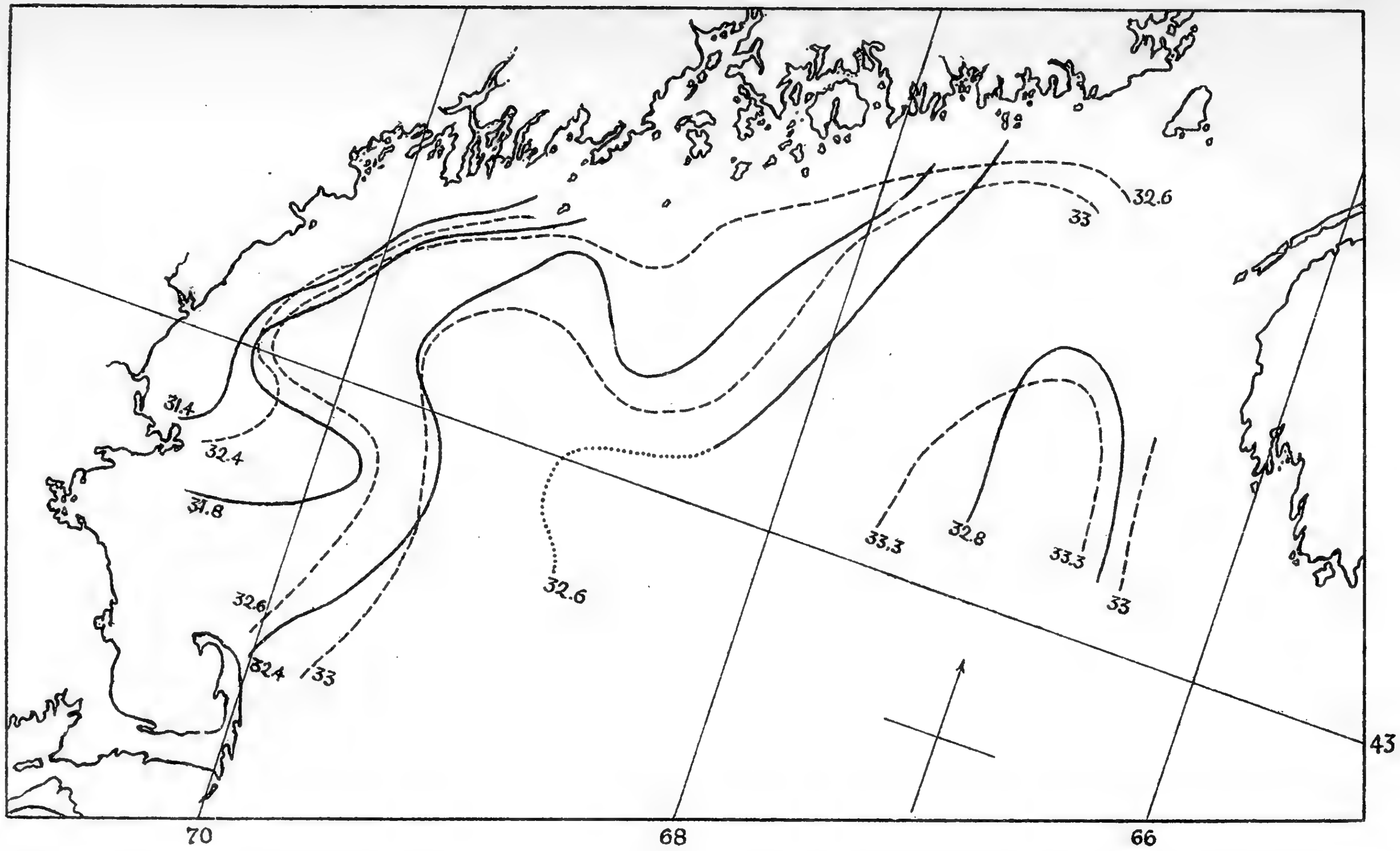

32.6
33
31.4
32.4
31.8
33.3
32.8
33.3
33
32.6
32.6
32.4
33
43
70
68
66

PLATE **3**.

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

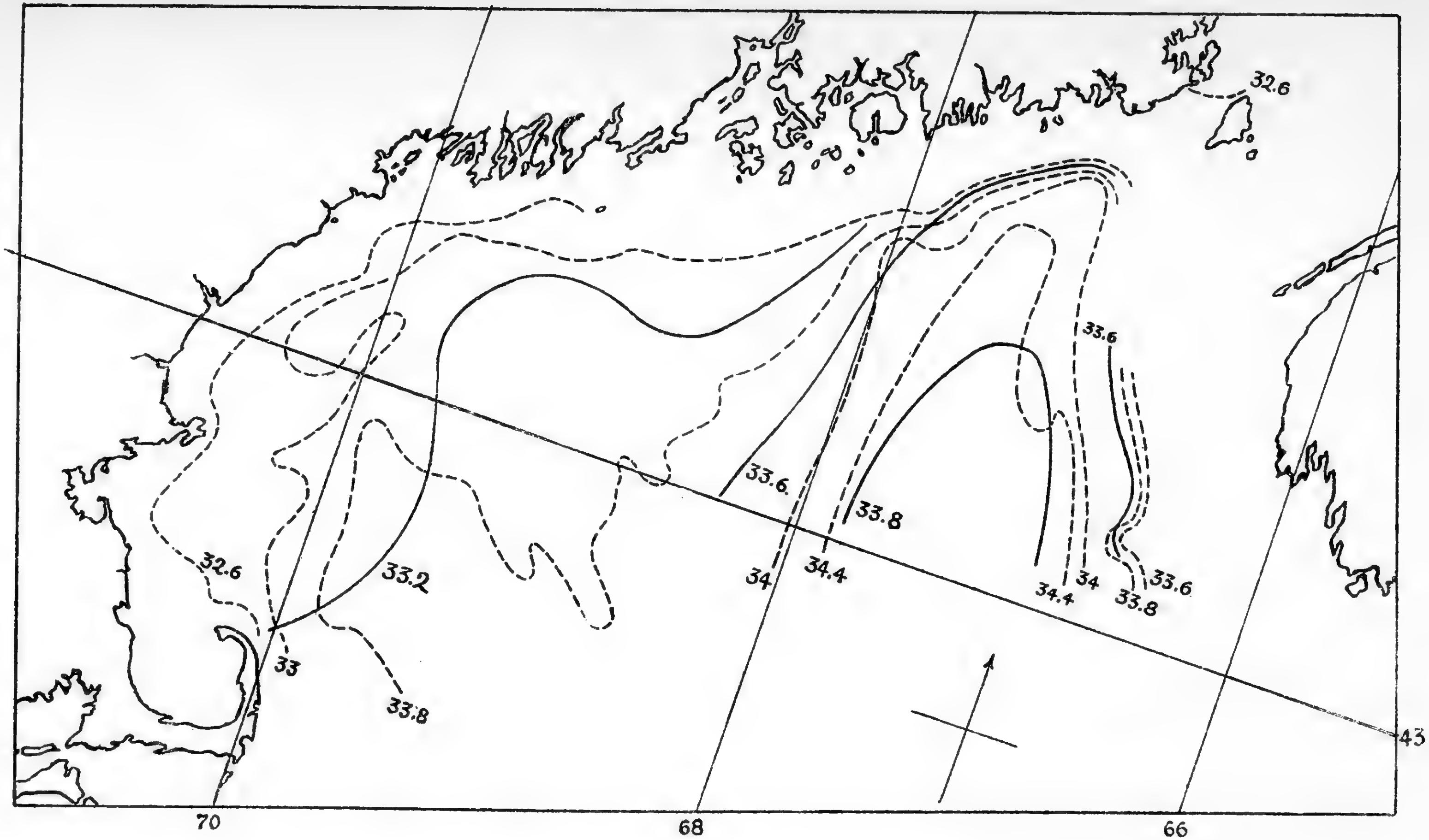

32.6
33.6
34.4
34
33.6
33.8
33.6.
33.8
34
34.4
32.6
33.2
33
33.8
43
70
68
66

PLATE 4.

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

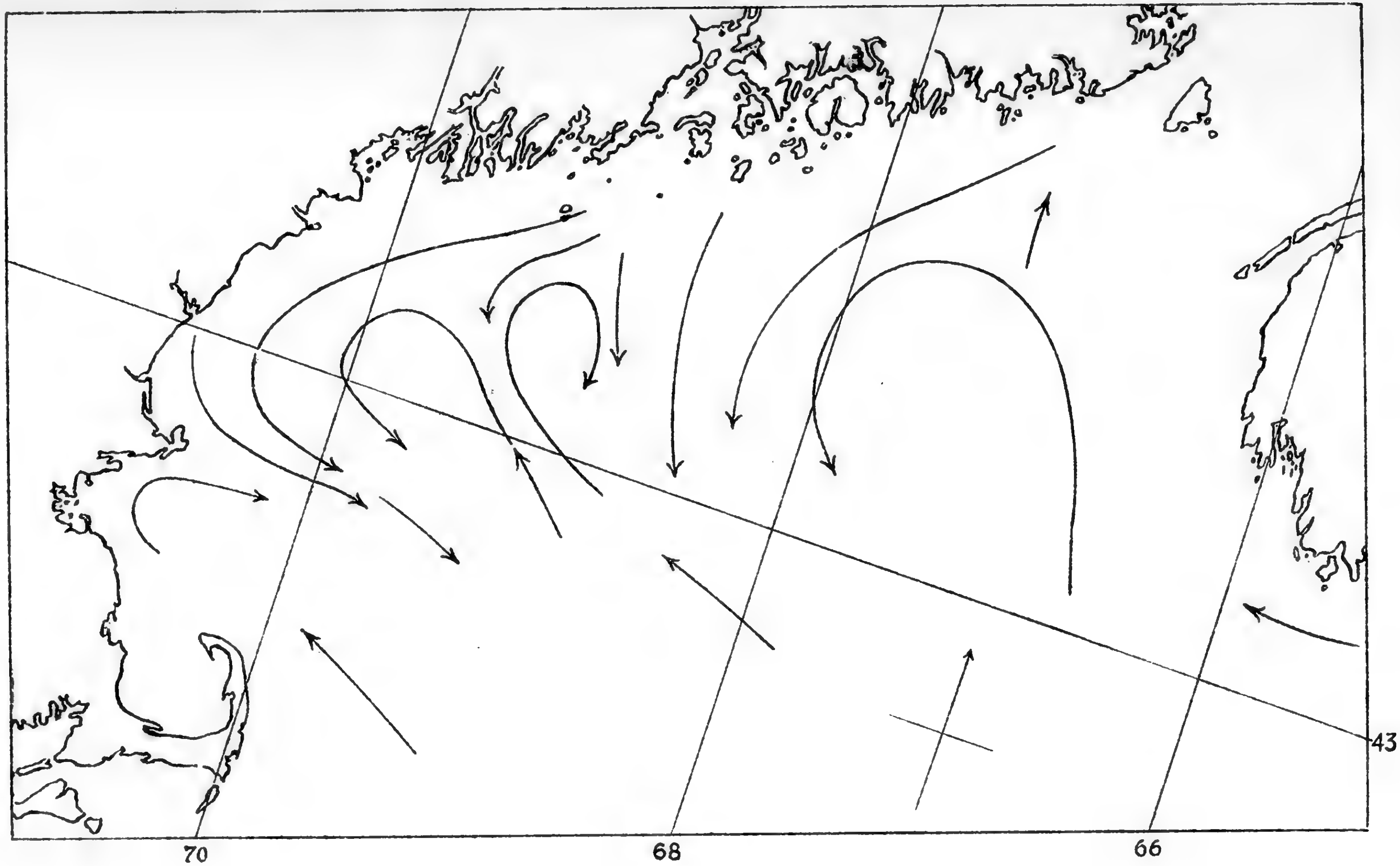
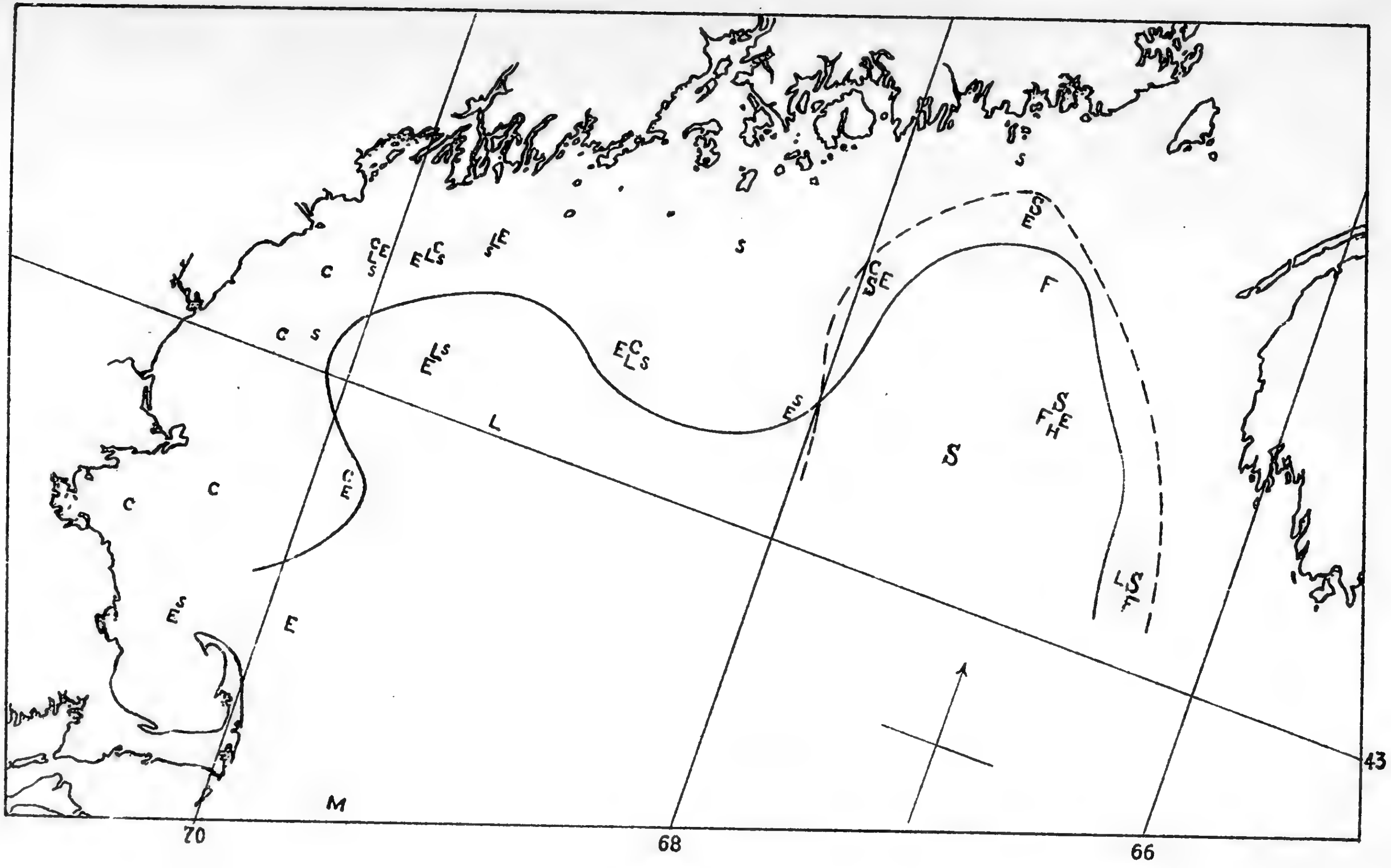

43
70
68
66

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.


C
CE LS
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E S
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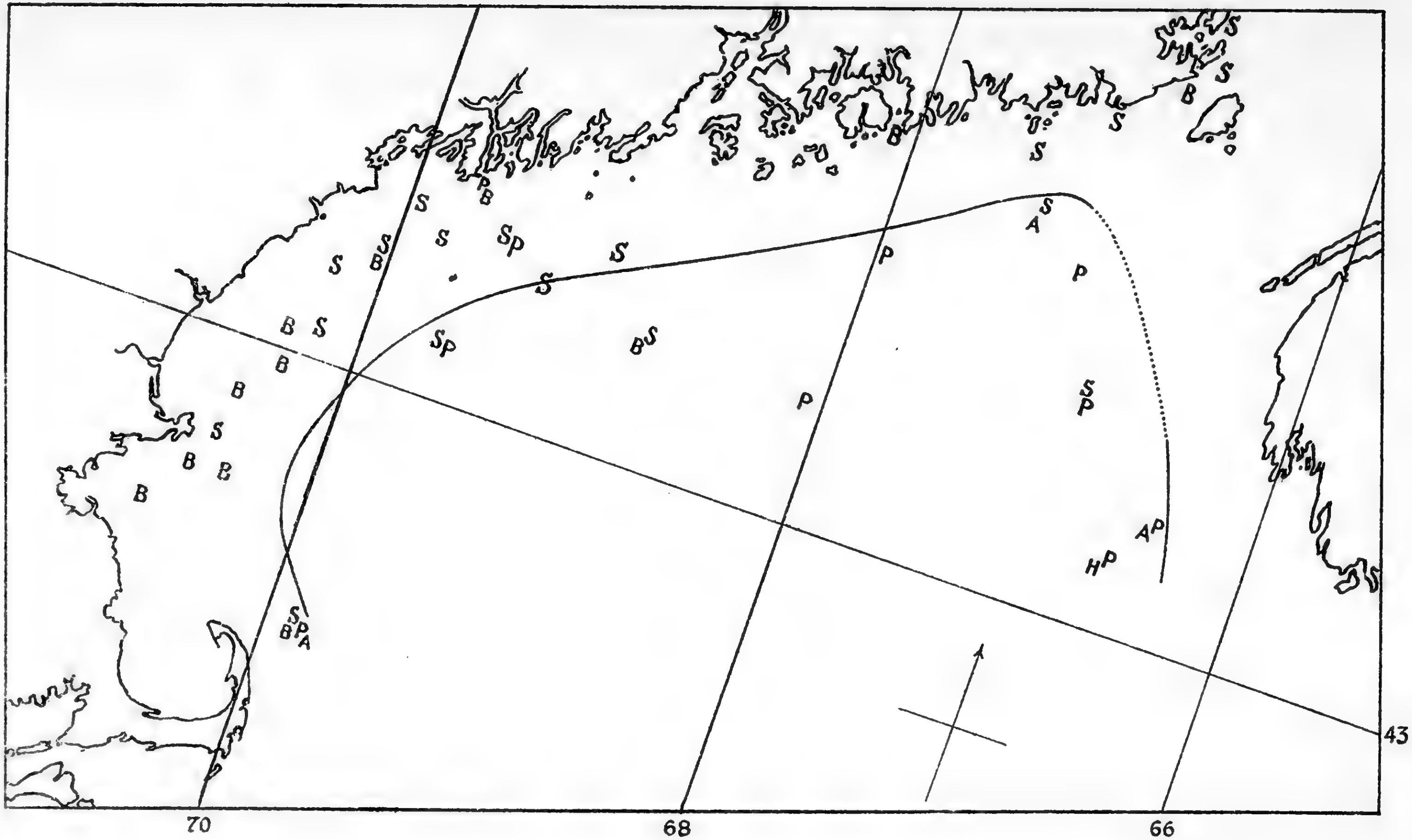
S FE H
LS F
CE
C
C
ES
E
M
70
68
66
43

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.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B
B
A
P
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S
B
P
A
70
68
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43

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).

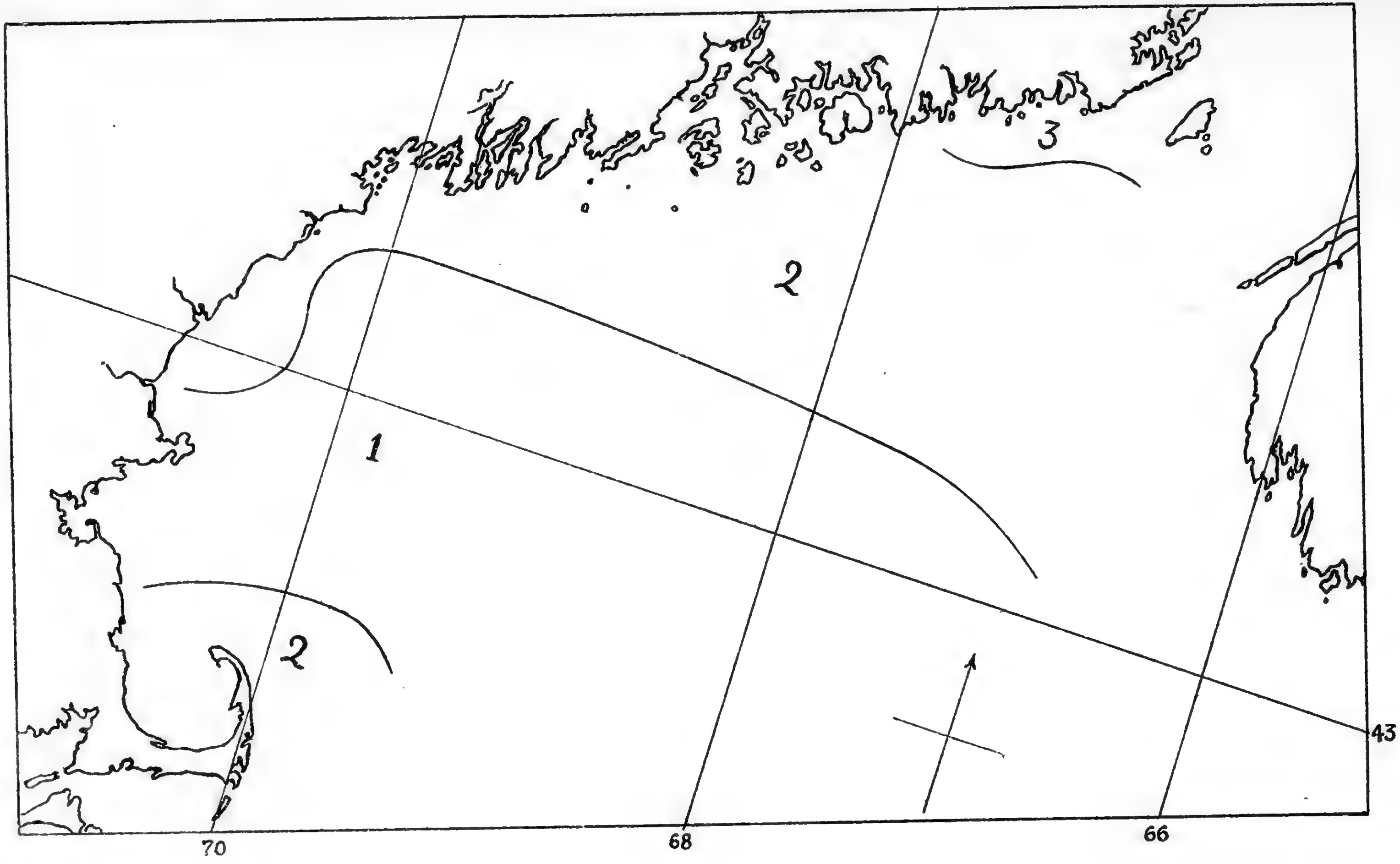

3
2
1
2
43
70
68
66

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. ▧

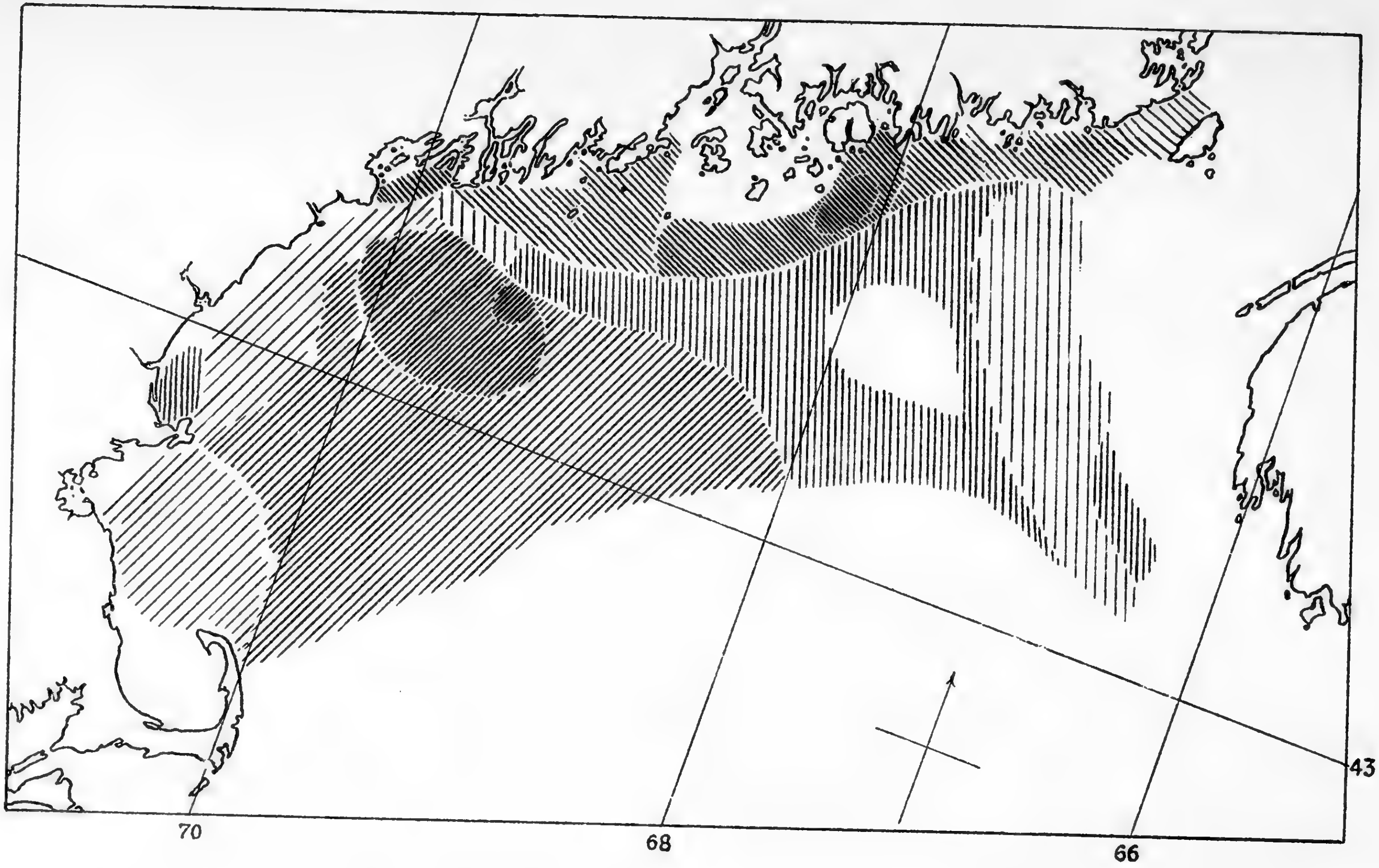
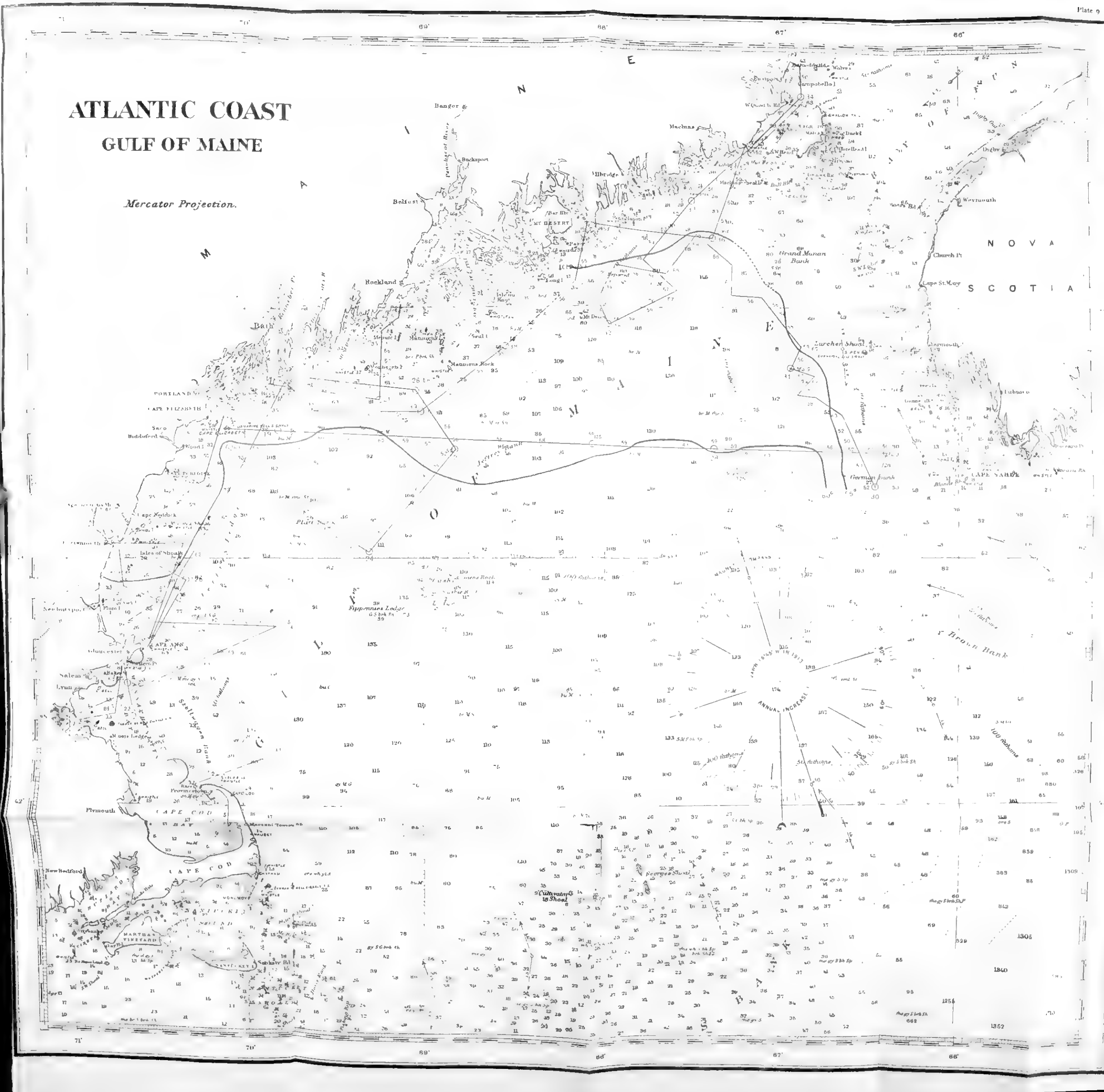

70
68
66
43

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.

a

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.

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. *Manãos* (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. *Abunã.* (Nearly opposite mouth of Rio Abunã. 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).

Belêm.

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.

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[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. Subsparsely 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.

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[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 pygometas 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. 4).

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*.

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[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: Independencia! (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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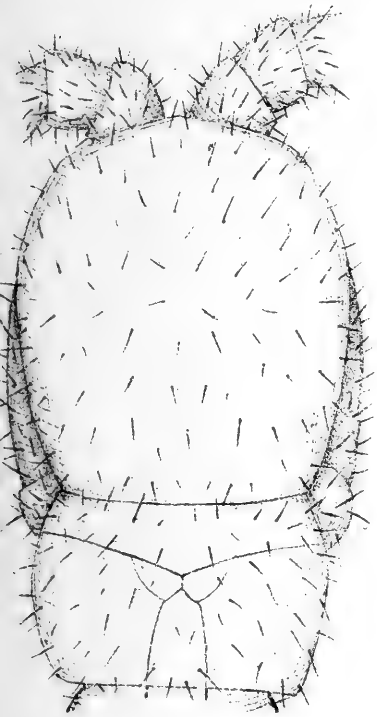

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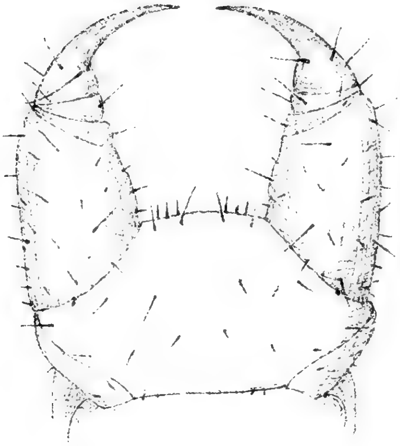

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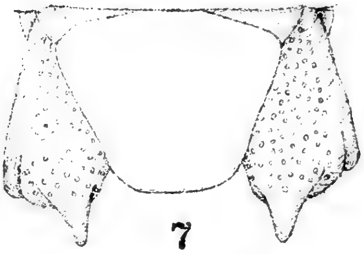

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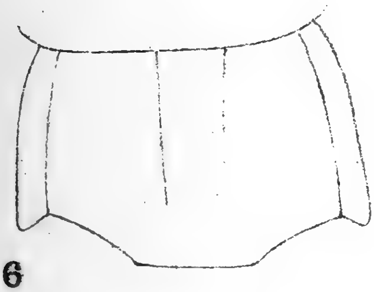

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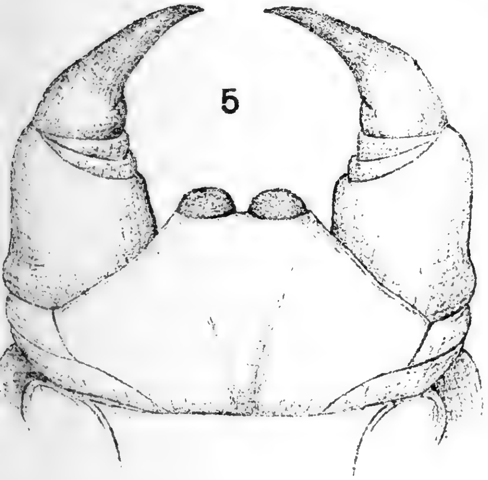

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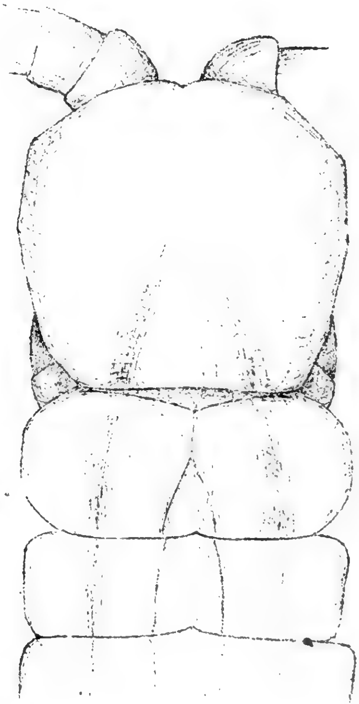

PLATE **2**.

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.

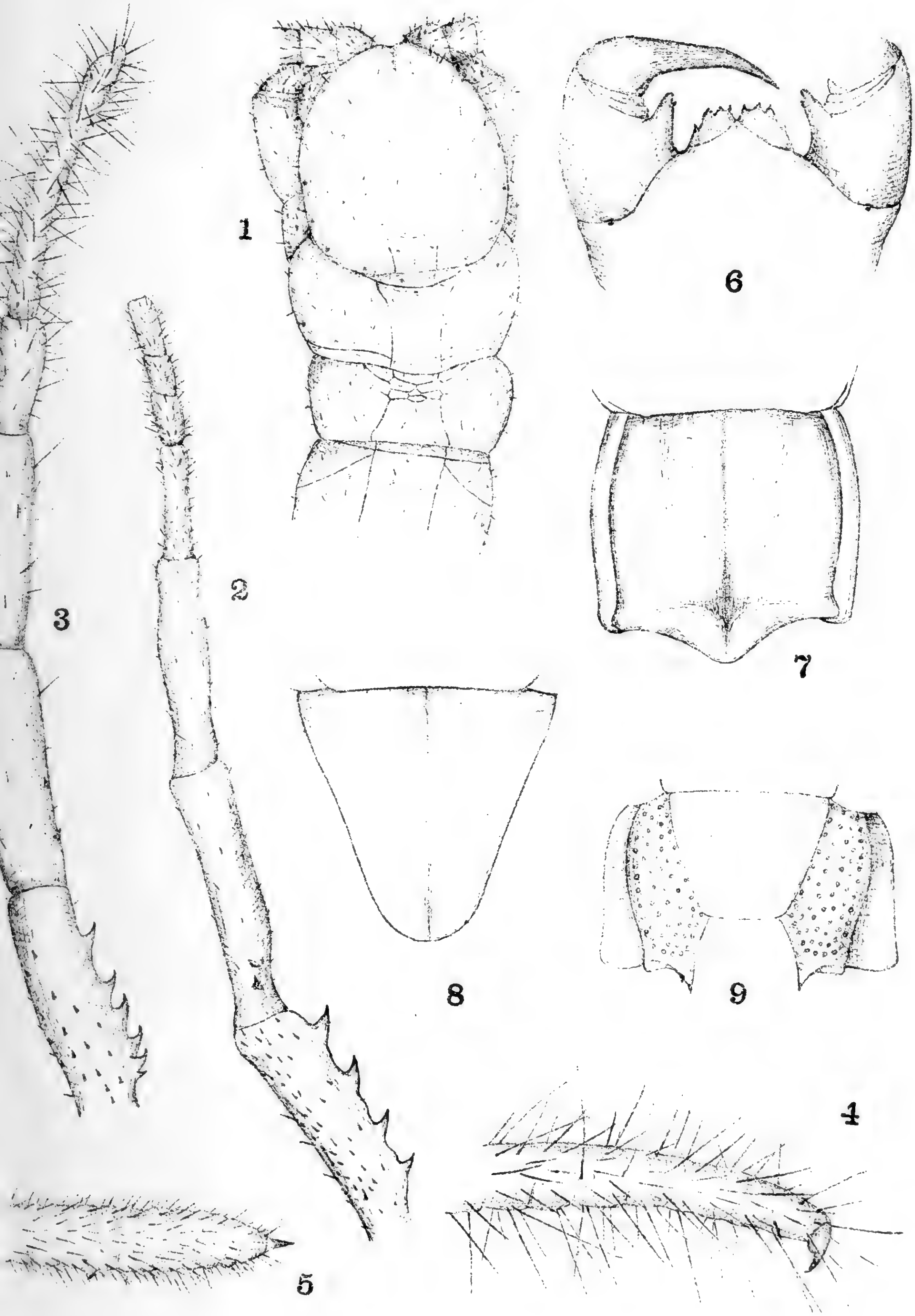
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PLATE **3**.

Otostigmus amazonae Chamberlin.

1. Last ventral plate.
2. Last dorsal plate.

Otostigmus suitus Chamberlin.

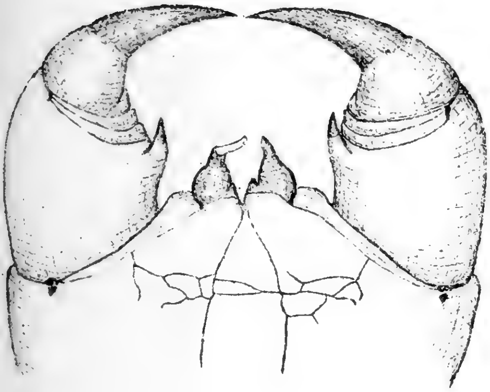
3. Last ventral plate.
4. Last dorsal plate.

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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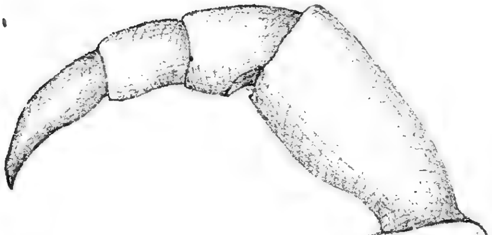

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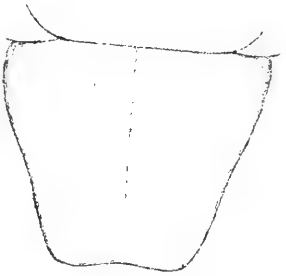

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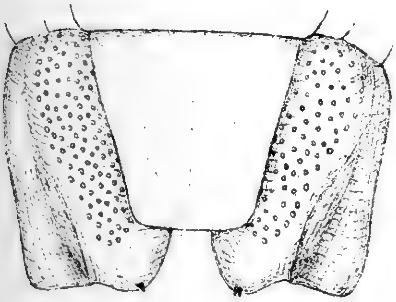

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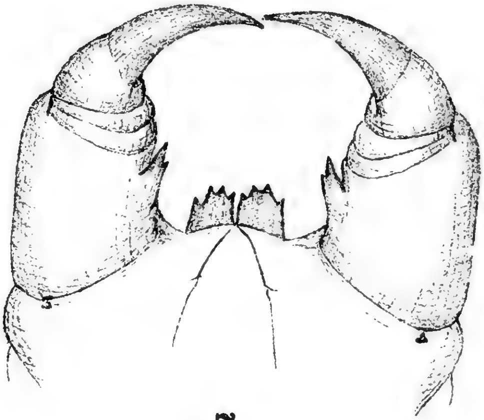

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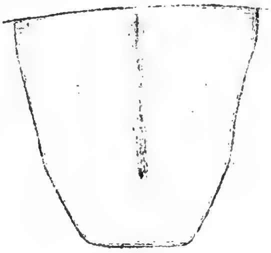

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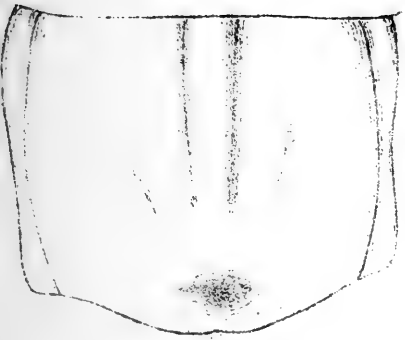

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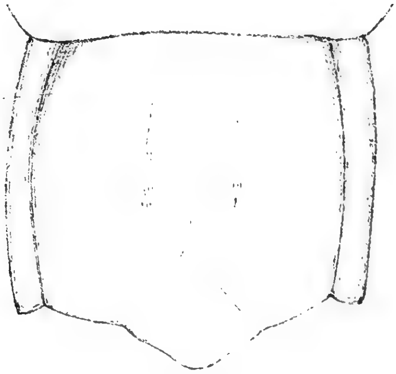

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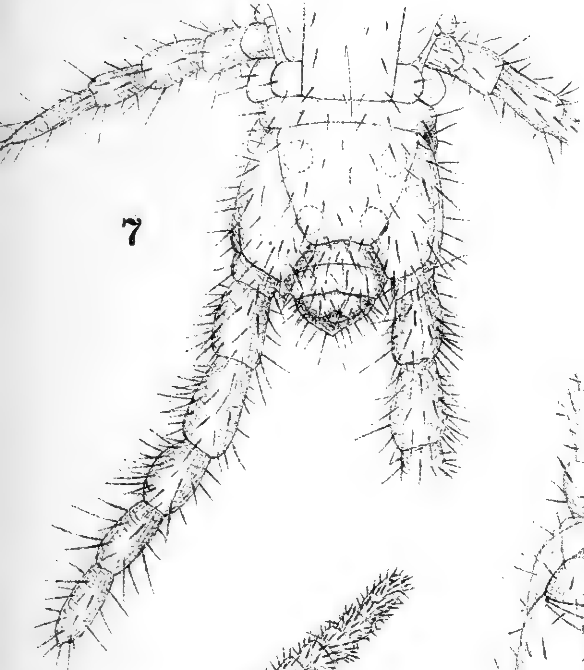
PLATE 4.

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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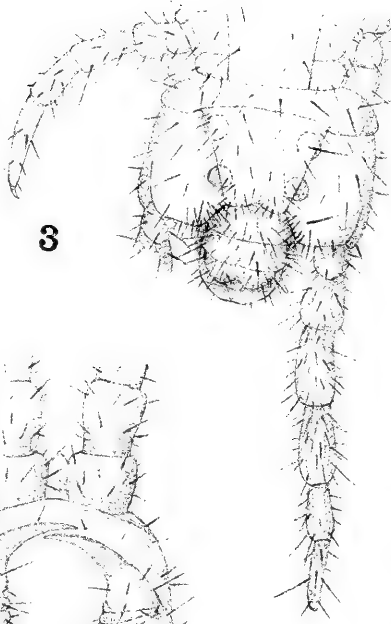
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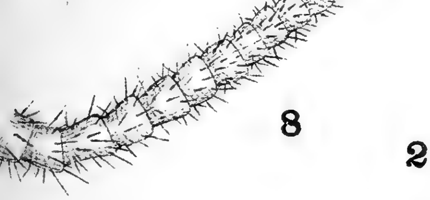
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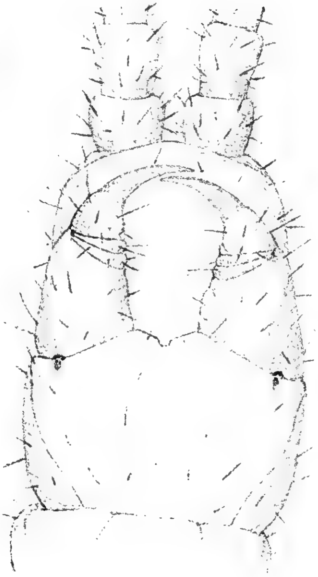
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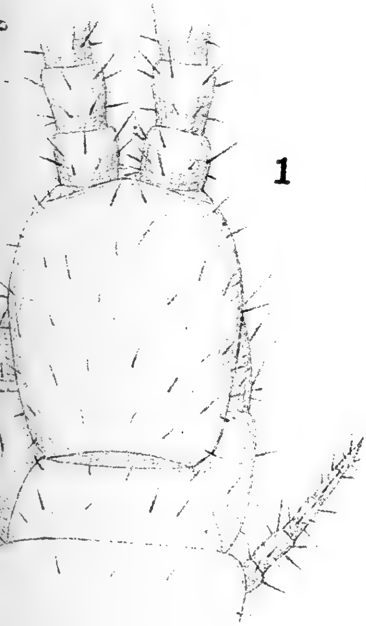
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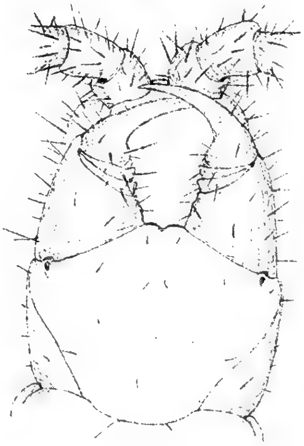
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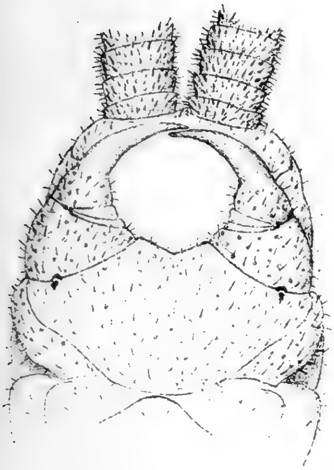
PLATE 5.

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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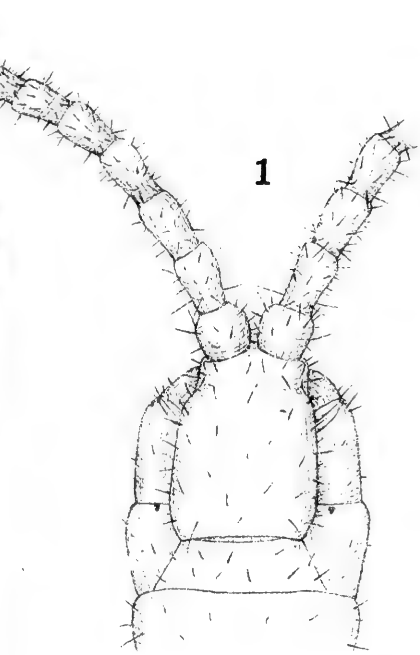

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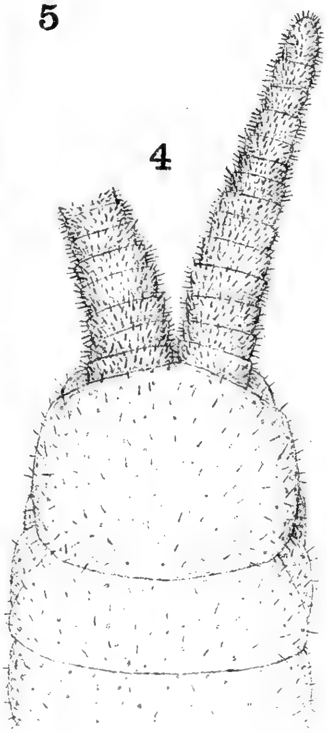

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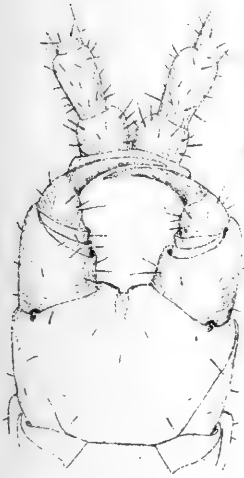

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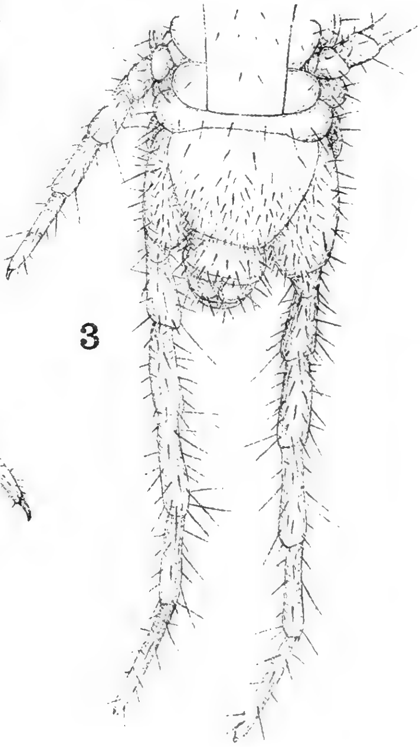

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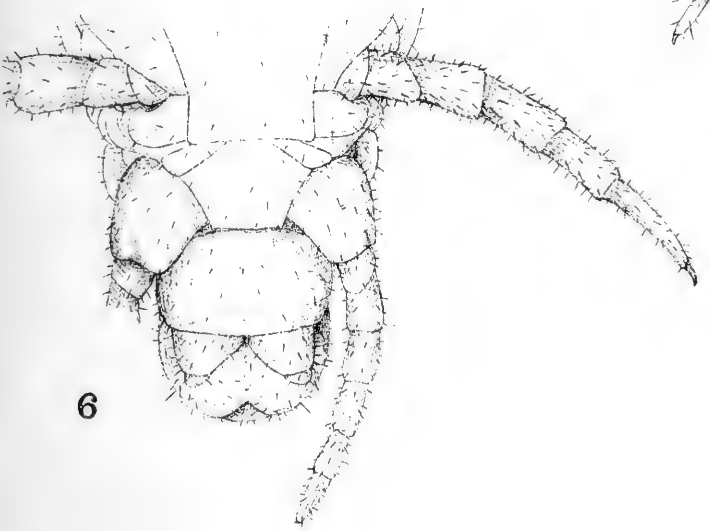

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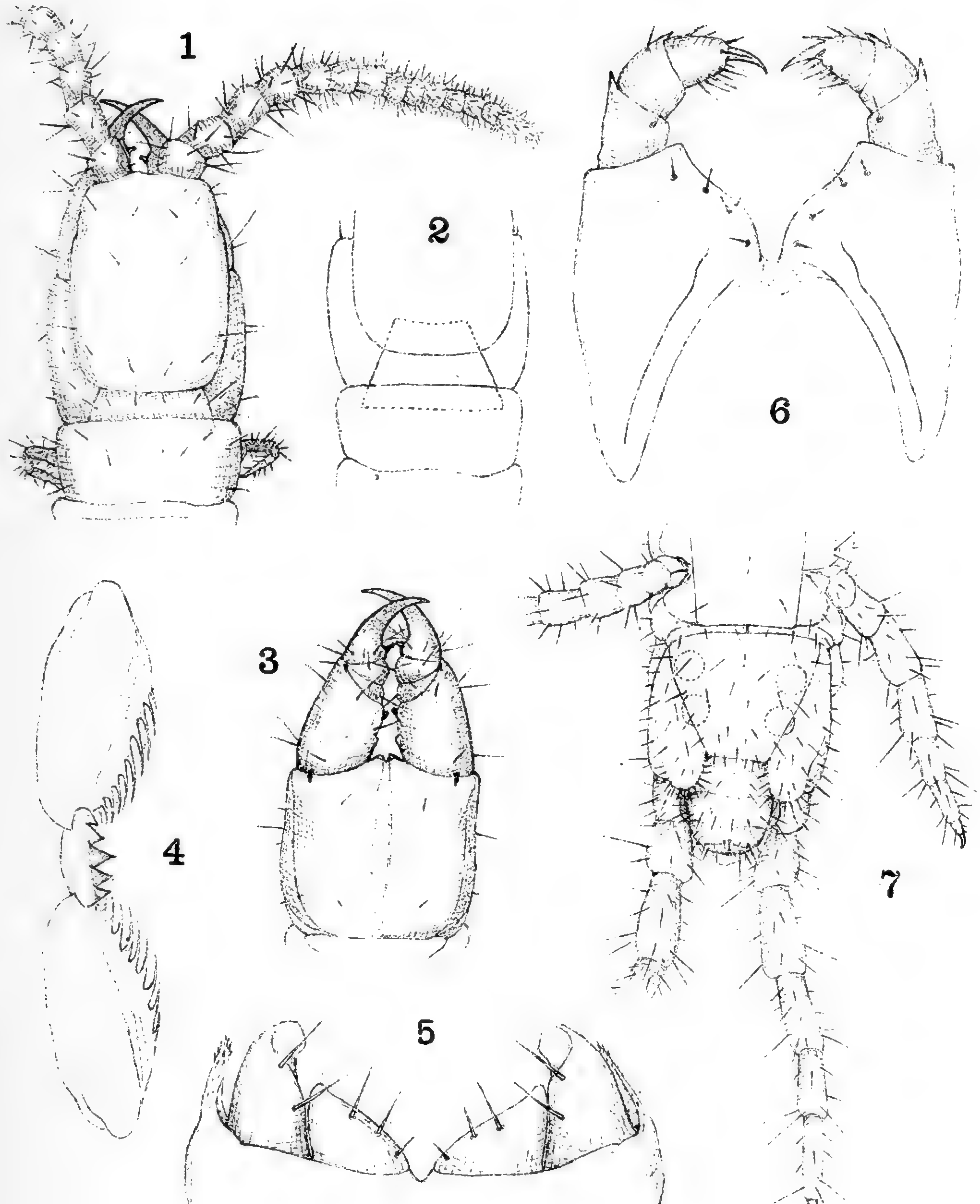
PLATE **6.**

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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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.:
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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, 40–44. 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. 254, Proc. Boston soc. nat. hist., 1859, **7**, p. 54, 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.

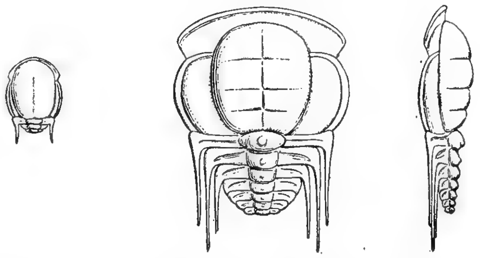

Fig. 1.— *Hydrocephalus saturnoides*, showing two of the stages of development. After Barrande. Note the wide, oval glabella. Compare with Plate, fig. 9.

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 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

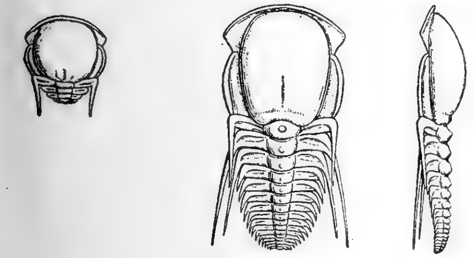

Fig. 2.

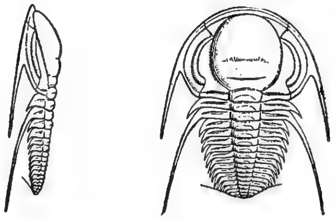

Fig. 3.

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.

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

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[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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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.

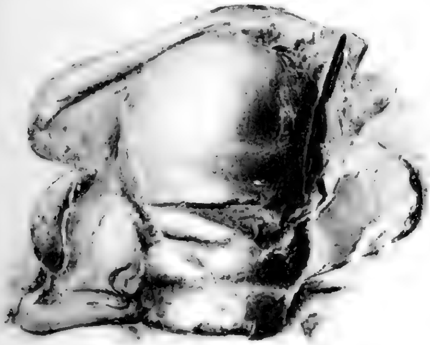
Fig. 4. The same species. An imperfect cranidium of about the same size as the cranidia of *P. haywardi* shown in fig. 1, 2. Same locality. Nat. size. No. 23, M. C. Z.

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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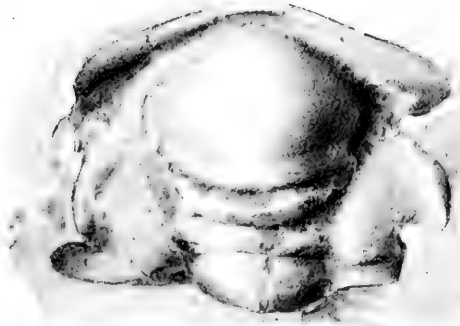

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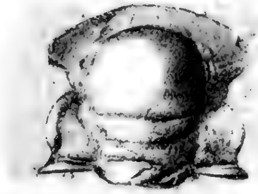

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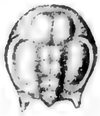

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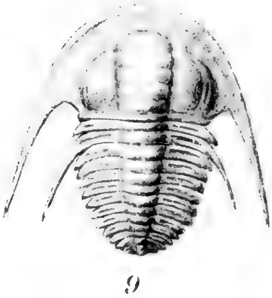

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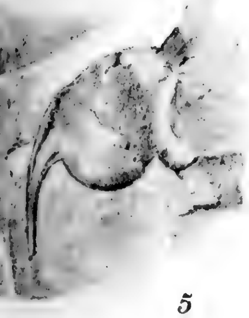

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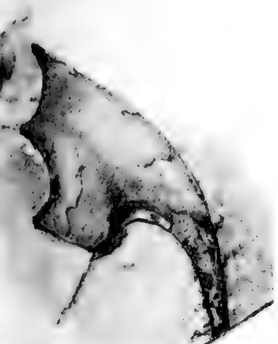

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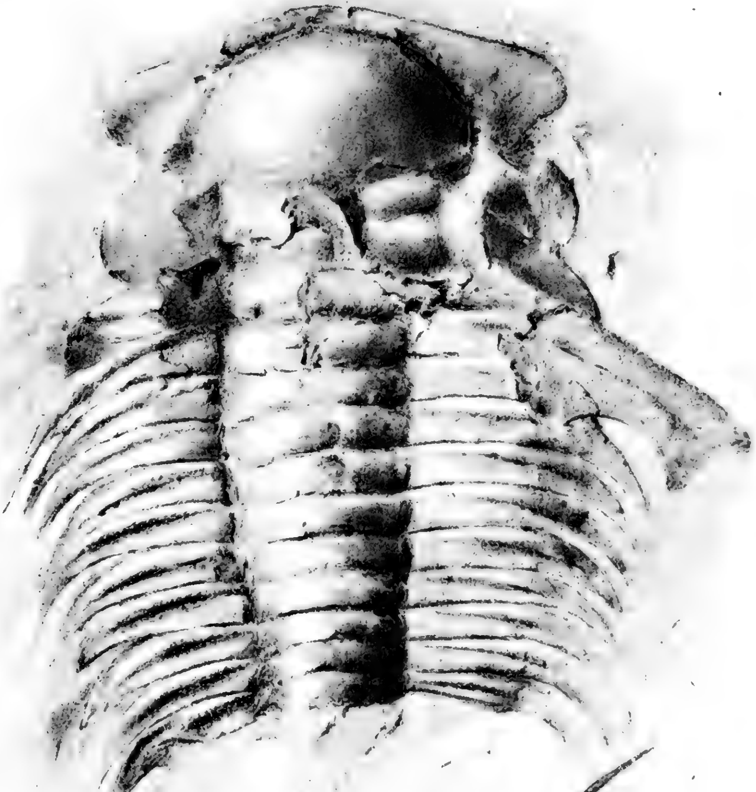

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OTES ON THE ONTOGENY OF ISOTELUS GIGAS DEKAY

By Percy E. Raymond

With Three Plates

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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. 1 (= *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).

saphus (Isotelus) gigas Salter, Mem. Geol. surv., Unit. Kingdom, 1864, dec. 11, pl. 3; Mon. Brit. Silur. tril., 1865, p. 161, pl. 24, fig. i–5; ? pl. 25, fig. 1. Reed, Lower Silur. tril. Girvan dist., 1904, p. 45, pl. 7, fig. 1.

saphus 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).

saphus 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. 184, 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 or the most part been omitted, as have also references where there is either description nor original figure. So far as can be judged from he published figures and descriptions, none of the foreign specimens eferred to this species really belong to it, and most of those which ave at one time or another been so referred are now known by other ames.

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). 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.

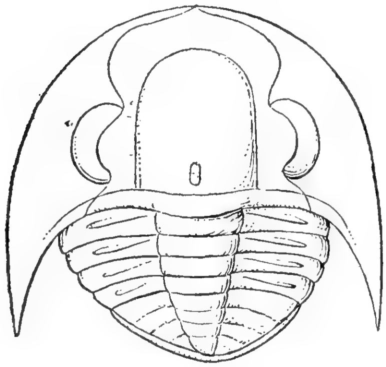

Fig. 1. *Isotelus gigas* Dekay. A small specimen in the Ogygites stage, the facial sutures being intramarginal. The pygidium is incurved so that the posterior part is not well shown. × 6. M. C. Z. No. 37.

The 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.

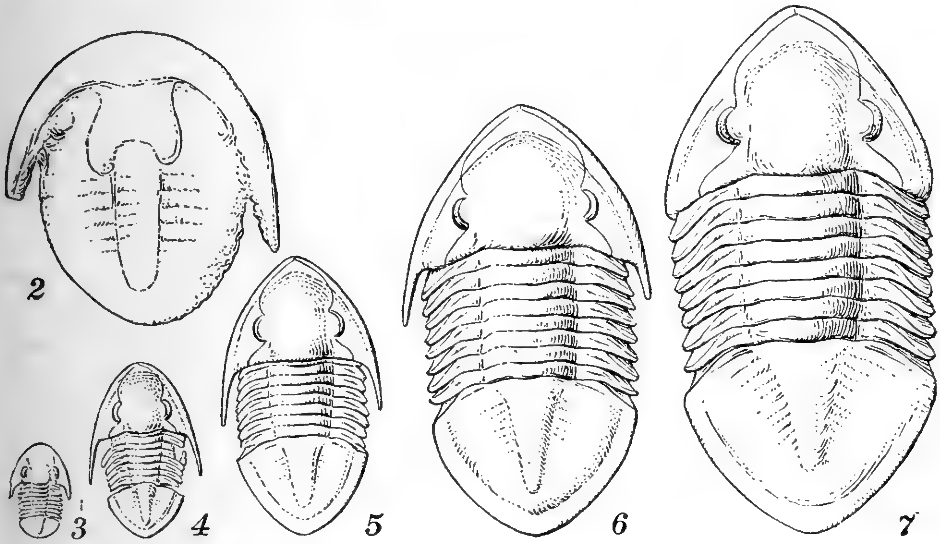

Fig. 2.— A very small specimen of *Isotelus gigas*, exposed from the under side. This specimen shows the rounded cephalon and pygidium and divided hypostoma, though it is too poorly preserved to show how many thoracic segments are present. × 10. M. C. Z. No. 36.

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

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[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, nd from Newport, New York, have been compared, and measurements aken to determine the ratio of the length of the glabella to the total ength of the cephalon. It was found that the glabella was relatively horter on young specimens than on older ones, although there was ot much difference. A cranidium 7 mm. long has the glabella .78 f the total length, while a specimen 62 mm. long has the glabella .88 f the length. The width of the brim is therefore relatively only about alf as great in the old specimen as in the young one. On the adult pecimen of *A. wisconsensis* in which the brim is widest, it occupies .19 f the length, and on the specimen on which it is narrowest it occupies nly .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, t occupies .11. With the exception of these two specimens, cranidia rom all the localities conform closely to the general average.

The agreement in proportions and ribbing among the pygidia rom the localities just mentioned is remarkable. The proportion f length to width is quite constant in specimens above 20 mm. long, nd is usually about .60. The ribbing on the larger specimens is nly a little less strong than on the small ones, and all have the same umber of ribs and rings. The largest pygidium in the collection is rom Platteville, and is 64 mm. long and about 105 mm. wide.

EXPLANATION OF PLATES.

PLATE 1.

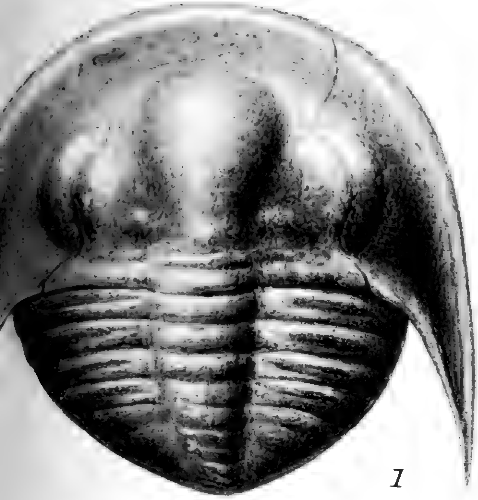
Fig. 1.— *Isotelus gigas* DeKay. An immature specimen with (apparently) three segments in the thorax. From the Trenton at Trenton Falls, N. Y. × 15. No. 45, M. C. Z., Walcott coll.

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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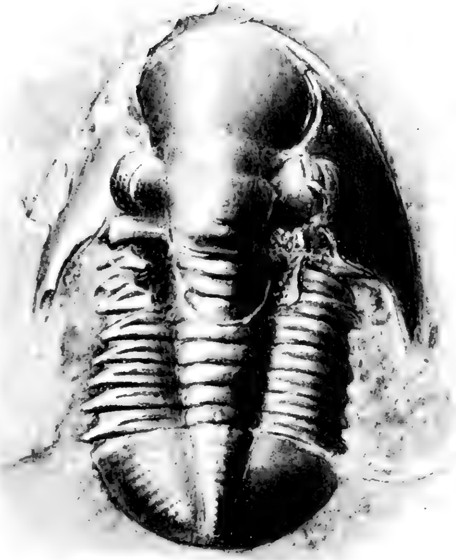

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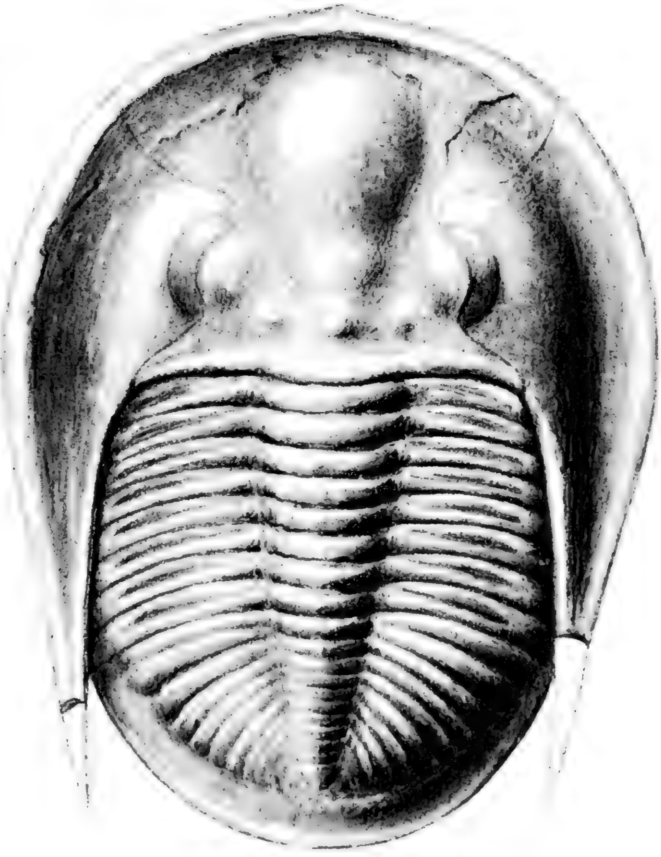

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HELIOTYPE CO., BOSTON

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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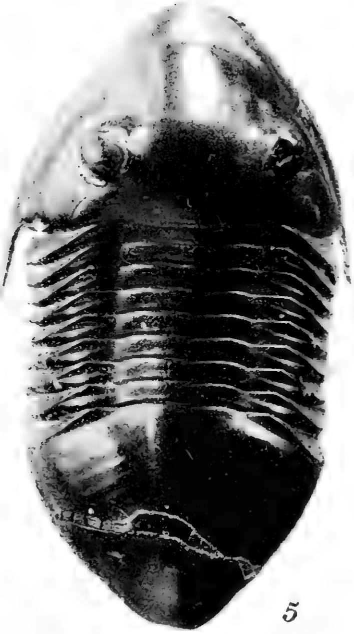

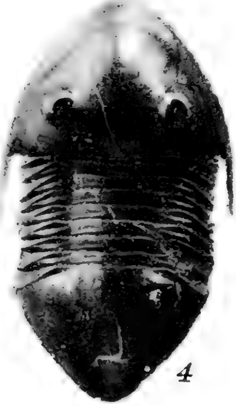

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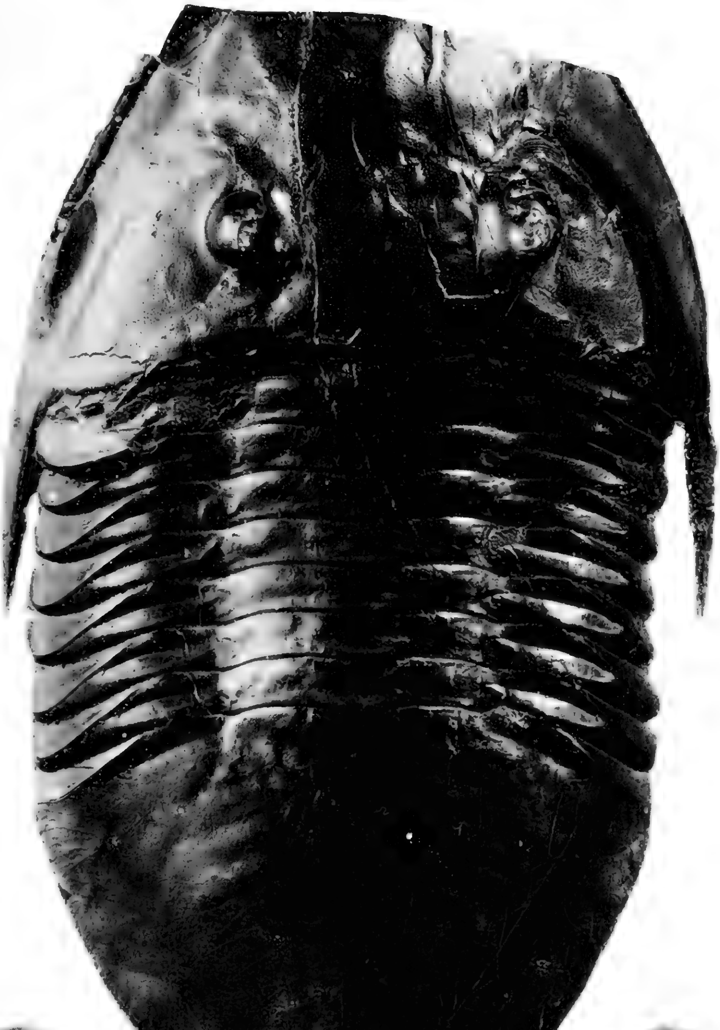
PLATE 3.

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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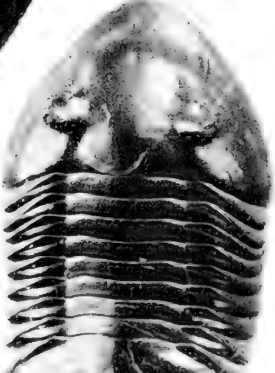

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HELIOTYPE CO., BOSTON

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AT HARVARD COLLEGE.

Vol. LVIII. No. 6.

NOTES ON A COLLECTION OF BIRDS FROM YUNNAN.

By Outram Bangs and John C. Phillips.

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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 ›y Matthews under the above name. If it can be maintained at all, t certainly is only a very close subspecies. We can find no differences n 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. *Perierocotus 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.

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MAMMALS FROM THE BLUE NILE VALLEY.

By Glover M. Allen.

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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 ater years. On these rivers now, however, the habitations are being eëstablished gradually, and population will doubtless reclaim the ountry in time. It therefore has seemed worth while to record the nore striking facts we noted concerning the habits and distribution of he larger mammals, for they must eventually be much reduced or estroyed 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 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

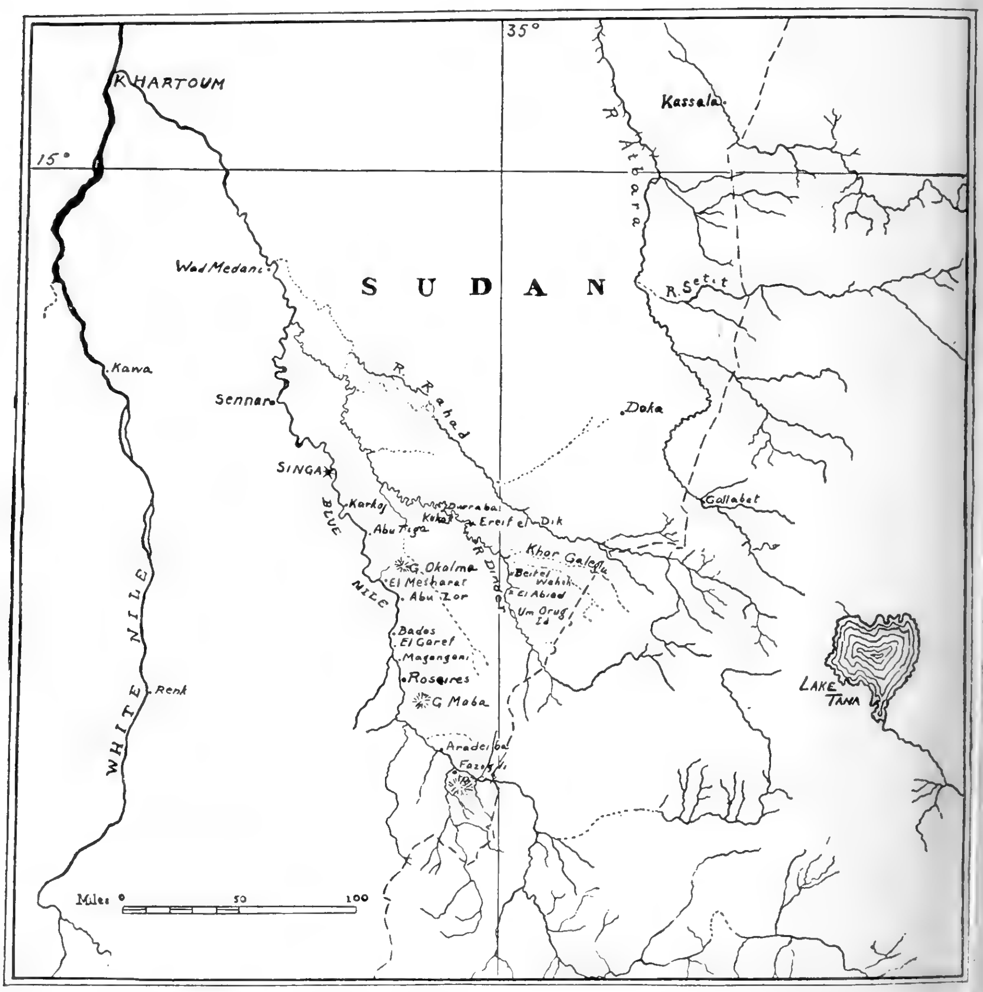

Fig. 1.— Sketch map of the Blue Nile Valley.

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 mamma- an fauna of the region has been of fragmentary nature, and consists hiefly of reports on occasional specimens sent by Europeans to the museums of England and Germany. In 1898, Lord Lovat's expedi- on 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. Flower, of the Gizeh Zoölogical Gardens has several times been the region to obtain living animals for the splendid collection under s charge. Mr. A. L. Butler, head of the Game Preservation Depart- ent of the Sudan, also knows the country well and has sent many ecimens 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 mm.	2 mm.	3 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 o 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 irregular 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 *karôri,* 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 Wahsh, 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 in 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.

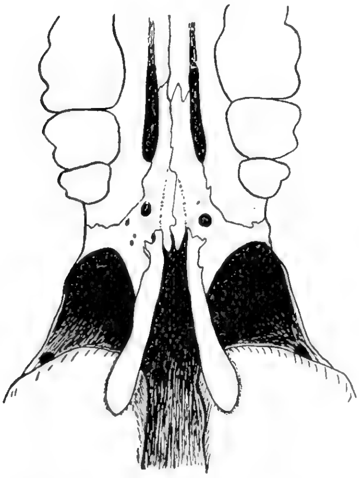

Fig. 2.— *Tatera flavipes*, palatal region. × 3.

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 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.*

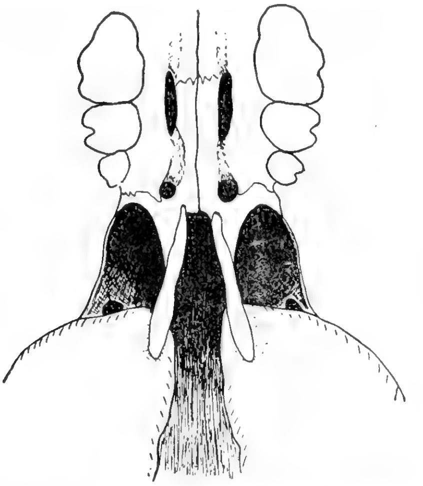

Fig. 3.— *Tatera soror,* palatal region. × 3.

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 bifurcate 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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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.

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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.

lcirona maldivensis Stebbing, Fauna & geography Maldive & Laccadive Archipelagoes, 1904, **2**, pt. 3, p. 708–709.

Locality. — Funafuti, Ellice slands. Two specimens, a male nd female.

Stebbing's specimen was from ulule, Maldive Islands.

The drawings of the abdoen and frontal lamina are of ne of the specimens from unafuti.

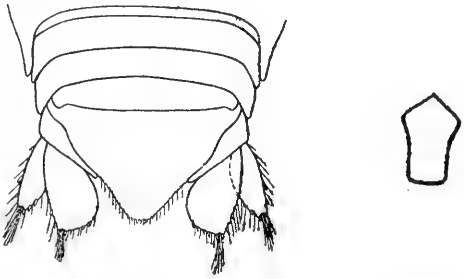


Fig. 1. Fig. 2.

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.

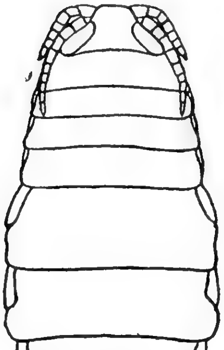


Fig. 3. — *Anilocra meridionalis.* 8. ×

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 pai of antennae are composed of eleven articles an extend to the posterior margin of the second thoracic segment. The fifth article is the longest, and is the last peduncular article, although the article of flagellum and peduncle are not clearly marked The first and fourth segments of the thorax are a little longer tha 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.

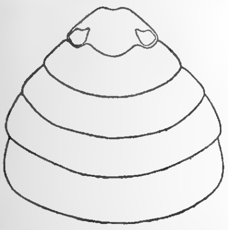
This species differs from all the others of the genus in the longer second antennae, which extend to the posterior margin of the second thoracic segment.

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 articles, extend to the anterolateral angles of the first thoracic segment. Second pair of antennae, composed of seven articles, are equal in



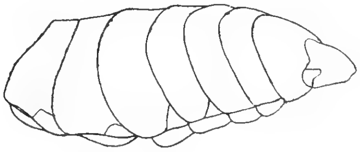


Fig. 4.— *Nerocila excisa.* Head and first three thoracic segments. 8. ×
Fig. 5.— *Nerocila excisa.* Lateral view of thorax. 8. ×

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.

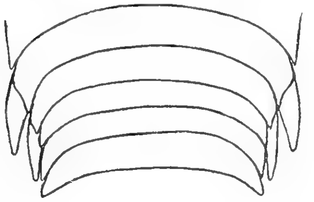


Fig. 6. — *Nerocila excisa.* First five segments of abdomen. 8. ×

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.

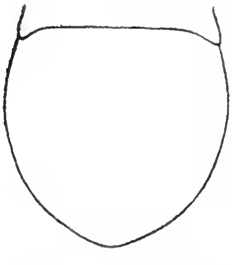


Fig. 7. — *Nerocila excisa.* Terminal segment of abdomen. 8. ×

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.

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. Fou specimens from surface.

ONISCIDAE.

Philoscia australis, sp. nov.

Body ovate, a little more than twice as long as wide 4½ mm.: 10 mm. (not including uropoda).

Head two and a half times wider than long, 1 mm.: 2½ 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.

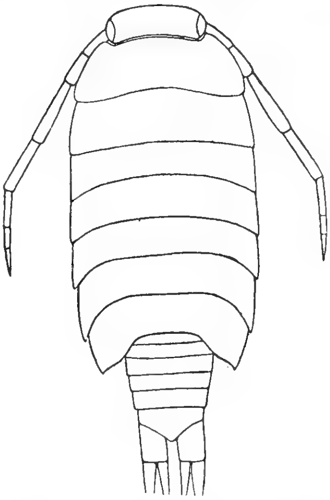


Fig. 8.— *Philoscia australis.* 16. ×

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.

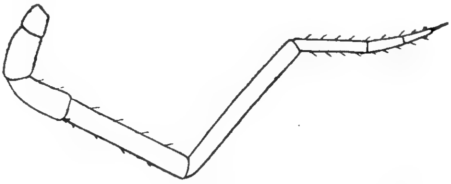


Fig. 9.— *Philoscia australis.* Second antenna. 26. ×

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 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.

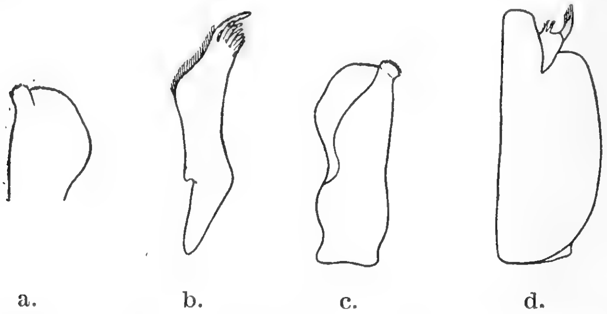


Fig. 10. *Philoscia australis.* a. Maxilliped. b. Second maxilla. c. Outer lobe of first maxilla. d. Extremity of second maxilla. 41. ×

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, 1804, **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.

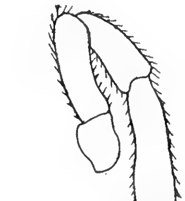


Fig. 11. — *Spherillo testudinalis.* Second antenna. 41. ×

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

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[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.

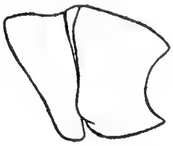

Fig. 12.

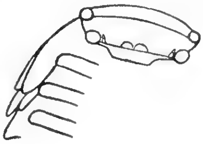

Fig. 13.

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.

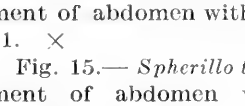

Fig. 14.

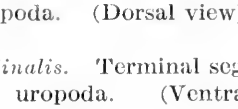

Fig. 15.

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 ofthe 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.

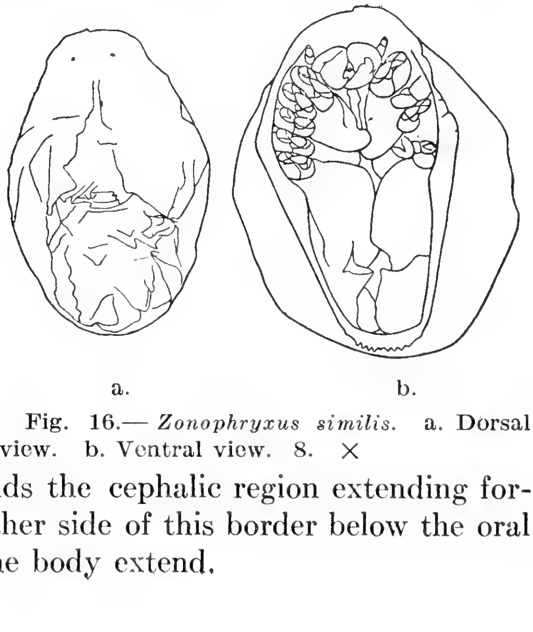
a. b.

Fig. 16.— *Zonophryxus similis*. a. Dorsal view. b. Ventral view. 8. ×

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.

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[1] In the specimen the third leg on the right side is broken off about the middle

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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.

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 ncluded 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 o Bouvier's (Monographie des onychophores, 1907, p. 158) group of Péripates caraïbes" which has lately been given the subgeneric ame of Epiperipatus by Clark (Proc. Biol. soc. Washington, 1913, **6**, p. 17). It may be mentioned, however, that Bouvier's division f the neotropical forms into Andicolous and Caribbean species does ot hold for the Colombian species as has recently been shown by uhrmann (Zool. anz., 1913, **42**, p. 242).

PERIPATUS (EPIPERIPATUS) VESPUCCII, 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 male and 30 pairs in the male. Integument similar to that of *P. asiliensis*, but there are two incomplete folds on each body segment.

Form and dimensions. Body rather slender, considerably narrowed each end, so that it tapers very decidedly from a broadened middle rtion toward the head and posterior end. In the three specimens fore me, the body measurements are as follows:—

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[1] Contributions from the Entomological Laboratory of the Bussey Institution, rvard 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 th
paratype is more fully expanded and consequently appears to be of
more slender form. The type female and the male are of very simila
shape (see Plate **2**, fig. 11).

Coloration. All three specimens are considerably decolorized fro
their preservation in alcohol, but still show very distinctly the gener
color-pattern of the body. To the naked eye, the legs and a broa
stripe directly above them are much lighter than the dorsal regio
exhibiting a dull yellowish gray tint with distinct purplish cast whi
is much more distinct in one specimen. In all three, the legs a
decidedly paler than the pleural stripe. The dorsal region, includi
two thirds of the animal when seen from above, is much darker th
the pleurae and differentiated into a complicated color-patter
This consists in a light-colored median dorsal broad stripe, strong
constricted between each body segment, and a narrow very da
beaded or interrupted median line, the interruptions of which coinci
with the constrictions of the light stripe. Examined under a mic
scope it is seen that the enlargements of the dorsal light stripe a
rhomboidal in form, but coalescent for about half their greatest wid
along the intersegmental lines, so that their margins form a continu
longitudinal serrate line. The dark color is confined to the spa
between the body folds and does not include the apices of the papill
even in the darkest portions of the stripe. The median blacke
line is discontinuous, passing over only five to seven folds on ea
segment and is much more strongly pigmented on the three or fo
alternate folds of each segmental group. The dorsal color-patt
fades out on the head and next segment, and continues to the poster
extremity of the body, although paler on the last two or three s-
ments. The antennae are pale.

Integument. The integumentary folds are very narrow on
ridges with the transverse grooves between them deep. At the le
of each leg two of the folds are incomplete, extending only about h

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 creep-ng pads of each leg are composed of four bands. The nephridial ubercles on the fourth and fifth pairs of legs lie between the third nd fourth bands of the creeping pad. They are free from the third and although lying partly in an margination of its proximal mar-in, and do not disturb the con-nuity of the fourth band.

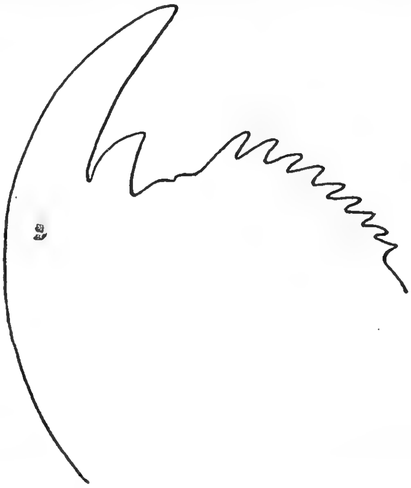


Fig. 1.— *Peripatus* (*Epiperipatus*) *vespuccii.* Outer blade of mandible.

Type:— M. C. Z., No. 239, Cin-nnati Coffee Plantation, near Santa Marta, Colombia, 2,300 feet. Field No. 92).

Paratypes: — M. C. Z., No. 240; Univ. Mich. Same locality, 2,200 et.

Named in honor of Amerigo Vespucci whose explorations led him ong 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), eems undoubtedly to belong to this species which has hitherto been ported 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 × 1½ 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 1½ 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 3½ 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. Dur-ng 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 i impossible to identify it with certainty from the unique, evidentl immature specimen. Although Carriacou is within sight of the northern coast of Grenada, it lies rather low and its comparatively dr climate is in great contrast to the very moist region in the highe mountains of Grenada where *P. barbouri* occurs.

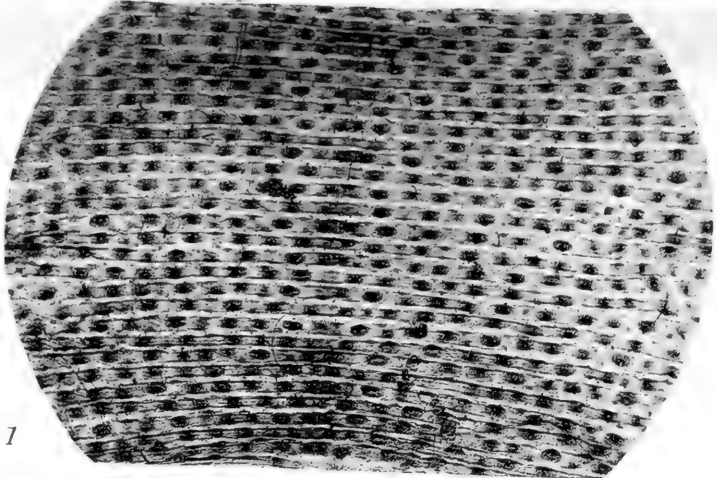
In Trinidad Professor Thaxter obtained fine series of both specie hitherto known from that island; six males and seven females (M C. Z. No. 201–208, 211–214, 217), of *P.* (*Epiperipatus*) *trinidadensi* Sedgwick, and two males and four females (M. C. Z. No. 209–210 215–216, 218–219), of *P.* (*Macroperipatus*) *torquatus* von Kennel. I addition there is a single female (M. C. Z. No. 200), measuring 8 mm. in length with 31 pairs of legs belonging to *P.* (*Epiperipatus*) *imthurmi*, a species hitherto known only from the mainland of Sout 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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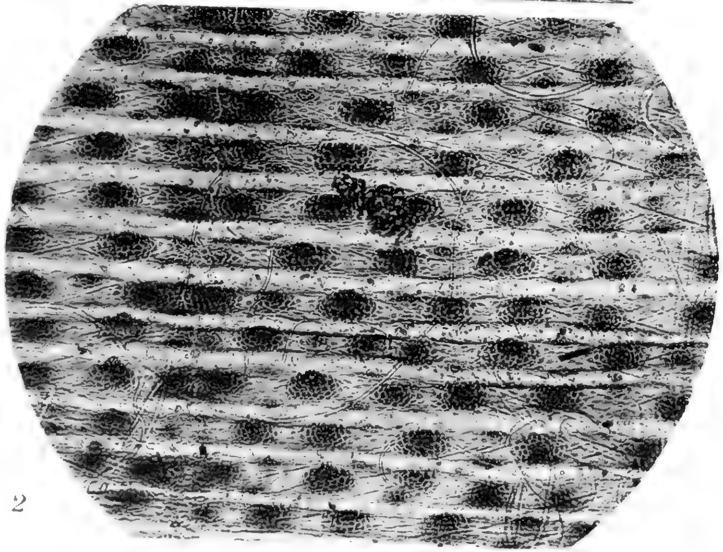

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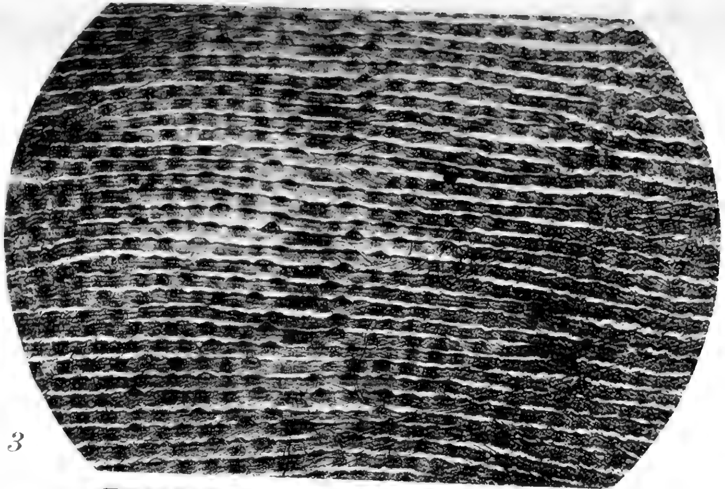

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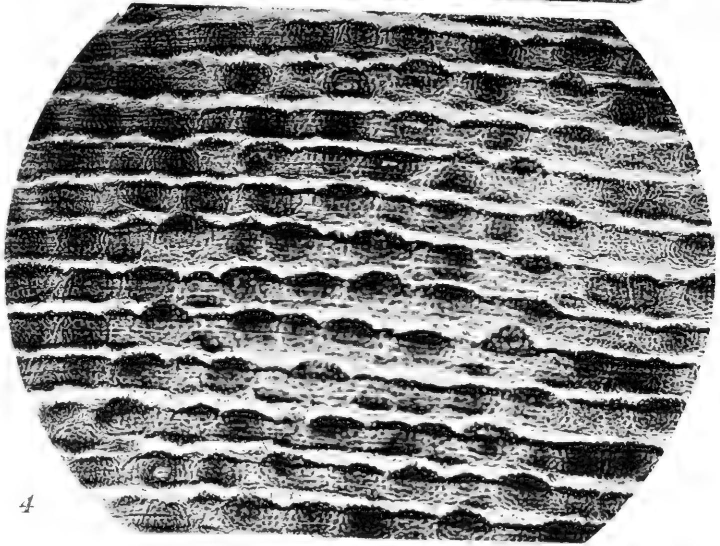

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HELIOTYPE CO., BOSTON

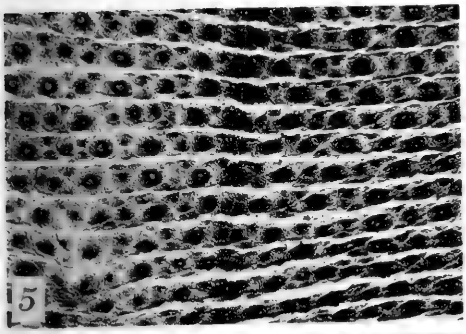
PLATE 2.

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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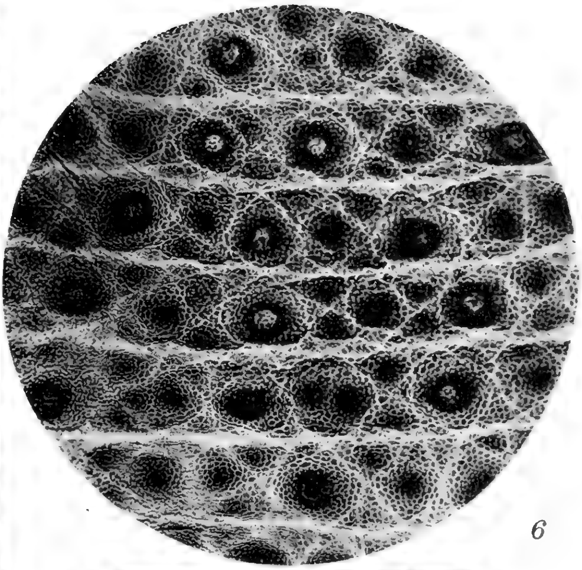
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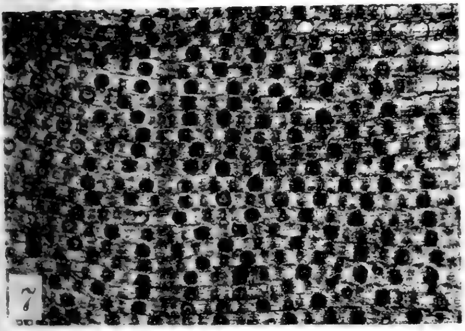
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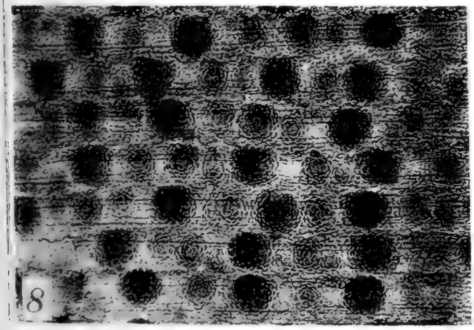
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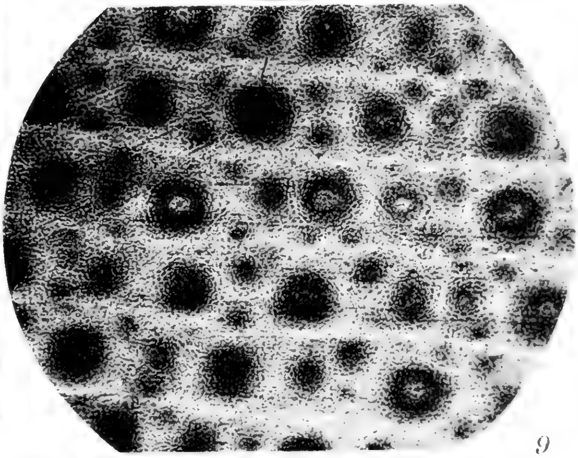
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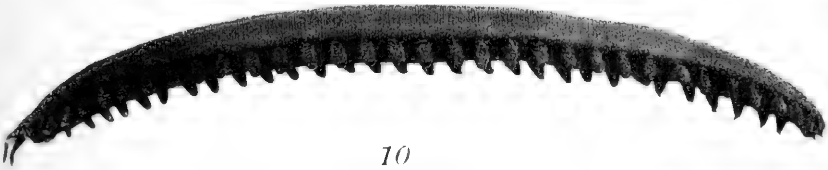
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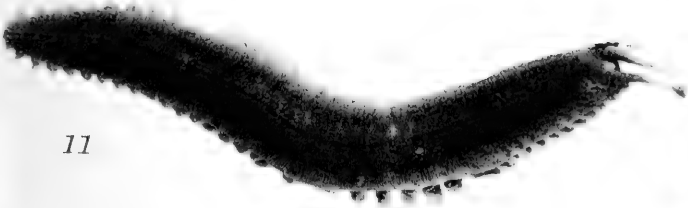
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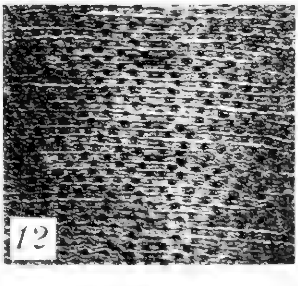
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Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

Vol. LVIII. No. 10.

OCEANOGRAPHY AND PLANKTON OF MASSACHUSETTS BAY AND ADJACENT WATERS, NOVEMBER, 1912-MAY, 1913.

By Henry B. Bigelow.

With One Plate.

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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. Douthart, of the Bureau of Fisheries.

The subsurface temperatures were all taken with the Negretti and Zambra reversing thermometers; the water samples with the stopcock 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

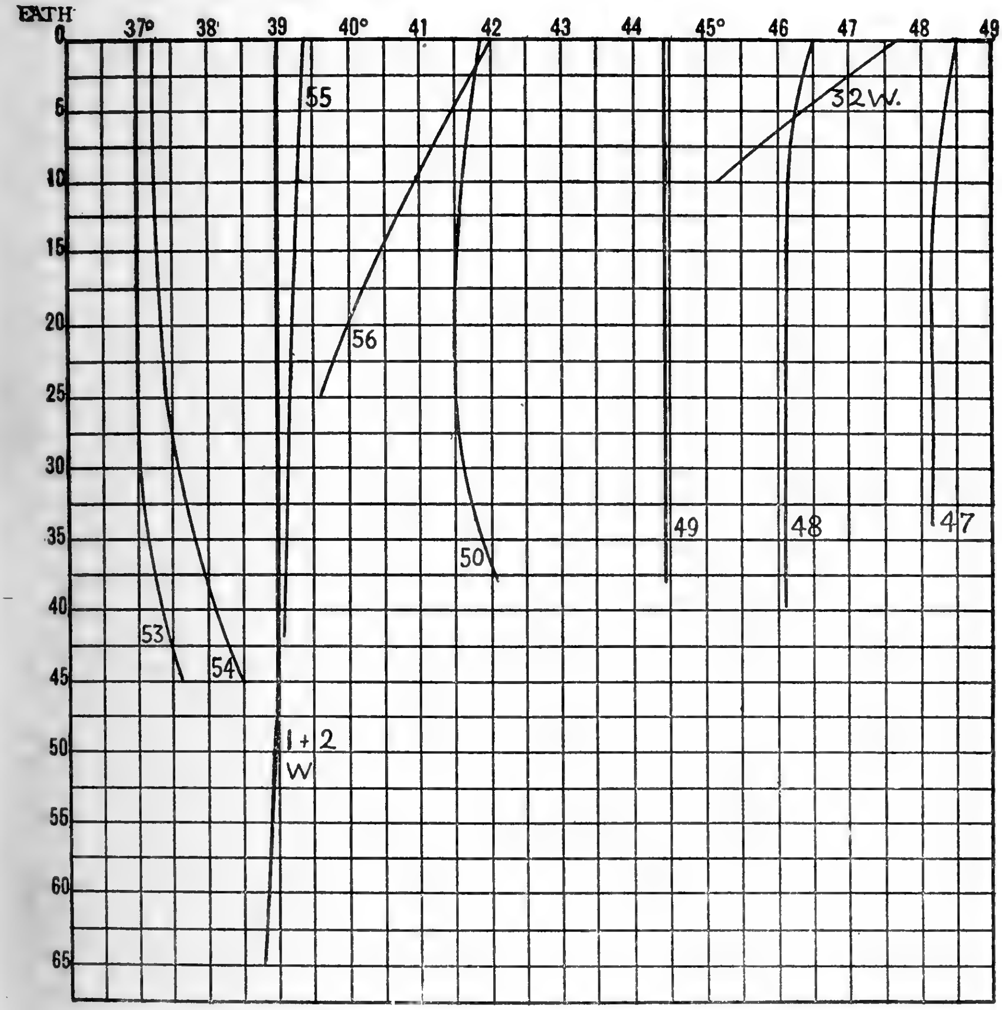

FIG. 1.—Temperature sections off Cape Ann, November 20 (Station 10,047); December 4 (Station 10,048); December 23 (Station 10,049); January 16 (Station 10,050); February 13 (Station 10,053); March 4 (Station 10,054); March 19 (Stations 1 and 2, W. W. Welsh); April 3 (Station 10,055); and off Gloucester 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.

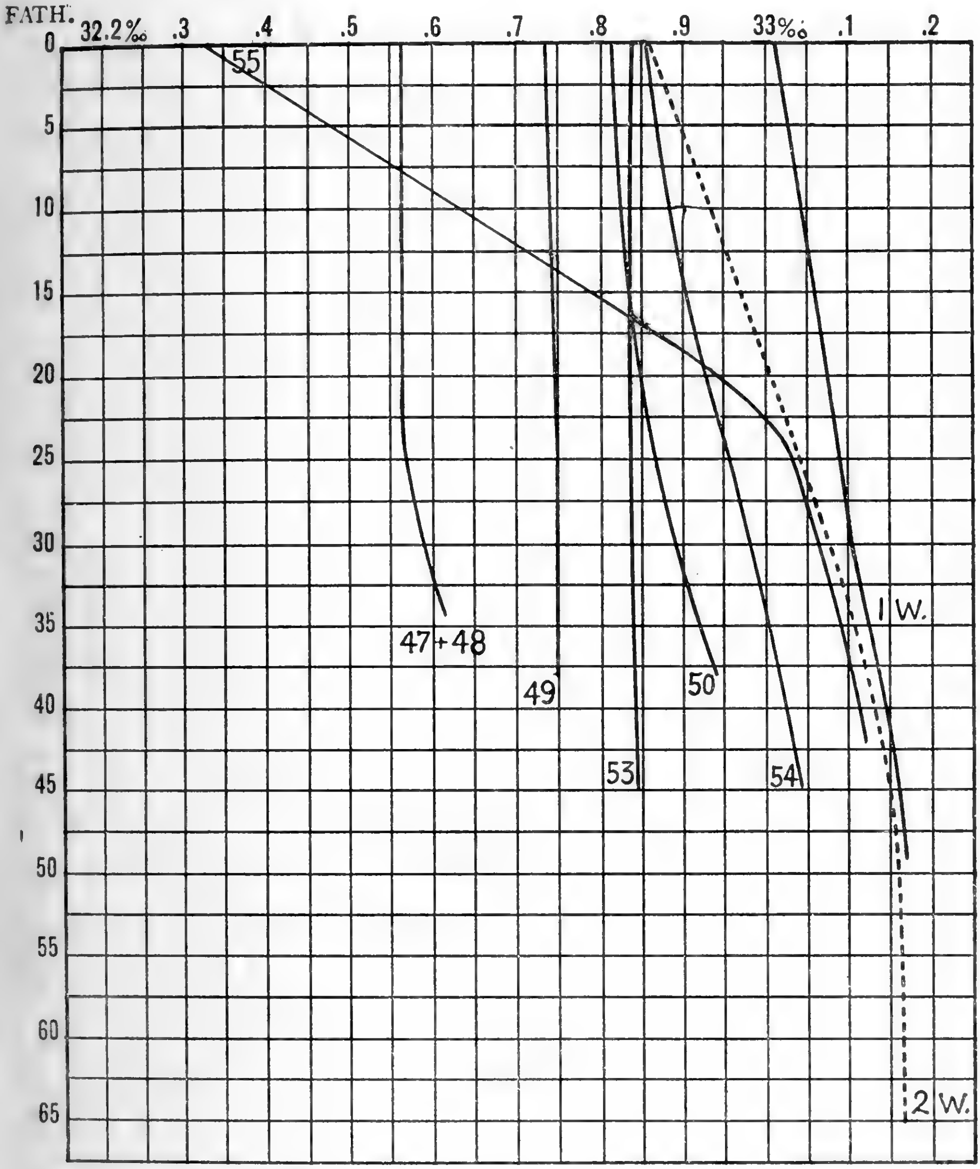

FIG. 2.— Salinity sections off Cape Ann, November 20 (Station 10,047); December 4 (Station 10,048); December 23 (Station 10,049); January 16 (Station 10,050); February 13 (Station 10,053), March 4 (Station 10,054); and March 19 (Stations 1 and 2 W. W. Welsh).

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 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

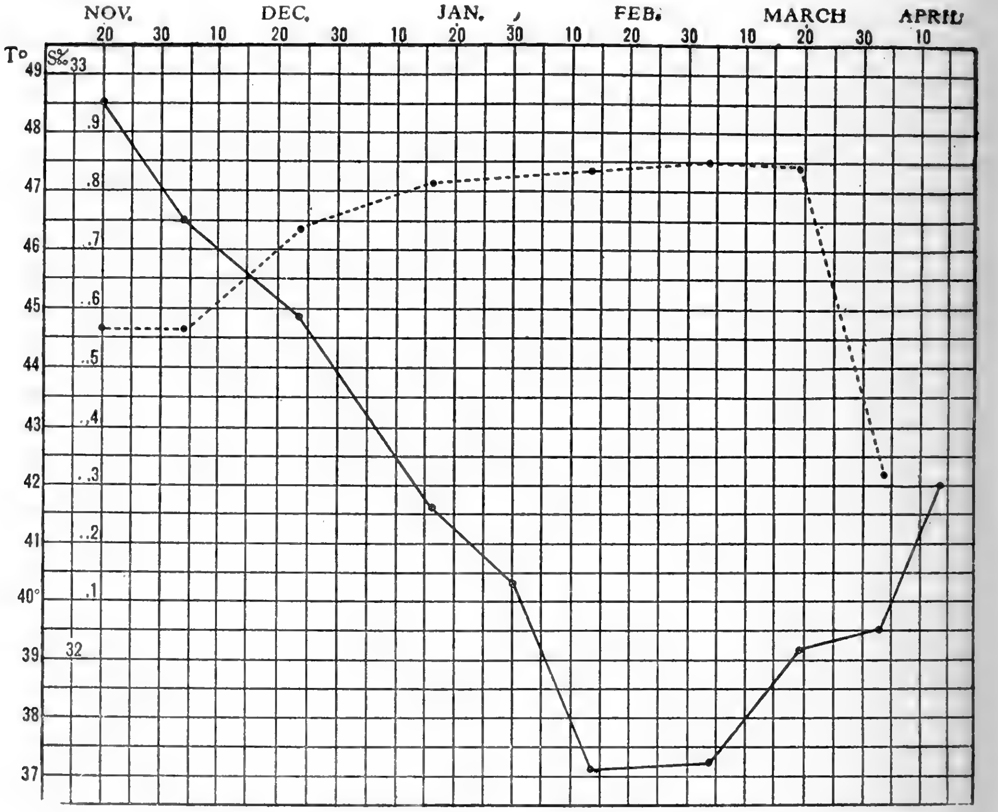

Fig. 3.— Surface Temperature ———, off Cape Ann and Gloucester, November 20 to April 13; and surface salinity . . . . , off Cape Ann, November 20 to April 3.

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 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 disturb-

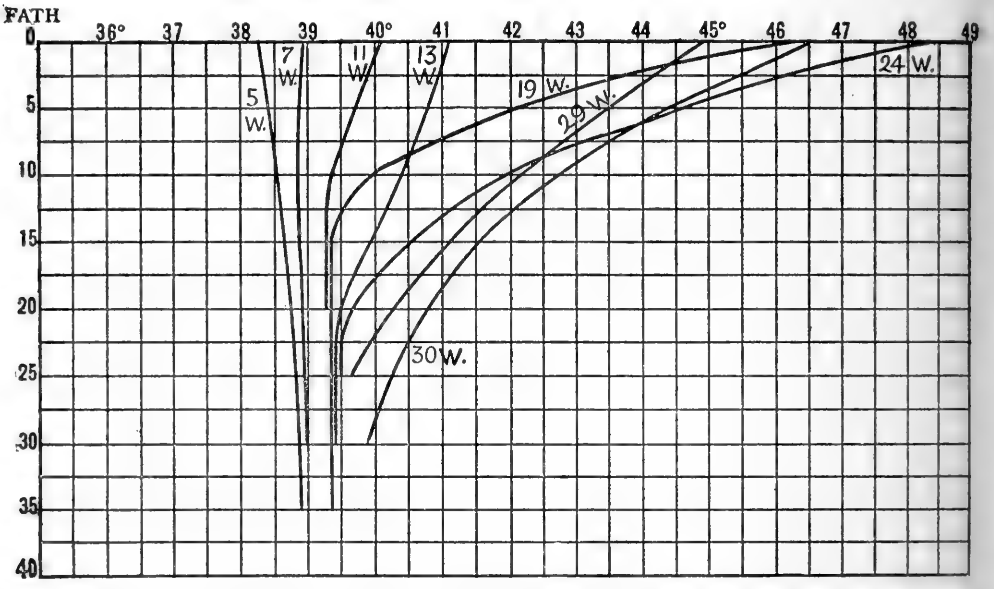

Fig. 4.— Temperature sections off Boon Island, March 29 (Station 5 W. W. Welsh); April 4 (Station 7 W. W. Welsh); and near the Isles of Shoals, April 13 (Station 11 W. W. Welsh); April 16 (Station 13 W. W. Welsh); April 26 (Station 19 W. W. Welsh); May 5 (Station 24 W. W. Welsh), May 13 (Station 29 W. W. Welsh) and May 14 (Station 30 W. W. Welsh).

ing 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 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.

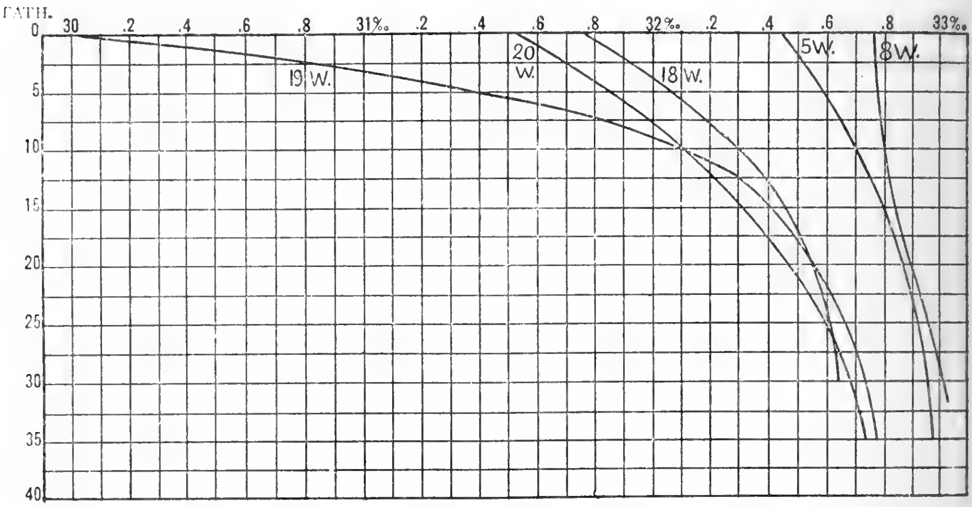

FIG. 5.— Salinity sections near Boon Island March 29 (Station 5 W. W. Welsh); April 5 (Station 8 W. W. Welsh); and April 25 (Station 18 W. W. Welsh); and east of the Isles of Shoals, April 26 (Station 19 W. W. Welsh) and April 29 (Station 20 W. W. Welsh).

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 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.

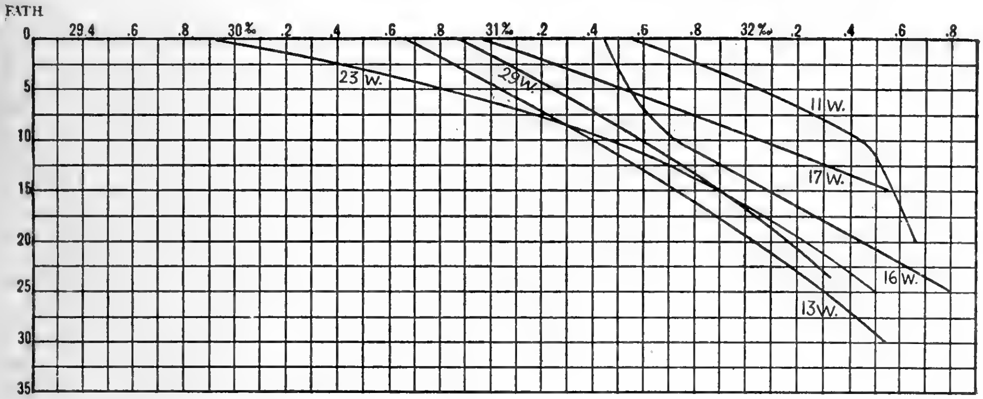

FIG. 6.— Salinity sections between the Isles of Shoals and the mainland, April 13 (Station 11 W. W. Welsh); April 16 (Station 13 W. W. Welsh); April 22 (Station 16 W. W. Welsh); April 23 (Station 17 W. W. Welsh); May 3 (Station 23 W. W. Welsh) and May 13 (Station 29 W. W. Welsh).

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.

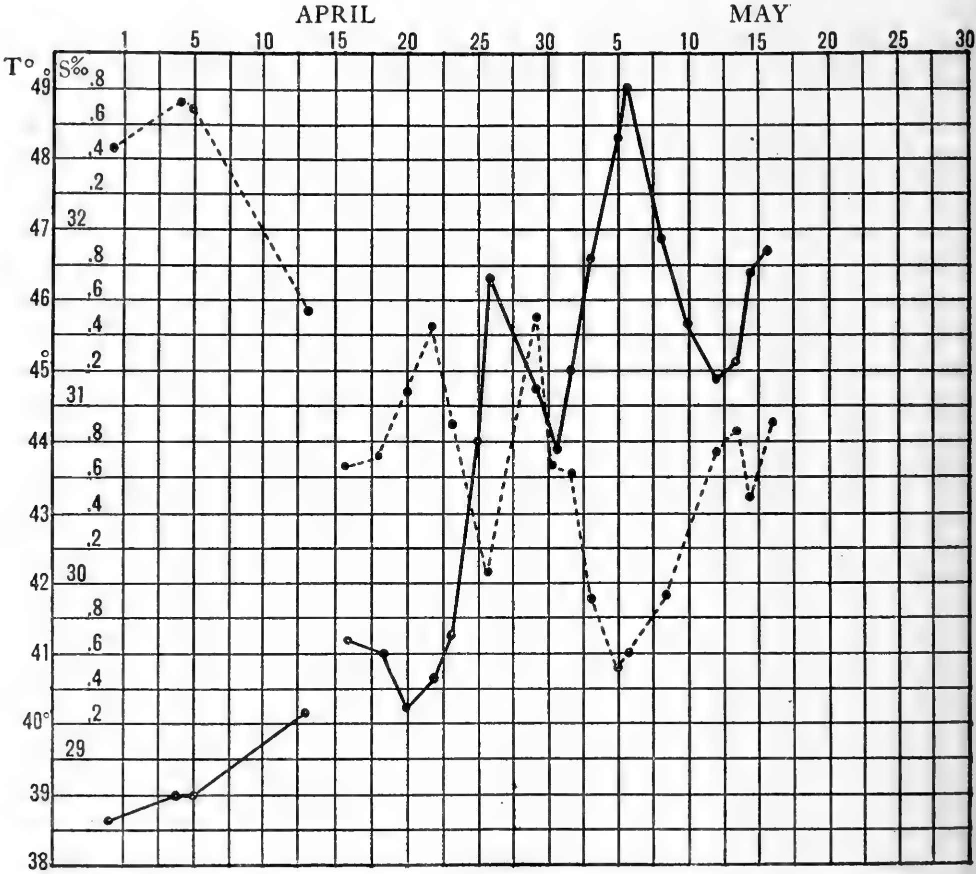

Fig. 7.— Surface temperature ——— and surface salinity, - - - - - - - -, near Boon Island, April 1–14, and near the Isles of Shoals, April 16–May 16

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

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[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.

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[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		Depth	Temp.	Sal. ‰
		Lat.	Long.			
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		Depth	Temp.	Sal. ‰
		Lat.	Long.			
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		Depth	Temp.	Sal. ‰
			Lat.	Long.			
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.	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		32.18
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

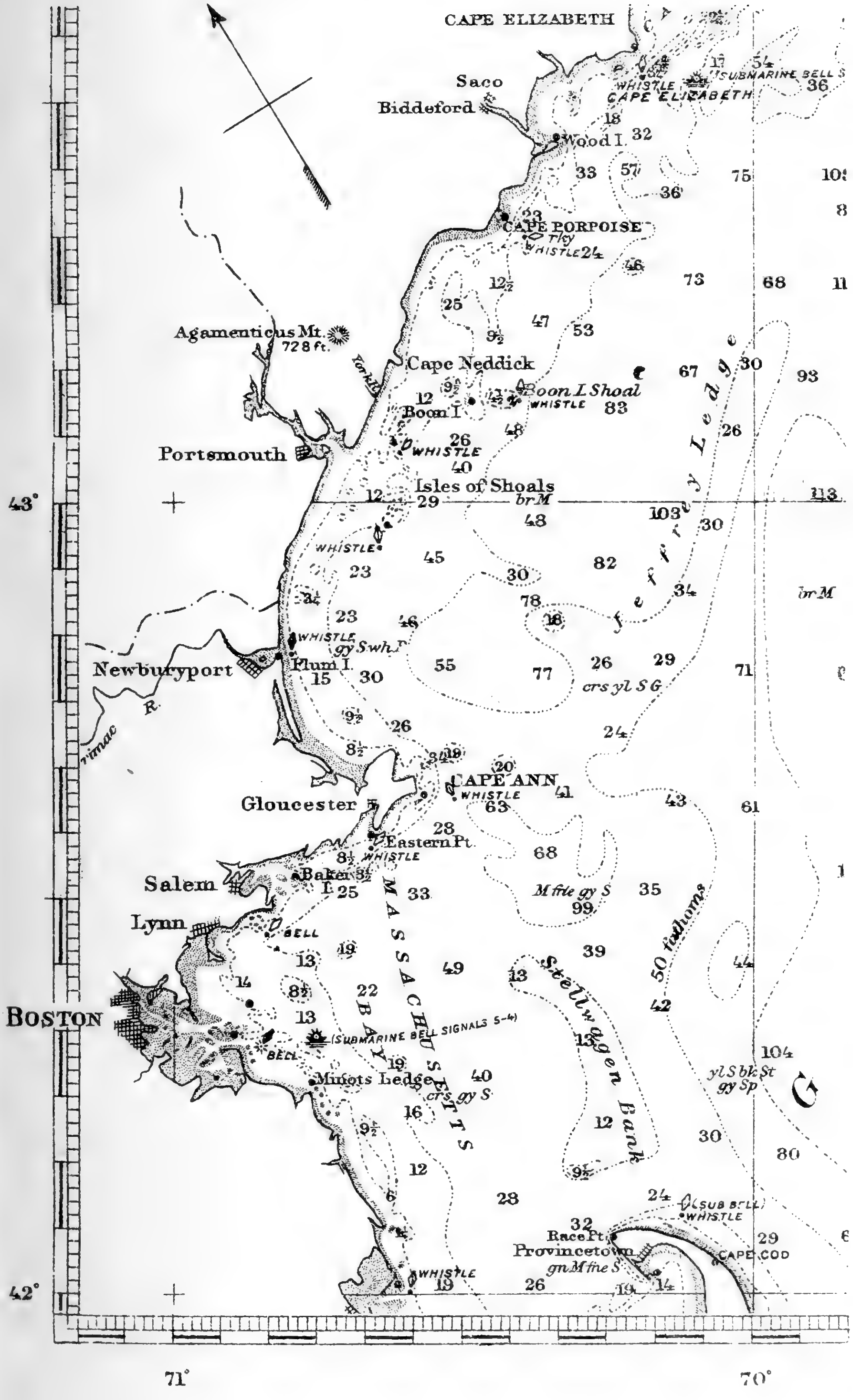
TEMPERATURES AND SALINITIES, MASSACHUSETTS BAY TO GEORGES BANK.

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
WHISTLE
SUBMARINE BELL S
CAPE ELIZABETH
Wood I.
CAPE PORPOISE
WHISTLE
Agamenticus Mt.
728 ft.
York R.
Cape Neddick
Boon I. Shoal
WHISTLE
Boon I.
WHISTLE
Portsmouth
Isles of Shoals
brM
Jeffreys Ledge
43°
WHISTLE
WHISTLE
gy S wh P
Newburyport
Plum I.
Merrimac R.
crs yl S G
CAPE ANN
WHISTLE
Gloucester
Eastern Pt.
WHISTLE
Salem
Baker I.
MASSACHUSETTS BAY
M fne gy S
Lynn
BELL
50 fathoms
Stellwagen Bank
BOSTON
SUBMARINE BELL SIGNALS
BELL
Minots Ledge
crs gy S
yl S bk St gy Sp
SUB BELL
WHISTLE
Race Pt.
Provincetown
gn M fne S
CAPE COD
WHISTLE
42°
71°
70°

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NEW MIOCENE COLEOPTERA FROM FLORISSANT.

By H. F. Wickham.

With Sixteen Plates.

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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. 5,869 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 prohorax, 5.50 mm.

Described from one specimen.

Type.— No. 2,471 M. C. Z. Florissant, Col. (No. 11,663 S. H. cudder 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.

Enoclerus 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 o 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 abdomen, 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. erraecolor*. The coloration seems to have been a mottling, arranged n irregular transverse bands, the best marked of which are in the form f two rather broad postmedian fasciae. It will be noted that the thoacic sides, as preserved, are not symmetrical, the left one showing about he 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. 3,594 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 species 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. exesa.*

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 Chaetocnema, 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 Chaetocnema.

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.

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 ong, mandibles only slightly prominent. Eyes not well defined but vhat remains indicates that they were rather small and widely sepa- ated on the vertex. Antennae long and slender, only very feebly errate basally, reaching nearly to the middle of the elytra, the second oint short, those following the third subequal in length, each more han twice as long as wide. Prothorax, as preserved, considerably nore than twice as wide as long, sides in rather poor condition but the etter preserved one indicates that they were gradually rounded from e broad base to the much narrower apex. Scutellum subcordiform, mall. Elytra a little less than four times the prothoracic length, unded at apices. Legs not displayed. Length, to elytral tip, 14 m.; 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 8 S. H. Scudder Coll.).

The entire upper surface is finely sculptured and clothed with ther close short hairs. The insect looks a good deal like the orissant fossil *C. antiqua* but has longer and more slender antennae. seems that the two are probably congeneric and may possibly present 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 *Evopes 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.

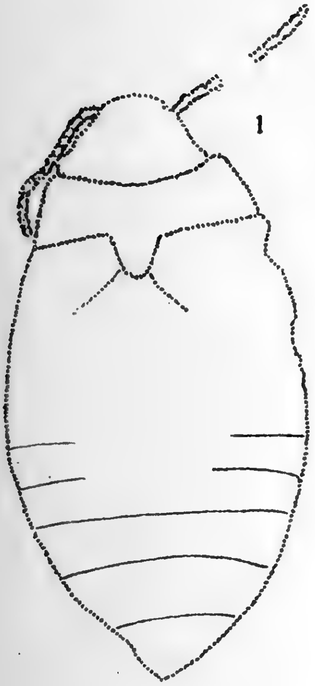
A single specimen, No. 2,706 M. C. Z. (No. 3,425 S. H. Scudder Coll.), is contained in the series. It is a little smaller than my type.

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.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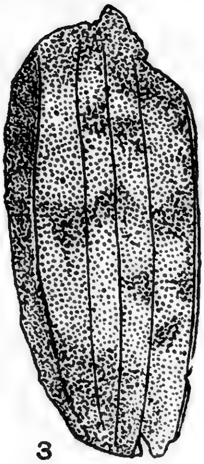
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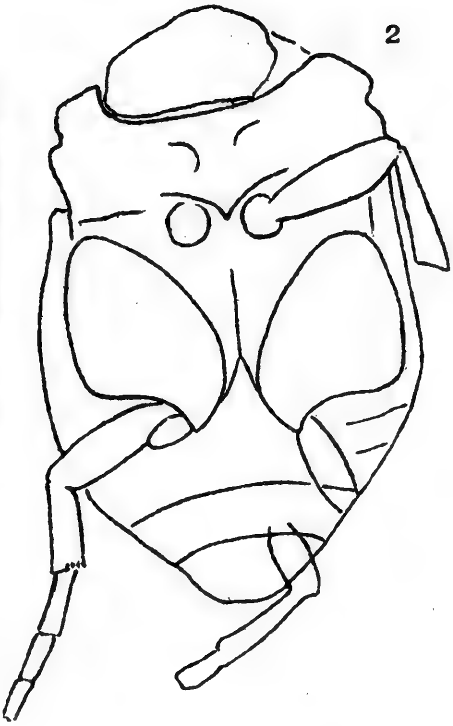
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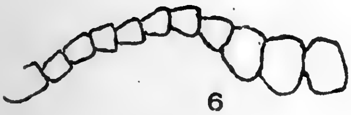
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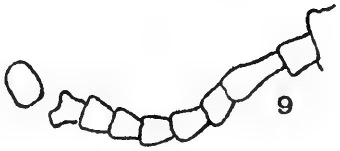
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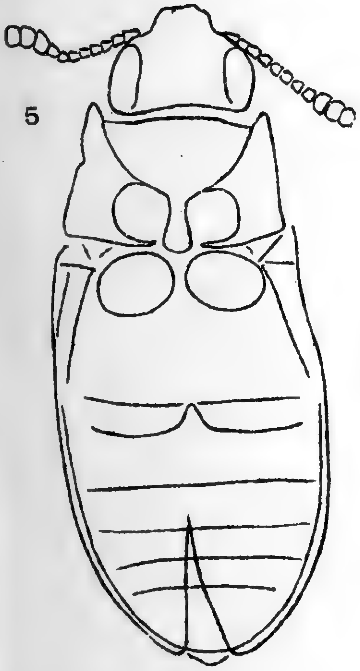
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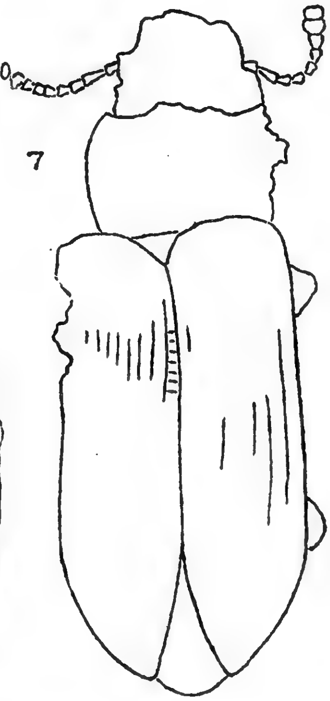
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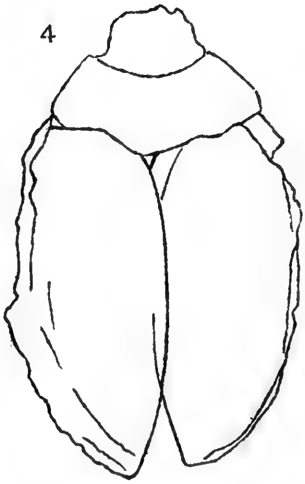
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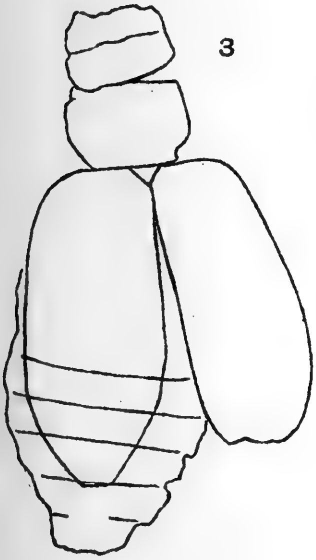
PLATE 2.

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.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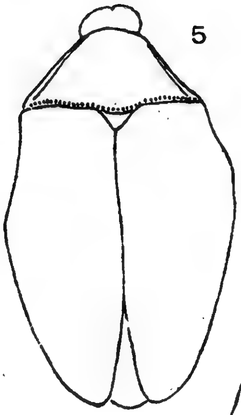
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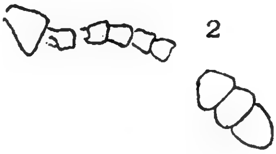
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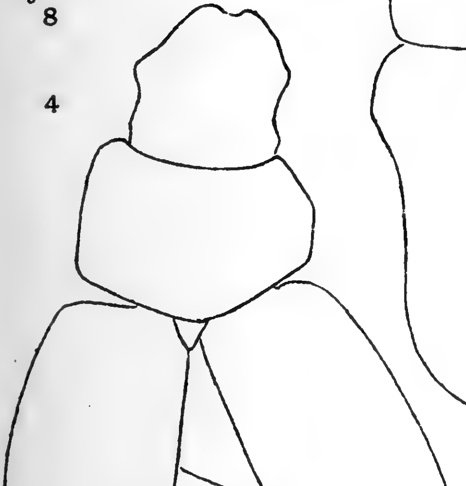
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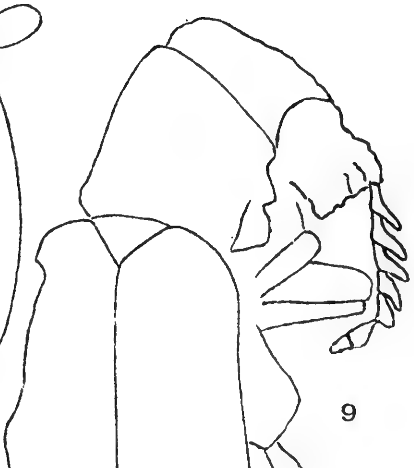
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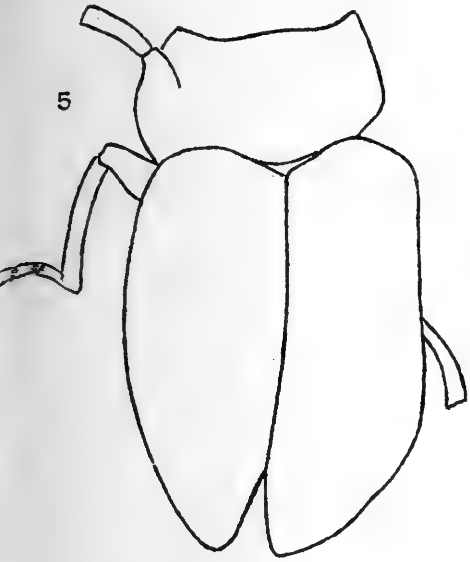
PLATE 3.

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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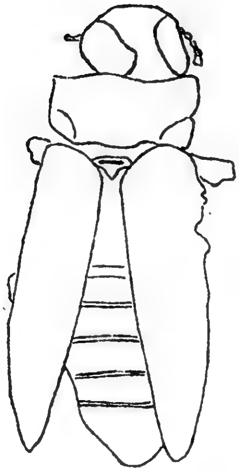
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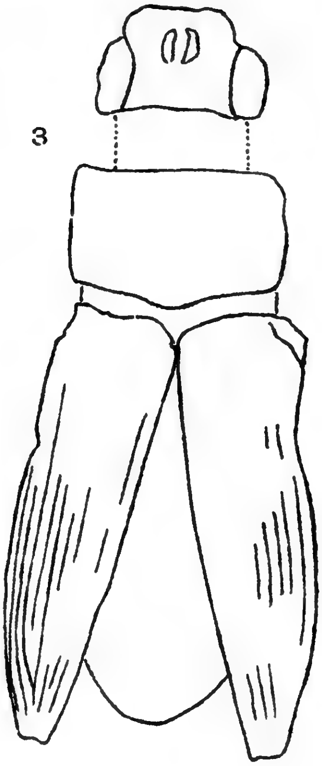
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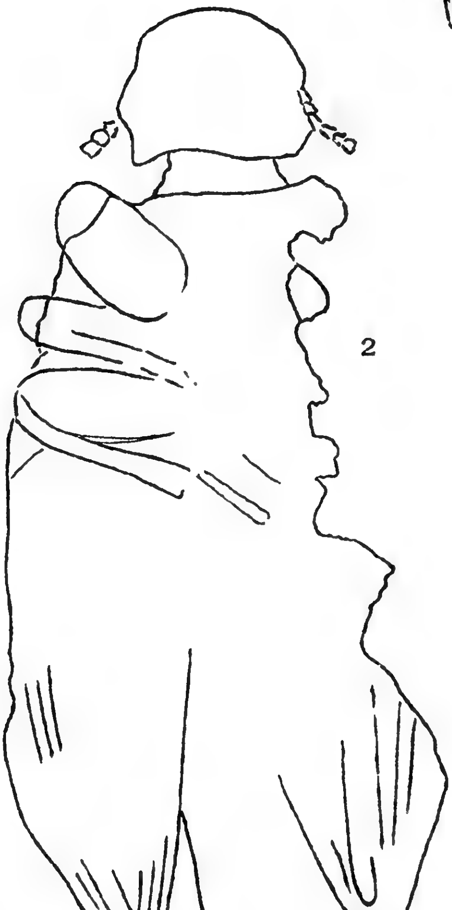
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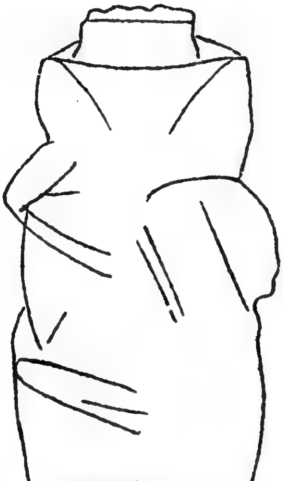
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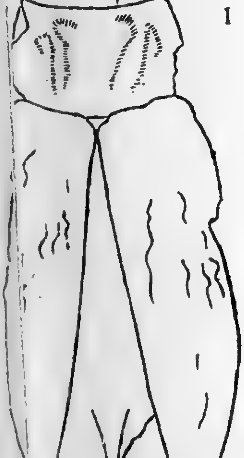
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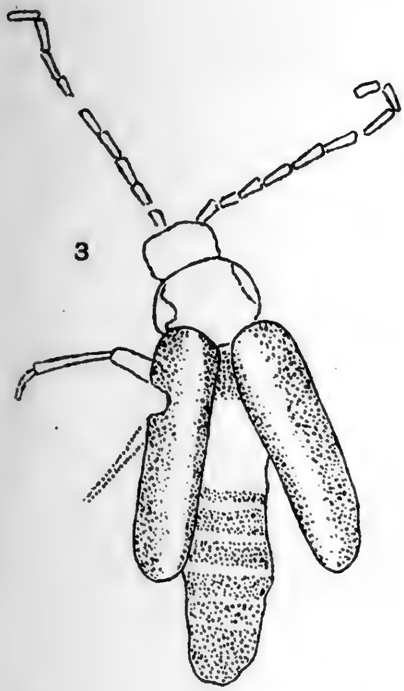
PLATE 4.

PLATE 4.

Fig. 1. Podabrus fragmentatus.
Fig. 2. Podabrus florissantensis.
Fig. 3. Telephorus hesperus.
Fig. 4. Polemius crassicornis.
Fig. 5. Protacnaeus tenuicornis.



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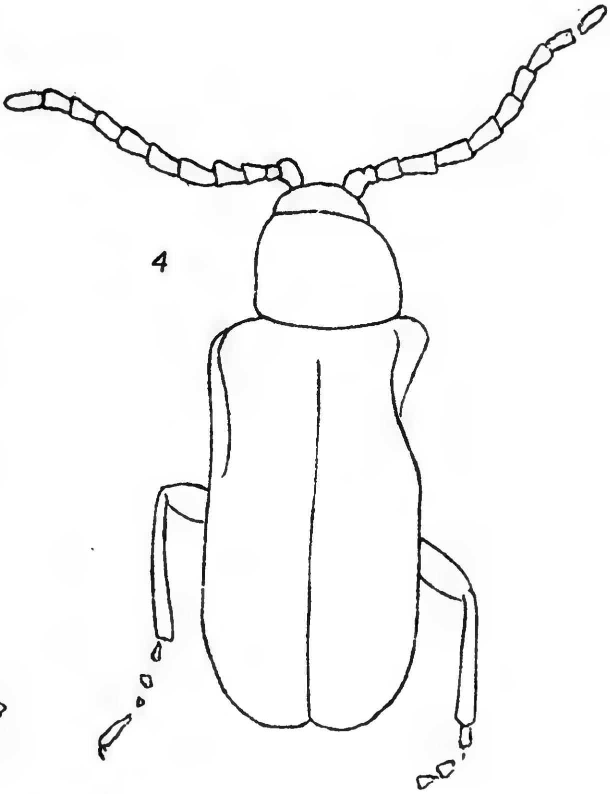

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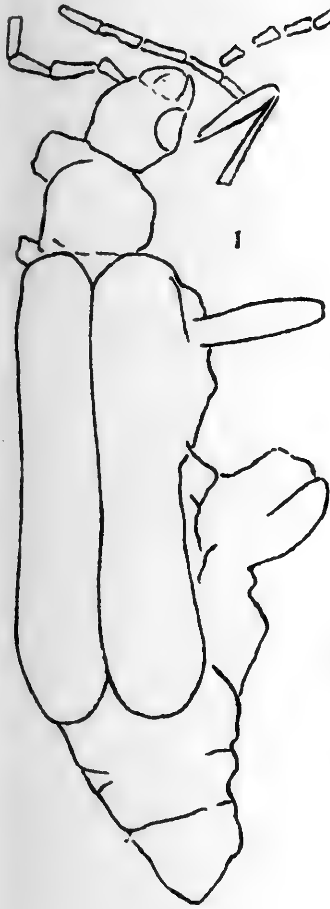

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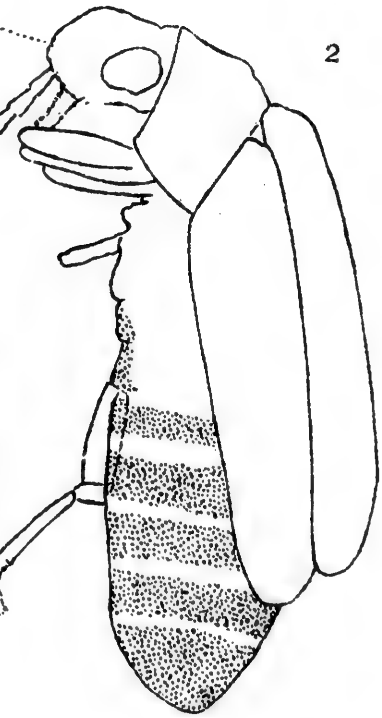

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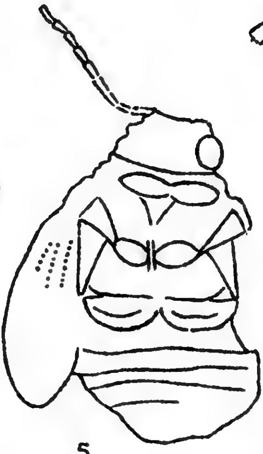

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PLATE 5.

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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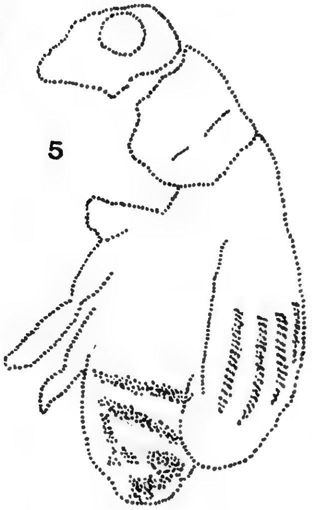

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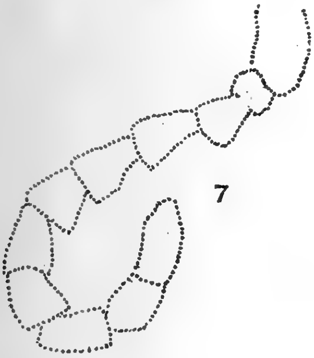

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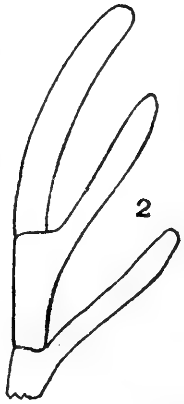

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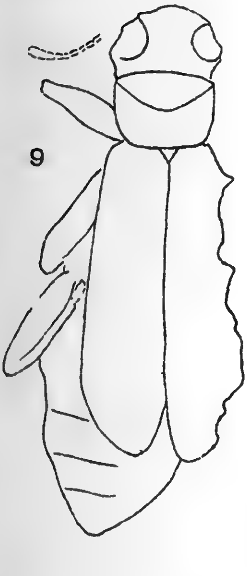

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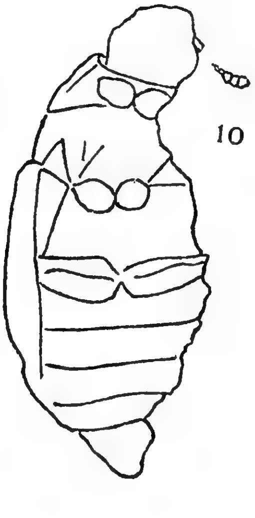

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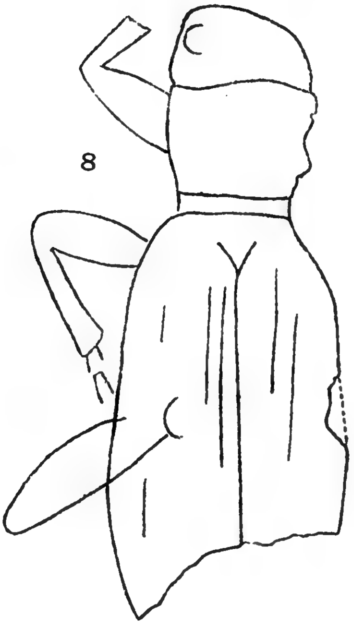

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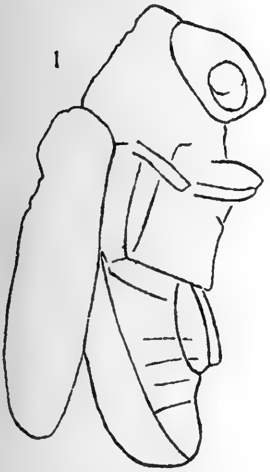
PLATE 6.

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.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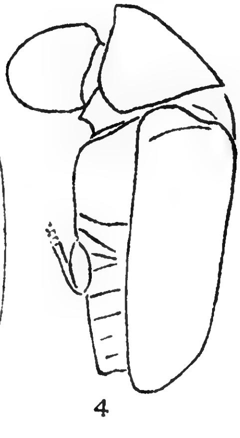
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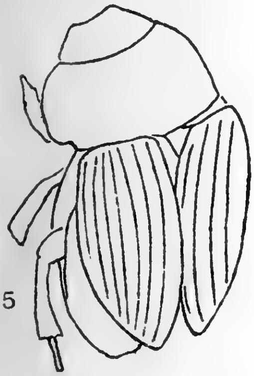
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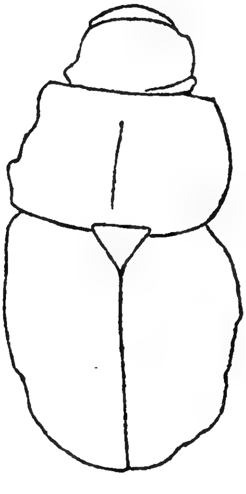
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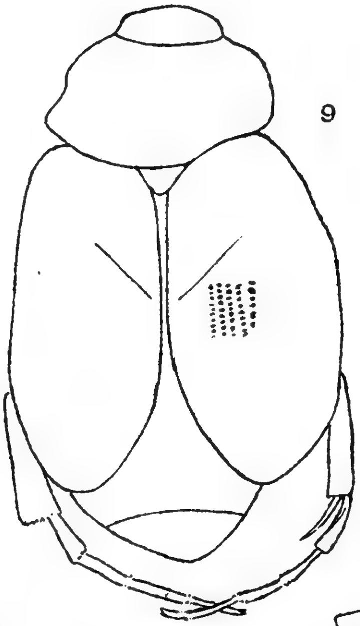
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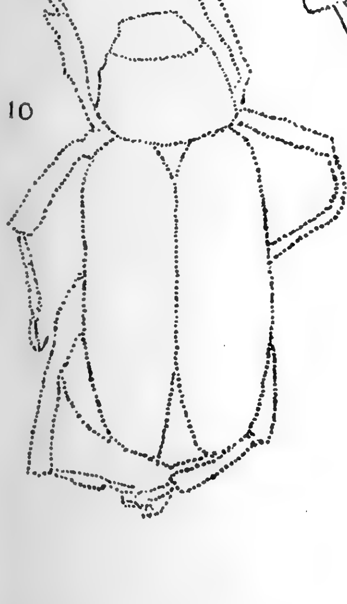
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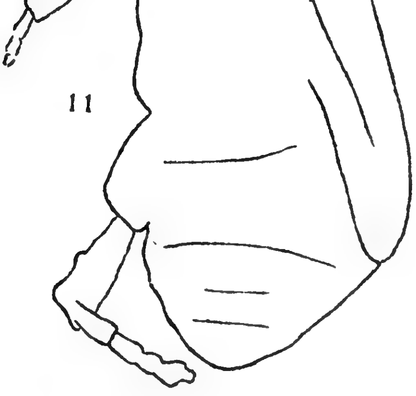
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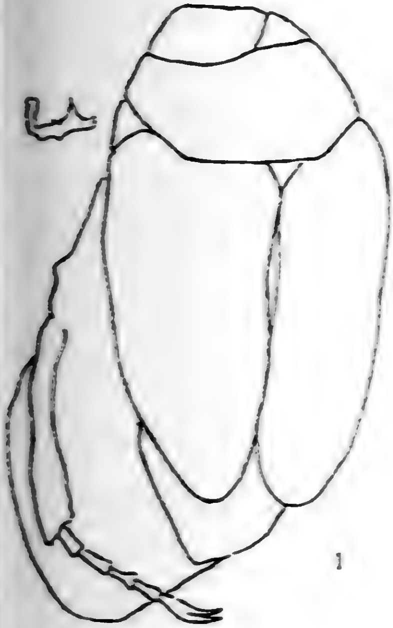
PLATE 7.

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.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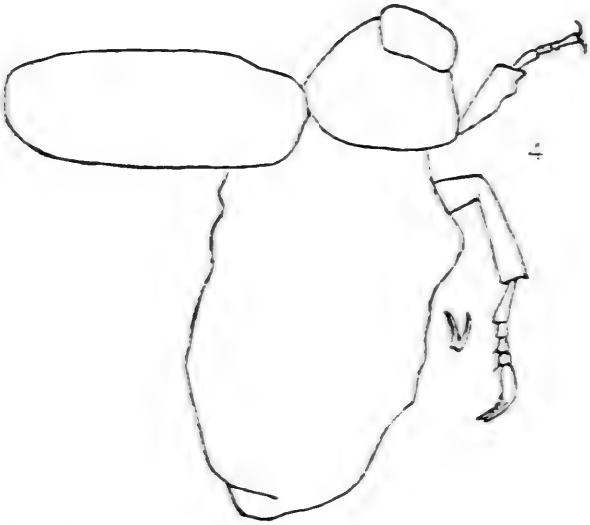
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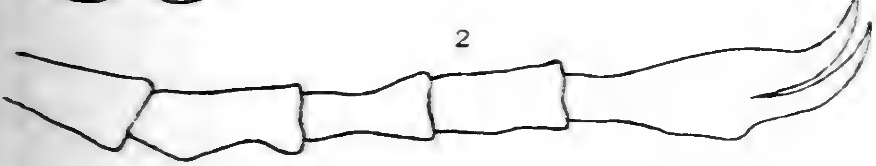
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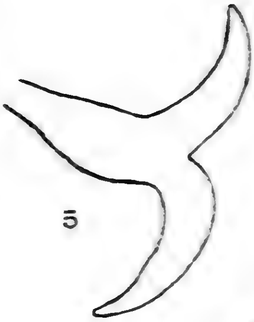
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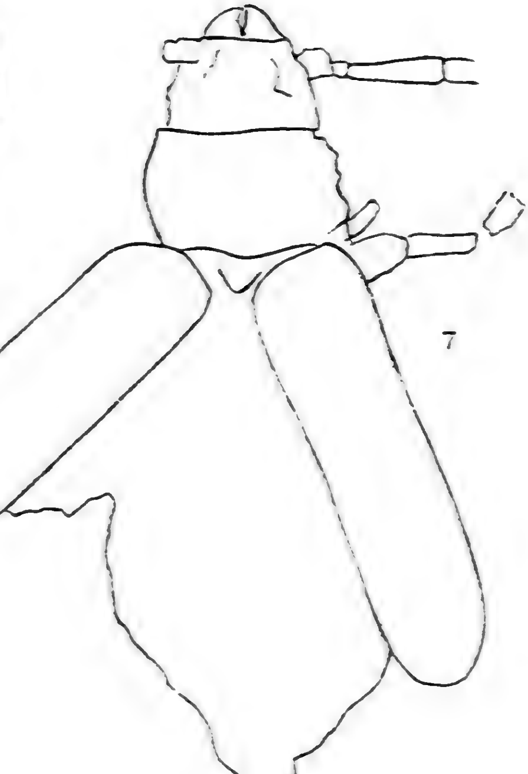
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PLATE 8.

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.


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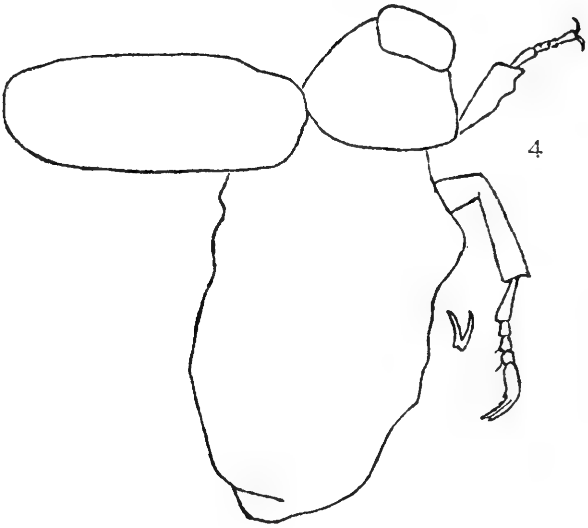
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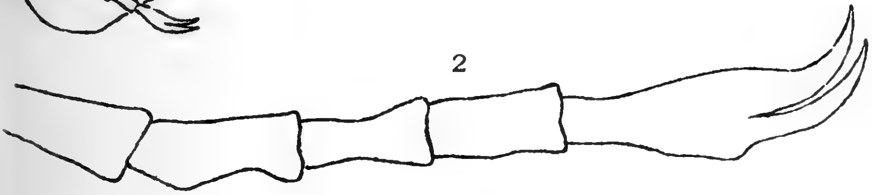
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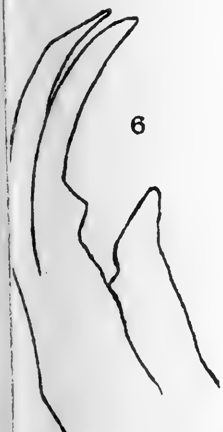
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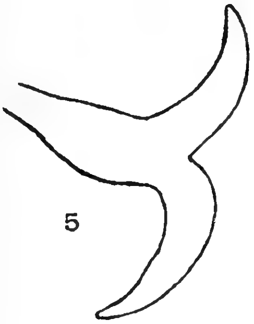
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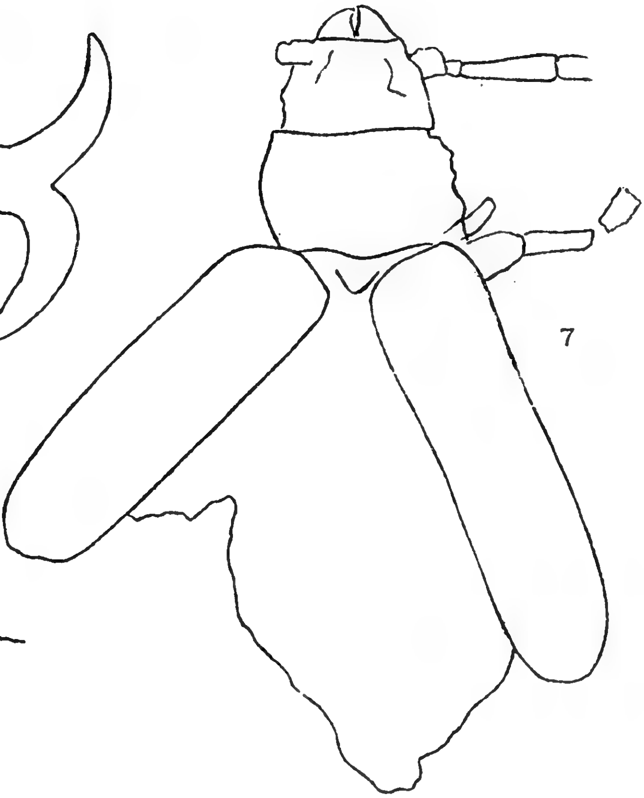
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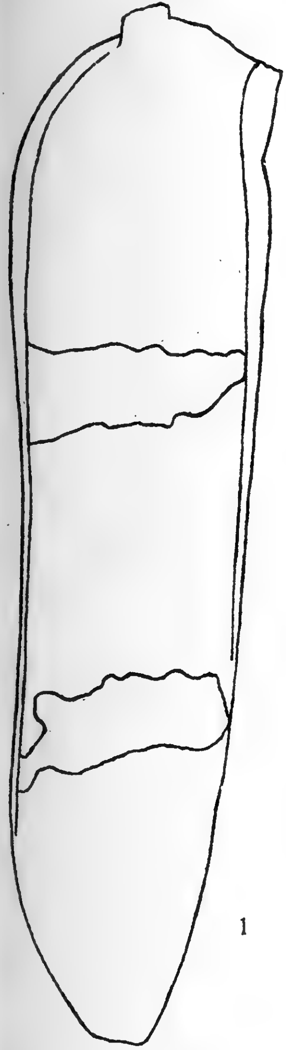
PLATE 9.

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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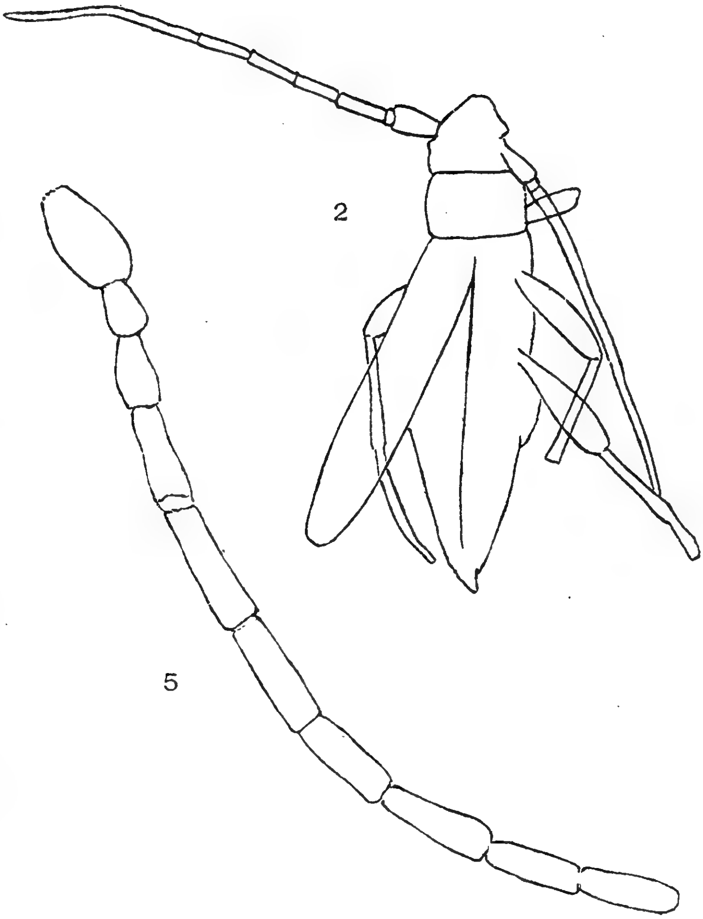

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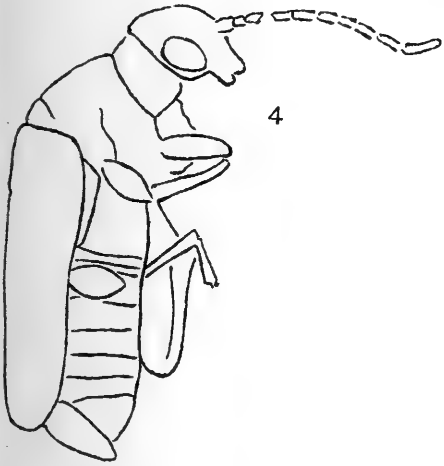

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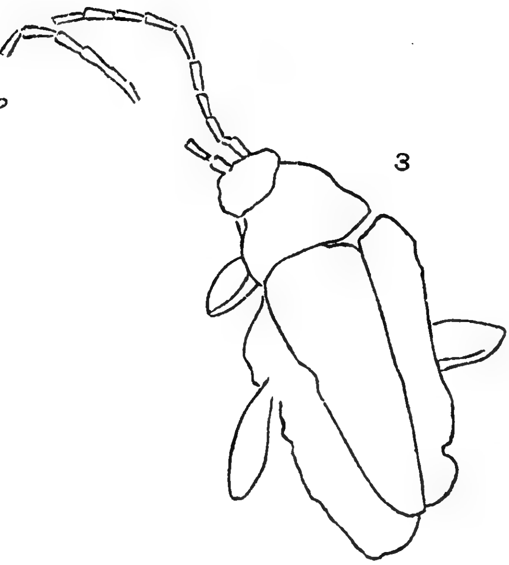

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PLATE 10.

PLATE 10.

Fig. 1. Clytus florissantensis.
Fig. 2. Leptura ingenua.
Fig. 3. Protipochus vandykei.
Fig. 4. Protipochus vandykei, middle leg.
Fig. 5. Leptostylus scudderi.

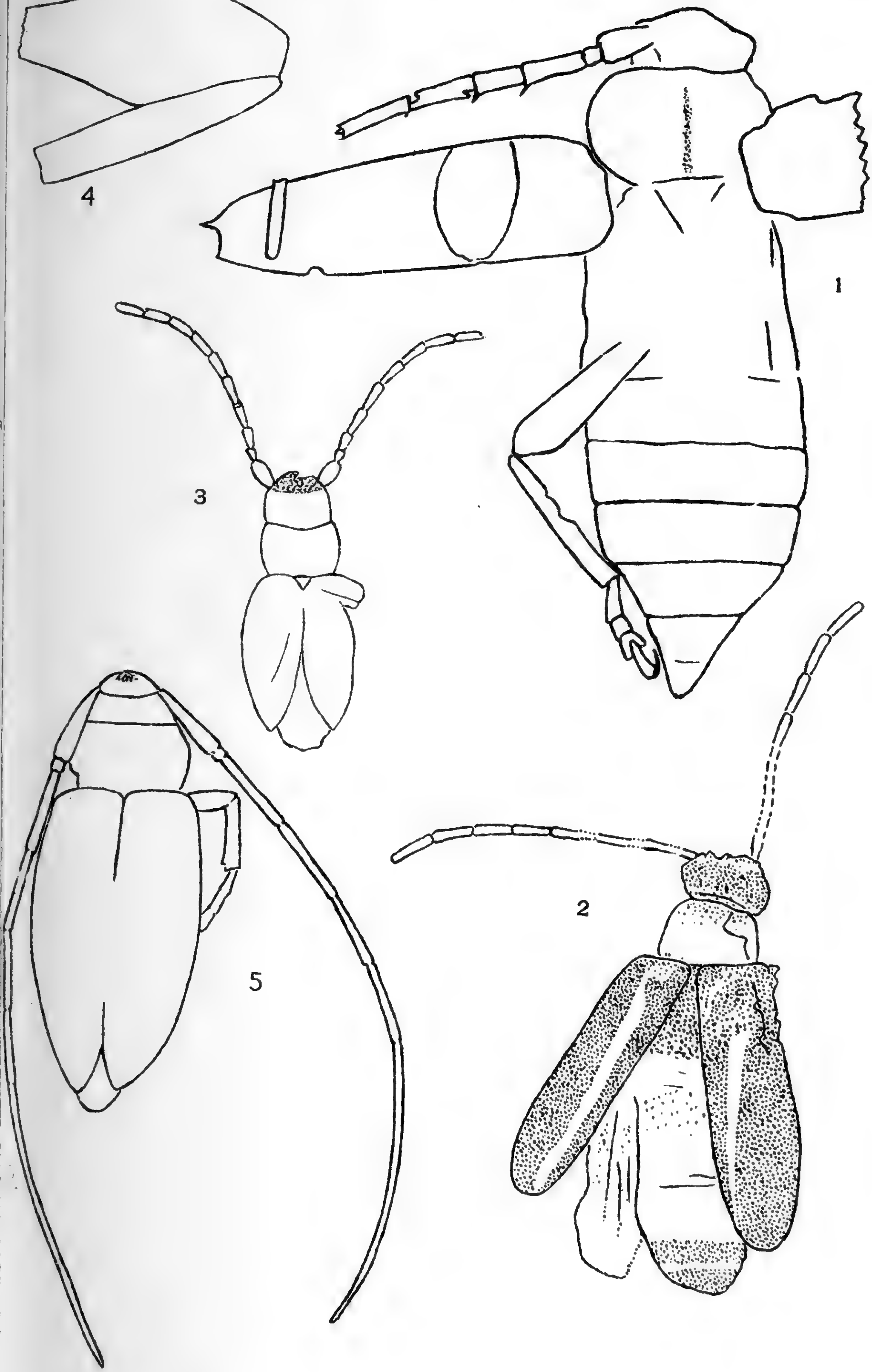
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PLATE **11**.

PLATE 11.

Fig. 1. Colaspis diluvialis.
Fig. 2. Colaspis proserpina.
Fig. 3. Diabrotica florissantella.
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Fig. 6. Trirhabda sepulta.
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Fig. 8. Odontota americana, antenna.
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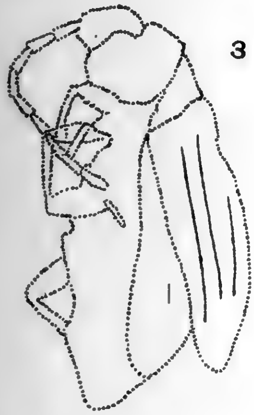

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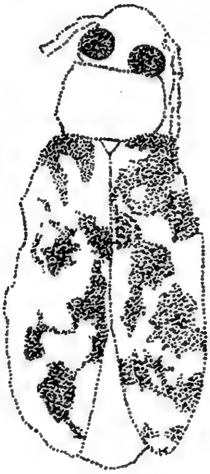

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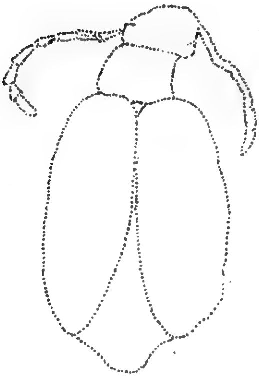

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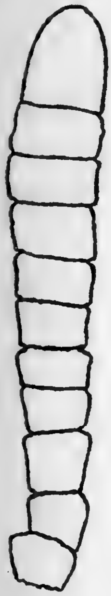

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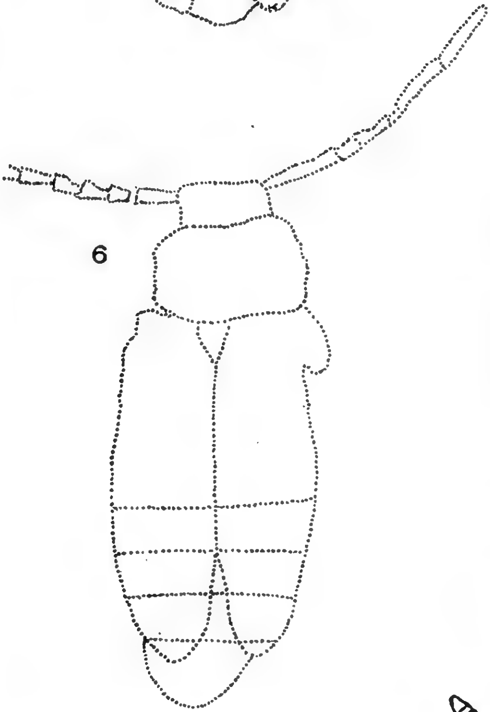

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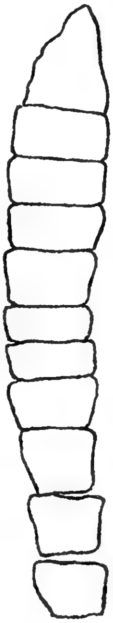

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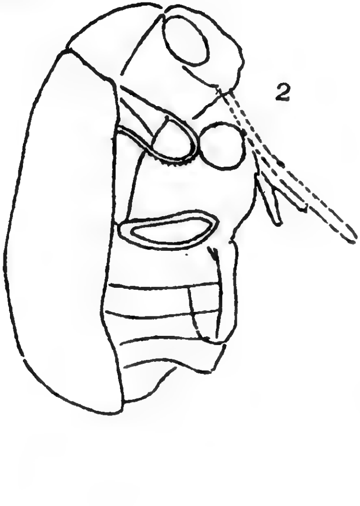

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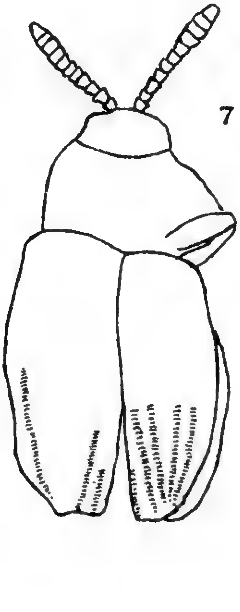

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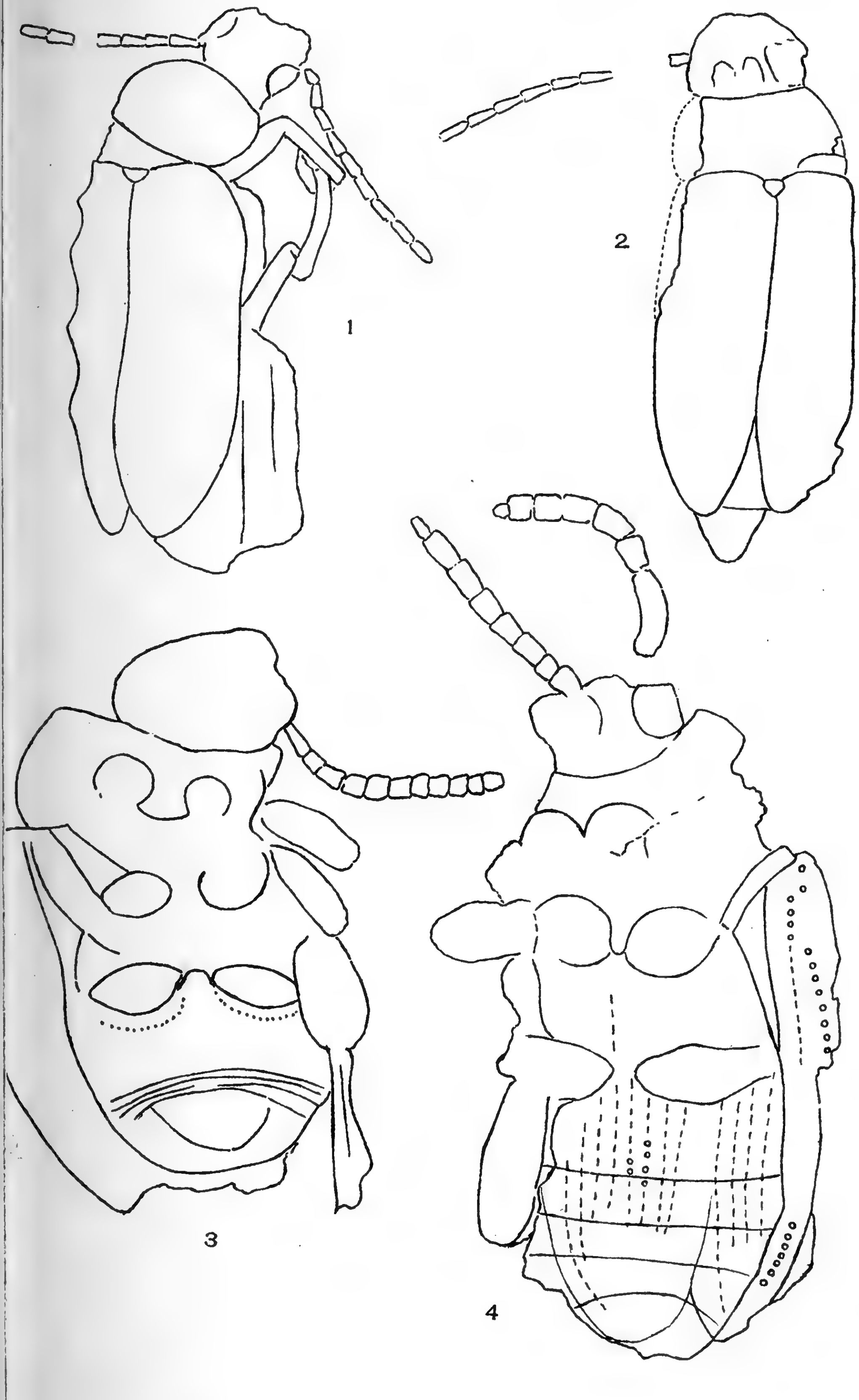
PLATE **12**.

PLATE 12.

Fig. 1. Trirhabda majuscula.
Fig. 2. Trirhabda megacephala.
Fig. 3. Prochaetocnema florissantella.
Fig. 4. Plectrotetrophanes hageni.



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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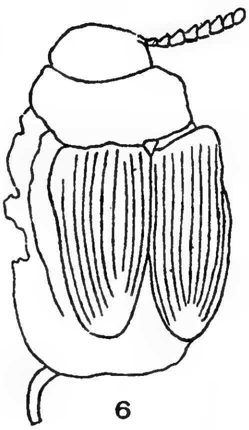
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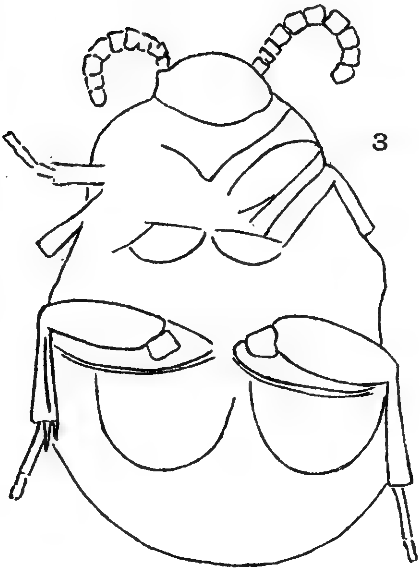
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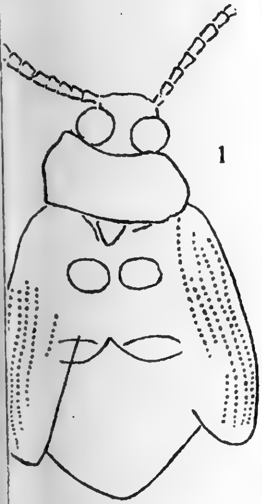
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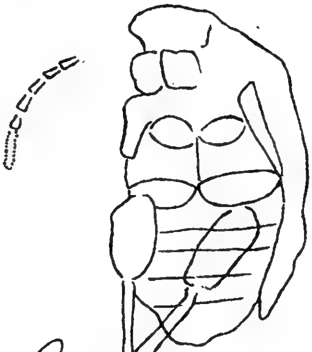
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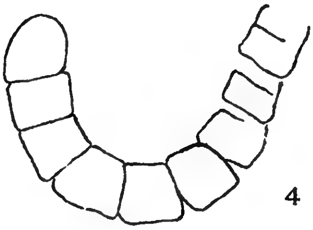
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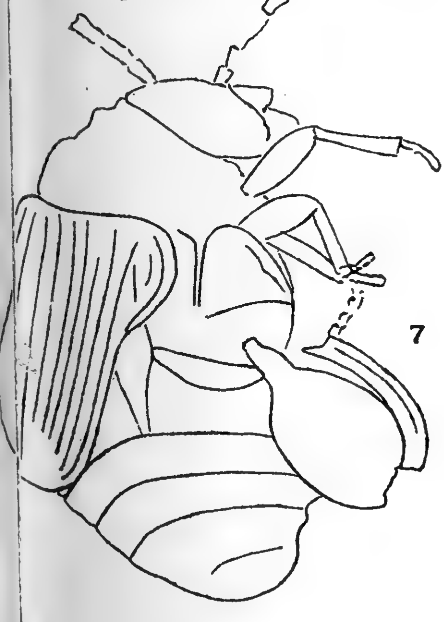
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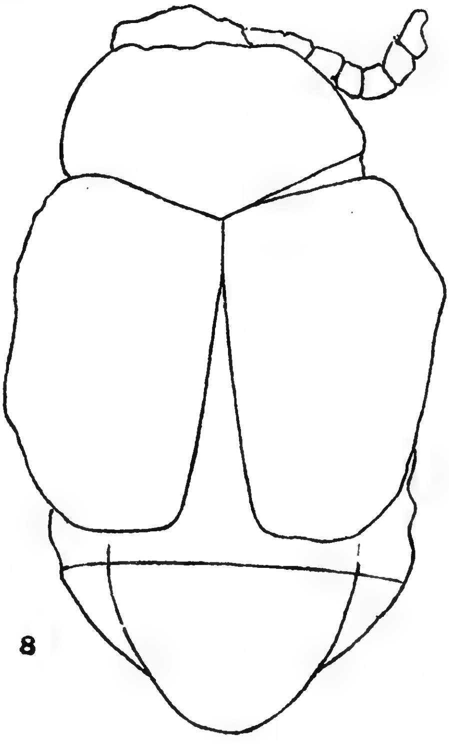
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PLATE 14.

PLATE 14.

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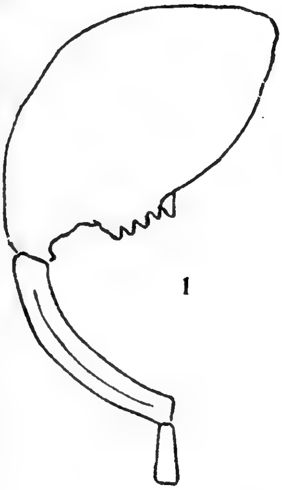

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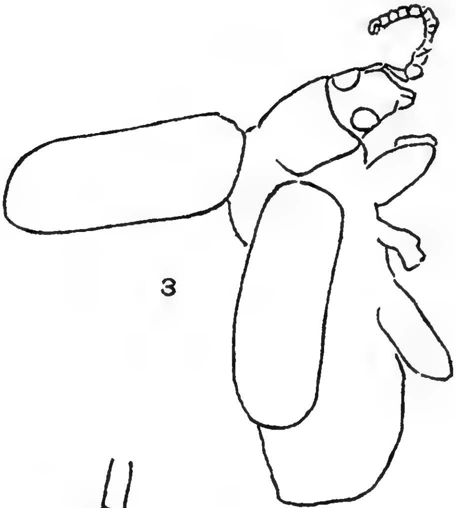

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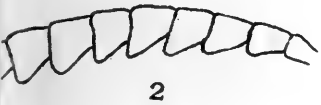

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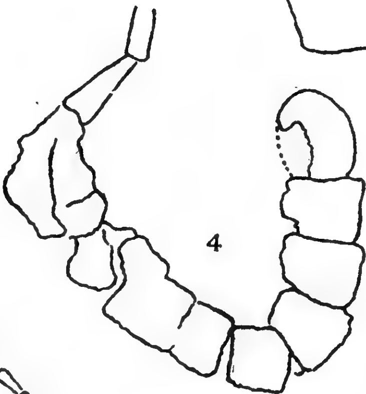

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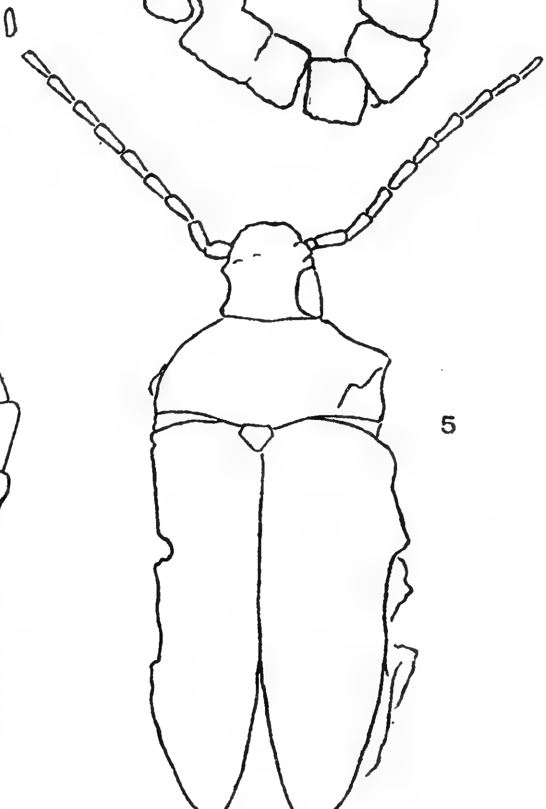

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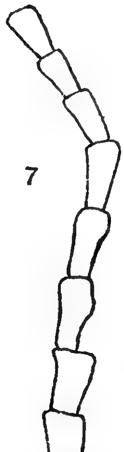

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PLATE 15.

PLATE 15.

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PLATE 16.

PLATE 16.

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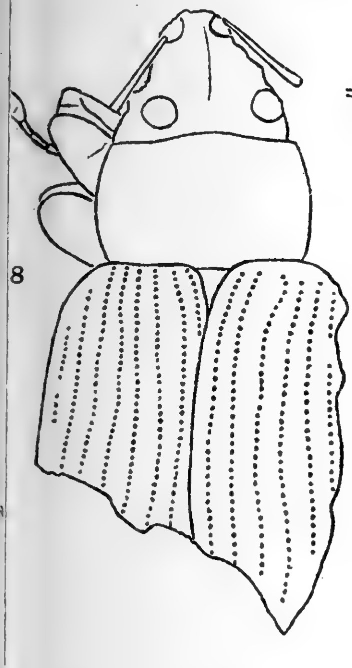

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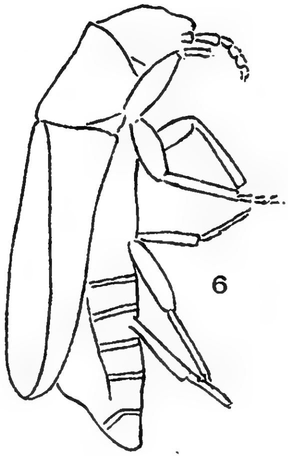

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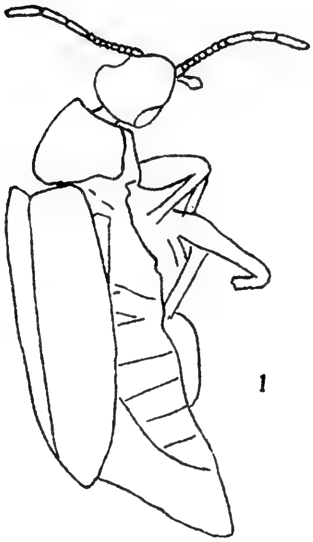

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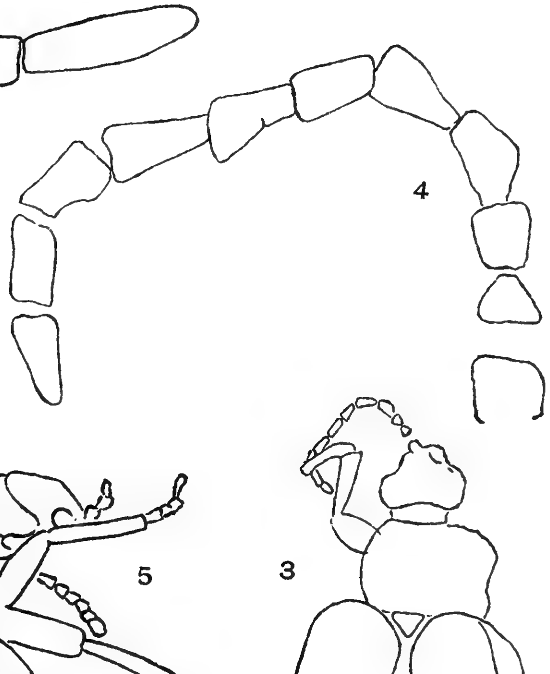

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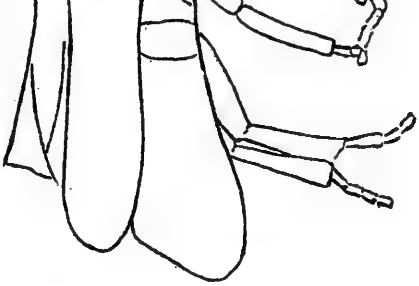

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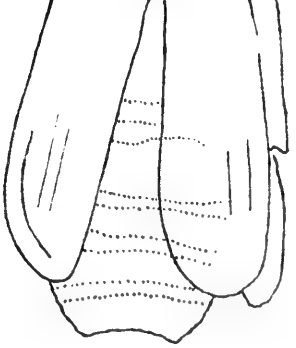

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BULLETIN

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY

AT

HARVARD COLLEGE, IN CAMBRIDGE.

VOL. LIX.

CAMBRIDGE, MASS., U. S. A.
1915.

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Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

Vol. LIX. No. 1.

MAMMALS OBTAINED BY THE PHILLIPS PALESTINE EXPEDITION.

By Glover M. Allen.

CAMBRIDGE, MASS., U. S. A.:
PRINTED FOR THE MUSEUM.
February, 1915.

No. 1.— *Mammals obtained by the Phillips Palestine Expedition.*

By Glover M. Allen.

The collection here reported on consists of about one hundred and fifty small mammals, mostly skins with skulls, presented to the Museum of Comparative Zoölogy by Dr. John C. Phillips, who obtained them during his expedition (March–June, 1914) to the Sinai Peninsula and Palestine. His route was from Cairo eastward along the west coast of the Gulf of Suez, to Mt. Sinai, thence northward to Akaba, at the head of the Gulf of Akaba, and on to the region of the Dead Sea. Mr. William M. Mann, who accompanied him, made further collections about the base of Mt. Hermon. Twenty-four species were obtained, some of which are yet very imperfectly known. The ranges of others are slightly extended by Dr. Phillips's collections. The country to the south of Syria is inhabited by a typical desert fauna of genera which for the most part are not found north of the Dead Sea region, where they give place to more strictly Palaearctic types, as Apodemus, Microtus, Eliomys. No new species were discovered, but the fine series of *Apodemus mystacinus* from the vicinity of Mt. Hermon makes it possible to determine the status of the form found in the Black Sea forest of Asia Minor, and it is here described as new.

Crocidura russula (Hermann).

White-toothed Shrew.

Sorex russulus Hermann, Zimmermann's Geogr. geschichte, 1780, **2**, p. 382.

No specimens of this genus were met with except in the country bout the western base of Mt. Hermon, at Rasheya, Bâniyâs, Ammik, nd Aithenit. The series of seven skins is of very uniform appearance nd seems to be indistinguishable from typical *russula*.

Pipistrellus kuhlii (Kuhl).

Kuhl's Bat.

spertilio kuhlii Kuhl, Ann. Wetterau. ges. naturk., 1819, **4**, p. 199.

A single specimen of this small species was taken at Shtora, Syria.

EPTESICUS SEROTINUS (Schreber).

Serotine Bat.

Vespertilio serotinus Schreber, Säugethiere, 1774, **1**, pl. 53; 1775, **1**, p. 167 (description).

This common species of southern and central Europe was taken once at Shtora, Syria.

TAPHOZOUS NUDIVENTRIS Cretzschmar.

Tomb-haunting Bat.

Taphozous nudiventris Cretzschmar, Rüppell's Atlas reise nördl. Afrika. Säugeth., 1826, p. 70, fig. 27*b*.

A small series was shot at evening from the walls of Jericho, which must be near its northward limit in Palestine.

CANIS AUREUS Linné.

Jackal.

Canis aureus Linné, Syst. nat., ed. 10, 1758, **1**, p. 40.

Throughout much of the country traversed, jackals were common and frequently proved a great nuisance by following the lines of traps and carrying off both trap and mouse. One specimen brought back has a deformed lower jaw, which is so much shorter than the upper, that the lower canines close *behind* the upper ones. All the teeth seem normally formed, however, but on account of the shortness of the ramus the premolar series is greatly crowded.

ELIOMYS MELANURUS Wagner.

Black-tailed Dormouse.

Eliomys melanurus Wagner, Abh. K. Bayer. akad. München, Math.-phys. cl., 1843, **3**, p. 176, pl. 3, fig. 1.

This beautiful dormouse was met with near the west base of Mt. Hermon, where at Ain Hersha and Rasheya, three specimens were taken. One from the former locality, May 31, is a young individual. It is known also from the Sinai region.

PSAMMOMYS OBESUS Cretzschmar.

Sand Mouse.

Psammomys obesus Cretzschmar, Rüppell's Atlas reise nördl. Afrika. Säugeth., 1826, p. 58, pl. 22, 23.

At Ain Abu Heran, to the north of Akaba, Dr. Phillips shot a subadult male which seems referable to this species. The type locality is Alexandria, so that this record extends its range well to the eastward. The Museum has also a skin from Palestine, without definite locality, but probably from near the southwest coast. The long-tailed *P. terraesanctae* of the Dead Sea region seems to be a species distinct from the shorter-tailed *obesus* and *algiricus*.

MERIONES TRISTRAMI Thomas.

Tristram's Gerbil.

Meriones tristrami Thomas, Ann. mag. nat. hist., 1892, ser. 6, **9**, p. 148.

This species was first described on the basis of specimens from the Dead Sea region and Mt. Carmel collected by Canon Tristram, who referred it to *M. tamaricinus*. Nehring (Sitzb. Ges. naturf. Freunde Berlin, 1901, p. 171) records a specimen from the south of Jaffa on the coast, west of the Dead Sea.

On his way north from Akaba, Dr. Phillips first met with this gerbil at Shobek, and on successive days, trapped it at Ain Gleidat nd Tafileh. The locality first-named, probably represents nearly its southern limit, as it was not found on the high plateau country o the south. Three individuals, not quite fully grown, lack the bright andy color of the adults, and are decidedly grayer. A young one rom Beir el Doleh, Syria, is more fulvous.

MERIONES CRASSUS Sundevall.

Silky Gerbil.

eriones crassus Sundevall, K. Vet. akad. Handl. för 1842, 1843, p. 233, pl. 2, fig. 4, a–d.

A single specimen sent by the Swedish traveller Hedenborg, served Sundevall's type of this remarkable species. Hedenborg's note accompanying it gives its habitat as the Sinai desert, "Ad vias circa fontes Mosis." The Wells of Moses (Ain Musa) near the west shore of the Gulf of Suez, may therefore be considered the type locality. Dr. Phillips obtained two adults near Mt. Sinai, at Wady Feiran and Um Shomer respectively, and a third on the eastern side of the Sinai peninsula, at Suweira, slightly to the north of Akaba. It therefore probably ranges over the greater part of the Sinai desert. Bonhote (Proc. Zool. soc. London, 1912, p. 226) has recorded a specimen from Tor in Sinai, collected by Capt. S. S. Flower.

The peculiar inflation of the auditory meatus causing it to touch the angle of the squamosal process, and the posterior enlargement of the bullae, so that they extend behind the supraoccipital and notably constrict the exoccipitals, may prove to be characters of generic value, when the time comes for a revision of the group. The pelage is extremely soft and silky; the pale, sand-colored hairs of the upper surface of the body are minutely black-tipped.

GERBILLUS CALURUS Thomas.

Bushy-tailed Gerbil.

Gerbillus calurus Thomas, Ann. mag. nat. hist., 1892, ser. 6, **9**, p. 76.

One of the most interesting of Dr. Phillips's captures is a fine adult male of this rare gerbil. Hitherto but three specimens seem to have been recorded, all of which are in the British Museum. The original specimen is an alcoholic without locality; the second, also an alcoholic, is from Sinai, and unfortunately in poor condition; the third is a skin with imperfect skull, from Wady Sikait, south of Gebel Sebara, eastern Egypt. Dr. Phillips's specimen (the fourth to be recorded) is from the Sinai region at Wady Sa'al. The type was for many years in the British Museum before it was made known by Thomas, and it was not till the publication of the two other records by Anderson in his Zoology of Egypt, **2**, Mammals, in 1902, that its probable range was indicated. The squirrel-like tail is a remarkable feature in the genus, but the skull seems sufficiently typical. The measurements of the present specimen are: — head and body 118 mm., tail 145, hind foot 33, ear 22; skull, greatest length 36.5, basal length 30, palatal length 19.3, diastema 8.5, zygomatic width 18.7, mastoid width 18.9, interorbital constriction 5.5, bullae 14 × 7.5, upper molar row (alveoli)

5.6. Posteriorly the inflated mastoids project slightly beyond the occipital region.

GERBILLUS GERBILLUS (Olivier).

Tawny Gerbil.

Dipus gerbillus Olivier, Voy. Egypt., 1801, **3**, p. 157, pl. 28; Bull. Soc. philom. Paris, 1801, **2**, p. 121.

This brightly colored gerbil was first trapped at Wady Shurandel in the Sinai region. Other specimens were taken at the head of the Gulf of Akaba to the northeast, namely at Akaba and Suweira, but none has been recorded to the northward of these places.

DIPODILLUS QUADRIMACULATUS Lataste.

Four-spotted Gerbil.

Dipodillus quadrimaculatus Lataste, Le naturaliste, 1882, **4**, p. 27.

A series of six specimens from Akaba, at the head of the Gulf of the same name, appears to represent this species, and extends its known range somewhat to the eastward. Its apparent absence from the high rough country of the interior of the Sinai peninsula may indicate that
t is confined to the low sandy areas along the coast.

DIPODILLUS DASYUROIDES Nehring.

Nehring's Smooth-footed Gerbil.

ipodillus dasyuroides Nehring, Sitzb. Ges. naturf. freunde Berlin, 1901, p. 173.

A series of thirteen skins, old and young, seems referable to Neh-
ng's species, the type of which is from Mount Moab, east of the
uthern end of the Dead Sea. The chief color character distinguish-
g it from Wagner's *dasyurus* of western Arabia is said to be the
lowish instead of pure white area above the eyes. In the series
fore me there is some variation in tint, chiefly due to the greater or
s suffusion of the upper parts with buffy. This seems partly a
tter of age, since the young and subadults are less buffy, the pale
a above the eyes is dirty white, and the ventral side of the tail is

white. In the adults with worn teeth the entire pelage above is buffier, as well as the eye spots and ventral side of the tail. The adult males are brighter buff or fulvous as compared with the females, which even in the adult, seem grayer, like the young. One specimen has the extreme tip of the tail white. The type locality, Moab, must be near the northern limit of its range. Dr. Phillips obtained it at Suweira, Nuheibeh, and Um Shomer in the Sinai region, then farther north at Petra, and in Syria at Wady Hesa, Wady Ain Musa, and Beir el Doleh. Several young specimens from one third to one half the adult size were collected in late April and early May at Petra and Beir el Doleh.

Dipodillus mariae Bonhote.

Mrs. Bonhote's Pigmy Gerbil.

Dipodillus mariae Bonhote, Proc. Zool. soc. London, 1909, p. 792.

This minute grayish species was but recently described on the basis of two specimens from the Mokattam Hills, near Cairo, Egypt. A single male collected by Dr. Phillips at Wady Feiran, Sinai, corresponds completely with the published description, and seems thus to represent the third recorded specimen. The known range of the species is extended considerably to the eastward by this capture.

Microtus guentheri (Danford and Alston).

Guenther's Vole.

Arvicola guentheri Danford and Alston, Proc. Zool. soc. London, 1880, p. 62, pl. 5.

Eight specimens of a short-tailed yellowish vole I have provisionally referred to *guentheri*, with the description of which they seem to agree. All are from localities in the valley west of Mt. Hermon. In the original diagnosis, the presence of five plantar tubercles is given as a chief distinguishing character, but in some specimens there seems to be a minute sixth one indicated. The ears project distinctly from the fur of the head, and instead of being well haired near their margins as stated by the describers of *guentheri*, they are clothed with very minute hairs and appear nearly naked unless narrowly examined. The relationship of this species to *M. socialis* is apparently close.

APODEMUS SYLVATICUS TAURICUS (Barrett-Hamilton).

Taurus Wood Mouse.

Mus sylvaticus tauricus Barrett-Hamilton, Proc. Zool. soc. London, 1900, p. 412.

Three specimens from Shiba, Rasheya, and Ain Hersha respectively, localities near the southwest base of Mt. Hermon, belong to the *sylvaticus* group, and here represent nearly the southern limit of its range in Palestine. Two of these, though nearly grown, are in the immature slaty gray pelage, and the third is an adult male. Barrett-Hamilton's name *tauricus* probably applies to these specimens, though he gives no description beyond the length and breadth of the type skull (23 × 12 mm.). His type is an alcoholic in the British Museum from Zebil in the Bulgar Dagh, southern Asia Minor, and thus not very far from Palestine. The adult skin brought back by Dr. Phillips's expedition s a very pale buffy animal uniformly 'lined' above with black hairs nd quite without the russet tints of true *sylvaticus*. Judging from escriptions alone it is nearly indistinguishable from *A. s. dichrurus* f the European Mediterranean region and in its measurements it hows no appreciable differences. The skull of the adult male is 24.6 m. in greatest length as against 23 mm. given for the type of *tauricus*, ut the latter measurement may well be within the limits of variaility for an immature individual.

APODEMUS FLAVICOLLIS (Melchior).

Yellow-collared Mouse.

us flavicollis Melchior, Den Danske Staats og Norges pattedyr, 1834, p. 99.

Two specimens, one adult, the other immature, from Ain Hersha ar the base of Mt. Hermon extend the recorded range of this species l into Palestine and probably indicate nearly the southeastern nit of its distribution. Through the kindness of Mr. Gerrit S. iller, Jr., I have been able to compare these with a series of European *vicollis*, including topotypes from Denmark, in the U. S. N. M. e adult, in russet pelage, is a mere shade paler than any of the

European skins yet probably falls within the limits of individual variation. Skins from the Harz Mountains of Germany and others from Switzerland match it very closely. The feet are a little small and the skull, compared with those from Europe having equally worn teeth, is a trifle smaller, yet in both these respects it can be duplicated in the European series. The braincase seems smaller, however, and the angle formed by the sides of the frontoparietal suture is more acute. Additional specimens from Palestine may show that the local representatives of the species are entitled to rank as a separate race.

The immature specimen is in the slaty gray pelage, and though taken June 1st, is fairly well grown (total length 190 mm.), indicating as Barrett-Hamilton has suggested, that it breeds early in the year.

Apodemus mystacinus (Danford and Alston).

Gray Wood Mouse.

Mus mystacinus Danford and Alston, Proc. Zool. soc. London, 1877, p. 279.

A series of fourteen skins, young and adult, represents this species, which seems to be rare in collections. All are from the region about the base of Mt. Hermon, and correspond in all details with the original description. The young, unlike those of the *sylvaticus* group, are colored practically like the adults, though the fawn tints on the sides of the face and body brighten slightly with age. The original series in the British Museum comprised three specimens, two at least in alcohol, collected in the Bulgar Dagh region of southern Asia Minor. The pale coloration is typical of the dry country in which this mouse lives, and Mr. Oldfield Thomas (Ann. mag. nat. hist., 1903, ser. 7, **12**, p. 188) has lately described an even paler race, *A. m. smyrnensis*, from extreme western Asia Minor at Smyrna. In this race the hairs of the lower surfaces are pure white to the roots instead of having slaty bases.

Through Mr. Thomas's kindness the M. C. Z. has received in exchange a specimen referred to *mystacinus* taken in the forest belt bordering the Black Sea, an area very different faunally from the arid country to the south. Dr. Phillips's fine series representing typical *mystacinus* shows that the Black Sea animal, as might be expected, is very different in color. It is much darker, and almost without the buffy tints of the former. It may be known as

Apodemus mystacinus euxinus, subsp. nov.

Black Sea Wood Mouse.

Type.— Skin and skull 14,887 M. C. Z., from Scalita (near Trebiond), Asia Minor; male, collected November 25, 1905, by A. Robert, ltitude 1,000 meters.

General Characters.— Similar to typical *mystacinus* but much darker, he back blacker, the buffy tints of face and sides replaced by grayish.

Description.— The type specimen is subadult, and in comparison ith specimens of similar age from Palestine, is much darker throughut. The entire dorsal surfaces are grayish, heavily washed with lack which predominates in the middle of the back. The sides of he head and body are paler gray very faintly washed with "pinkishuff" but in much less degree than in the typical race so that the eneral appearance is dark gray. Along the sides of the body a faint and of 'pinkish buff' delimits the color of the dorsal surface from the hite of the belly. The slaty bases of the hairs of the ventral surface how through sufficiently to darken the entire underparts except on e forearms, which are pure white below. Feet and hands white, nkles slaty, with a dusky prolongation reaching the calcaneum hind, though the tarsal joint is white on its upper surface. Tail arply bicolor, blackish above, white below.

Measurements.— Head and body 94 mm., tail 109, hind foot 24, r 18. The skull shows no appreciable differences from that of pical *mystacinus;* condylobasal length 26, palatal length 14, zygoatic width 14, upper cheek teeth (alveoli) 4.5.

Remarks.— Mr. Thomas has already described several new forms mammals from the forest belt along the northern coast of Asia inor on the Black Sea. Here, he says, "there is a strip of forest, ne 50 miles wide, sloping northwards to the Black Sea from an itude of 1500 to 2000 metres at its southern edge. The forest then ruptly disappears and an open steppe country commences, inhabited Hamsters and Spermophiles, and continuous with the more desert intries further south. Compared with this more open and desert ntry the coast-forest has a very different fauna, of a distinctly hern character. * * * Mr. Robert's work was done at two localities the heart of the forest-strip — Sumela * * * and Scalita * * * a age in the same valley as Sumela but about 3000 m. [= 300 m.?] er," and some 30 or more miles south of Trebizond (Ann. mag. nat. ., 1906, ser. 7, **17**, p. 415).

The dark color and lack of buffy patches on the sides of the head and behind the ears in the Black Sea form are no doubt correlated with life in this coastal forest. Apparently *A. mystacinus* is not closely related to *A. epimelas* of Europe which is sharply distinguished by the presence of a fourth minute tubercle at the posteroexternal margin of the first and second upper molars.

Mus musculus Linné.

House Mouse.

Mus musculus Linné, Syst. nat., ed. 10, 1758, **1**, p. 62.

Three skins from Akaba do not seem different from the form of House Mouse introduced into the eastern United States. Probably at Akaba the typical variety has been introduced by the shipping.

Mus musculus orientalis Cretzschmar.

Mus orientalis Cretzschmar, Rüppell's Atlas reise nördl. Afrika. Säugeth., 1826, p. 76, pl. 30, fig. *a*.

Four skins are pale-bellied, yet with conspicuous dusky bases to the white-tipped hairs, and with a buffy line along the sides of the body. They are to be considered as representing *orientalis* though it seems questionable if they are not better referred to *gentilis*, of which they would be reckoned a dark extreme. The four specimens are from Akaba, Arabia, and from Rasheya, Hasbeiya, and Shiba, Syria (near Mt. Hermon).

Mus musculus gentilis Brants.

White-bellied House Mouse.

Mus gentilis Brants, Muizen, 1827, p. 126.

This pale, white-bellied form was taken at Shobek in Arabia and at Wady Kerak and El Kerak in Syria. The hairs of the belly are clear white to the base, or with the very base only light plumbeous. Probably these are the native form of House Mouse.

ACOMYS RUSSATUS Wagner.

Short-tailed Spiny Mouse.

comys russatus Wagner, Abh. K. Bayer. akad. München, Math.-phys. cl., 1843, **3**, p. 195, pl. 3, fig. 2.

Of this rare species, two specimens were procured at Wady Feiran, the dry rocky country of Sinai, and so are practically topotypes. ehring (Sitzb. Ges. naturf. freunde Berlin, 1901), records one each om Moab and Engeddi, Palestine, and Tristram had previously found at Massada at the south end of the Dead Sea. In describing as a istinct race the specimens he found in the Mokattam Hills, near airo, Bonhote (Proc. Zool. soc. London, 1912, p. 229) also mentions pair from Sinai that he kept alive. The known range of the typical rm is thus from the region of the Dead Sea through the Sinai eninsula.

ACOMYS DIMIDIATUS (Cretzschmar).

Desert Spiny Mouse.

us dimidiatus Cretzschmar, Rüppell's Atlas reise nördl. Afrika. Säugeth., 1826, p. 37, pl. 13, fig. *a*.

This is the commonest small rodent in the collection. Many specimens were taken in the Sinai region, at Akaba (head of the Gulf of Akaba) and northward at Petra and Tafileh. The most northerly specimen is from Wady Kerak at the southern end of the Dead Sea.

JACULUS MACROTARSUS (Wagner).

Long-footed Jerboa.

D us macrotarsus Wagner, Abh. K. Bayer. akad. München, Math.-phys. cl., 43, **3**, p. 214, pl. 4, fig. 2.

single specimen from Wady Feiran, Mt. Sinai, is practically a to ype of this species, which was originally described from specimens sent from Mt. Sinai. Nehring (Sitzb. Ges. naturf. freunde Berlin, 1901, p. 163), in naming *schlüteri* from southwestern Palestine, compared it with examples from western Arabia, which he took to represent *macrotarsus*. It seems likely that in this he was correct.

At all events the ventral hook-like process of the jugal is lacking in the Sinai specimen as in these, and they have two perforations of the angle of the jaw instead of one as in the other species. In color *J. macrotarsus* seems to be very much darker than *J. jaculus* by reason of the many dark-tipped hairs among the pale buffy fur of the back. These dark tips also extend to the sides of the belly, and give a soiled appearance to the white of this area. Among the vibrissae is a single one of great length on each side (some 104 mm.). The collector's measurements are: — total length 300 mm., tail 180, hind foot 55, ear 22.5. The skull measures: greatest median length 31.7 mm., basal length 28, palatal length 18.5, diastema 8.8, zygomatic breadth 21.5, width across malars 20.5, mastoid width 23, upper tooth row (alveoli) 5.1.

CAPRA NUBIANA SINAITICA Hemprich and Ehrenberg.

Sinai Ibex.

Capra sinaitica Hemprich and Ehrenberg, Symb. phys. zool., 1828, **1**, pl. 18.

Dr. Phillips supplies the following interesting note as to the present status of this animal.

"The Sinai Ibex still persists over all the rugged parts of the Sinai peninsula, near Akaba and up at least as far as the northeast end of the Dead Sea. Although undoubtedly greatly reduced in numbers since Tristram's time (1884), it manages to persist in spite of the fact that every hand is against it during the entire year, and its freshly dropped kids are eagerly hunted by the natives with dogs. I hunted three days and saw only four smallish animals, but signs were fairly numerous. The Ibex appears to be independent of water, at least during winter and spring. The leopard hunts these Ibexes and presumably kills a good many, as various sportsmen have testified. We obtained a new born kid at Feiran, March 30th, and another at Akaba, April 16th." Dr. Phillips found evidence that they frequent caves among the rocks as hiding places.

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THE CRANIAL NERVES OF ANOLIS CAROLINENSIS.

By William A. Willard.

With Seven Plates.

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No. 2. — *The Cranial Nerves of Anolis carolinensis.*

NTRIBUTIONS FROM THE ZOÖLOGICAL LABORATORY OF THE
MUSEUM OF COMPARATIVE ZOÖLOGY AT HARVARD
COLLEGE. NO. 261.

By William A. Willard.

TABLE OF CONTENTS.

A. INTRODUCTION.

It is now generally recognized that the comparative anatomy of th
nervous system can not be profitably studied without recourse t
microscopic analysis in the peripheral region as well as in the centra
organs. It is further recognized that, for their final explanation, th
highly complex nervous organs of mammals, including man, mus
await the revisions and additions which such a method of study
applied to the lower vertebrates, will suggest for their interpretation
Inasmuch as the nervous system is essentially a correlating structur
it follows naturally that changes in its mechanism should be studie
in connection with a study of the correlated organs and function
This gives to the study of the nervous system a broader biologic
significance than is possessed by other organs. But this relation add
much to the technical difficulties and makes it almost impossible t
bring within the scope of a single research the complete analysis
even a single form. The shortcomings of the present study from tha
point of view are recognized by the author. However, in the metho
pursued, he has had constantly in mind the larger problem, whic
does not recognize the arbitrary distinction between central and p
ripheral nervous systems. In fact, he has already collected muc
material and information on the central nervous system of Anoli
but it seems advisable to reserve that material for a more comple
account of the Anolis brain. The present investigation is carried f
enough toward the nerve centers to articulate easily with such a stud

A large part of this work was done a number of years ago in t
Zoölogical Laboratory of Harvard University. Since then it has be
continued in the Laboratory of Histology and Embryology of t
University of Nebraska, College of Medicine. In this connection
wish to acknowledge my gratitude to Dr. E. L. Mark for placing eve

acility at my disposal and for his continued interest and encouragement. Also the work has been aided not a little through the courtesy f Professor H. W. Norris of Grinnell College and Dr. C. J. Herrick f Chicago University, who on different occasions have given me working facilities in their laboratories.

B. SCOPE OF THE PAPER.

This paper includes, to some extent, the general anatomy of the ead of Anolis; much of this, however, is of quite secondary importance and there has been no attempt to treat critically anything but e nervous organs; even within this field certain features have been mitted, since they can better be considered in connection with the entral nervous system. This is true of the larger sense organs and eir nerves, *i. e.*, eye, ear, and olfactory organs. Also the distribution of the vagus nerve is not carried into the trunk region beyond e limits of the series of sections figured. Of the non-nervous ructures, the skeleton is included for the purpose of more exact pography. The muscles and glands, and the integument and ucous membrane with their sense organs are included on account of eir relation to the peripheral distribution of neurones.

The aim of this work is to give as complete an account as possible a single reptilian form, which may serve as a basis for further comparative study. The entire absence of such an account within the ole sauropsidan group is believed to be sufficient justification for publication of the present paper. But this plan is not compatible h the intensive treatment of many of the problems that arise in nection with various details of the work. Much of the literature t has been consulted in the course of the study has not been specifiy cited as it would have been, had the field been more limited. s is particularly true of most of the reptilian studies whose results based on dissections alone and are therefore open to more than one rpretation, because an attempt at detailed comparisons in such s would serve only to impair the usefulness of the present study. egard to the Icthyopsida, where more exact work has been done, it ems premature to go far with comparisons until the study of the opsida has covered several forms. Such comparisons as are made ld, therefore, be considered tentative.

C. MATERIAL AND METHODS.

The adults of *Anolis carolinensis* were obtained from Jacksonville, Florida, and later from Colmesneil, Texas. They were sent alive by express, being received in good condition. After arriving they could be kept alive for any length of time by feeding with living flies. With such material constantly on hand, the use of the various special nerve methods was practicable. The methods of staining found best adapted to the purpose of the present study were Weigert's and Vom Rath's. The projection drawings of the peripheral distribution of the cranial nerves were made from a head prepared by the Vom Rath method, which was found the best for this material.

The animals were killed with chloroform; the head, with the anterior part of the body as far back as the region of the fore legs, was removed and, after some of the tissue on the right side had been cut away so as to expose the brain and insure more rapid penetration, was put into a Vom Rath's solution (formula for vertebrates). The length of time necessary in this fluid depends upon the requirements of decalcification, for the fluid serves the double purpose of decalcifying the bone and impregnating the medullary sheaths of the nerve fibers. I found that a week to ten days served the purpose well. After the required length of time the specimen was brought through the grades of alcohol and left in 80% alcohol long enough to remove as much of the picric acid as would readily come out. The after treatment with pyroligneous acid was not used. From 100% alcohol it was cleared in cedar oil, then passed into xylol and, finally, embedded in paraffin. For better embedding it was found advantageous to use the air pump, either while the object was in the melted paraffin or before, while in the oil. It was always found necessary to re-embed several times during the cutting of a complete series, as there were cavities not filled at first. This resulted at several places in the series in partial sections which, however, were numbered in sequence with the others. The series from which the large plots were made was cut transversely 10 micra thick. In place of artificial orientation lines the median plane was used for projection on the frontal plane, but for projection on the sagittal plane there was no natural line available for the whole distance. The border of the upper lip served for this purpose as far back as the corner of the mouth. From this point caudad the orientation was determined from a comparison with a drawing of the lateral external view of the same head, and also with sagittal sections of heads of the same size.

The projection plots were made from camera drawings magnified 37 diameters and, except in regions of greatest complication, each nerve was projected accurately throughout its entire course. In a few cases some of the nerves are displaced a little from the position they really occupy in the middle of their course in order to avoid too great confusion of lines. Of course the essential points such as central and peripheral endings and relationship of branches given off in the intermediate course are strictly adhered to.

Even after the most careful study of serial sections and reconstructions, one is likely to fall into error unless the work is supplemented by free-hand dissections. This is particularly true in case of very small branching rami or fine plexuses. Animals that are small enough to be practicable for sectioning are generally too small for entire dissections, but by the following method it was possible to make accurate and fairly complete dissections of the head: — the integument of the part wanted for dissection was carefully removed to avoid cutting any of the underlying muscles. Then the animal was put into the Vom Rath fluid, as for sectioning, but treated a shorter time (24 to 36 hours). This decalcifies sufficiently well, hardens the muscles and leaves them well defined because of a slight shrinkage; it also hardens and blackens the nerves. Instead of further hardening in alcohol, the specimen was washed out in water and put into a mixture of alcohol and glycerine. It was afterwards dissected in water under a lens. For best results, however, it should be dissected soon. Although the whole muscle is much darkened, there is contrast enough between it and the nerves to allow the identification of the finest branches of the blackened nerves. The muscles are also more or less brittle, whereas the nerves retain their characteristic toughness. As the dissection progressed portions were removed and cleared for permanent mounts in balsam. I consider the making of balsam preparations a very valuable part of the technique of this work, for in no other way can the fiber course in the finer anastomoses be made out. For ascertaining the courses of nerves and for topographical relations this short Vom Rath method is a valuable adjunct and the two methods — sections and dissections — were constantly used together.

For the central relations I found that properly prepared Weigert preparations gave more satisfactory results than the Vom Rath, but the latter method allowed the roots to be followed well into the brain and in some instances served even there better than the Weigert. Portions of the courses brought out by one method overlap those by the other, so there could be no chance of error in combining these two methods of study.

For the best Weigert preparations, Herrick's method of fixation for fishes with Flemming's fluid was found the best for the lizard also, although I was unsuccessful in my attempts to get the best results in both the central and peripheral fibers by a single treatment. That is to say, when the sections were decolorized properly for the central nervous fibers, the peripheral nerves were decolorized too far. On the whole I found it much more satisfactory to base the study of the peripheral nerves on the Vom Rath series, and the present paper chiefly rests on the findings in such material.

D. SYSTEMATIC POSITION OF ANOLIS.

Following Cope (**:00**, p. 158, ff.), we have the following division of the living Reptilia: —

Class Monocondylia.
  Subclass Reptilia
    Orders Testudinata
      Loricata
      Rhynchocephalia
      Squamata
    Suborders Ophidia
      Sauria

The group characters of the Sauria are as follows: "Quadrate bone articulating with the exoccipital; parietal bones not closing the brain case in front; generally an epipterygoid and sternum; teeth with dentinal roots; phalanges with condyles" (p. 178). The family Iguanidae is represented in North America by twelve genera; it is subdivided as follows: —

Subfamilies Anolinae
  Basiliscinae
  Iguaninae

The genus Anolis falls under the first of these three subfamilies, which includes six known genera, Anolis being the only one found in the United States. Cope (p. 233) describes *Anolis carolinensis* and states that it "is distributed from the Rio Grande to Florida, inclusive, and as far north as Kinston, North Carolina. It is, moreover, common in the Bahama Islands and Cuba, where it reaches a size rather superior to what is usual in the United States." Among other Iguanidae found in the United States are the well-known forms Sceloporus and Phrynosoma. As to general external features and habits of life, the members of this family are most diverse, as will be seen by comparing two such forms as Phrynosoma and Anolis.

E. HISTORICAL STATEMENT.

The Sauropsida have been quite generally neglected as regards the anatomy of the nervous system in the adult, most of the descriptive accounts having been written more than fifty years ago. This applies equally well to other reptiles and to birds, notwithstanding the fact that the latter have long since become of classic forms for embryological study. Aside from the embryological studies on birds and reptiles, such work as has been done has used exclusively the methods of gross anatomy and must necessarily be incomplete. It might be added that those who have more recently contributed to our knowledge of the sauropsidan nervous system and who use only the methods of the older anatomists increase our knowledge comparatively little. Much of the older work cannot be excelled within its limitations. The modern investigator should profit by modern methods and remove some of these limitations. The first important account of reptilian anatomy is by Bojanus (**'19**) in his monograph on the anatomy of the turtle. This is a classic, and is still the authority for much of the subject it covers. No other investigator has gone over the same field in so thorough a manner.

Vogt (**'39**) gives us, in his dissection of *Python tigris,* our first information on the cranial nerves of the Ophidia. This, however, is incomplete, nerves IV, VI, and IX not being found at all, and III only partially dissected out.

Müller (**'40**) about the same time discussed the nervous system of reptiles in his Neurologie der Myxinoiden. Bendz (**'43**) made a comparative study of the last four cranial nerves (or the vagus group) in reptiles, including among those studied two saurians, the alligator and the chamaeleon. Fischer's (**'52**) paper on the saurians is still the most important descriptive work on the cranial nerves of reptiles. He studied eleven species of lizards, two of crocodiles and the alligator. He treated the subject quite exhaustively and made use of comparative methods to establish certain homologies. Rabl-Rückhard (**'78**) gave in his description of the alligator's central nervous system, the first account of a reptilian brain. He incidentally mentioned the roots of the cranial nerves. Hoffmann (**'79–90**), in the part of Bronn's Thier-Reich devoted to the Reptilia, based his description of the cranial nerves of lizards largely upon the work Fischer published forty years previously. More recently Osawa ('**98**) has given a quite full account of the anatomy of Hatteria, in which the cranial nerves are described. This work fails of much of its usefulness because of lack of plates; the text figures are too obscure to be of much use. Watkinson (:**06**) describes *Varanus bivittatus,* including the skull and musculature among her drawings. In matters of close comparison, however, her work has proved to be inadequately illustrated properly to supplement her description. In the same manner Cords (:**04**) attempts to meet a long felt need in the anatomy of the nervous system of birds; but here, again, the lack of a diagram of the complete system, for the purpose of comparison, is felt.

In addition to the works mentioned, the cranial nervous system of reptiles and birds has been touched upon by various authors in the comparative treatment of certain nerves or groups of nerves.

In the following work on Anolis there is presented for the first time a description of the cranial nerves of an adult amniote form based upon a complete series of sections.

F. SKELETAL STRUCTURES.

1. Skull.

The skeletal parts involved in this account are those which are related topographically to the cranial nerve roots or serve for the attachment of muscles whose description follows, or have some other important, though indirect, relation to the main subject. Many points of secondary importance in regard to length of rami, points of branching, and course of peripheral nerves are explained when reference is made to the skull and its foramina. The skeletal parts appearing in the transverse sections are not readily understood without reference to the entire structure, therefore the three drawings of the skull are made with accuracy with a view to their permanent value in any problem involving the comparative anatomy of the reptilian head. Cope (:**00**) is followed in naming the parts of the skull and hyoid apparatus. As he separates the Reptilia altogether on osteological characters, the basis for a large part of his definition of the Sauria may be recognized in this skull, *e. g.*, "Quadrate bone articulating with exoccipital; parietal bones not closing the brain case in front, generally an epipterygoid present"....(p. 178). The labelled drawings of the skull (Plate **1**, figs. 1–3), and the cross-section drawings (Plates **4–7**) furnish all the description called for in this connection. Certain cartilaginous elements appearing in the sections were not preserved in the preparation of the skull.

2. Hyoid Apparatus.

The hyoid apparatus is entirely free from any cranial attachments. "The hyoid system in lizards consists of a glossohyal, which is continuous with a basihyal tract, a hypohyal, often continuous with the basihyal tract, a ceratohyal, a first ceratobranchial, and a second ceratobranchial, which is always continuous with the basihyal tract. There may be in addition an epibranchial, which belongs to the first ceratobranchial" (Cope, p. 189). Taking *Anolis carolinensis* as typical of the genus in this respect, Cope (p. 232) says, "the hyoid apparatus has the extreme development seen in all the lizards with a gular compressed pouch or fan. That is, the ceratobranchials of the second pair are closely appressed and produced to a great length. First pair of ceratobranchials and ceratohyals simple, the latter attached to the extremities of the moderately developed hypohyals."

G. CUTANEOUS SENSE ORGANS.

The cutaneous innervation and the epidermal sense organs deserve exhaustive study in the reptiles in view of the fact that these sense organs are apparently absent as such in mammals, although abundant in the Amphibia and fishes. On the other hand, mammals possess dermal tactile organs of problematic origin. Inasmuch as some new facts are presented in this general account of Anolis, a brief statement of what has already been described within the group of reptiles is necessary. Maurer (**'95**, p. 228) refers to Reinhardt's (**'61**) article in which 191 species of snakes were examined for the epidermal sense organs. In 85 of these nothing of this nature was found; in 44 species there was one organ, and in 62 species two organs, to each scale. Maurer's (**'95**, p. 17, 196–239) own work covers the field sufficiently for our purpose. This can best be understood by reference to his text figures (9–14), which include most of his illustrations relating to the distribution of these sense organs. Besides Hatteria, only one lizard (*Anguis fragilis*) is shown. Maurer studied Lacerta, but does not mention the occurrence of the "Tastflecken." He found them, however, in Chamaeleo, but does not figure them. He calls attention to their large number, as many as six on one scale, in the primitive reptile Hatteria, and to their reduction to one to a scale in some of the snakes and in the crocodiles. His study of the minute structure of these organs results in his putting forth a theory that the epidermal organs are evolving into dermal organs, the cells of which come in all cases from the epidermis. The condition found in Coronella (Maurer, '**95**, Taf. viii, fig. 2, *t.*) shows one stage in the process; the crocodile (Taf. vii, fig. 12, *t*) a more advanced stage. Moreover the crocodile's single organ in the middle of the scale is really a multiple organ, as is indicated by the number of these tactile bodies, as many as six being found under one of the tactile spots. In Hatteria, which he regards as most primitive, the subepidermal tissue is involved in the organ (Taf. vii, fig 11, *s.*). In all cases he represents nerves going to these organs.

The tactile organs of Anolis. It is assumed that the organs in question are tactile in this animal for the reason that structurally there is more evidence for this view than has been put forth for any other related form. We find projecting from the center of each tactile spot a slender "tactile bristle" of considerable length. The distribution of these sense organs, provided with tactile bristles or "hairs," is very readily and accurately made out through the study of the moulted horny layer of the skin. From a lot of individuals procured in early spring a number showed a tendency to "shed" the skin. From an animal showing the beginning of this process it is possible to strip off artificially the whole corneous layer, and before it dries and curls it may be spread out on a slide and covered so as to remain in a perfectly flat condition. By mounting the whole cast, or at least half of it, piecemeal, on different slides, any part of the body surface can be readily referred to. While there is a variation in the number and size of these sensory organs there is no part of the body lacking them. Attention was first directed to a closer examination of the cast through the discovery of the central bristle in the sections. Under a low power (× 37), which was used for general drawings, these fine structures escaped notice, but a higher power never failed to bring them out. In the several camera drawings (Figures *A–D*) are shown some of the differences in arrangement and distribution that occur in several regions of the body. The sense organs are most abundant, although of inferior size, in the large pavement scales covering the

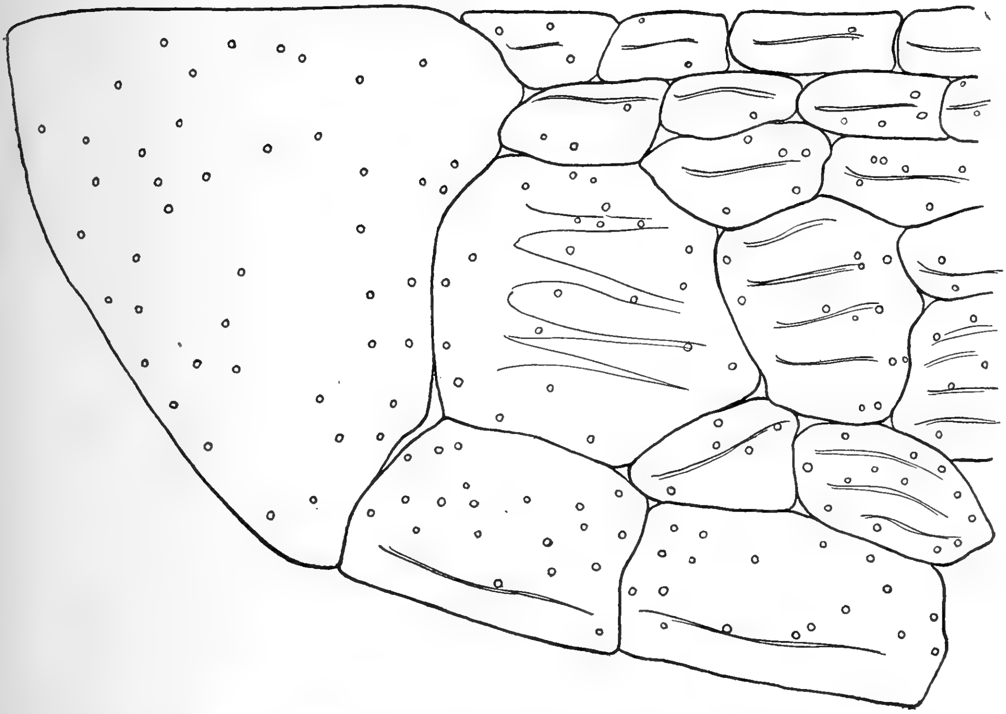

FIG. A.— Pavement scales covering the right half of the anterior end of lower jaw; the position of sense buds is shown by the circles; each bud possesses a tactile "hair," which is visible under higher magnification.

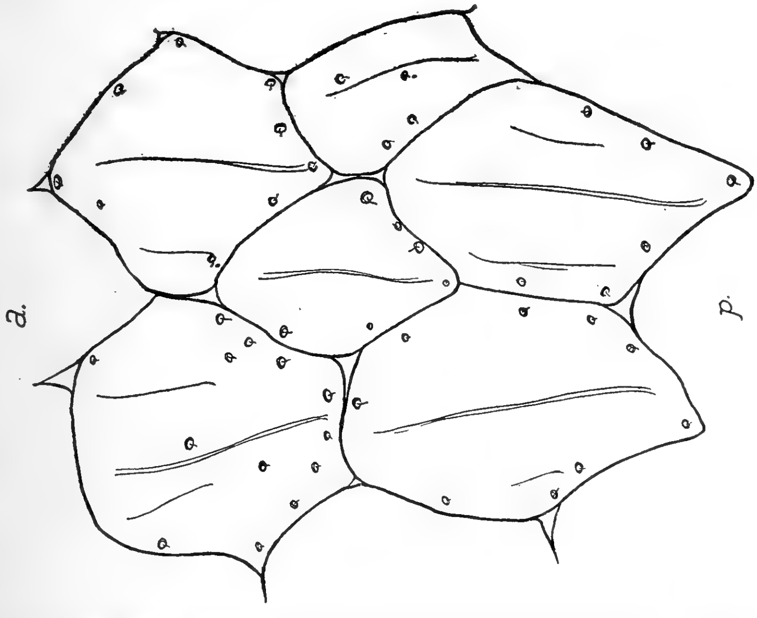

FIG. B.— Pavement scales from frontal region of the head, showing that the sense organs are arranged near the margin of the scales.

upper and lower jaws (Figure *A*). Where the scales show a tendency to be imbricated, as they are on most of the body region, the organs are situated on the thicker caudal border of each scale, the bristles projecting backward. From one to three were found on each scale

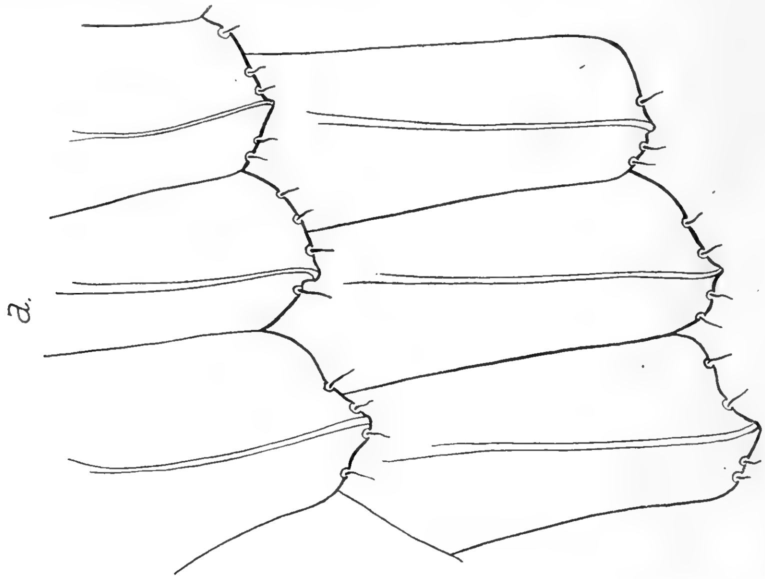

FIG. C.— Imbricated scales from the ventral tail region, showing sense organs at the posterior margin of the scales.

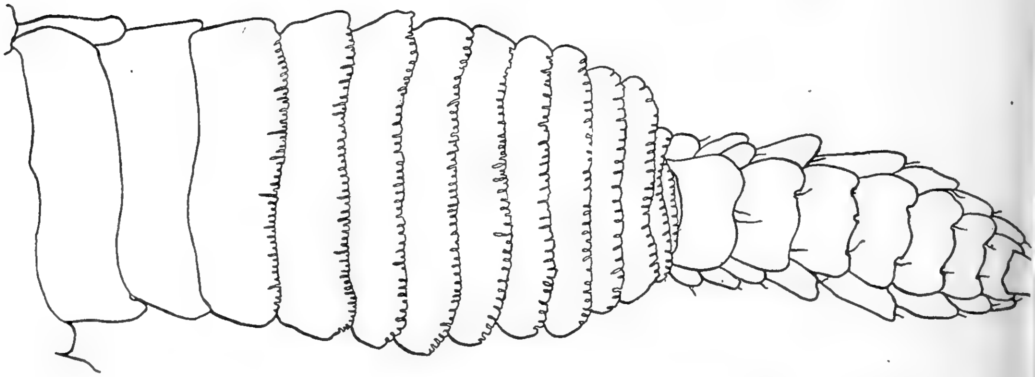

FIG. D.— Ventral surface of a portion of a fore-foot digit. The terminal part shows the "hairs" projecting from the distal edges of the scales; the subterminal part, where the tactile "hairs" are absent, shows the position of the adhesive organs.

in the dorsal cervical region, while they are more abundant in the dorsal tail region (Figure *C*). The scales from the frontal region of the head (Figure *B*) show a distribution of sense organs intermediated between Figures *A* and *C*. An exception should possibly be made to the statement of their universal distribution, for they are apparently absent from that part of the digit which is provided with adhesive organs, "suckers," but they appear again on the small terminal part of the digit, where the bristle projects well beyond the imbricated margin of the scales (Figure *D*).

The structure of this tactile organ is described here only in so far as it was shown in the material prepared for general study. The fixation in Vom Rath's fluid is of course excellent, but it precludes varied staining methods, and certain differences that might thus have been brought out have not been observed. In section these organs are very inconspicuous, and if they did not interrupt slightly the free and basal margins of the epidermal layer, they would escape notice in the unstained osmic-fixed sections. In nearly all regions the corneous layer of the skin is slightly parted from the underlying epidermis and the abrupt thinning of this layer where it covers the tactile spot is more conspicuous than the organ itself. The modification in the horny layer, aside from the bristle, is effected more by the projection of the sense bud into this layer than by a depression of the circular area covering the bud. The cuticular bristle projects from the center of this circular area. It is slightly tapering, ending in a fine point. No structure could be recognized within this, nor any indication of how it is produced. The full length of these structures is not often preserved in sections. Those found in sections measure up to 20 micra in length. The surface view shows them somewhat longer; however, the text figures do not represent them with accuracy on this point. The structure of the organ itself agrees closely with that of Coronella (Maurer, **'95**), with this difference, however, that the column of cells forming the tactile end organ (*t*) could not be identified as a definite and separate structure. The continuity of the basal layer of the epidermal cells is interrupted by a ball of very small cells with rounded nuclei forming a bud which projects beyond the limits of the other cells and this approaches nearer to the free surface of the horny layer. Should the corneum be stripped off in Coronella (see Maurer), the tactile spots would appear in it as in Anolis. Despite the fact that all the other published figures show it, the innervation was not determined in Anolis beyond the fact that medullated fibers are often found directed through the corium toward the organ. Pieces of integument were stripped off in the fresh condition, stretched out, and stained with osmic acid, but with no more definite results. The skin is seen to be richly supplied with medullated nerve fibers, but their distribution is not of such pattern as to point out these organs. It seems probable that the nerves innervating these organs lose their sheaths before reaching the epidermis. The exact innervation of these organs should not be difficult to determine by one of the finer histological methods, and offers an interesting problem.

H. VISCERAL END ORGANS.

The organs in which visceral nerves terminate, both efferent and afferent, include glands and smooth muscle fibers for the former and specific visceral sense organs and mucous membrane epithelium for the latter. As no methods were employed to determine the actual nerve terminations, a detailed description of these structures at this time would have no significance for the general descriptive anatomy of the cranial nerves which follows. In Anolis the mucous membrane of the mouth cavity, the pharynx, and the nasopharynx presents a variety of conditions in different regions which are demonstrable without the use of special staining methods. It is throughout richly glandular, the glands having the simple vesicular or tubular type along the gums and the tongue, while in the postlingual region the epithelium is ciliated and has a rich supply of unicellular glands of the goblet-cell type.

The taste buds are confined almost entirely to the mouth cavity proper, although an occasional bud was found in the region of the larynx (Plate **4**, Fig. 11, *gm. gus.*). They have the structure which is typical for these organs elsewhere, possessing a well-defined gustatory pit, in the base of which the sensory cells terminate. These taste buds are distributed along areas which stand out as sensory-glandular patches along the roof of the mouth and inner gums of both upper and lower jaws (Plates **4**, **5**, Figs. 9–12, *gm. gus. m.*, *gm. gus. l.*). Their position is shown by the course of the sensory rami of nerve VII (palatine and chorda tympani). No taste buds were found on the tongue itself. Whether there are other sensory buds besides taste buds, was a question that suggested itself through the presence of clumps of cells which lacked the gustatory pit and were less sharply defined but were not like glands in their structure. The fact of importance in connection with visceral end organs is that typical gustatory buds are readily demonstrated, and their distribution fully determined in the series of sections from which the study was made. Upon this are based certain conclusions as to the nature of some of the branches of nerve VII.

I. MUSCLES.

1. Muscles of the Orbit.

This group includes the muscles of the eyeball proper and those of the eyelid, or their derivatives. The former are the dorsal, ventral, anterior, and posterior recti, and the dorsal and ventral oblique, together with the m. retractor oculi and m. bursalis. Those of the eyelid consist of the m. depressor palpebrae inferioris and its specialized part, m. protrusor oculi (Bruner).

Mm. rectus posterior (*externus*), *bursalis, and retractor oculi.* Not only in their innervation but also in their skeletal connections, these muscles form one group, having a more posterior origin than any of the other muscles of the eyeball. The bursalis (*brs.*) and the retractor oculi (*rtr. oc.*) arise close together within the basisphenoid bone (Plate **6**, fig. 16), that of the bursalis being on the inner lateral surface of the bony cap containing the distal end of the pituitary body. The area of origin of the fibers of the retractor forms a median forward continuation of that of the bursalis; the two muscles then run rostrad together into the orbit, where they separate (Plate **5**, figs. 14, 15). The bursalis fibers bend rather sharply dorsolaterad within the orbit to be inserted on the posterior median side of the eyeball, thus offering a sort of loop through which passes the tendon from the nictitating membrane (Plate **5**, fig. 14, *tnd. mb. nic.*).

The retractor oculi passes directly forward across the floor of the orbit as a relatively slender muscle to be inserted on the median side of the eyeball anterior and ventral to the optic nerve (Plate **5**, figs. 13, 14).

Somewhat anterior to the origin of these the posterior rectus arises from the presphenoid bone (*presph.*) along the median line and passes directly out around the posterior side of the orbit to its insertion on the eyeball (Plate **3**, fig. 7 and Plate **5**, fig. 15, *rt. p.*).

Mm. recti dorsalis and ventralis. These muscles arise at the same cross-section level as the rectus posterior, but dorsal to it, from a median fascia between the presphenoid and a cartilaginous rod which continues forward from the inner lamellae of the basisphenoid bone Plate **5**, fig. 15, *rt. d.*, *rt. v.*). The one passes dorsal to the optic nerve, he other ventral, and each spreads out into a broad fan-like insertion n the dorsal and ventral sides of eyeball respectively (Plate **5**, figs. 2, 13).

M. rectus anterior (*internus*) has its origin around the cartilaginous rod mentioned in the preceding paragraph, a little anterior to the others and dorsal to the optic chiasma. This muscle is flattened out against the median connective-tissue septum which forms the common floor of the orbits, so that the muscles of the two sides are close together and parallel, inclosing between them the cartilaginous bar. It has a wide insertion on the anterior side of the eyeball (Plate **5**, figs. 12, 13; Plate **4**, fig. 11, *rt. a.*).

Mm. obliquus dorsalis and obliquus ventralis. Both oblique muscles (*ob. d.*, *ob. v.*) arise at about the same level along the cartilaginous bar which is a continuation of the interorbital septum, their fibers diverging to their respective insertions on the eye ball (Plate **4**, figs. 10, 11; Plate **5**, figs. 12–14). The dorsal oblique takes origin from two distinct bundles (Plate **4**, fig. 11), the ventral thickened edge of the muscle beginning as a separate bundle, which has a tendinous origin anterior to that of the inferior oblique (Fig. 10 and Fig. 7). As nerve IV reaches the dorsal oblique, crossing the orbit mesad to the dorsal rectus, it divides to innervate by one part this ventral portion, while the rest of the nerve passes across the muscle a little distance to innervate the more dorsal and anterior part. There is in the muscle, however, no apparent separation into two bundles at the level where this distinction in innervation occurs (Plate **5**, fig. 12, *IV*).

Somewhat in contrast with the uniformity of the six principal eye muscles of vertebrates, is the variability in occurrence and structure of the accessory muscles which arise from them. Osawa (**'98**, p. 536) describes for Hatteria a retractor oculi muscle only, but from his description it is evident that he has found practically the same conditions as exist in Anolis, for he states that it is inserted "mit zwei Portionen an der Umgebung der Eintrittsstelle des N. opticus und an der laterale Fläche des Bulbus etwa in der Gegend des Aequators." This would indicate the presence of a bursalis muscle included in his retractor oculi. He (**'98**, p. 537) describes the innervation of m. retractor oculi in Hatteria as follows: "Der M. retractor oculi weist in der Innervation eine Eigenthümlichkeit auf insofern, als er am Ursprung einen Zweig aus dem N. abducens und in seinem weiteren Verlauf mehrere kleine Zweige vom Ganglion ciliare bekommt." The probability of such innervation in Anolis is discussed in connection with the ciliary nerves (p. 46).

M. depressor palpebrae inferioris. This is the muscle first described by Bojanus (**'19**) for the turtle as the m. palpebralis, and later by Fischer (**'52**) as the m. adductor maxillae, and finally by Weber (**'77**) as the m. depressor palpebrae inferioris. Bradley (**:03**), in analyzing the musculature with a view to explaining its relation to the masticatory movements, recognizes in several of the lizards a double function for this muscle, as suggested by the fact that some of its fibers are inserted on the lower eyelid, while others appear to have their insertion in the "fibrous membrane circumscribed by the pterygoid, palatine and the transverse bones" (p. 481). This is also brought out more fully by Bruner (**:07**),[1] who, in looking in the head musculature for an apparatus to control the flooding and distension of the orbital blood sinuses, discovered that a part of this muscle was completely differentiated into a *m. protrusor oculi*, and records its occurrence in eleven lizards, including Anolis. It is apparent, however, from a study of several series of sections that the two are not completely distinct morphologically in Anolis, as the following description will indicate. It seems probable, however, that the two functions as described by Bruner are here subserved. The following is the condition in Anolis:— the thin layer of striated muscle (Plate **3**, fig. 7; Plates **4**, **5**, figs. 11–15, *protru. oc.*, *dep. palb. if.*) which lines the floor of the orbit ventromesad to all other orbital structures has two distinct origins; one (*protru. oc.*) is from a slender tendon attached to the membranous wall of the cranium just anterior to the bony part on a level with the Gasserian ganglion (Plate **3**, fig. 7; Plate **6**, fig. 16). This tendon passes down mesad to the columella (epipterygoid) and is continuous with a muscle band which lies closely applied to the membranous region (Plate **5**, figs. 14–15) referred to by Bradley. While some of its fibers may be inserted here, most of them continue and spread out to form the anterior part of the broad palpebral muscle with insertion on the lower lid. This is best shown in the dissection (Plate **3**, fig. 7). The second origin, ventral to that of the first, is from the fascia on the ventral face of the bursalis muscle; this band crosses ventral to the posterior rectus muscle (Plate **3**, fig. 7; Plate **5**, fig. 15, *dep. palp. if.*) and turns sharply to form the posterior half, or more, of the palpebral muscle. The two bundles of origin include between them the jugular vein and suborbital sinus of the same side. The innervation of these muscles favors the view of a double function, and suggests for a part f it at least a more visceral function, such as that assigned to it by Bruner. This will be described in detail in connection with the acount of the nerves (p. 50).

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[1] **Bruner does not mention the earlier recognition of this muscle by Bradley.**

2. Muscles of the Tongue.

The tongue musculature consists of a set of longitudinal muscles and an interlacing system of intrinsic fibers inserted on its mucous membrane perpendicularly to the surface. The longitudinal muscles consist of *m. genioglossus* (*gen–gls.*) and some others, to which specific names will not be given. The genioglossus muscle is a paired structure having its origin along a considerable extent of the cerato-branchial I. (Plates **5–7**, figs. 13–22; Fig. *E*). These bands passing forward form rounded bundles extending the full length of the tongue and are more or less surrounded by the other tongue muscles. Ventrally, however, they are bounded by large lymph sinuses, which leave the tongue attached by only its lateral muscular walls and thus permit its free movement and change of form (Plate **4**, figs. 9–11).

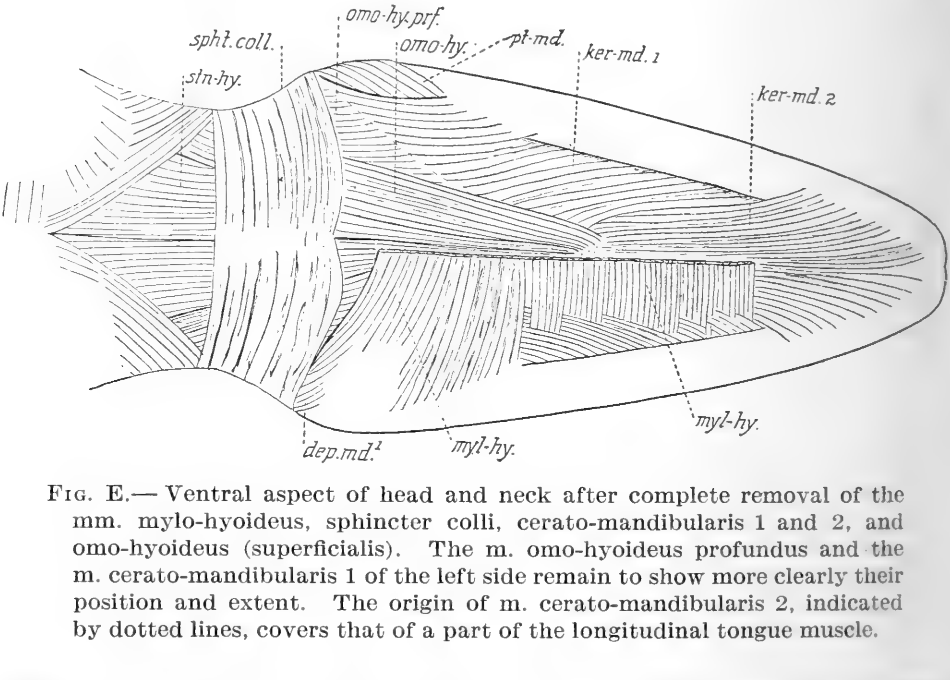

Fig. E.— Ventral aspect of head and neck after complete removal of the mm. mylo-hyoideus, sphincter colli, cerato-mandibularis 1 and 2, and omo-hyoideus (superficialis). The m. omo-hyoideus profundus and the m. cerato-mandibularis 1 of the left side remain to show more clearly their position and extent. The origin of m. cerato-mandibularis 2, indicated by dotted lines, covers that of a part of the longitudinal tongue muscle.

Two other longitudinal muscles may be recognized. These are not separable in their origin, but differ in their anterior attachment. They arise on the ventral face of the genioglossus (Fig. *E*) at about the level of the larynx, and the bundles are increased by fibers springing apparently from the connective tissue underlying the mucous membrane lateral to this muscle (Plate **5**, fig. 12, *lng. lg.*) Passing forward this divides into two bundles with different relations to the tongue.

One (Plate **4**, fig. 9, *lng. lg. 1*) forms the lateral wall of the tongue at its base and continues forward in the same relative position finally to dwindle out in the mucous membrane anterior to the sublingual gland (Plate **4**, fig. 8). For practically its whole distance it is closely adherent to the mucous membrane lateral to the tongue proper. The second part of this muscle (*lng. lg. 2*) separates from the ventro-median side of the common bundle and has nothing to do directly with the tongue or mucous membrane. It passes forward as a free bundle to be attached to the anterior end of the mandibular ramus (Fig. *E*). Its action is to pull the base of the tongue forward. In addition to these longitudinal muscles there is an intrinsic musculature. A detailed analysis of this is not attempted, but it is somewhat as follows: — At about the level of the larynx there appears in cross sections a mass of transverse fibers (*lng. t.*) applied to the dorsal face of the m. genioglossus and a mass of vertical fibers (*lng. vrt.*) on the median side of the same muscle (Plate **4**, figs. 10, 11). Farther cephalad this intrinsic tongue musculature becomes what might be called a vertical decussating system; these fibres, originating along the median side of m. genioglossus and around the glossohyal, cross the median plane just dorsal to the latter and radiate up into the long lingual papillae, which are well developed in the subterminal region of the tongue (Plate **4**, fig. 9).

The innervation of the tongue musculature is from the main bundle of nerve XII, although a part of this innervation occurs distal to the anastomosis of XII with lingual V, making an analysis by means of sections impossible. However, other facts, to be referred to later, support the assumption that lingual V provides a general cutaneous sensory component to the papillae and mucous surface in the anterior part of the mouth cavity, that the chorda tympani comes in with it to innervate the taste buds, and that XII innervates the tongue musculature.

3. Muscles of the Hyoid Apparatus.

M. cerato-mandibularis 1 (*ker-md.*^{1} = mylohyoides, Sanders). This a broad, rather thin muscle (Figs. *E, F, G*) having its origin long the inner margin of the dentary bone and inserted along the hole extent of the cerato-branchials I.

M. cerato-mandibularis 2 (*ker-md.*^{2}). This is a compact bundle ig. *F*) having its origin on the ventral face of the anterior end of the mandibular ramus near the median line and its insertion on the basihyal. In section it appears as a median part of m. cerato-mandibularis 1, except anteriorly, where it extends forward beyond the origin of the latter.

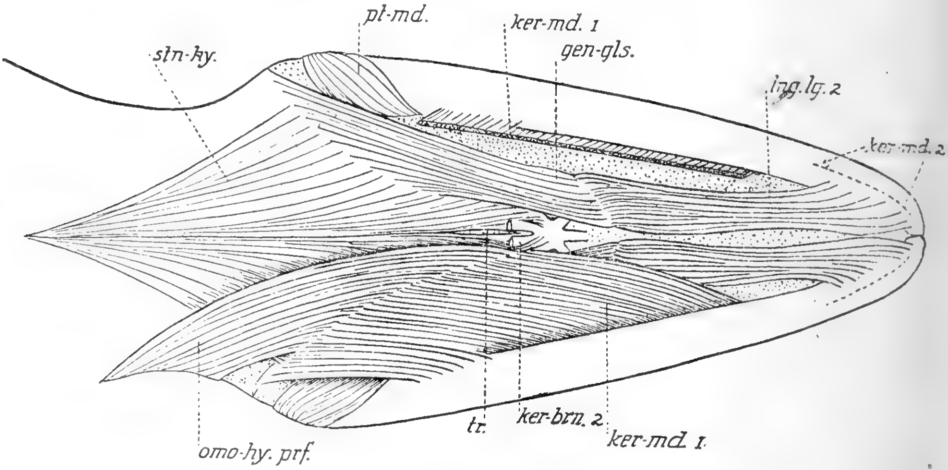

Fig. F.— Ventral aspect of the head and neck with integument removed to show the superficial muscles. The right half of the mylo-hyoideus muscle is also removed exposing the underlying muscles.

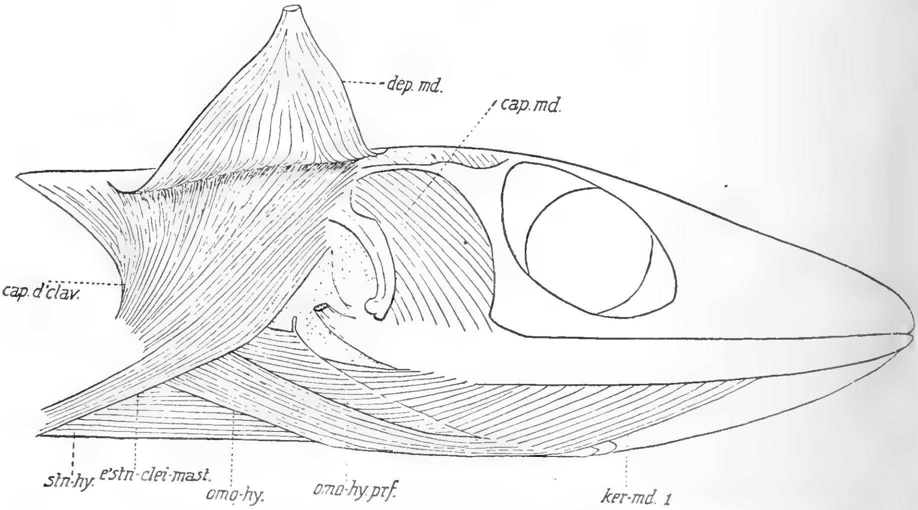

Fig. G.— Right lateral aspect of the head with the mm. mylo-hyoideus and sphincter colli removed; digastric muscle (*dep. md.*) is cut at its insertion and turned up.

M. cerato-mandibularis 3 (*ker-md.*^{3}). This is a very small muscle band, to which the above name is applied because, like the other two, it extends from the mandible to the hyoid apparatus. This, however, is a perfectly distinct muscle, having its origin under cover of m. cerato-mandibularis 1 about half way along the jaw, and being inserted near the distal end of the cerato-hyal instead of the cerato-branchial (Plates **5**, **6**, figs. 13–19). No corresponding muscle has been found in any of the descriptions of saurians.

The innervation of the above three muscles is from nerve XII, which passes across the deeper surface of the first described portion (*ker-md.*^{1}); two branches are given off here, the anterior of which runs cephalad to supply also the anterior muscle (*ker-md.*^{2}). The small bundle (*ker-md.*^{3}) is innervated by an independent ramus, directly from XII.

M. ceratohyoideus = *hyoglossus* (*hy-gls.*). This is a muscle (Plates **5**, **6**, figs. 13–19) extending between the first and second horns of the hyoid apparatus (i. e., between cerato-hyal and cerato-branchial I). The attachment on the latter is more extended than that on the cerato-hyal, so that the muscle sheet is much thinned posteriorly, consisting of fine bands somewhat separated from one another. The pharyngo-laryngeal branch of IX + X (*phx-lar.*^{1}) passes along the superficial face of this muscle between it and m. genioglossus. It is innervated by motor fibers carried in this branch (Plate **2**, fig. 5), which might indicate either a visceral origin for the muscle or the presence of fibers from XII in the nerve.

M. omohyoideus (*omo-hy.*). This (Figs. *F-G*; Plates **6**, **7**, figs. 16–24) has its origin on the shoulder girdle along the clavicle, extending to near the median line, and passes forward as a broad sheet slightly converging with its mate to be inserted on the cerato-branchial I along almost its entire length and also on the basihyal. The fibers with the latter insertion form a bundle which, through a difference in direction, differentiates the superficial part (*omo-hy.*) from the deeper part (*omo-hy. prf.*), a distinction of slight importance in this form.

M. sterno-hyoideus (*stn-hy.*). The removal of m. omohyoideus uncovers a muscle (Plate **5**, figs. 13–15) which takes its origin from the sternum, the muscles of the two sides having a common median origin. The insertion is along the cerato-branchial I, co-extensive with that or the omohyoideus, but at a deeper level. At the angle of cerato-ranchials I and II (Plate **5**, fig. 13) the fibers of the median edge of terno-hyoideus turn mesad to be inserted on the base of cerato-ranchial II, on both the ventral and dorsal sides. The median edges f these muscles are the thickest and they spread out fan-shaped from edian origin to insertion on the cerato-branchial I. A little of the achea (*tr.*) is exposed just caudad to the basihyal, as is shown in igure *E*.

The innervation of the two preceding muscles is from the ventral ramus of the first spinal nerve, which passes between m. sternohyoideus and m. omohyoideus to supply both (Plate **7**, fig. 22; Plates **2, 3**).

4. MUSCLES OF THE JAW AND NECK.

M. pterygo-mandibularis (Bradley). This is the muscle (Plates **5, 6**, figs. 14–19, *pt-md.*) generally described as the external pterygoid. It is best seen from the ventral side with the roof of the pharynx removed (Fig. *I*). Its origin is along the entire posterior edge of the main portion of the pterygoid bone, and chiefly by means of a strong tendinous fascia that is continuous with the muscle sheath on the ventral side. The most posterior fibers have a fleshy origin along the posterior wing of the pterygoid. The insertion of this muscle is on the angulare and articulare over the entire ventral plate as well as on the dorsal face of the median extension of these bones (Plate **6**, fig. 19). Those muscle fibers that pass around the ventral side of the jaw to an extreme lateral insertion have their origin along the surface of the tendinous sheath instead of extending to the pterygoid bone.

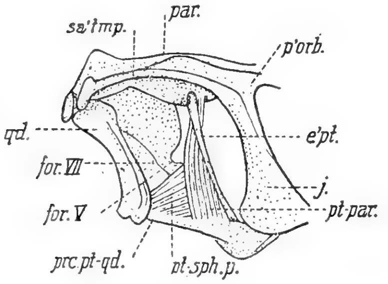

Fig. H.

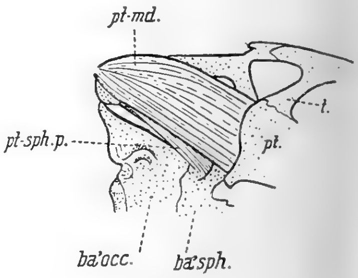

Fig. I.

Fig. H.— Right lateral aspect of a portion of the skull to show attachments of the deeper muscles, m. pterygo-parietalis and m. pterygo-sphenoidalis posterior.

Fig. I.— Ventral aspect of a portion of the right half of the skull with mandible removed to show m. pterygo-mandibularis. This really covers the m. pterygo-sphenoidalis posterior, but is slightly displaced to show the position of the latter.

The innervation (Plate **3**, fig. 6, *pt-md.*) is from a ventral twig of the same ramus of mandibular V which innervates the deeper portion of the m. pterygoideus.

M. pterygo-sphenoidalis posterior (*pt-sph. p.*, Figs. *H, I,* Plate **6**, figs. 16, 17) of Bradley. The following is Bradley's (:**03**, p. 478) description for this muscle in Varanus: — "This is a triangular muscle arising by its apex from that part of the basisphenoid which forms the lower boundary of the notch whose upper limit is established by the proötic bone and into which the Gasserian ganglion projects,. . . . Insertion to the full extent of the upper and lower surfaces of the pterygoid bone from its posterior extremity to as far forward as a level with the articulation between the basipterygoid process of the sphenoid and the pterygoid." With this Anolis agrees quite closely; in the latter the origin is also from the basipterygoid process of the sphenoid, and its insertion is along the whole length of the pterygoquadrate.

The innervation is from a motor ramus separating itself from the other motor components at the Gasserian ganglion (Plate **3**, fig. 6; Plate **6**, figs. 16, 17).

M. pterygo-parietalis of Bradley. (Fig. *H;* Plate **6**, fig. 16, *pt-par.*) This muscle lies just posterior to the epipterygoid bone and its tendinous origin passes mesad of the latter to attach to the edge of the parietal, while its fibers take a direction that diverges somewhat from the epipterygoid and find insertion on the pterygoid just mesad to that of the deeper part of the pterygoideus, that is, on the upper surface of the pterygoid bone immediately caudad to the articulation of the epipterygoid.

Bradley homologized these two muscles, pterygo-parietalis and pterygo-sphenoidalis posterior, with muscles described by Katheriner (**:00**) in the snakes under the same name, and calls attention to the fact that there are but two references to them found by him in the literature of the Saurians, viz., Stanius (**'56**) and Sanders (**'70**). Hoffmann (**'79–90**) does not refer to them in his description of Reptilia given in Bronn's Thier-reich. Bradley, therefore, concludes that these muscles are peculiar to snakes and to those lizards (Kiokrania) which have a columella (epipterygoid).

In Anolis m. pterygo-parietalis also has a special motor-nerve ramus (Plate **3**, fig. 6, *pt-par.*) leaving the main motor bundle through the ganglion.

M. capiti mandibularis (temporalis). (Plates **5**, **6**, figs. 14–19, *cap. md.*) The origin of this large muscle is from the postfrontal, jugal, postorbital, supratemporal, parietal, proötic, and quadrate bones. The superficial part of the muscle shows a parallel sheet of fibers running diagonally down to the lower jaw. The deeper portions, however, show toward their insertions a tendency to differentiate into several bundles. When the quadrato-jugal arch is removed, it is shown that the fibers having origin on the median face of the jugal and postfrontal converge to a tendinous insertion on the coronoid bone of the lower jaw. There is also a tendinous fascia at the dorsal end of the quadrate, which extends forward on to the parietal. In large part the fibers have a fleshy insertion along the complementare. The innervation (Plate **3**, fig. 6, *cap. md.*[1] and *cap. md.*[2]) is from several motor rami which leave ramus mandibularis V just distal to the Gasserian ganglion.

M. pterygoideus (internal pterygoid). It is difficult clearly to delimit this muscle from the foregoing, as that part of its origin on the parietal is simply a continuation of the area of origin of m. capiti mandibularis; the part of it originating along the epipterygoid (Plate **6**, fig. 16, *pt.*[1]), known as the "deeper portion," forms a mass of fibers more vertical in direction and innervated by a branch of the ramus which also innervates the m. pterygo-mandibularis. The portion described by Bradley as the "superficial" part (Plates **5**, **6**, figs. 14–16, *pt.*) originates from the parietal and upper end of the columella, its fibers converging to a tendinous insertion on the coronoideum mesad to that of m. capiti mandibularis. With the pterygo-mandibularis removed, the deeper part of the pterygoideus is well demonstrated from the ventral aspect, where it appears as a flat band extending from nearly the whole length of the epipterygoid to be inserted mesad to the superficial part.

M. sphincter colli (*spht. coll.*, Fig. *F*). This is not a well developed muscle in Anolis and is very easily torn off with the skin. Its fibers are so little massed that the innervation is very difficult to determine, except by means of the dissection of preparations blackened in osmic acid. The fibers have their origin superficial to the digastric, they cover this muscle to some extent and, forming an extremely thin band, pass as a continuous bundle to the opposite side. The distinctness of this muscle is emphasized in the figure. In the median ventral region its fibers pass dorsal to cerato-branchials II, where they are interrupted by fascia, and some of them dip under the fibers of the ventral longitudinal muscles so that it becomes impossible to dissect the sphincter colli free along the ventral median line. Its innervation (Fig. *J*) is from a very fine bundle of the ventral division of motor VII.

In Anolis this muscle does not take any part in bounding the external auditory meatus, nor does it form a "Schliessmuskel," as described by Versluys (**'98**) for some of the Geckoniden.

M. mylo-hyoideus (intermandibularis). This muscle (Fig. *F*, *myl-hy.*) is also very thin and similar to the sphincter colli, although not so attenuated as the latter. It forms a sheet of muscle extending from one ramus of the mandible to the other, and reaching from the articulare to the anterior fourth of the mandible, thus covering all of the intermandibular space except a small anterior area. From the figure it is seen that the posterior half of the sheet has its origin on the ventral side of the mandible, while the anterior half is inserted on the median face of that bone. Many of the fibers from the latter pass underneath those of the cerato-mandibularis, so that there is an interlacing of these two muscles along the inner border of the mandible. The innervation is from the anterior fibers of ramus hyoideus VII and from two or three rami of the mandibular V (*myl-hy.*, Fig. *J.*), which leave the main trunk as mixed nerves (Plate **2**, fig. 5; Plate **3**, fig. 6, *myl-hy.*).

Versluys (**'98**, fig. 60–62) figures the m. mylo-hyoideus of *Mabuia multifasciata* as dovetailing with the cerato-mandibularis, as in Anolis.

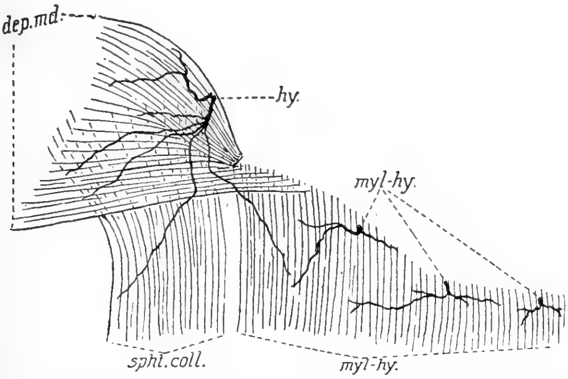

FIG. J.— Camera drawing of the distribution of the motor rami of the facial nerve and the motor rami of the trigeminal nerve that are carried in the ramus mandibularis. From a preparation made by removing sphincter, digastric, and mylo-hyoideus muscles from a specimen fixed in vom Rath's solution; the muscles are retained in their relative positions to one another and mounted for microscopic examination. The nerve fibers are all well blackened as far as the myelin extends. The preparation is viewed from its deeper surface. Three rami from the fifth nerve are shown in this figure, whereas only two appear in the plotting (figures 5 and 6 of Plates **2** and **3**). Although not demonstrated, it is probable that the two more anterior rami arise from a common branch of the mandibular ramus, which corresponds to the second ramus of the mylo-hyoideus shown in figs. 5 and 6, Plates **2** and **3**.

The muscle described as the posterior part of the mylo-hyoideus is designated by Versluys as the m. intermandibularis. This is the part innervated by a branch of VII.

M. depressor mandibulae (digastric). This (*dep. md.*) is a well-developed, but not a powerful muscle in Anolis. It is broad and fan shaped, having its origin from the parietal ridge and neck fascia along an irregular line which anteriorly lies near the median plane, but posteriorly assumes a more lateral position (Fig. *G*). All the fibers converge to the articulare of the lower jaw, where most of them are inserted at the extreme posterior point by means of a ligamentous attachment. A thin band (*dep. md.*[1]), however, passes around to the ventral side and a little farther cephalad finds attachment in the fascia which also serves for the posterior fibers of m. mylohyoides (Figs. *F* and *J*). The anterior border of this muscle (Plate **3**, fig. 7, *dep. md.*) forms the posterior border of the external auditory meatus and is the thickest and strongest part of the muscle. This portion is roughly separable from the sheet-like part behind it and has a firmer origin in the skull, the thinner portions behind arising from the neck. The tympanic chamber extends backward underneath this muscle (Plates **6**, **7**, figs. 19–24).

The innervation of this muscle is wholly from motor VII, which supplies it by two main branches (Fig. *J*).

Versluys (**'98**, p. 285) refers to the thinner posterior portion as occurring in many Lacertilia. It corresponds to the "superficial" portion and C_2 *md* of Ruge (**'97**, p. 326–331) for Varanus. The thicker part is the "Hauptportion" of Versluys.

M. episterno-cleido-mastoideus (Versluys) capiti-cleido-episternalis, (Watkinson). This muscle (*e'stn-clei-mast.*), which extends from the skull, having its origin underneath the main part of the m. depressor mandibulae, passes caudo-ventrad to be inserted on the sternum (Fig. *G*). It forms a thickened ventral border to the cucullaris muscle, next to be described, and has the same innervation (Plate **7**, fig. 24).

M. capiti-dorso-clavicularis (trapezius, or cucullaris). The fibers of this muscle (Fig. *G*, *cap. d'clav.*), have the same direction as the preceding, but both origin and insertion are different. It is an extremely thin sheet of fibers having origin underneath the thin posterior part of the m. depressor mandibulae and being inserted on the pectoral girdle. The line of origin extends well back past the level of insertion, so that the most posterior fibers are directed forward. It does not form a continuous sheet, but between the successive bundles are spaces which leave exposed the underlying lymph sac (Plate **7**, fig. 24, *sac. en'lym.*). These spaces are not indicated in figure *G*.

The innervation of the two foregoing muscles is from two or more spinal nerves, (Plates **2** and **3**, figs. 4, 6, *spi. v. 3*) the first muscle being supplied wholly from the motor part of the third spinal nerve, which comes out to the muscle as a mixed lateral ramus. The sensory part passes through this muscle and is distributed to the ventral skin region. Three branches of spinal nerves are shown to innervate the cucullaris muscle; their precise relation to particular spinal nerves was not determined owing to apparent anastomoses of rami. No relation that would suggest an innervation from a spinal accessory nerve was established with any nerves anterior to spinal II.

M. laxator tympani of Versluys (*lax. tym.*). A very small muscle, less than one half mm. in length, extends caudad from the insertion of the tympanic ligament on the extra-columella (Plate **7**, figs. 21, 22). Its fibers end on the connective-tissue covering of the parotic process. The motor component of nerve VII passes ventral to the posterior end of this small bundle and in contact with it. The series of sections did not show with certainty the innervation of this muscle from motor VII, but a few fibers are given off from the main nerve bundle which in all probability accomplish such innervation. This is the more probable because there is no other nerve in the vicinity. Owing to its minute size this muscle was not isolated in dissection, but is a constant feature of the sections.

This muscle was first described by Versluys (**'98**) and given the name descriptive of its function. He found it in a number of lizards, all members of the family Geckonidae, while he failed to discover it in as many others, which belonged to different families. No more positive statement of its innervation than is here given for Anolis is contained in Versluys's account.

M. constrictor venae jugularis internae of Bruner (*co'st. vn. j. i.*). In Anolis this muscle is found in relations similar to those described by Bruner (:**07**, p. 42) for Phrynosoma. These striate muscle fibers urround the internal jugular vein or a distance of .84 mm. The most anterior fibers, for a distance f .14 mm., have their origin from he most posterior portion of the arotic process (Plate **7**, fig. 23, *rc. pa'ot.*) and from the ligamentous extension of it. These anterior

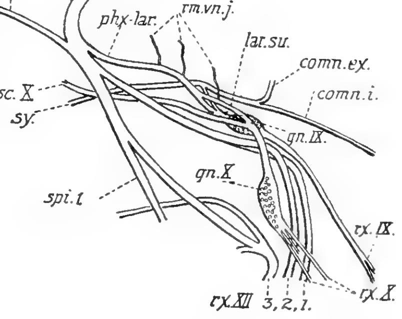

FIG. K.— Frontal projection, dorsal aspect, of nerves IX and X of the left side, showing the region of the roots and ganglia only, together with their connections. Plotted from Anolis, transverse series 48a. Two tumefactor nerves (*rm. vn. j.*) are given off from the ramus pharyngo-laryngeus and one from the ramus superior laryngeus.

fibers surround the vessel in a circular manner. For the remainder of the distance the fibers are diagonal or longitudinal to the wall of the vessel. Here the latter lies in immediate contact with the thymus gland.

The muscle is innervated by some very fine rami (not included in plotting) from X and IX + X (Fig. *K*, *rm. vn. j.*), as was determined by study of the sections. Some undetermined rami appearing in the dissection (Plate **3**, fig. 7) are probably of like function.

J. OCULOMOTOR NERVE.

The oculomotor nerve (*III*) arises from its nucleus of origin in the floor of the aqueduct of Sylvius and emerges as one large root from the ventral side of the mesencephalon (Plate **2**, fig. 4). It swings laterad and cephalad to pass out of the cranium through the membranous wall, being covered laterally at this point by the bursalis muscle. (Plate **6**, fig. 16). Posterior to the origin of the recti muscles the nerve divides into three large rami; the dorsal one goes to the dorsal rectus; a large ventral one, which later divides (Plate **5**, fig. 14, *III*), supplies the ventral rectus, the anterior rectus and the ventral oblique; between these two large rami is the short root of the ciliary nerve. The latter is composed chiefly of fine neuraxons, which may be recognized as a distinct bundle in the center of the main trunk from the point where it emerges from the brain to its separation from the somatic motor components as the ciliary root. Within the brain itself it could not be independently traced in this series.

The branch of nerve III to the dorsal rectus muscle (Plate **2**, fig. 4, *rt. d.*) is a large one. It follows the lateral face of this muscle near its anterior ventral edge (Plate **5**, fig. 14), several successive bundles of fibers being given off to accomplish the innervation of the muscle.

The large ventral ramus (Plate **5**, fig. 15, *III*) passes mesad of the retractor oculi to attain a position on the ventral face of the ventral rectus muscle. It is in this part of its course that a group of long rami separate from it, and penetrate the ventral rectus from both the dorsal and ventral surfaces (Plate **2**, fig. 4). The remainder of the nerve (Plate **5**, fig. 14, *III*) passes cephalad close to the median line, dividing to send more than half of its fibers dorsally into the anterior rectus (Plate **5**, fig. 13, *rt. a.*), the remainder passing on to the ventral oblique (Fig. 13, *ob. v.*).

K. TROCHLEAR NERVE.

Nerve IV (Plate **2**, fig. 4, *IV*), from its nucleus of origin on the side of the aqueduct floor opposite to that of its emergence, passes dorsad of the mesocoele directly to the surface, the whole central course showing in a single transverse section. Peripherally it turns cephalad for a short intracranial course, lying between the brain and the Gasserian ganglion. It then passes through the membranous cranium, but keeps a median position throughout its course, to the dorsal oblique muscle, which receives all of its fibers (Plates **5**, **6**, figs. 12–17).

L. ABDUCENT NERVE.

The central origin of nerve VI (Plate **2**, fig. 4, *VI*) in the metencephalon was readily found. The neuraxons leave this part of the brain in small groups as large heavily medullated fibers. These emerge from the ventral side of the brain in small rootlets, which immediately combine into one main trunk. After a short intracranial course nerve VI enters the sphenoid bone and takes a course cephalad through a special foramen between the outer and inner lamellae of this bone, and dorsal to the beginnings of the basipterygoid process of the sphenoid (Plate **6**, fig. 17). This foramen opens mesally into the bony pocket protecting the ventral end of the pituitary body and at the point of origin of the bursalis and retractor oculi muscles. Nerve VI passes through these muscles to reach the posterior rectus, which it innervates (Plate **5**, **6**, figs. 15, 16). The bursalis and retractor oculi muscles are innervated by a small ramus of not more than 25 fibers which is given off from VI as it passes between them. This is shown in Plate **6**, fig. 16 (*brs.*), but in the plotting Plate **2**, fig. 4) it is covered by the main trunk. It is difficult to xplain the very pronounced disproportion between this small ramus nd the remainder of the abducent nerve. No connection was found which would relate the abducent nerve to any structures other than he three muscles named.

CILIARY GANGLION AND NERVES.

In their macroscopic features the ciliary nerves and ganglion and heir relation to the trigeminal and oculo motor nerves are comparatively simple. The ganglion (Plate **5**, fig. 15, *gn. cil.*) lies between the membranous cranium on one side and the bursalis and retractor oculi muscles on the other, and is separated from both III and V by roots of considerable size. It is connected with nerve III, as is generally the case in other forms, by a shorter, thicker root, radix brevis (Plate **2**, fig. 4, *rx. cil. III*), while the root from V (*rx. cil. V*) is longer and more slender. Only the proximal end of this root is shown in the figure. Both roots communicate with the ganglion directly and in like manner the two ciliary nerves arise directly from its distal end. In the plotting (Plate **2**, fig. 4) this point is hidden by nerve III. These ciliary nerves (Plate **5**, figs. 13, 14, *cil.*) cross dorsad of the optic nerve to enter the sclerotic coat of the eyeball. They keep close together in their course as they pass laterad and cephalad around the eyeball to their terminations in the striated muscles of the ciliary body and epithelial surfaces. From the smaller of these ciliary nerves is given off a very fine branch, which follows the others for a distance but is lost before its entrance into the eyeball. In sections individual medullated fibers are seen to be given off from this small ramus. These are lost along the walls of the small blood vessels. The presence of these fine rami in immediate contact with the retractor oculi muscle at its end of insertion could readily give rise to a misinterpretation in regard to their distribution (see p. 32). It is possible that Osawa (**'98**, p. 537), basing his conclusions on dissections alone, made such an error in his account of Hatteria. In Anolis every recognized fiber leaving the ciliary nerves could be traced cephalad beyond the most anterior extent of this muscle (*rtr. oc.*), and in no case were these fibers distributed to the muscle.

In many points the microscopic evidence was far from conclusive for determining the relations of the ciliary roots and nerves to the ganglion, but they offer certain facts worth recording. The short root is a large one and is principally composed of fibers of very light medullation, but not of the smallest caliber, *i. e.*, they are larger than those of the visceral sensory system as shown in palatine VII. Among these are a very few coarser fibers of a medullation sufficiently heavier to make them conspicuous. These are as large as many that remain in the somatic motor rami, but do not equal in size those which predominate in these motor nerves, nor are they segregated into a single group to be readily followed through the ganglion. However, the fact that every section through the ganglion shows about the same number of these coarser fibers points to the possibility of their uninterrupted passage. The ganglion is a uniformly oval structure, the cells of which entirely surround the short root.

The long root (*rx. cil. V.*), from the nasalis division of the opthalmic, is composed of both medullated and non-medullated fibers and joins the ganglion on its dorsal side (Plate **5**, fig. 15) about midway of its length, many of its fibers immediately mingling with the ganglion cells. The independence of the bundle is, however, preserved throughout by the continuity of the non-medullated components of this root, which passes across the dorsal side of the anterior half of the ganglion and on into the large ciliary nerve, in which it appears for a considerable distance as a lighter area in the cross section. These facts do not preclude the possibility that many of the non-medullated fibers end in the ganglion, nor that a part of the postganglionic bundle of fine fibers takes origin in the ganglion. Further analysis of the ciliary nerves discloses some of the coarse fibers of the short root in each. The rest are of the smaller medullated variety and appear to take their rise as peripheral neuraxons of the cells of the ciliary ganglion, since they do not occur in the ciliary roots.

In comparing Anolis with other Sauropsida we find that the arrangement of roots, ganglion and ciliary nerves is that which Fischer (**'52**, p. 117) describes as typical for reptiles. As an exception he mentions *Salvator merianae,* where the trigeminal and oculomotor roots join proximal to the ganglion. Other accounts agree with Anolis. Osawa (**'98**, p. 602), in describing Hatteria, establishes another exception, wherein the ganglion itself is not connected with the trigeminal nerve by an independent root, but, if at all, through recurrent fibers, as in the fowl, the ciliary rami from V joining the ciliary nerve distal to the ganglion.

Carpenter's (**:06**, p. 158) careful analysis of the ciliary ganglion and its connections in the adult fowl is the only basis we have for a comparison of histological features with conditions in birds. In the fowl, the short root from the oculomotor being much the same as for Anolis, one main ciliary nerve leaves this ganglion. This contains all he well medullated fibers. Another small bundle, of feebly medulated fibers, leaves the ganglion dorsal to the large one. A third small) ramus accompanies the other two; microscopic study, hower, showed Carpenter that it contains no fibers from the ganglion, ut is merely a communicating ramus from the trigeminal, which meets the ciliary nerve distal to the ganglion. The same ramus ends some recurrent fibers back to the ganglion. Other fine rami ay be given off from the communicating ramus. All the trigeminal ements are non-medullated. The ciliary ganglion itself is divisible to a sympathetic and a cerebro-spinal part.

As compared with this, we find in Anolis the following differences:— (a) nerve V connects directly with the ciliary ganglion by a branch which contains a large proportion of medullated fibers; (b) the non-medullated components from the trigeminal are carried in the large ciliary nerve and form no small non-medullated rami; (c) the ganglion is not divisible into two parts and has more the appearance of a cerebro-spinal ganglion. It should be noted, however, in regard to this last point (c), that the complete Vom Rath method was not used in the preparation of the Anolis material, the treatment with pyroligneous acid being omitted. This omission may have resulted in less differentiation within the ganglion and a consequent failure to discover the differences recorded by Carpenter.

M. TRIGEMINAL NERVE.

The afferent and efferent neurons that go to make up the mixed root of nerve V form one large bundle, in the cross section of which there is shown no segregation of components at the point of emergence from the brain. More centrally, however, the main sources of these components may readily be found. More complete study of the brain will no doubt result in some addition to this account of peripheral structure and possibly to some revision. The central relations of the neurons are here referred to briefly and only in so far as they were brought out in the series of sections from which the plottings were made.

The efferent neurons. The motor components were seen, in sections posterior to the superficial origin of the root, to arise from two sources: (a) a group of cells lying a short distance mesad and slightly dorsad to the connection of the root with the brain, and (b) from a region just laterad to the median longitudinal fasciculus. From both these sources the bundles of heavily medullated fibers pass directly out to the ventro-median part of the root. Here they form with the afferent components a common root-bundle, in which it is difficult to distinguish the two. At the point of superficial origin the mixed root-bundle is covered dorsally by the ganglion of nerve VIII (Plate **6**, fig. 18, *rx. V; gn. VIII*). The root passes cephalad between the proötic bone and the skull to the Gasserian ganglion (Plate **6**, fig. 17, *gn. V*), which lies in the foramen prooticum (Gaupp). The foramen is represented in the skull of Anolis by a notch in the anterior border of the proötic bone, being bounded anteriorly by the membranous part of the cranial wall (Plate **1**, fig. 2; *for. V*).

Before the ganglion is reached, the root shows a distinct separation into three parts, which in cross section appear as three unequal segments of a circle. The largest is the dorsal segment, which passes into the main part (*gn. V*) of the ganglion (semilunar of Fischer); the ventral comprises the motor neurons, while the median division from this point on is free from all other connections and passes into the ophthalmic ganglion (Plate **2**, fig. 4; Plate **3**, figs. 6, 7, *gn. V; gn. opth.*).

The motor components, thus segregated just proximal to the ganglion, are almost exclusively distributed in small pure rami directly from the ganglion (Plate **3**, fig. 6). A few motor fibers are, however, included in mandibular V and reappear in several small mixed rami innervating a part of m. mylo-hyoideus (Plates **2** and **3**, figs. 5 and 6).

Those rami which supply the dorsal and lateral jaw musculature arise from the dorsal division of the main motor bundle. This passes across the ventral side of the ganglion and the base of mandibular V to be split into two rami, one of which (*cap. md. 1* and *2*) supplies chiefly the m. capiti mandibularis, and the other (*pt.*) the greater part of the m. pterygoideus. Of the former a part passes directly dorsad, while the rest follows the course of maxillaris V as several slender rami to supply the anterior part of these muscles (Plates **2** and **3**, figs. 4 and 6).

The motor components which do not enter into this dorsal and lateral distribution pass directly cephalad on the ventral face of the ganglion. A part follows for a short distance mandibular V on its ventral side and then divides, one branch (*pt-md.*) going to innervate the m. pterygo-mandibularis, the other (*pt.*) to innervate the deeper part of the m. pterygoideus. The rest separates into three rami, two of which are very small. Of these one (*pt-par.*) innervates m. pterygo-parietalis, the other (*pt-sph. p.*) m. pterygo-sphenoidalis posterior. The third ramus (*protru. oc.*) is larger than either of these two. It passes cephalad to the orbit to innervate m. protrusor oculi and m. depressor palpebrae inferioris. Because of its special functional and tructural relations, this nerve demands a more detailed account.

Ramus ad m. depressor palpebrae inferioris (*dep. palb. if.*). This amus is recognizable on the ventral side of the main motor bundle pposite the proximal end of the ganglion (Plate **6**, fig. 17). The undle as a whole has a characteristic appearance, the fibers being ell medullated but somewhat finer than those of the other motor nerves. Upon closer examination it is found to contain fibers of still finer caliber and of lighter medullation and also possibly some non-medullated fibers. The latter point is difficult to establish where such fibers are relatively few and not grouped into a bundle. The course of this nerve is directly cephalad to the orbit keeping to the ventro-lateral side of all the eye muscles (Plates **3**, **5**, **6**). Soon after this nerve has begun its peripheral course its lightly medullated fibers become grouped into a bundle on its ventral side. These leave the main ramus about midway between the Gasserian ganglion and the orbit, and form a communicating ramus (*comn.*), which joins palatine VII a short distance cephalad of this point (Plate **3**, figs. 6, 7; Plate **5**, figs. 14, 15). In the palatine nerve its identity is wholly lost, although the nature of its union strongly indicates that it does not form a recurrent bundle, but continues its course cephalad.

Two very small but noteworthy twigs (Plate **3**, figs. 6, 7, *protru. oc.*) are given off from this communicating ramus to innervate the muscle which has been described as the protrusor oculi. In the dissection (Plate **3**, fig. 7), where this was clearly worked out, it will be noticed that one twig is given off from the rm. palpebralis inferior itself and only one from the communicating ramus. The fibers innervating this muscle are of the sâme character as those of the communicating ramus and in distinct contrast to those remaining in the main motor ramus, which, farther cephalad, innervate the depressor muscle of the lower eyelid. A comparison with the opposite side of the head and with other series of sections shows practically the same relation, although on the opposite side in the same series a twig is given off proximal to the communicating rami, as in Plate **3**, fig. 7. It comes, however, from the ventral lightly medullated bundle, which is as clearly marked off as though it were a separate ramus.

Although Fischer (**'52**) describes the innervation of the m. depressor palpebrae inferioris by a ramus coming directly from the motor root, as in Anolis, he makes no mention of a communicating ramus between this nerve and palatine VII. The one mention of it met with is by Watkinson (**:06**, p. 457, 463) in Varanus, where it is described as a communicating ramus between palatine VII and the Gasserian ganglion by way of this motor nerve. From dissections alone it would appear to be mere assumption that it takes this course. From the sections of Anolis it seems quite clear that the components of this connecting ramus have a distal existence in the palatine. Such an anastomosis between a pure motor ramus and the viscero-sensory is not met with in Anolis in any other connection. No reference is made by any writer to a muscle innervation similar to the one above described. This peculiarity, coupled with the described function (p. 33) of this muscle, offers a problem for comparative study. It is to be noted that no ganglion cells were found at the point of union either on V or VII.

Afferent neurons. The central course of these fibers is so involved in other brain tracts that the present description will begin at the superficial origin of the root. The descending root of the trigeminal nerve traced cephalad approaches the surface of the medulla and produces a swelling of the surface beneath the roots of nerves VII and VIII (Plate **6**, fig. 18, *rx. V*). The motor neurons, as before described, join this bundle rather abruptly from a more median position, and the two together leave the brain as a single root. The fibers making up the sensory components of the trigeminal lack uniformity of size and medullation. They are, however, of a size approximately that of the motor components of the trigeminal and facial, but also have among them both larger and smaller fibers. A characteristic feature of the cross sections is the presence of a few very large, strongly medullated fibers. These are recognizable in the brain, and a central connection may possibly be established for them. Peripherally they seem to offer no special relation to end organs. They occur in limited numbers and are always scattered as isolated fibers. It is possible they are motor in their character and are transferred to the motor rami.

The ophthalmic, maxillary, and mandibular divisions of the trigeminal are recognizable even proximal to the ganglion (*gn. V; gn. opth.*), the two ganglia being entirely distinct and scarcely in contact in series 30. The relative sizes and positions of the ganglia are best seen from the figures on Plates **2**, **3**. The cross section (Plate **6**, fig. 17) shows the segregation of the two cell groups. In addition to these two ganglia, one of the figures (Fig. 6) shows a third; a very small ventral group of cells entirely similar in the sections to those of the larger ganglia. Careful study was made of this small ganglion to discover any structural features that would indicate a sympathetic character, but comparison showed no such group on the opposite side of the same individual; in this case therefore it is probably a separation (inconstant) of a few cells of the main ganglion. From what we know of other forms, it seems probable that the sympathetic rami of the lachrymal plexus send fibers to the Gasserian ganglion, but that could not be demonstrated in Anolis, and there is no deep sympathetic trunk connecting the Gasserian with more posterior ganglia.

A detailed account of the peripheral distribution of the sensory components of the trigeminal nerve will be preceded by a more general statement. The main branches of this nerve correspond quite closely with the typical condition found in lower vertebrates. The ophthalmicus profundus, proceeding from its own independent ganglion, is distributed to the skin of the dorsal surface of the head over an area extending from a post orbital region forward to the tip of the snout, the frontal region receiving its fibers over a special ramus, which leaves the ophthalmic at the ganglion; the rest of the nerve, as the *nasalis* branch, takes the course through the orbit typical of the profundus, receiving the long root of the ciliary nerve on its way, and supplies the skin of the dorsal surface of the snout and the epithelium of anterior nasal chamber.

The second and third (maxillary and mandibular) branches of the trigeminus join the main trigeminal ganglion as large branches from the upper and lower jaw regions. The maxillary supplies the skin around the eye and the upper and lower lids; it crosses the floor of the orbit to the upper jaw, in which it runs forward to the tip of the snout, supplying the skin lateral to the jaw and the epithelium of the gums and the teeth.

The mandibular branch passes down to the lower jaw, which it enters, supplying the skin, gums and teeth in a manner similar to that described for the upper jaw. It also supplies the anterior regions of mouth and tongue. In this latter distribution it is closely associated with the somatic motor components of XII and the viscero-sensory components of the chorda tympani. Certain plexuses and anastomoses omitted from this general account will be included in the detailed description which follows.

I. *Nervus ophthalmicus profundus.* This term, as including all the fibers entering the ophthalmic ganglion, has no application in Anolis, as the two main branches (r. nasalis and r. frontalis) do not unite distal to the ganglion. These two branches will be described as the frontal and nasal rami.

Ia. *Ramus frontalis* (*f.*).— The point where in different reptiles the frontal ramus joins the nasalis is determined somewhat by the relation of the ganglion to the orbit. In Anolis (Plates **2**, **3**) the orbit is large and the frontal ramus takes rather an abrupt dorsal course to reach the skin posterior to it; the ramus therefore joins the ganglion directly. The frontalis is about half the size of the nasalis. Both are composed of the same kind of fibers, except that the nasalis carries the non-medullated fibers of the radix longa of the ciliary nerve, which collectively can be recognized from the beginning of the ramus. The frontal ramus lies dorsal to the other and both run cephalad for some distance, passing between the membranous cranium and the ligamentous origin of the protrusor oculi muscle (Plate **6**, fig. 16, *f.* and *na.*). A little farther forward the frontalis turns abruptly dorsad to the posterior angle of the orbit (Plate **5**, fig. 15). In this course it keeps next the membranous cranium and attains a position just caudad to the lachrymal gland. As it turns dorsally it gives off a branch that becomes involved in the sympathetic plexus (Plate **3**, figs. 6, 7), but, like the other branches, this contains cutaneous sensory elements that can be traced to the skin. The main branch continues between the brain and the large blood sinus which lies just posterior to the lachrymal gland (Plate **5**, fig. 15). A little farther forward, and at a level where the gland is beginning to be cut, there are given off a number of branches, which anastomose with the sympathetic, but for the most part supply the upper lid. These lie just mesad of the lachrymal gland (Plate **5**, fig. 14, *gl. lch.*). The main part continues forward and supplies, from time to time, small rami to the skin between the eyes (Plate **5**, figs. 12, 13).

Ib. *Ramus nasalis* (*na.*). This is the main ophthalmic branch and takes the characteristic course through the orbit (Plates **4**, **5**, **6**, figs. 10–17). It passes into the orbit with nerve III and passes dorsally to the optic nerve and over the ocular face of the dorsal rectus muscle (Plate **5**, fig. 14). Just before its entrance into the orbit (Plates **2**, **3**, figs. 4, 6, *rx. cil. V.*) it gives off the long root of the ciliary nerve (see p. 46). With this exception there are no branches or connections within the orbit. It passes out of the orbit on the median side of the Harderian gland (Plate **3**, fig. 7; Plate **4**, fig. 11) into the space bounded by the anterior median wing of the palatine, the frontal, the prefrontal and the origin of the ventral oblique muscle (Plate **4**, fig. 10). Here the nerve passes through the "ethmoidal" sympathetic ganglion (*gn. eth.*), which will receive especial description. This ganglion lies on a level with the anterior boundary of the bony orbit, and through it a cutaneous branch of coarse fibers is given off to the skin of the anterior angle of the eyelids (Plate **4**, fig. 10, *na.*[1]). Soon after this the main nerve divides into a *lateral* branch (Plate **4**, fig. 9, *na. l.*) and a *median* branch (*na. m.*). These richly supply the skin of the snout. The median one gives off in addition a branch to the mucous membrane of the nose; its cutaneous branch passes forward along the median line to be distributed to the end of the snout (Plate **2**, fig. 4).

According to Watkinson (**:06**, p. 458), who mentions both the frontalis and the nasalis, Varanus agrees with Anolis in so far as no branches are given off from the nasalis between the ciliaris and the posterior extremity of the internal nares, where, as she states, the "r. comm. cum ramo platinus VII" is "composed of at least two distinct fiber bundles," which communicate with palatine VII; then follow the same divisions as noted for Anolis anterior to this, i. e., "r. lateralis" and "r. medialis," these having much the same distribution as in Anolis. To the medialis are assigned the following branches, r. premaxillaris superior (dorsal) and r. premaxillaris inferior, these innervating the skin of the nose and the lips.

Ethmoidal ganglion (*gn. eth.*). This is a ganglion of oval form and one fourth mm. in length, which lies closely applied to the ventral and lateral sides of the nasalis nerve (Plates **2**, **3**; Plate **4**, fig. 10). The ganglionic cells do not entirely surround this nerve, and there is no passage of medullated fibers from nerve to ganglion. The ganglion is in connection with the median branch of the palatine nerve through communicating bundles of fibers; these fibers are also accompanied by sympathetic ganglion cells, which form a sort of column of cells extending from the side of the ganglion opposite the nasalis nerve to the palatine ramus (Plate **4**, fig. 10). A dissection of this ganglion and its connections, mounted in balsam, shows some fine, lightly medullated fibers from the stalk passing both caudad and cephalad in the palatine. The almost complete lack of medullated fibers among the cells indicates that the ganglion has to do largely with non-medullated fibers. A very small bundle of such fibers joins the ganglion on its posterior side close to the nasalis nerve. To what extent this ganglion may be in connection with non-medullated fibers of the nasalis, could not be determined, but such a relation would appear to be the only explanation of the anatomical relations observed. The cells of the ganglion are smaller and less clearly defined than those of the cerebral ganglia, showing in this their sympathetic character (Carpenter, **:06**).

The ethmoidal ganglion occurs regularly in birds, as far as they have been studied, as a group of ganglion cells on the ophthalmic branch of V. Bonsdorff (**'52**) gave it the name of "ganglion ethmoidale," and Rochas (**'85**) "g. orbitonasale." In the goose Cords (**:04**, p. 59) describes this ganglion as being 1 mm. long and $\frac{1}{2}$ to $\frac{2}{3}$ mm. broad, and as having the same connections as we find in Anolis, i. e., with the ophthalmic branch of V and the palatine branch of VII. There can be no doubt of the homology of this ganglion as described for birds with the structure to which the name has been given in Anolis.

An anastomosis of palatine VII with the ophthalmic branch of V in the anterior orbital region seems to be of wide occurrence in the Sauropsida and Amphibia. It is described in Amblystoma (Herrick, **'94**), tadpole of the frog (Strong, **'95** [farther forward here]), Spelerpes (Bowers, **:00**), Amblystoma (Coghill, **:02**) and Amphiuma (Norris, **:08**).

Of the above mentioned investigators, Coghill finds a ganglion at the point of union, and Norris (p. 540) says "there seems to be a ganglion on the palatine nerve shortly before the anastomosis"; beyond the anastomosis he finds mixed cutaneous and viscero-sensory rami. With this observation by Norris agrees the statement I have made regarding Anolis; that this ganglion, while surrounding ophthalmic V, is really more closely related to palatine VII.

Among the reptiles an anastomosis is mentioned by Gaupp (**'88**), Osawa (**'98**), and Watkinson (**:06**). On the other hand Fischer (**'52**) does not mention it at all. The presence also of a ganglion, at least one discernible by dissection, seems to be less general in the described reptiles than the condition in Anolis would suggest. The only mention of it which I have found was in Gaupp's (**'88**, p. 469) description of the snake Tropidonotus, in which he refers to it as "eine leichte Anschwellung," and further "Vielleicht entspricht dieselbe dem ganglion ethmoidale der Vögel." Watkinson (**:06**, p. 463) speaks of palatine VII and nasalis V as lying quite close together at a point corresponding to the ethmoidal ganglion and having one or two connecting branches. It is probable that sections would have disclosed a ganglion here. She found no cutaneous branch of the nasalis at this point.

Peripheral distribution of the ramus nasalis. The distribution of the cutaneous sensory fibers carried in this nerve begins with the bundle of coarse fibers entering the posterior end of the ethmoidal ganglion. Distal to the ganglion the main nerve divides into the lateral and median branches before mentioned (Plates **2**, **3**, figs. 4, 6, *na. l.*, and *na. m.*), which are of about equal size. One of these retains a median position while the other crosses the roof of the nasal capsule to a more lateral one.

(a) *Ramus lateralis nasi.* This ramus in passing cephalad and laterad across the roof of the olfactory chamber occupies a position between the cartilaginous capsule of the chamber and the cranial bones. It is distributed to the skin over the subterminal region of the snout, that is, just posterior to the external nares. Before reaching the integument the lateral ramus passes through the nasal gland, where it bifurcates. Each branch gives off a small twig (Plate **2**, fig. 4, *na. l.*[1] and *na. l.*[2]), which passes out through this gland to the skin. The more lateral of the two bundles again divides, and these three terminal divisions of the ramus (Plate **4**, fig. 9) then emerge from the anterior side of the gland to innervate the skin overlying that region. The two small twigs proximal to the three terminal divisions (Fig. 4) supply a somatic sensory innervation to the olfactory epithelium.

(b) *Ramus medialis nasi.* After giving off a few fibers to the olfactory epithelium, the median ramus supplies a larger branch (*na. m.*[1]) to the skin over the nasal bone; the foramen (*for. na. m.*) through which this nerve emerges is clearly indicated in fig. 1, Plate **1**. The main ramus then passes cephalad without branching to the extreme tip of the snout to innervate richly the skin anterior to the external nares. Its terminal branches are shown in Plate **2**, fig. 4, but not in Plate **3**, fig. 6. In its course it keeps close to the internasal septum and the median dorsal part of the premaxillary bone (Plate **4**, figs. 8, 9).

II. *Ramus maxillaris* (Plates **2**, **3**, figs. 4, 6, 7, *mx.*). The second main branch of the trigeminus is given off from the lateral side of the portio major of the Gasserian ganglion. It passes between mm. pterygoideus and capiti-mandibularis to reach the posterior ventral rim of the bony orbit. It makes a circuit of this ventral rim to the anterior side of the orbit where it passes into the marrow cavity of the maxillary bone and continues its course in the upper jaw. Besides numerous rami distributing somatic sensory components, this nerve becomes involved with the superficial sympathetic rami of the head in what may be called the "lachrymal plexus," and with the viscero-sensory-sympathetic in the orbital plexus. It will simplify the account to describe first the somatic sensory rami, as far as possible, as though the plexus did not exist and give an account of the latter separately.

The following branches are given off from the ramus maxillaris: (a) the first branch (*mx.*[1]) is given off from the dorsal side. It passes around the anterior side of the m. capitis mandibularis and turning back supplies the skin (Plate **2**, fig. 4; Plate **3**, fig. 6). In its course it crosses the sympathetic rami in the lachrymal region, but its cutaneous fibers do not mingle. In some dissections it appears to be independent, although in figure 7 it joins the lachrymal plexus in such a way that its terminal ramus could not be identified. (b) The second branch (*mx.*[2]) also passes across the plexus, where it is difficult to follow it in sections, but a dissection, upon being cleared and mounted, showed the continuity of the cutaneous fibers, which is indicated in Plate **3**, fig. 6, by dotted lines. This ramus divides into several branches to supply the skin at the posterior angle of the eyelids, and also the posterior half of the lower eyelid. (c) Another branch (*mx.*^{3}), similar to (*mx.*^{2}), runs forward to supply the anterior half of the lower eyelid. This shows an anastomosis with *mx.*^{2} (Plate **3**, figs. 6, 7). (d) A branch (*mx.*^{4}) which passes into the cavity of the ventral bony arch of the orbit supplies the skin over it as far forward as the anterior limits of the orbit. The rest of the nerve (*if'orb.*) now passes cephalad across the orbit to enter the infraorbital foramen, an opening bounded by the maxillary, lachrymal and jugal bones (Plate **1**, fig. 1, *for. if'orb.*). Before entering this foramen it gives off cutaneous fibers at two points, which, however, are not free from connection with the palatine rami and are indicated only by the somatic sensory component (yellow) included in these palatine rami. One of these combines with the visceral components of VII to form a good sized branch (*pal. l.*), which passes cephalad under the fold of epithelium on the median side of the maxillary bone. This fold is rich in tubular glands and taste buds (Plate **4**, figs. 9–11). The other passes mesad to meet the intermediate ramus of the palatine (*pal. i'm.*), and the combined nerve comes out to the mucous membrane farther cephalad, where it continues the innervation of the lateral field (Plates **2**, **3**).

Ramus alveolaris superior (*alv. su.*). This is the term applied to the intra-maxillary portion of the maxillary nerve. In Anolis its distribution is wholly to the integument at the side of the jaw, which it reaches through numerous foramina that are indicated in the skull (Plate **1**, fig. 2), and to the teeth, as described more fully for the lower jaw.

Connection of the sympathetic with the ramus maxillaris trigemini. There is one well defined and constant sympathetic ganglion on the main trunk of the maxillary nerve. This, because of its position at the beginning of the infraorbital course of this nerve, is known as the *infraorbital* ganglion (Plate **2**, **3**, figs. 4, 7, *gn. if'orb.*). It is much flattened laterally (Plate **5**, fig. 14), the flattening being due, no doubt, to its location. It is connected with the main superficial sympathetic ramus of the head by a strand of non-medullated, or very slightly medullated, fibers. The medullation is so slight that the connection is very difficult to establish in the sections, the dissection preparations, however, leave no doubt on this point. It is impossible to tell to what extent recurrent fibers may connect with the trigeminal ganglion. It is certain, however, that the main extension of the sympathetic ramus is cephalad in the infraorbital nerve. This is shown by the character of the cross section of the nerve and by the direction of the fibers in the ganglion. The further anastomoses of nerves V and VII to form the infraorbital plexus offers opportunity for the wide distribution of this system throughout the head region. Practically every point of juncture in this complex is the seat of a larger or smaller group of sympathetic ganglion cells (Plate **2**, fig. 4, *cl. gn. sy.*). Except in the case of the infraorbital ganglion, none of those on the maxillary nerve is large enough to have been discovered by gross dissection without the aid of mounted preparations of dissected parts, a method which apparently has not been used by my predecessors. It is noticeable that, after the nerve is free from visceral connection, as in the ramus alveolaris superior, no more ganglia are found.

III. *Ramus mandibularis* (*md.*). This is the largest of the trigeminal branches, but, unlike the other two, it is not wholly afferent in its composition. It includes a certain number of motor components, which are given off to the mylo-hyoideus muscle. The mandibular ramus leaves the portio major of the Gasserian ganglion from its ventro-lateral side (Plate **3**, figs. 6, 7), being covered dorsally by the ramus maxillaris. Its course to the lower jaw lies between the mm. pterygoideus and pterygo-sphenoidalis posterior. It crosses dorsal (lateral) to the pterygoquadrate process just behind the insertion of the m. pterygo-parietalis, passing through the deeper part of the pterygoideus to reach the median side of the mandible (Plates **5**, **6**, figs. 15–17). As it approaches the mandible two rami are given off together to be distributed to skin and muscle of this region. The continuation of the main nerve is known as the *ramus alveolaris inferior* (*alv. if.*). It still contains a few motor fibers for the innervation of the anterior part of the m. mylo-hyoideus.

III, 1. The two branches above mentioned are given off from the main ramus at the point where the latter makes a turn cephalad to enter the mandible. They might be considered one branch which immediately divides into a posterior and an anterior ramus. The posterior ramus ($md.^1$) turns back (Plates **2**, **3**, figs. 5, 6) and crosses Meckel's cartilage dorsally, reaching the lateral side of the mandible (Plate **6**, fig. 16) through a foramen between the dentary and angulare bones. It passes through the superficial throat muscles to the mylo-hyoideus muscle, a very small sensory twig passing on to the skin. Most of the fibers are motor, innervating a part of the mylohyoideus muscle (Fig. *J*).

The anterior ramus (*lab. if. md.*) is much the larger of the two and appears in the sections to be purely cutaneous sensory. It passes into the cavity of the complementare bone (Plate **5**, fig. 15) to run cephalad a little distance and then out through a foramen on the dorsal side of this bone. It passes forward along the side of the mandible to innervate the integumentary portion of the lower lip for about two thirds of its length (Plates **4**, **5**, figs. 10–15), the anterior part of the labial region being cared for by branches from the alveolar ramus (Plates **2**, **3**, **4**, figs. 5, 6, 8, 9, *lab. if. md.*).

III, 2. *Ramus alveolaris inferior.* This (*alv. if.*) is the continuation of the mandibular ramus into the lower jaw. It takes a position on the dorsal side of Meckel's cartilage (*crt. Mkl.*) where this is still exposed (Plate **5**, fig. 15), and when the membrane bones of the mandible close around the cartilage they include both this nerve and the chorda tympani. The latter is at first ventral to the alveolaris, but gradually assumes a more median position and finally takes up the medio-dorsal part of the cross section of the combined nerves (Plate **5**, figs. 13–15, *alv. if.* and *cd. tym.*). The two bundles are easily distinguishable up to the place where the first branches are given off. The alveolaris gives off several branches at a level with the angle of the mouth.

(a) A small branch, not shown in the figures, is given off from the dorsal side of the main ramus at the line of separation between the fine fibers of chorda tympani and the coarser ones of the alveolaris. It contains the coarser, well-medullated fibers, not more than ten or twelve in number. This appears to be a constant structure, but its distribution and its function remain undetermined. There is nothing in the nature of its fibers to indicate that it is viscero-sensory or sympathetic, yet it cannot be followed to any peripheral structure; the fibers separate in the interosseous tissues of the jaw and cannot be traced outside. It is recurrent in its course, passing caudad and dorsad between the outer dentale and the enclosed complementare and is lost on the epitheliod osteoblastic layer between the dentale and coronoideum. Its course continued a little farther caudad would bring it to the lateral side of the coronoideum, to the place of insertion of a part of the m. pterygoideus, but such a distribution was not established. Some of the fibers passing out in this nerve appear to be the coarser ones originally carried by the corda tympani.

(b) Opposite the point where (a) is given off a ventral mixed branch (*md.*^{2}) leaves the ramus alveolaris. In passing cephalad it circles Meckel's cartilage swinging down the lateral side and up the median side to emerge through the same foramen with another large branch (*lng. V.* + *cd. tym.*), which includes the chorda tympani (Plates **2**, **3**, and **5**, figs. 5, 6, 12). Upon its exit from the jaw it turns ventrally, dividing to send to the skin a branch which also includes a small motor twig (*myl–hy.*) supplied to the mylo-hyoideus muscle. The main part goes farther cephalad among the interlocking ends of the mylo-hyoideus and cerato-mandibularis muscles to an overlying cutaneous area between mandibles (Plate **4**, fig. 9, *md.*^{2}).

(c) A short distance cephalad of the place where (a) and (b) are given off, the main ramus bears on its dorsal side a sympathetic ganglion (Plates **2**, **3**, figs. 5, 6, *gn. md.*), which is composed of small cells forming a group flattened against the sides of the chorda tympani and alveolar portions of the nerve. As the combined lingualis and chorda tympani separate from the intramandibular portion of the nerve, the cells of this ganglion crowd down into the angle thus formed in the shape of a wedge. As in other sympathetic ganglia, there appears to be no admixture of medullated fibers among the cells. The ganglion seems to be more closely associated with nerve V than with nerve VII, and after the division its cells continue forward, appearing in a number of sections within the perineurium of the alveolar part.

Gaupp (**'88**, p. 460) states that in Lacerta there is an "Anschwellung" at the point of union of the chorda tympani with the alveolaris. He also refers to the lingualis, which includes the chorda tympani, as given off immediately after this union. This swelling undoubtedly corresponds to the mandibular ganglion (*gn. md.*) of Anolis.

The lingual ramus of V passes out of the jaw in a common sheath with the chorda tympani (Plates **2**, **3**, **5**, figs. 5, 6 and 12, *lng. V* + *cd. tym.*). The combined bundle goes cephalad for some distance without branching, then divides into two rami of about equal size. The dorsal one is composed almost entirely of the fine fibers of the chorda tympani and will be considered as the continuation of that nerve, to be described with the facialis. It includes, however, about a dozen large cutaneous fibers. The other (ventral) division is almost entirely cutaneous, as is shown by comparison with ramus (*md.*^{2}), which lies next to it. It contains, however, some of the fine fibers characteristic of the chorda tympani. It appears, therefore, that in the final separation of the lingualis and chorda tympani there is a slight interchange of fibers.

The lingualis (*lng. V.*) now runs cephalad and divides for distribution to the papillae of the tongue. In this peripheral region, however, its fibers are inextricably mingled with those of XII, which they closely resemble. The difficulties of plotting the mixed rami are here further increased by the retraction of the tongue muscles, which throws the terminal rami into numerous coils. The plotting (Plate **3**, fig. 5) attempts to trace the lingualis and XII only so far as to show the union of the entire lingualis by two branches with branches of XII. This takes place after the lingualis has been traced cephalad for some distance parallel with the chorda tympani and then back again parallel with XII close to the mucous membrane at the base of the groove which bounds the tongue laterally (Plate **4**, figs. 10, 11). Numerous dissections were made in this region, which added little information as to the exact form of the anastomoses. The fact was established, however, that, after joining XII, some of the fibers of V continue caudad presumably to reach the periphery through more proximal branches.

Terminal distribution of the ramus alveolaris inferior. The final distribution of the sensory components, left in the alveolar branch after the separation of the chorda tympani, the lingualis, and a large cutaneous branch, is accomplished through a series of terminal rami, which make their exit from the alveolar canal through a number of foramina on the lateral side of the dentary bone (Plates **2**, **3**, figs. 5, 6, *lab. if. alv.*). These are termed by Watkinson (**:06**, p. 462) the "rami ad glandulae labiales inferiores," the emphasis thus being placed upon their distribution to glands. They probably carry sympathetic fibers to the glands, but if so, these are non-medullated and are not distinguishable in sections. A conspicuous feature in Anolis is the highly sensitive nature of the lips, as is indicated by the rich supply of typical cutaneous sensory fibers to the skin in this region. The epidermal sense organs are also more numerous here than elsewhere. The strongly medullated sensory fibers are strictly limited to the epidermis at the sides of the lips lateral to the external labial gland (Plate **4**, figs. 8–10). The external glands are not very largely developed here, although they occur along the entire length of the lips both upper and lower.

The n. alveolaris does not emerge as a whole from the alveolar canal until the end of the mandible is reached. Here it comes out as four or five terminal branches, giving to this region an even richer nerve supply than was accorded the lips along the lateral part.

Innervation of the teeth. The teeth are of the typical pleurodont type, being fused directly with the median side of the dentary bone. The pulp cavity of each tooth is in communication with the cavity of the dentary bone, which carries the nerve. Through this opening into its cavity the tooth receives its nerve and blood supply. The innervation was not determined for the posterior teeth, the first fibers given off from the alveolar nerve being farther forward, where a small number (3 or 4) of fibers with distinct sheaths come off from the main ramus and run forward within the alveolar cavity for some distance, but eventually pass into the cavities of the teeth (Plate **4**, fig. 9, *rm. de.*). Where these fibers are given off they show a character similar to the cutaneous sensory components, although they either become less heavily myelinated or, what is more likely, their position makes fixation defective, for they can with difficulty be traced through the communication into the pulp cavity of the tooth. It is not improbable that here they do lose their myelin sheaths. It is noticeable in the mature teeth that the dentinal tubules are particularly large at the apex of the teeth. No nerve fibers could be followed, however, as far as the odontoblasts underlying this region.

This alveolar ramus is described by Watkinson (**:06**, p. 462) as innervating the teeth through the "rami dentales." Such rami in Anolis would consist of a few fibers given off at wide intervals, which would be difficult to discover except by microscopic methods, even though they were not entirely within the bony part of the jaw. Norris (**:08**, p. 522) referred the innervation of the teeth in Amphiuma to a combined V and VII nerve which runs along the median side of the mandible. This nerve corresponds to the main part of the chorda tympani in Anolis, which after temporary union with the mandibular nerve has separated from it, reappearing with a mixture of cutaneous components, which are distributed with it. Although many fine fibers pass from this nerve along the base of the teeth to the epithelium of the lingual gums, no connection was established with the teeth themselves.

N. FACIAL NERVE.

The roots of the facial nerve. Two roots can be demonstrated for nerve VII, a lateral (motor) one and a dorsal (sensory) one. The sensory passes out directly from the fasciculus solitarius (Plate **6**, fig. 18, *rx. VII*) as a strong bundle to emerge from the brain dorsal to, but in contact with, the root of VIII. It passes around the anterior side of this root, being entirely covered laterally by the large acoustic ganglion. On the ventral side of the root of VIII the sensory root of

VII joins the motor root and the combined roots pass out through the foramen as one (Plate **6**, fig. 18).

The motor root leaves the brain just ventral to the fibers of nerve VIII where it is joined by the sensory root. It was traced centrally as a distinct bundle near to the ventro-lateral floor of the fourth ventricle. Here the root bundle becomes diffuse and its nucleus of origin was not identified among the several groups of cells occurring in this locality.

The motor components of the facial are all included in the hyomandibular nerve (*hy-md.*), with a distribution posterior to the ear. The viscero-sensory components are distributed anterior to the ganglion, the roof of the mouth being supplied through the palatine ramus (*pal. VII*), while the tongue and adjacent regions are supplied by the chorda tympani (*cd. tym.*), which leaves the ganglion in company with the motor elements and includes the sensory components of the hyomandibular nerve.

The geniculate ganglion (Plate **3**, fig. 7, Plate **6**, fig. 18, *gn. VII.*) lies closely applied to the cranial wall just outside the foramen (Plate **1**, fig. 2, *for. VII*), through which the roots make their exit. It is a small ganglion, but one readily demonstrated by dissection. Fischer (**'52**) found it in all cases, but Watkinson (**:06**) states that in Varanus VII shows no swelling at the point where the ganglion should appear.

(1) *Ramus palatinus VII* (Plates **2–6**, *pal.*). This is composed wholly of fine lightly medullated fibers of quite uniform character. This at least is the condition presented by the sections. The presence of *some* non-medullated fibers cannot be denied, however, in regard to any nerve described. The source of these medullated fibers of the palatine nerve is twofold: (1) from the cells of geniculate ganglion, and (2) from fibers carried in the communicating branch between the IX + X complex and nerve VII. The latter is known in lower groups of vertebrates as Jacobson's anastomosis, where it is homologized with the pretrematic ramus of IX and considered viscero-sensory in character. It was pointed out by Cole (**'98**, p. 145) that many fishes show this communicating ramus as combined sympathetic and viscero-sensory components derived from IX. This appears to be the condition in Anolis. The connection is by one or two fine strands (*comn. i.*), which lie close to the artery just outside the ear capsule (Plate **3**, fig. 7). They come into the proximal part of the palatine ramus where some, if not all, of the medullated fibers of the communicating ramus join those of the palatine to be distributed with the latter. Other fibers, for the most part non-medullated,

apparently stop here, and a small group of sympathetic ganglion cells is found at the point of juncture of the two nerves. These facts support the conclusion that we have here a combined sympathetic and viscero-sensory ramus.

The palatine ramus passes cephalad from the ganglion swinging in toward the median line (Plate **3**, fig. 7). Its course is along the groove which marks the division between the proötic and the basioccipital (Plate **1**, fig. 3). It passes into the sphenoid and crosses the base of its process dorsally, being carried in an imperfectly closed foramen (Plate **6**, fig. 17, *pal*). The palatine passes into a narrow space of the sphenoid and out again on the median side to assume a position just underneath the mucous membrane median to the basiptergoid process of the sphenoid (Plate **5**, fig. 15). In its course cephalad it keeps along the dorsal side of the pterygoid near its median border, gradually taking a more lateral position, to the point where it bears the ganglion palatinum (Plate **3**, fig. 7, *gn. pal.*). Throughout this portion of its extent it gives off no fibers for distribution. It receives (or gives off) the anastomosing branch connecting with V by way of the ramus to the palpebral muscle (Plate **3**, fig. 6, *dep. palp. if.*, see p. 50). This does not change the character of the palatine in any recognizable way, and there are no ganglion cells in connection with this anastomosis.

The ganglion palatinum is a sympathetic ganglion, which appears on the main palatine ramus proximal to any terminal branches. It lies on the floor of the orbit ventral to the palpebralis muscle and marks the beginning of the infraorbital plexus between nerves V and VII. A small number of medullated fibers are given off laterally, the main bundle dividing again just distal to the ganglion. The ganglion cells are strongly grouped at the first division point and also extend along the lateral branch for a considerable distance (Plates **2**, **3**, figs. 4–6). From this point forward to the level of the ethmoidal ganglion the palatine components are carried in rami which anastomose more or less with each other and with the infraorbital ramus of nerve V.

The infraorbital plexus consists of a number of anastomosing branches spread out in the orbit on the dorsal side of the pterygoid and palatine bones, these branches connecting rm. palatinus VII with maxillaris V (infra orbital portion). The posterior (proximal) limits of this plexus are marked by the sympathetic ganglia of palatine VII and infraorbital V (Plates **2**, **3**, figs. 4, 6, 7, *gn. pal.* and *gn if' orb.*). This plexus was studied both from series of sections and from dissections with a view to determining its constant features. The complete plexus was much better demonstrated by the latter method

(Plate **3**, fig. 7), the plotting from sections (Plates **2**, **3**, figs. 4, 6) being incomplete. Notwithstanding great variation in detail, the scheme of the plexus seemed to be in the main the following: — (1) Taking the main palatine as a point of departure, all the rami have their origin from VII at one point, or nearly so. This is where the palatine ganglion lies, as described by several authors. The palatine here is a ramus of considerable size and immediately gives off two main branches. These come off separately, but close together, in the plotted series (Plate **2**, **3**, figs. 4, 6). In fig. 7, Plate **3**, they both arise from the ganglion. One of these (*pal.*^{1}) swings abruptly outward crossing ventral to the infraorbital ramus of V (Fig. 7). It innervates the mucous membrane and taste buds (*gm. gus.*) on the way. The other (*pal.*^{2}) keeps a more median position until it crosses V to anastomose with the first (*pal.*^{1}) to form the lateral branch of the palatine (*pal. l.*). (2) There is an anastomosis (*an'stm. pal. l.*) with V, from near this juncture, and sections always show ganglion cells at this point (Fig. 4, *cl. gn. sy.*). (3) There are always two or three branches (Fig. 7, α, β, γ) which turn back to join V just distal to the infraorbital ganglion, and their appearance indicates a large proportion of non-medullated fibers. (4) Anterior to the orbit there are anastomoses (a) that connect the intermediate branch of the palatine with the maxillary nerve just before the latter passes into the maxillary bone (Plate **2**, **3**, figs. 4, 6 and 7, *an'stm. pal.i'm*), and (b) that connect the median palatine ramus with ramus nasalis V through the ethmoidal ganglion. These anastomoses account for the mixed character of the lateral and intermediate rami of palatine VII.

Terminal twigs given off from the infraorbital plexus. Of more importance than the exact form of the anastomoses are the twigs for terminal distribution given off from the branches making up this plexus. In all cases the main course of the principal branches is explained by an examination of the mucous membrane of the roof of the mouth. All the rami carry viscero-sensory fibers for the innervation of the taste buds. These sense organs are distributed within two restricted fields of the mucous membrane underlying the orbit, a small median area and a lateral one. The median group of taste buds (Plate **5**, fig. 12, *gm. gus. m.*) is much more limited than the lateral group. Here the buds are within a sensory-glandular patch little more than a millimeter in length (between sections 732 and 874), which lies on the pterygoid. The position is approximately indicated in the figure of the skull by the foramen in the pterygoid bone (Plate **1**, fig. 3, *for. pt.*). The innervation is from a twig (*gm. gus.*) of the median palatine ramus (Plate **3**, figs. 6, 7, *pal.*[3]), which passes through the foramen along with an artery and vein. The medullated fibers in this twig can not be followed farther in their distribution than the limits of this gustatory patch.

Anterior to the orbit the viscero-sensory fibers are found in three rami, a median (*pal. m.*), an intermediate (*pal. i'm.*), and a lateral (*pal. l.*) ramus. All these rami carry a few coarser fibers not characteristic of the palatine proximal to its anastomoses. These are interpreted as cutaneous sensory from V.

(a) *Ramus medialis.* This is a continuation of the principal branch of the palatine (*pal.*[3]). At about the level of the ethmoidal ganglion (*gn. eth.*), or proximal to it, there is a division of the principal ramus (*pal.*[3]), which results in a branch passing laterad to help make up the intermediate ramus (Plates **2**, **3**, figs. 4, 6, 7), but the main branch is continued forward as the ramus medialis (*pal. m.*). In the dissection (Plate **3**, fig. 7) this connection seems to be opposite the ganglion instead of proximal to it. A very small group of sympathetic ganglion cells is found at this junction. Another, shorter, branch connects the median ramus with the ethmoidal ganglion, thus forming an anastomosis with the nasalis. It would appear that this anastomosis serves the purpose of bringing the ethmoidal ganglion into connection with all the other rami. This connection of the median ramus with the ethmoidal ganglion has already been described (p. 54). Distal to this point the median ramus continues an uninterrupted course to the tip of the snout to innervate the mucous membrane of the premaxillary region. This is a glandular region richly supplied with taste buds. It is produced by the median union of the lateral glandular gustatory folds of the two sides. The course of the ramus medialis is just dorsal to the median edges of the palatine and vomer bones on either side of the interscapular nasal cartilage (Plate **4**, figs. 8, 9). A short distance proximal to its distribution this ramus is joined beneath the cartilage with its fellow of the opposite side by a median group of sympathetic ganglion cells (Plate **2**, fig. 4, *cl. gn. sy.*). Distal to this the united mediales continue forward for some distance as a common median bundle; this bundle, however, splits again near the region of its distribution.

(b) *Ramus intermedius* (*pal. i'm.*). This one of the terminal rami of the palatine is formed by the union of two branches lying dorsad of the palatine bone, one from maxillary V, just before its entrance into the infraorbital foramen, the other from the ramus medialis at, or proximal to, the ethmoidal ganglion. At all three of these junction points sympathetic ganglion cells are to be found. When formed, the ramus is a mixed nerve containing some fine medullated viscerosensory fibers from the palatine VII, some coarser medullated fibers of the cutaneous type from the maxillary V, and likewise non-medullated sympathetic fibers. The distribution of the medullated fibers of this ramus (Plate **4**, figs. 9–11) is along the median side of the glandular gustatory strip (Plate **4**, fig. 9, *gm. gus. l.*), which begins at the angle of the mouth and extends to the anterior end of the upper jaw. Posterior to the distribution of this ramus the glandular band is narrower and is innervated wholly from the ramus lateralis (Figs. 10, 11); here however, it broadens. By the narrowing of the jaw the two rami (r. lateralis and r. intermedius) are brought closer together, until finally their terminal branches mingle (Plates **2**, **3**, figs. 4, 6; Plate **4**, fig. 9).

(c) *Ramus lateralis* (*pal. l.*). This, like the preceding, is a mixed ramus; but contains a larger proportion of cutaneous fibers. These are drawn off from the maxillary ramus at the anastomoses indicated in the plotting and dissection (*an'stm. pal. l.*). In the dissection (Plate **3**, fig. 7) these anastomoses of the intermediate and lateral palatine branches with maxillary V are effected at the same point. The ramus lateralis passes cephalad along the median side of the maxillary bone and innervates taste buds and general epithelial surfaces (Plate **4**, fig. 10). As described above, it has a terminal area of distribution which is common to it and to the intermediate ramus.

The relation between nerves V and VII, described here as the infraorbital plexus, may be taken as representative of the group. About the only constant feature in the complex, however, is the palatine ganglion or the point corresponding to it. It is believed that this junction of V and VII would always disclose a ganglion if examined microscopically, and the apparent importance of this ganglion as a structural feature in Hatteria (Osawa, **'98**, p. 603, fig. 45) may be due to the fact that the cells are clustered instead of being scattered along the nerve. The latter condition is probably due to the position of the nerve, compressed as it is against the floor of the orbit. There is seen to be some evidence, from the character of the fibers in these anastomosing branches, to justify the acceptance, in a general way, of Fischer's (**'52**, p. 138, 139) distinction between a posterior and an anterior anastomosis, the posterior being a "sling" of the sympathetic system, while the anterior is a mixture of fibers from V and VII for distribution. Fischer did not recognize the sympathetic ganglia present in this region, but based his view on the proximity of the connection between the superficial sympathetic trunk of the head and the infraorbital nerve.

(2) *Ramus hyomandibularis* (*hy-md.*). This nerve leaves the geniculate ganglion (Plates **2**, **3**, figs. 4, 6, 7, *gn. VII*) at its posterior end. It embraces viscero-motor and viscero-sensory components. In cross sections it is to be seen that these two components are entirely separate throughout their course, the motor fibers having the more dorsal position. The latter include all the motor elements of nerve VII; these pass from the root across the dorsal side of the geniculate ganglion, not penetrating it, and then turn sharply into the ramus hyomandibularis. The motor and sensory elements each take up about half the area of a cross section of the nerve, the sensory components being of course much finer in caliber than the others. The course of this ramus is dorsad and caudad, following the same projecting ledge of the proötic bone (Plate **1**) as does the palatine, but in an opposite direction (Plate **3**, fig. 7). This course leads it to a point just ventral to the articulation of the quadrate with the proötic process of the ear capsule (Plate **6**, **7**, figs. 19–20). Here occur the crossing and anastomoses of the head sympathetic trunk (*comn. ex.*) with the hyomandibular ramus of VII (Plate **3**, fig. 7). The superficial sympathetic trunk (*comn. ex.*) from this point to the lachrymal plexus and infraorbital ganglion is called by Watkinson (**:06**, p. 464) "ramus recurrens nervi trigemini ad facialem"; its continuation to nerve IX, the "ramus communicans externus cum glossopharyngeo."

In a series of sections of Anolis, in which fixation in this region was excellent, it is shown with certainty that practically all the medullated fibers in this sympathetic ramus, which in every way resemble viscero-sensory fibers, pass the facial nerve in continuous course. The facial, however, makes its way between the sympathetic fibers, most of which cross the facial nerve mesally; a few only split away from the others to cross it laterally, and then immediately rejoin the main bundle. This is not a sympathetic center of any importance, although from four to six very small ganglion cells are inclosed between the two nerves at the point of crossing. While there was no evidence that any of the fibers in the part of the sympathetic ramus between VII and V turned into any of the parts of VII at this point of union, there does seem to be a strong indication that some of the fine medullated fibers contained in the hyomandibular ramus of VII are continuous with a part of those in the posterior section of this sympathetic trunk, i. e., that between VII and IX.

Attention is here called to the fact that cutaneous fibers are not demonstrable in VII and are not generally considered present in reptiles. They are, however, found in the Amphibia (Norris and others), and their distribution there would agree quite closely with the reptiles *if* it were discovered that a trace of the cutaneous component were carried to the skin in this sympathetic ramus, for the course of this ramus is superficial, and anteriorly it anastomoses freely with the cutaneous fibers of V. The conditions for study here were not such that a failure to observe this would preclude the possibility of a *very few* cutaneous fibers taking this course, should the central relations indicate a connection with the somatic sensory tract. The hyomandibular just distal to the crossing of the sympathetic divides into the motor ramus hyoideus and the sensory chorda tympani (Plate **7**, figs. 20, 21, *hy.* and *cd. tym.*).

(a) *Ramus hyoideus* (*hy.*). After parting with its sensory components, the motor part of the hyomandibularis continues its course to the muscles supplied by it. As this nerve reaches the depressor mandibular (digastric) muscle it divides into two branches for dorsal and ventral distribution (Plate **3**, figs. 6, 7, *hy.*, and Plate **7**, fig. 23). The final distribution of this nerve is well shown in figure *J*, which is a drawing from a mounted dissection that had previously been treated with vom Rath's mixtures. This shows that the digastric, sphincter colli, and the most posterior part of the mylo-hyoideus are innervated by ramus hyodeus (motor VII). This agrees with what Ruge (**'97**, p. 331) found in Varanus, although Watkinson (**:06**) was not able to discover it in her dissection.

Ruge (**'97**), in his extensive monograph on the facial nerve in the vertebrates, considers the mylo-hyoideus muscle in reptiles as belonging to the innervation field of motor VII, and he finds this demonstrable in Hatteria (p. 325), where the ventral ramus of VII is figured as extending almost to the end of the jaws. In the same form the ramus mylo-hyoideus of V leaves the jaw in the manner typical of that nerve, but Ruge considers it wholly cutaneous sensory. In the alligator the same muscle is innervated by the motor fibers carried in the ramus mylo-hyoideus of V, and Ruge (p. 381) concludes that V has received these "intracranially" from VII. Comparing with the amphibian Amphiuma, as described by Norris (**:08**), the motor components in ramus hyoideus VII of Anolis are directly homologous with the ramus jugularis of Amphiuma, which innervates the digastric, sphincter colli and posterior part of the mylo-hyoideus muscles, leaving the anterior part of the mylo-hyoideus to be innervated by the ventral division of the main mandibular, which is evidently the ramus mylo-hyoideus of V as described in Anolis (p. 61).

(b) *Chorda tympani* (*cd. tym.*). This nerve, which draws off all the sensory elements from the hyomandibular ramus (except possibly some which turn back into the sympathetic trunk), passes laterad on the roof of the middle ear chamber to reach the median face of the quadrate bone (Plate **3**, fig. 7, *qd.*). In its course it passes dorsad of the ligament of the columella auris (Plate **3**, fig. 7, *clml. aur.* and Plate **7**, fig. 20, *lig. tym.*) and then follows the quadrate ventrally on the anterior side of the middle ear chamber (*aur. m.*). It at once enters the cavity of the articulare (Plate **6**, fig. 18) through a special foramen. Its course is now cephalad within the jaw; but at some distance forward it passes out through the dorsal side of the articulare (or angulare) to take a position on the dorsal side of Meckel's cartilage, which is here exposed (Plate **5**, figs. 14, 15). It keeps this position in its forward course until joined by mandibularis V, which comes down on to it from the dorsal side. It becomes included within the same perineurium with this mandibular ramus, gradually shifting around to the dorso-median side of it (Plate **5**, fig. 13). At about the middle of the length of the jaw it is split off with a large somatic-sensory contingent and passes out of the foramen as previously (p. 59) described (Plates **2**, **3**; Plate **5**, fig. 12).

The question of the homology of the chorda tympani in the different vertebrate groups has been recently discussed by Sheldon (**:09**) in a very thorough manner and it need only be added here that Anolis offers no obstacle to the conclusions there reached. My studies of Anolis embryos in connection with the present work show the chorda tympani to have a history similar to what it has in mammals (Emmel **:04**), in that it belongs to a posttrematic ramus which is drawn across the developing tympanum after it has established connections distally with the lower jaw.

Versluys (**:03**) has recorded for Lacerta a development similar to that of Anolis and shows in an embryo with one open cleft that the chorda tympani passes posterior to the cleft to reach the lower jaw. He interprets the adult condition as due to the fact that the closing membrane of this cleft does not give rise to the adult tympanum, this structure being developed posterior to the chorda tympani nerve. Thus the latter is a true posttrematic ramus notwithstanding the evidence to the contrary which is presented in the adult.

In the adult Anolis the chorda tympani can be followed in the main to its terminal branches, and the close correspondence between these and the distribution of taste buds in the lower mouth region adds a new kind of evidence to support the conclusion that the chorda tympani is the nerve of taste for the tongue region.

Gaupp (**'88**) made a comparative study of the innervation of the mouth and nasal glands in vertebrates. Of the saurians he studied Chamaeleo, Platydactylus, and Lacerta. He also described the conditions in the other reptilian orders. His results for the lizards, briefly summarized, are as follows.

Superior labial glands innervated by maxillary V in the maxillary part, by the ophthalmic V (nasalis) in the premaxillary part, possibly by VII also. Median palatine glands by palatine VII exclusively. Lateral palatine glands by V and VII. Inferior labial glands by the terminal twigs from ramus alveolaris inferior V. Sublingual gland by lingual V and chorda tympani VII. Lingual glands same as sublingual. On the basis of innervation he homologizes the palatine glands of the lizard with the "Rachendruse" (Born **'76**) of Amphibia, and the reptilian sublingual with the mammalian sublingual and submaxillary. In the nerve distribution described, Gaupp recognized the essential relations between V and VII in both upper and lower mouth wall that have been pointed out in Anolis. He does not take into account other structures associated with the glands, which might account for the presence of certain nerves in proximity to them; for example, the taste buds, which are universally present wherever glands occur within the mouth region (not including the labial glands). Nor does he recognize important visceral elements in the form of sympathetic fibers which are carried by all these nerves and whose relation to the glands is not well understood.

O. GLOSSOPHARYNGEAL NERVE.

Nerve IX is connected with the brain by two roots (Plates **2**, **3**, figs. 6, 7), a dorsal fine-fibered and a more ventral coarse-fibered root. Both roots appear at about the same point in the series of cross sections, which, because of the flexure of the medulla, would indicate a more posterior position for the ventral one. The dorsal root is composed wholly of fine fibers of the viscero-sensory type. The ventral is presumably a motor root because the fibers are similar to the motor components of VII and may be traced directly through the ganglion and to its union with XII along with some of the fine fibers. The motor and sensory roots pass down separately to the closing membrane of the foramen, through which they emerge as a common trunk (Plate **6**, fig. 19, *rx. IX*).

The central courses of these two components were partly made out from the series of cross sections. The fasciculus solitarius is a clearly marked tract posterior to the sensory root of nerve VII and, as in the case of nerve X described below, the fine-fibered sensory root of IX passes directly to this tract. What is stated regarding the motor components of IX would apply equally well to nerve X.

The combined roots pass out of the cranium by way of the recessus scalae tympani between the ear capsule and the basoccipital bone. Versluy's ('**98**, p. 180) general statement applies to Anolis on this point: "Bei allen Lacertilia vera tritt demnach der Nervus glossopharyngeus nicht durch ein eigenes Loch in der Paukenhöhle, sondern durch eine grosse Oeffung, welche die ältern Autoren meist Fenestra rotunda, die neuern Foramen jugulare externum genannt haben." The root passes caudad underneath the mucous membrane to its ganglion (Plate **7**, figs. 20–23). This, the ganglion petrosum (*gn.* IX), as compared to the root ganglion of the vagus, has a much more distal position on its root (Plates **2**, **3**), and probably represents the trunk ganglion of X, inasmuch as there has been described in other forms a root ganglion in addition to the petrosum. This ganglion occupies the free space between the other organs on a level with the posterior edge of the ear capsule (Plate **7**, fig. 23). Its form is that of a uniform oval, and it lies on the dorsomedian side of its fiber bundle, which it incompletely surrounds.

The coarse motor fibers may be traced directly through this bundle and out into the nerve trunk beyond. They have the most ventral position — that farthest removed from the ganglion cells — in their course through the ganglion. The other fibers seem to be non-medullated within the ganglion, but this appearance may be due to absence of impregnation by the osmic acid.

Between the ganglion of IX and the union of its main trunk with XII there are connections with X and with the sympathetic system. These vary in their position, as study of several series of sections has shown, although certain relations are quite constant. In the series plotted (Plates **2**, **3**) the anastomoses are relatively simple. The frontal projection (Plate **2**, fig. 4) is the only one that shows them. These will be described first and the variations referred to later. A very small bundle of fibers from the vagus (Plate **3**, fig. 7, *comn.* IX–X) enters the petrosal ganglion on its proximal side; these become entirely mingled with fibers of IX so that the two are not separable beyond the limits of the ganglion. When the bundle emerges from the ganglion as the main trunk of IX, it shows in cross section six or eight coarse motor fibers, which have been followed from the motor root above described; the rest are very fine fibers, but with sharply staining medullary sheaths. These fibers are not placed compactly together and there is an appearance as though non-medullated fibers lay between them. The second connection of IX with other nerves occurs at the level of the distal end of the ganglion. Here the sympathetic, formed by the union of the "rami communicantes internus et externus IX et VII" (*comn. i.* and *comn. ex.*), joins the bundle of IX on its ventral side and, after contact and some mingling of fibers for the distance of 1/10 mm. becomes free again (Plates **2** and **3**, figs. 4, 7). (In dissections, no distinction can be made between the actual mingling of fibers and inclosure within a common sheath). This connection apparently has no relation to the ganglion, for it occurs on the ventral side of the ganglion at a point where the most distal ganglion cells occupy only the dorsal side. After this contact the nerve shows no more connections up to its union with the superior laryngeal X.

The variability in these connections is further emphasized when figure *K* is compared with figs. 4–7, Plates **2**, **3**. In the former the first named connection is absent and the second is accomplished by means of a small ramus joining the sympathetic trunk.

P. VAGUS NERVE

The central connections of the vagus nerve were less fully determined than those of the other nerves, owing to the fact that the roots are extremely small and the few fibers which each contains do not keep together within the brain but separate into even smaller bundles or single fibers. There is also some variation as to the number of roots that could be identified peripherally. There is considerable shifting of central nuclei in the sharp flexure of the hind brain, making it impossible to determine conclusively the origin of efferent fibers from particular cell groups without the aid of the Golgi, or some similar method.

Roots of the vagus. In series 30 (Plates **2**, **3**, figs. 4–6) the vagus enters the jugular foramen as three roots (*cf.* Fig. *K*). Two of these ppear in Plate **7**, fig. 20 (*rx. X*); to avoid confusion of lines, the plottings show only one root for each component. Of the three, he posterior one contains the deeply staining motor roots; the fibers n the other two do not appear to be of uniform character. The middle oot is the smallest. The posterior root has its superficial origin along the lateral surface of the medulla a few sections anterior to the foramen. Its fibers enter the brain at a sharp upward angle. The coarser fibers of the posterior root remain together and may be traced as they pass mesad in a broad upward curve to become spread out in the midst of a group of cells lying a little dorsal and lateral to the fasciculus solitarius. The more lightly medullated components of this root could be found making continuous connection with the fasciculus solitarius, into which they abruptly turn. The other two roots enter the brain along the same line as the posterior one. The smaller one could not be followed, but the larger could be traced to the fasciculus solitarius. It also contained several coarse fibers, which take the same direction as those of like character in the posterior root. The three roots remain separate until they enter the jugular ganglion.

The *ganglion jugulare,* or root ganglion of the vagus (Plates **2**, **3**, figs. 4, 5, 6, *gn. rx. X*), Plates **3**, **7**, figs. 7, 22, *gn. X*), lies closely crowded into the angle formed between the otic capsule and the basioccipital where the jugular foramen opens. This foramen appears in the same transverse section as the first occipital foramen of XII (Plate **7**, fig. 20). The ganglion which is larger than that of IX or VII, is triangular in transverse sections of the head (Fig. 22, *gn. X*). This form is the result of the pressure of surrounding structures, the ganglion being crowded against the otic capsule by the spinalis colli muscle (Plate **7**, fig. 22, *spi. coll.*). The form of the ganglion as a whole is notable, owing to the fact that the ganglion cells are so grouped on the mesial side of the fiber bundle that in dissections (Plate **3**, fig. 7) the ganglion appears to lie free along the root bundles for a short distance.

The fibers entering the ganglion as separate roots emerge on its distal side as one bundle, the coarse motor fibers, about sixteen in number, being grouped in its dorsal portion. This bundle (*X*) passes caudad parallel with IX and XII (Plates **2** and **3**). On its way it shows the small ramus connecting it with IX (Plates **2** and **3**, figs. 4, 7, *comn. IX–X*). Posterior to the ganglion of IX, the trunk of the vagus divides into a *superior laryngeal* ramus and a *visceral* ramus (*vsc. X.*). The superior laryngeal ramus soon joins the pharyngeal ramus of IX to form the pharyngo-laryngeal ramus of IX + X (Plate **2**, fig. 4, *phx-lar.*). This then combines with the trunk of XII (fig. 7) to reach the ventral side of the pharynx. (*cf.* fig. *K*).

(a) *Ramus laryngeus superior* (*lar. su.*). This division of the vagus includes all the coarse fibers of the main trunk and about one half the fine fibers. It forms a bundle about two thirds the diameter of the main trunk of IX, which it joins to form the pharyngo-laryngeal nerve (fig. *K*, Plate **2**, fig. 4, *phx-lar.*). From this ramus are given off several small twigs to the constrictor muscle of the jugular vein (p. 44). These are fibers somewhat larger than the viscero-sensory fibers, but with extremely delicate myelin sheaths, and for this reason they were not discovered in the series of sections plotted; but in another series through this region (Fig. *K*), especially fixed, the innervation of these muscle fibers was determined. Of the three twigs shown in the drawing only one is given off from the superior laryngeus before its union with the ramus pharyngeus IX.

It is important to note that these visceral muscle fibers (Plate **7**, fig. 23, *co'st. vn. j.i.*), although striated, do not draw off any of the coarse fibers from the vagus, but are supplied by nerve fibers which are indistinguishable from the other fine fibers when mingled with them, but which nevertheless possess slight differences, as is shown when they are grouped together. We probably have in the innervation of this muscle a case analogous to that of the ciliary muscle, which primarily is non-striated, but in the sauropsida is striated. If the striated muscle fibers surrounding the jugular vein have been differentiated from the smooth muscle cells of the vessel wall, which are believed to be innervated by non-medullated postganglionic neurons, the question suggests itself as to what modification of the innervation has accompanied that of the musculature. As before stated the nerve fibers show a slight medullation indicating to that extent a change from the sympathetic type, but their continued course through the ganglion, suggesting direct central origin, was not shown in the sections although this was clearly demonstrated for the more heavily medullated fibers passing into the pharyngo-laryngeal branch. Onuf and Collins (**:00**, p. 174) describe two nuclei for efferent neurons of nerves IX and X in the mammals (cat). The dorsal glossopharyngeal and vagus nucleus, is, according to them, the nucleus of origin for the efferent sympathetic fibers carried in the roots of these nerves; the ventral, nucleus ambiguus, gives rise to the nerve fibers innervating muscles of visceral origin but of somatic function, derivatives of the striated gill-arch musculature of the fishes. The spinal accessory nerve, when present, is exclusively of the latter type. The innervation of the special jugular vein muscle of Anolis suggests a condition intermediate between the sympathetic and the viscero-motor of the cerebro-spinal type. The slight development of this latter component in nerves IX and X made it impossible to establish this suggestion as a fact through the analysis of the central terminations.

Bruner (:**07**, p. 47) gives quite a detailed description of the innervation of the striated muscle of the jugular vein in reptiles. He finds this muscle in *Lacerta agilis* to be innervated by a number of nerve twigs which are given off from the rami communicantes internus et externus. The latter join the proximal end of the petrosal ganglion, of nerve IX, which, in addition to its root is also joined by a communicating ramus from ganglion X. Bruner applied stimulation methods at various points in this nerve complex and thus determined the path of the motor fibers to the "m. constrictor venae jugularis internae" to be from the brain through the roots and root ganglion of nerve X, across to the petrosal ganglion through the communicating ramus between IX and X, and then cephalad along the rami communicantes internus and externus to points where the "nervi tumefactores capitis" are given off to the adjacent muscle surrounding the jugular vein. According to Bruner the function of this musculo-nervous mechanism is to contribute to the swelling of the cephalic veins and sinuses of the head by blocking the return of blood through the internal jugular vein. In Anolis (Fig. *K*) these "tumefactor" nerves show closest anatomical relations to nerve X, the indirect course described by Bruner being unnecessary because here the constrictor muscle lies relatively more caudad than in Lacerta. Notwithstanding the fact that these nerves are given off elsewhere, the ramus communicans X et IX occurs quite constantly (see Plates **2**, **3**, absent Fig. *K*). It is possible, then, that this communicating ramus is an efferent sympathetic path not exclusively related to the constrictor muscles of the jugular vein.

After the union of the superior laryngeal ramus of X with that of pharyngeal IX the combined nerve (*phx-lar.*) joins XII in its course to the ventral side of the pharynx. Beyond this point not all the components of IX and X can be followed and accounted for positively in their distribution. It seems certain, however, that the laryngeal branch (*phx-lar.'*), the first given off from XII after it reaches the ventral side (figs. 5, 6), represents a large portion of this nerve, although its smaller size establishes the fact that the trunk of XII still carries some of the fine fibers. By using fine needles in dissection this laryngeal ramus can be split away from the main trunk of XII and thus it may be demonstrated to represent the larger part of ramus pharyngolaryngeus, whose union with XII is mentioned above.

1. Relations between Nerves IX and X.

Preceding an account of the terminal rami of IX and X, a generalized summary of the relations of roots and main trunks of these two nerves will be given. It is based on the details of this nerve complex as worked out in six cases, and gives the features common to all.

There is much variation in the details of the connection between nerves IX and X. Without reference, for the time being, to the anastomoses of uncertain significance, the essential features of the two nerves may be stated as follows:

(a) Nerves IX and X arise each by several separate roots, at least one root of each nerve being motor. The component character of each nerve appears to be the same, although X exceeds IX in the number of both its sensory and motor components. The ganglion of IX (Plates **2**, **7**, figs. 4, 23) lies some distance from the brain, as already stated, and probably is not strictly homologous with the ganglion of X, the jugular, which is just outside the foramen.

(b) The coarser motor fibers in each case are readily seen to pass through their respective ganglia.

(c) There is a postganglionic division of each nerve which results in each case in two bundles; a bundle of mixed coarse and fine fibers and a bundle composed exclusively of fine fibers.

(d) The *mixed* bundles come together (as pharyngo-laryngeal branch) and then join XII for distribution on the floor of the pharynx.

(e) The *fine fibered* bundle of IX is very small and joins the sympathetic trunk, from which it *may* later separate, along with sympathetic elements, to reach palatine VII.

(f) The purely sensory bundle of X is a large one, and passes caudad to its trunk ganglion, ganglion nodosum (*gn. nd.*); it then divides (Fig. *L*) to form the ramus recurrens X and the ramus visceralis distributed to the lungs, heart and alimentary canal.

(g) In all cases studied except one IX and X show an anastomosing ramus (Fig. 4, *comn. IX–X*) which connects a preganglionic point of IX with a postganglionic point of X. The one exception is shown in Figure *K*, already referred to, where there is no connection whatever between IX and X proximal to the union of the pharyngeal and laryngeal rami.

2. A vestigial dorsal Ganglion on the Roots of the Vagus.

There was found in several cases in Anolis a very small group of ganglion cells situated on the dorsal side of one of the roots of nerve X. Such gangla were studied in three cases. In two cases they were situated upon the largest, most posterior root, which carries the motor bers. In the third case the ganglion, being smaller than in the others, consisted of only three or four cells located on the small middle root.

In no case observed did there occur more than one group of such ganglion cells upon the several roots of the same vagus nerve. No such ganglia were found upon IX. The size of these cells shows them to be of the cerebro-spinal rather than the sympathetic kind. This fact is brought out by comparing them with cells of the geniculate ganglion, and also with those of the spinal ganglion, and contrasting these with the sympathetic cells found at the base of the palatine.

Embryological studies by various investigators have demonstrated for both reptiles and mammals transitory root ganglia in this region. These are generally interpreted as the remnants of the lost dorsal roots between the first spinal ganglion and the vagus. Van Wijhe (**'86**) and Chiarugi (**'89**) considered these ganglia as contributing permanently to the accessorius part of the vagus. Fürbringer (**'97**, p. 502) recognizes the existence of these ganglia in Sauropsida, but states that they later disappear entirely and have nothing to do with the vago-accessorius. In mammals such rudimentary ganglia have been noted in the embryo of the pig (Lewis, **:03**) and in man (Streeter, **:04**). In the Amphibia IX, X, and sometimes VII, possess cutaneous components. In mammals these are reduced to a small bundle, which proceeds from the jugular ganglion as the ramus auricularis, and small clumps of cells may remain among the vagus roots even in the adult, an indication of the more extensive existence of this cutaneous component.

In Anolis no cutaneous fibers were discovered in any of the nerves between V and the third spinal; unless these rudimentary vagus ganglia be ascribed to the cutaneous components, all traces of these components have been lost in these segments. In the whole group of reptiles this absence of cutaneous rami appears to prevail, as no mention of such nerves is made by any author. If this is the case, the reptiles stand alone in the extent to which this component has been lost. The birds, however, need investigation on this as well as on other points. Cords (**:04**) has described in birds a cutaneous sensory branch of VII going to the lining of the external auditory meatus, to which she gave the name "ramus auricularis," the same term that is applied to a nerve of similar component character in mammals, but derived from X. If microscopic study should verify Cords's observation, we should have in birds the persistence in VII of a component which is absent from this nerve in practically all other forms above fishes; but the same component would in birds be absent from a nerve (X) which possesses it in all vertebrates except the Sauropsida. It is important in this connection to note that Cords describes a root ganglion, "ganglion jugulare," for IX in addition to the petrosal ganglion. When this appears in a rudimentary form it is called a somatic sensory structure. If it is large enough to be discovered by dissection methods, one might look for a cutaneous ramus associated with it. Is it possible that Cords's ramus auricularis VII has any relation to her "ganglion jugulare" IX?

The value of Fischer's (**'52**) work lies in the range of his material, which justifies certain deductions, the validity of which might be arrived at directly by microscopic study. For comparison with Anolis some of the more important statements made by Fischer may be considered. This author does not find a root ganglion on IX, although the petrosal ganglion is to be recognized in practically all cases. This ganglion is united with nerve X and joined by rami of larger or smaller size, the union with the latter is generally on the proximal end of the ganglion through the combined rami communicantes internus et externus IX ad VII. In Platydactylus, however, the external sympathetic ramus does not join the internal; this leaves, then, only the connection to palatine VII known as Jacobson's anastomosis and consequently no apparent connection with the sympathetic system. In another form (*Varanus bengalensis*) the reverse is true, the internal communicating ramus passes IX to join the main sympathetic trunk farther distad. A Jacobson's anastomosis in this case would have to go by way of the external ramus. In this form also no ganglion petrosum was discoverable, although it is very large in another species (*Varanus nilotocus*) of the same genus. Neither Watkinson (**:06**) nor Osawa (**'98**) discovered with certainty the petrosal ganglion. This would indicate either a scattered condition of the ganglionic cells along the trunk, or a less developed viscero-sensory component in Varanus and Hatteria than exists in the case of Anolis, in which, though a smaller animal, it was demonstrable by dissection methods. The failure to find the ganglion by this method would not indicate ts entire absence.

The union of IX and X also shows considerable variation, as does ikewise the union of these two, combined or separately, with the nain trunk of the hypoglossal. In comparing with all the forms iitherto described, Anolis may be put down as typical in the combina- on of the main pharyngeal branches of IX, X, and XII into a common runk, which later separates; but as this union has no significance ther than as a common path around the pharynx, it is modified herever there is much variation in shape of head and relative posi- ion of parts innervated. In a few cases XII is wholly free, and in others IX is independent of both X and XII; these conditions hav significance in determining the probable source of the termina branches in such a form as Anolis, where these branches cannot b followed back through the combined trunk; they will be referre to again in the account of the terminal distribution of IX and X Since nerve X is larger than IX in all the forms described, its gangli have been more regularly found than those of IX. The trunk ganglion of X (*gn. nd.*) is a more constant feature than its root ganglio (*gn. rx. X*, *gn. X*), having been described for all species hithert studied. On the other hand, the root ganglion, such as is found i Anolis, has been definitely identified as an independent ganglion i only three forms.

3. Terminal Distribution of Nerves IX and X.

From the foregoing account it is seen that all the components o IX and X (excepting the rami to the jugular vein) are distributed peripherally from three rami. (1) Jacobson's anastomosis, carryin viscero-sensory fibers to VII; (2) Pharyngo-laryngeal, carrying th superior laryngeal branch of X and the pharyngeal branch of IX both of which include viscero-sensory and viscero-motor fibers (3) ramus visceralis, carrying viscero-sensory fibers of X. To wha extent efferent sympathetic fibers may be carried in any of these ram could not be determined.

(1) *Jacobson's anastomosis.* This term is here used for the communicating ramus (*comn. i.*) between IX and VII, which joins th base of the ramus palatinus. As the term is generally employed i is restricted to a connection between these points, which carries viscero-sensory palatine branch from IX to be distributed with pal tine VII, and also innervates the mucous surfaces caudad to VI Because of the development of the sympathetic system of the hea the main trunk of which takes this course, it is difficult to determi to what extent this is a true viscero-sensory branch. In Anolis tw points on VII are connected with IX, usually at the distal end of t petrosal ganglion. This connection is often so slight that it is lo sight of in the more evident fact of the direct passage of this symp thetic bundle caudad to its ganglion. It is always large enoug however, to give rise to all the medullated fibers contained in t internal communicating branch, which is the one having the positi of Jacobson's anastomosis. Whether it *does* give rise to them cann be stated. It can be stated that if Jacobson's anastomosis (as r stricted) exists in Anolis, it contains very few viscero-sensory elemen

A comparison with other reptiles would seem to warrant the broadening of this statement to a general one applicable to reptiles as a group. There are found in practically all forms of reptiles these two sympathetic rami named by Fischer (**'52**, p. 30) "ramus communicans internus rami palatini cum glossopharyngeo" and "ramus communicans externus nervi facialis cum glossopharyngeo." The first of these, which would have the position of Jacobson's anastomosis, Fischer (p. 30) refers to as one of the finest nerves in saurian anatomy, which could be identified only with great difficulty; at the same time he adds that it belongs to "den beständigsten Nerven," and for this reason must be considered essential to the plan of the saurian nervous system. Fischer, however, showed one case, before referred to (p. 79), where this internal ramus makes no connection with IX, which supports the view that it is principally a sympathetic ramus from the deeper part of the head to the common cervical trunk.

Bender (**:06**, p. 388) gives to this connection both a sympathetic and viscero-sensory function in Chelonia, and states that the petrosal ganglion is closely bound up with a ganglion of the sympathetic. In Anolis no sympathetic cells were recognized, nor did the petrosal ganglion show any division. Cords (**:04**, p. 79) also specifically states that, in the goose, this anastomosing branch from IX to VII is composed of fibers from IX and from the sympathetic ganglion.

(2) *Ramus pharyngo-laryngeus* (*phx-lar'*.). This nerve is given off from the main trunk of XII, in which it is temporarily carried, at about the posterior end of the genioglossus muscle. Its course is cephalad and mesad between the genioglossus and the cerato-hyoideus to the trachea posterior to the larynx. As it leaves XII its composition is almost identical with that of the combined IX and X pharyngeal rami before they join XII, although it is somewhat smaller. There are about 20 coarse fibers mingled with the fine ones. In its course across the m. cerato-hyoideus it loses about half of the larger fibers, so that it is found to contain about eight or ten of these fibers distal to its course across that muscle. The remaining coarse fibers supply the muscles of the larynx, the fine fibres being sensory. When the nerve has reached a position just beneath the mucous membrane (Plate **5**, fig. 13), some very fine fibered branches are given off om the main trunk (not shown in the figure). They are so twisted bout the blood vessels that their final distribution, whether to the pithelium or elsewhere, was not demonstrable. A small ganglion at he base of the fine fibered ramus indicates that a part of the fibers are f sympathetic character.

The main trunk passes forward, giving off two more branches to the mucous membrane (Plate **2**, fig. 5) before turning abruptly across the ventral floor of the larynx to form an H-shaped anastomosis with the same nerve of the opposite side (Plate **2**, fig. 5, *an'stm. lar.*). The chiasma is not a complete one; hence each muscle of the larynx is stimulated through motor fibers from both sides of the brain.

The muscles of the larynx consist of an outer longitudinal (dilator) and an inner transverse (constrictor) pair, (Plate **4**, fig. 11, *lar. lg.* and *co'st. lar.*). They are innervated exclusively from the coarse fibered elements carried in the pharyngo-laryngeus IX and X. Attention is called to the fact that this motor innervation may be from IX, from X, or from both. There is no possibility of determining in Anolis, except experimentally, which nerve has given up its fibers to the cerato-hyoideus muscle. If dissections may be trusted on this point, the condition as described by Watkinson (**:06**) in Varanus would support the view that the fibers innervating the cerato-hyoideus (hyoglossus) muscle are from IX. In Varanus IX does not anastomose with XII and does not appear to combine with X in a manner corresponding to the condition in Anolis. In the former the nerve described as IX innervates the cerato-hyoideus muscle as it crosses the ventral face of that muscle. There are more proximal anastomoses, however, making possible some combination of the fibers of IX and X as in Anolis; so, in the absence of microscopic observation, any conclusion must be tentative.

The laryngeal anastomosis is quite generally mentioned where the innervation of this region is described in higher vertebrates. The ramus recurrens X is usually described as entering into this "sling" and joining in the motor innervation. In Anolis, however, the ramus recurrens takes no part in the sling, although the terminal ramus of this nerve passes through the longitudinal laryngeal muscle (Plate **2**, Fig. 5, *lar. lg.*) to reach the dorsal free edge of the laryngeal cartilage, where its fibers may be seen turning in to innervate the epithelium of the larynx (Plate **2**, fig. 5, *rcr. X*).

(3) *Ramus visceralis* (*vsc. X*). This is the name given the main trunk of the vagus after the superior laryngeal nerve is given off. It is a fine-fibered bundle, which closely resembles the main sympathetic, with which it has a parallel course across the dorsal side of the thymus gland. It bears the large trunk ganglion (*gn. nd.*) in its course and then gives off to the mucous membrane sensory branches, which correspond to the posterior laryngeal, and also the ramus recurrens X. In the series plotted the sections are not carried

back far enough to reach the trunk ganglion. This was done in another series. The best demonstration however, of the course of the vagus to show the trunk ganglion and the postganglionic branches was furnished by a dissection of this region mounted in balsam. As these structures lie underneath all muscles, it was possible to remove the floor of the pharynx in this region and pin it out on cork and then fix it in Vom Rath's fluid. The preparation, which consisted of the mucous membrane, the blood vessels and the nerve trunk with all the branches to the mucous membrane, was cleared and mounted on a glass slide giving a diagrammatic picture of the distribution of the nerves. A drawing (Fig. *L*) of a portion of such a preparation is given

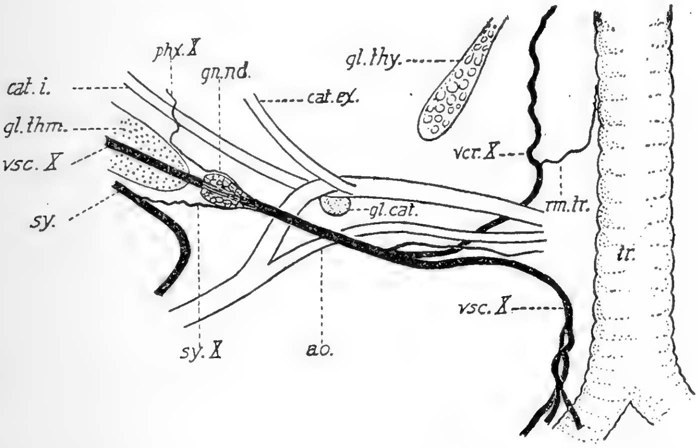

Fig. L.— Camera drawing of a portion of a dissection to show trunk ganglion of the vagus and the relation of ramus recurrens to the arterial arches. This is part of a preparation made in the same manner as that showing distribution of motor VII (figure *J*). For *vcr. X*, read *rcr. X*.

o supplement the plotting. It will be seen that no branches are given off proximal to the ganglion, which lies just clear of the thymus gland at its posterior end. The ganglion itself is a pear-shaped structure through the center of which there is a distinct fiber path. At its distal end two very fine rami are given off, one (*phx. X*) mesally, to he pharynx wall, the other (*sy. X.*) to the main sympathetic trunk. The vagus nerve crosses the arterial arches on their ventral side and aches a position alongside the trachea just cephalad of the bronchial ivision. As it nears the median line the ramus recurrens laryngis *cr. X.*) is given off. It crosses the arterial arches on their dorsal de thus forming the loop. The posterior ramus visceralis proper was ot followed farther than is shown in this preparation. It branches almost immediately and the lungs are very richly supplied. The branches to the heart did not appear.

Ramus recurrens laryngis X (Plate **2**, fig. 5; *rcr. X.*). The course of this ramus is directly cephalad to the larynx, following along the lateral side of trachea to reach it. Numerous very fine branches are given off in its course (not shown in Plate **2**, fig. 5). Reaching the larynx this nerve breaks up, first dividing into the two main terminal divisions shown in the figure. One of these lies on the dorso-lateral side of the larynx and passes through a portion of the longitudinal muscle to reach a more anterior position, where it innervates the *mucous membrane* just posterior to the glottis. The other branch, the more median one in the figure, innervates the mucous membrane of the ventro-lateral part of the larynx. The first branch in its passage through the muscle becomes closely involved in the motor complex, and is separable from it only through the study of sections. If it contributes motor fibers to this, it is only very slightly, and my belief is that in Anolis the ramus recurrens is wholly sensory. Section 659 (Plate **4**, fig. 11) is anterior to the main branches so that no part of the recurrent ramus appears. Some motor twigs are shown in the muscle.

More data are needed to homologize the branches of nerves IX and X with those of Amphibia. In the latter the ramus recurrens X innervates the *muscles* of the larynx (Coghill, **:02**, p. 245; Norris, **:08**, p. 552).

Through comparative anatomy Fischer arrived at conclusions which conform with the facts as stated for Anolis. He found the intimate mingling of the terminal twigs of the ramus recurrens X and the pharyngo-laryngeus, so generally described in other forms, to be absent in two cases, so that the distribution of the two nerves was distinct, and in these cases the recurrent ramus is held to be sensory, not motor. "In den Fällen, wo der R. recurrens sich nicht mit jenem [pharyngo-laryngeus] verbindet (Varanus Bengalensis, Platydactylus guttatus) geht dieser [r. recurrens] nicht in die Muskeln, sondern an die Schleimhäute des Kehlkopfes" (Fischer **'52**, p. 48). But Watkinson (**:06**, p. 467) for another species of Varanus states that the united fibers of the ramus recurrens X and the terminal branches of IX are distributed to the *muscles* of the larynx. Her observation was not properly supported, however, in regard to either point, as in her species (1) nerve IX previously received fibers from X, as in Anolis, and (2) a mere union of rami as demonstrated in dissection does not in itself prove similarity of distribution.

By the same comparative method Fischer (**'52**, p. 49) established the innervation of the cerato-hyoideus from IX and the laryngeal muscles from X. For in two cases (*Euprepes sebae* and *Lacerta ocellata*) IX was found to be free from X, and in these cases its distribution was to the cerato-hyoideus muscle and to the pharynx wall anterior to the larynx. Nerve X in these cases is a pure superior laryngeal and goes to muscles and mucous surfaces of the larynx (i. e. is of mixed nature, carrying both motor and sensory fibers). This gives ground for the view that a like condition exists in those forms where it cannot be actually demonstrated.

Van Bemmelen (**'89**) considers Fischer's work open to criticism in this particular connection because he did not establish the homology of the rami by means of their relation to the aortic arches. Both Van Bemmelen and, more recently, Göppert (**'99**) contradict Fischer's conclusions regarding the sensory nature of ramus recurrens X. Göppert, in an article which deals comparatively with the larynx region in Amphibia and reptiles, concludes with this statement (p. 23): "Bei allen Reptilien haben wir also Berechtigung zu der Annahme, dass der Recurrens bis zum Kehlkopf gelangt, trotz des oft weiten, von ihm zurückzulegenden Weges. Dass er dann aber überall die Kehlkopfmuskulatur versorgt, wird keinem Zweifel unterliegen können, nachdem er sich für die Lactertilier direkt erweisen liess." These differences of opinion cannot be attributed to the study of different reptiles, for Göppert makes use of the same genus (Platydactylus) as that employed by Fischer.

The present results in Anolis, then, do not clear away the uncertainties of the general question of larynx innervation; they tend, however, to suggest the probability that both the superior laryngeal and the recurrent branch may carry motor fibers, these showing different proportions in the rami of different forms.

Q. SPINAL ACCESSORY NERVE.

A spinal accessory nerve was not discovered in Anolis. In all the described reptiles a portion of the vago-glossopharyngeal components are grouped as nerve XI, or spinal accessory. Peripherally there are generally two anatomical conditions which warrant this interpretaion: (a) the caudad extension of the vagus series of roots beyond the imits of the cranium, and (b) the distribution of a motor ramus from he vagus (distal to the ganglion) to certain of the muscles of the houlder girdle. Both these features are absent in Anolis.

By examination into the component character and central relations of this nerve, where it exists, it is found to be similar to those viscero-motor components of X and IX which innervate striated muscles (Johnston, **:06**, p. 203), such as the laryngeal muscles. These all have their cells of origin (in the higher vertebrates at least) in a portion of the viscero-motor column ventrally separated from the rest and known as the nucleus ambiguus. While the motor nuclei of this region of the hind brain have been incompletely identified in Anolis, microscopic study has fully demonstrated that IX and X contain a very limited number of components such as innervate the laryngeal muscles and that these *all* pass ventrally with XII, which gives off no branches that cannot be directly traced to muscles of the ventral head region.

It still remains to be demonstrated whether there is a caudally extended motor nucleus ambiguus which contributes fibers to the spinal nerves innervating the muscles originally supplied by the accessorius. In the absence of such a relation, it would then be a question whether the trapezius muscle in Anolis is homologous to the one so named elsewhere.

The apparent absence in Anolis of anything corresponding to the spinal accessory is an anomolous condition in reptiles, because, even making allowance for many misinterpretations depending on gross dissections, the universal mention of such a nerve in the literature bearing on reptilian anatomy would indicate a greater development of the vago-accessorius group than is shown in Anolis. Fischer (**'52**, p. 62) finds that the condition first described by Bischoff (**'32**) is realized in all the forms he studied, viz. that from 5 to 9 fine bundles, generally increasing in strength posteriorly, arise along an irregular line extending from the level of the second cervical nerve to the origin of the vagus. All these root bundles assemble into one trunk, which generally fuses with the vagus. In two species of the genus Salvator, however, this trunk remains separate, although it passes out through the same foramen with the vagus. This independent course of the accessorius was also described by Bendz (**'43**) for *Chelonia mydas.* What Fischer calls the accessorius includes, in addition to the ramus externus, fibers which have a distribution with the laryngeal branch of the vagus, or with the ramus recurrens vagi, or with both. The ramus externus, which by gross methods is the only portion of the accessorius that can be followed to its distribution, was not found by him in all forms. It was absent in *Chamaeleo vulgaris* and *Agama spinosa.* No mention was made as to whether there was a correlated reduction of the posterior roots; if such a reduction occurred in these two species, they would be in correspondence with Anolis. Fischer demonstrated the ramus externus definitely in nine other species of lizards and in the crocodile. Bischoff (**'32**) and Vogt (**'39**) had described this ramus externus as supplying a small twig to the cervical muscle, but this could not be expected, and was not verified by Fischer.

Fürbringer (**'76**, p. 649) in his account of the innervation of the shoulder muscles of saurians refers to the part taken in their innervation by the vago-accessorius as though it were a regular feature to be met with in all forms. The ramus externus is distributed, he says, to the ventral half of the capiti-cleido-episternalis (capiti-dorso-clavicularis), where it as a rule anastomoses with the cervical plexus of the anterior spinal nerves.

More recently Osawa (**'98**, p. 616) has described in Hatteria a spinal accessory having the typical superficial origin, which extends caudally as far as the third spinal nerve. This accessory joins X, and distal to the ganglion there is given off a weak ramus internus and a strong ramus externus, the latter going to innervate the muscle capiti-dorso-clavicularis. Schauinsland's (**:03**, Taf. VIII, fig. 70) observation on the embryo of the same form practically coincides with Osawa's description.

There appears to be some confusion in Watkinson's (**:06**) account of this nerve in Varanus. She says (p. 467) "the ramus externus vagi innervates the muscle sterno-cleido-hyoideus near its origin from the skull. This muscle also receiving innervation from the third cervical nerve, the end fibers forming an intricate sling with those of the ramus externus." Reference to her Plate XII, figs. 10 and 11, shows that the author means "m. capiti-cleido-episternalis." Another ambiguity rests in the use of the term "m. cucullaris" (Plate XII, fig. VIII) for the most superficial neck muscle. This evidently corresponds to the sphincter colli of Anolis and, like the latter, is innervated by VII.

Notwithstanding the great number of papers that have appeared on the morphology of the nervus accessorius, the subject is far from settled, and, in view of the great range of variation in the anatomical relations of roots and peripheral nerves, the necessity of microscopical analysis is obvious. Lubosch's (**'98** and **'99**) extensive review of the ubject in vertebrates from the standpoint of comparative anatomy only tends to emphasize the fragmentary nature of our knowledge egarding this region in amniotes.

R. HYPOGLOSSAL NERVE.

The twelfth cranial nerve is well developed in Anolis, in correlation with the condition of the tongue and especially with its muscular tongue papillae. It arises from three distinct roots and, with the exception of the brief union with the pharyngo-laryngeal ramus of IX and X, takes an independent course to the tongue, where the greater part of its fibers are distributed to the intrinsic musculature. A few small bundles are given off to the cerato-mandibularis group as it crosses these muscles. Not all the hypoglossal nerve is distributed to the ventral region, a part of the last (third) root retaining the dorsal and lateral rami of the spinal nerve from which it phylogenetically has arisen. These go to the cervical muscles.

Roots of the hypoglossal. Although nerve XII is a combination of roots which emerge from the cranium through three separate foramina, there is no separation of root bundles at their origin into three groups. They form a continuous series along the somatic motor line, and a comparison shows that they may be differently combined to emerge from the cranium. There is, however, one feature which is constant, viz., the presence of a *cervical* part on the last root of the series, which is marked off from the *hypoglossal* part by a difference in the size of its fibers, thus showing a correlation between its functions (as indicated by its distribution) and the structure of its fibers. Special series of sections prepared for the purpose of tracing these differences to central nuclei have thus far failed, owing to the difficulty of carrying them through the meninges of the brain. Where the root bundles pass through the foramina the fibers are well preserved and here the two kinds of fibers are distinctly segregated and were easily followed into their respective rami.

Distribution of the cervical part (Plates **2, 3,** figs. 4–6). The cervical part is made up of larger fibers than those forming the hypoglossal nerve proper. They equal in caliber the motor components of the first and second spinal nerves, and their distribution is similar. The hypoglossal bundle in the posterior root of XII is in every way like the other roots of this nerve which join it to form the main hypoglossal trunk. The cervical portion, having a dorsal position in the common root as it emerges from the foramen, divides at once into a lateral (*crv. l. XII*) and a dorsal (*crv. d. XII*) ramus. The lateral ramus is the larger and is distributed to the spinalis colli muscle (Plate **7,** fig. 23, *spi. coll.*). The dorsal ramus passes caudad on the dorsal side of this muscle to join the dorsal ramus of the first spinal nerve, with which its terminal fibers become mingled (Plate **3**, fig. 6, *spi. d. 1*). It is anticipated that, upon careful study of the brain with reference to the nucleus of XII, some difference in origin of these two bundles (*crv. l. XII* and *crv. d. XII*) as compared with XII proper, will be demonstrable.

In its course around the pharynx to reach the ventral side of the neck XII crosses dorsad of the thymus gland (Plate **7**, fig. 24, *gl. thy.*), and also of the visceral ramus of X and the sympathetic trunk, which lie close together on the dorsal side of this gland (Plates **2**, **3**, figs. 4, 6, and 7, *vsc. X* and *sy.*). XII, turning ventrally, passes between the thymus gland and the jugular vein mesad of all muscles. Section 1595 (Plate **7**, fig. 24) falls in a plane just caudad of XII so that no part of it appears; the other structures referred to show well in this section. Section 1480 (Plate **7**, fig. 23) shows XII after it has attained its ventral position. This is reached by crossing the end of the first cerato-branchial on its lateral side. Nerve XII then takes a direction cephalad (Plate **7**, figs. 22, 23) between the cerato-hyal (*ker-hy.*) and the first cerato-branchial (*ker-brn. I*), on the ventral side of the cerato-hyoideus (hyo-glossus) muscle. Its direction from this point onward is cephalad and mesad along the lateral edge of the genio-glossus muscle and the median side of the cerato-hyal. As it passes forward it comes to lie on the ventral side of the genio-glossus (*gen-gls.*), where it parallels the mandible to a point as far forward as the basi-hyal (Plate **6**, figs. 16–18). Here we find a division of the main trunk into two rami of about equal size. The median one immediately divides, so we then have a three-fold division (Plate **5**, fig. 12, *lng. l. XII*, *lng. i'm. XII*, and *lng. m. XII*) of the main trunk, the lateral one containing about half the fibers. From this point forward these three main rami diverge and pass up into the tongue musculature for distribution (Plate **2**, fig. 5). This course of the main trunk and terminal divisions of XII has been described without reference as yet to certain small rami which it gives off. The branches of XII will now be described in more detail:

Distribution of the hypoglossal nerve. (*a*) *Ramus pharyngo-laryngeus* (*phx-lar'.*). Although r. pharyngo-laryngeus is given off as a branch f XII, the principal, if not the sole, source of its fibers is from nerves IX and X, as described in connection with the account of those nerves.

(*b*). Between (*a*) and the main divisions of XII there are given ff several very small rami, which innervate the muscles between which the hypoglossal nerve passes. The first of these (Plate **2**, fig. 5, XII^{1}) supplies the cerato-mandibularis 1 (Fig. 18) in its posterior region. The second (*XII* [2]) goes to the small slip of muscle described as the cerato-mandibularis 3 (Plate **6**, figs. 16–19, *ker-md.*[3]) sending also a few fibers to the same muscle that receives the first twig. Some distance cephalad a third ramus (*XII* [3]) is given off, which innervates this first muscle, the most of the bundle, however, passing far forward to reach the portion described as cerato-mandibularis 2 (Plate **2**, fig. 5; Plates **4**, **5**, figs. 9–12, *ker-md.*[2]). Just anterior to this several small branches (Plate **2**, fig. 5, *XII* [4]) supply the posterior portion of the genioglossus.

It is noticeable that all these small rami to the more superficial tongue muscles draw off from XII the largest and most strongly medullated of its fibers, although not exclusively fibers of this kind. There is no further distribution of fibers of XII from the main trunk, which now may be said to supply the tongue proper through the three main divisions referred to above. For convenience in description these will be described as median, intermediate and lateral rami.

Ramus lingualis medialis XII (*lng. m. XII*). This ramus crosses the ventral side of the main longitudinal tongue muscle, genioglossus, to reach the median edge of this muscle. Here, on either side of the glossohyal (*gls-hy.*) and underlying the larynx, begins a mass of muscle composed of short vertical fibers (Plate **4**, fig. 11, *lng. vrt.*). This forms a continuous vertical muscle surrounding the glossohyal as far forward as its anterior end, which is well toward the tip of the tongue. The median ramus of XII runs the length of this muscle supplying it on the way (Plate **2**, fig. 5). As the vertical fibers gradually run out, this nerve also dwindles. The fibers innervating this muscle are less heavily medullated than those of the small rami previously described.

Ramus lingualis intermedius XII (Plate **2**, fig. 5, *lng. i'm. XII*). This ramus is a little larger than the median one and the fibers are larger and more heavily myelinated. It runs cephalad first on the surface of the muscle genioglossus then within that muscle. This ramus appears to supply the genioglossus exclusively. Its course may be followed in the drawings of cross sections (Plate **4**, **5**, figs. 9–12).

Ramus lingualis lateralis XII (*lng. l. XII*). This is the largest division of XII and the one which forms the anastomoses with the lingual branch of V (Plate **2**, fig. 5, *lng. V*); before this union, however, it divides into two rami of about equal size (*lng. l. XII* [1] and *lng. l. XII* [2]) giving off just proximal to the division a small ramus (XII [5]) supplying the longitudinal tongue muscles. Of the two main divisions one is distributed at once in a series of branches to the transverse musculature (Plate **4**, figs. 10, 11, *lng. t.*) on the upper surface of the tongue, the nerve fibers reaching this muscle at its extreme lateral margin by passing around the genioglossus muscle (Plate **4**, fig. 10, *lng. l. XII*[1]). The other division (*lng. l. XII*[2]) of the lateralis XII combines with lingual V and the two mingled components are distributed together (Plate **2**, fig. 5). The dorsal musculature of the tongue begins here to take on the crossed arrangement of its fibres (p. 35), and this seems to be related to the presence of papillae on the surface characteristic of the anterior end of the tongue (Plate **4**, fig. 9).

In the distribution of the three main divisions of XII, it is important to note how each is quite definitely limited to a particular part of the musculature, and that the part of XII which is mingled with V innervates only the strictly intrinsic musculature, for the most part those short muscle fibers which are inserted into the mucous membrane of the papillae-bearing dorsal surface.

These papillae deserve special study because of certain peculiarities in their finer structure. These conditions were in part brought out in the unstained material. The muscle fibers, which show a high degree of differentiation between the light and dark transverse bands, extend all the way to the tip of the papillae, and medullated nerve fibers could also be followed the same distance. Inasmuch as these somatic motor and general cutaneous fibers are approximately of the same size, it is not possible to distinguish between them by this criterion. It is fair to assume, however, that the fibers at the ends of the papillae are sensory, for, from what we know of the innervation of striated muscle, it is not to be expected that the muscle fibers are innervated at their scattered distal ends rather than at a more proximal point, where they are closer together and nearer the source of nerve supply. We know also that nerve fibers of the general cutaneous type have come into this region in the lingual branch of ramus maxillaris V, and presumably they must reach the surface. No taste buds were found among these papillae, although at the sides of the tongue such buds were found among the tubular glands.[1] In a region where these papillae are best developed they are flattened at the end, where the epithelium is of the stratified columnar type. The sides are covered with simple glandular epithelium. The flattened ends show many cells extending out as though protruding individually. The free ends, being knob-like, contain the nuclei, while the base is attenuated into a slender column. The result is a sort of tuft of knobbed projections forming the end of each papilla. It is to this flattened terminal portion that the muscle and nerve fibers pass.

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[1] Later study on the histology of the tongue has disclosed a few papillae bearing single taste buds in their flattened ends.

S. SUMMARY ON THE DISTRIBUTION OF NERVES IX, X AND XII.

These nerves contain viscero-sensory (red), viscero-motor (dark blue), and somatic motor (pale blue) elements. The viscero-sensory (red) are contained in IX and X, and reach their end organs by two nerves, (a) the pharyngo-laryngeal branch, coming off from XII, and (b) the visceral and recurrent rami of X. The sensory elements of the former appear to be distributed to the mucous membrane of the pharynx lateral and anterior to the glottis; those of the latter (not including those in the posterior visceral ramus) to the pharynx wall posterior to (a) and, through the ramus recurrens X, to the tracheal and laryngeal epithelium itself.

The viscero-motor elements (dark blue) are carried in the pharyngo-laryngeal ramus of XII (excepting the fine motor fibers to the m. constrictor jugulae) and may reasonably be assumed to be the same as those found in the coarse fibered roots of IX and X. They first give off fibers to the cerato-hyoideus muscle, then, after losing the sensory elements to the pharyngeal wall, they form a partial crossing and each has a bilateral distribution to the laryngeal muscles.

The somatic motor components (pale blue) comprise the three roots of XII. These differ from the somatic motor of the spinal nerves in presenting collectively a much smaller-fibered nerve. A marked exception exists however, in the third root, which possesses a cervical part and a hypoglossal part, the two standing in contrast to each other in size of fibers. The cervical part is distributed to the dorso-lateral longitudinal neck muscle. The hypoglossal part, combining with all the components of the other two roots to form the main trunk of XII, innervates all the muscles of the ventral longitudinal series except those extending from the girdle to the hyoid apparatus and the cerato-hyoideus.

T. ADDITIONAL INNERVATION TO THE VENTRAL HEAD REGION.

The other muscles of the ventral head region are supplied by V and VII, thus indicating their visceral origin. Nerve VII innervates the digastric and superficial constrictors, *i. e.*, sphincter colli and mylohyoideus in part; V innervates the mandibular series and all but the posterior part of mylo-hyoideus. The mucous membrane covering the tongue and along the inner side of the lower jaw is innervated by somatic sensory and viscero-sensory components, these being mingled in the same rami, the former by way of the lingual branch of mandibular V, the latter through the chorda tympani from VII. The somatic sensory elements appear to be especially well distributed to the long papillae in the glandular subterminal region of the tongue, while the viscero-sensory are associated with regions bearing taste buds and glands along the sides of the tongue and the jaw.

U. SPINAL NERVES.

Inasmuch as the anterior spinal nerves have undergone modification of their typical character due to the same process of cephalization which has affected the cranial nerves, an account of the first three is included in this paper. The third cervical is the first one that possesses both somatic-motor, and somatic-sensory components typical of a complete spinal nerve.

1. *The third spinal nerve*, as might be inferred from the last sentence, is the most anterior spinal nerve to have both ventral and dorsal roots. The two roots and the spinal ganglion lie in nearly the same transverse plane (Plate **7**, fig. 24). The dorsal root enters the spinal cord on its dorso-lateral side as one compact strand, coming, within the vertebral canal, from the spinal ganglion, which lies in the large intervertebral foramen at the level of the ventral side of the spinal cord. This foramen is between the second and third cervical vertebrae. It is impossible to analyze these roots further than to indicate the position of their somatic components. The sections do not show visceral components in the distribution of peripheral branches, but since the muscles tend to obstruct the fixation and blackening of the nerve fibers, it is possible that some have escaped observation. The sensory bundles emerge from the ganglion as parts of dorsal and ventral rami, the ventral ramus being about double the diameter of the dorsal. The ventral root, composed of somatic-motor fibers, arises as a number of rootlets passing out from the ventral horn of the cord. This root, while on the median side of the ganglion, splits into dorsal and ventral divisions (Plates **2**, **3**, figs. 4, 6). The ventral immediately joins the ventral sensory ramus, while the dorsal again divides, dorsal to the ganglion, into a part which joins the dorsal sensory ramus and a

lateral part (*spi. l. 3*), which divides at once into several small rami, innervating the muscles immediately adjacent and caudad to it.

The *dorsal ramus* (*spi. d. 3*) divides into two branches; the one, wholly motor (Plate **2**, fig. 6), passes dorso-mesad to supply the muscle lying against the neural arch; the other, a mixed sensory-motor, receives a communicating branch from the dorsal ramus of the second spinal nerve and innervates the most dorsal portion of the longissimus muscle anterior to the general position of the nerve as a whole (Plates **2**, **3**, figs. 4, 6). The cutaneous part passes through this muscle to the skin, where it divides to be distributed both dorsally and laterally; but like the motor part its field of distribution is chiefly anterior to the nerve.

The *ventral ramus* is a combination of the ventral divisions of the motor and sensory components. The mixed branch thus formed passes ventro-laterad between the m. longissimus colli and spinalis colli (Plate **7**, fig. 24, *spi. v.3*). It crosses on the dorsal side of ramus visceralis X and the sympathetic trunk (Plate **2**, fig. 4). Between the muscles above mentioned it receives a reinforcement of motor fibers from the ventral ramus of the second spinal nerve (Plate **7**, fig. 24, *spi. v. 2*), about half of whose fibers join the third spinal for distribution, the rest continuing caudad. This combined ventral ramus now passes laterad into m. capiti-cleido-episternalis. Here the motor elements leave the main ramus to supply this muscle in both caudal and rostral directions. (The motor fibers appearing in m. depressor mandibulae adjacent to this region are found by dissection to come from ramus hyoideus VII). The cutaneous components also divide into two branches (Plate **2**, fig. 4). One passes ventrad between mm. cucullaris and depressor mandibulae, the other passes directly through the latter muscle to a position just lateral to the main trunk of nerve XII, where it turns cephalad to be distributed to the integument along the ventro-lateral region of the neck and throat (Plates **3**, **7**, figs. 6, 23, *spi. v. 3*).

A variation in the ganglion of the third spinal nerve deserves mention in this connection. This is indicated in the plotting and consists of a small group of ganglion cells on the dorsal sensory ramus not far from the main ganglion. In the labelling a dotted line runs to this as well as to the main ganglion from the letters (*gn. spi. 3*). In other series of sections of Anolis this small ganglion did not appear. The size of its cells and its nerve connections do not suggest for it a sympathetic function, the cells being in every way similar to spinal ganglion cells, their position probably being due to a migration o some of these cells from the main ganglion.

2. *Second spinal nerve.* The ventral root of the second spinal, which constitutes the entire nerve, is similar to that of the 3rd spinal, being composed of coarse somatic-motor fibers arising from several bundles that have their origin in the ventral-horn cells. The 2nd spinal is somewhat smaller than the 1st. The rootlets in each case combine to form a compact bundle, which passes out through the intervertebral foramen and immediately divides into a large dorsal ramus (Plates **2**, **3**, *spi. d.2*) and a smaller ventral ramus (*spi. v.2*). A lateral ramus (*spi. l.2*) is given off as a branch of the dorsal ramus.

The ventral ramus passes ventrad between the neck muscles, where it turns abruptly caudad to cross the ventral ramus of the 3rd spinal on its median side, giving up a portion of its fibers to that nerve, as already mentioned. The rest continues caudad to be distributed to the ventral neck muscles in the region of the 4th spinal nerve.

The dorsal ramus of the 2nd spinal is a large branch, which supplies the dorsal and lateral neck musculature.

3. *First spinal nerve.* This nerve (Plate **7**, fig. 23) has the largest number of somatic motor fibers of any yet described. It supplies the dorsal muscles with a large dorsal ramus, as does the 2nd spinal, and, in addition, sends a good sized branch to the ventral side to innervate the omo-hyoideus and sterno-hyoideus muscles. The large root trunk passes out between the cranium and the first vertebra. Just utside the foramen it divides into ventral and dorsal rami.

The ventral ramus (Plates **2**, **3**, figs. 4, 6, *spi. v.1*) passes ventrally long the body of the vertebra and gives off one branch supplying the entral cervical musculature, and another that passes between the ongus colli and more superficial muscles. The latter then turns lightly dorsad to pass on the dorsal side of X and the sympathetic erve, attaining a position alongside the third root of XII, with which is sometimes loosely bound. From here it passes ventrally (Plates **2**, , figs. 5, 6, *omo-hy.* and *stn-hy.*) between the omo-hyoideus and erno-hyoideus muscles, both of which it richly supplies.

The dorsal ramus (*spi. d.1*). This splits into three branches (Plate **3**, g. 6), the lateral (Plate **7**, fig. 23, *spi. l.1*) is distributed immediately the adjacent muscle, another to the ventral part of the longissimus uscle, and the largest to the dorsal neck muscle, a portion being dis-buted at once to the muscle lying alongside the vertebra (Plate **7**, . 23), while the rest passes into the most dorsal division of the ngissimus, where it divides into four small terminal branches, two ssing cephalad and two caudad.

4. *Connections of first three spinal nerves with sympathetic.* While

dissections indicated a connection with the median sympathetic trunk, the study of sections shows this to be only a connective-tissue union, the sympathetic bundle passing directly across without any break in its sheath that would indicate the passage of nerve fibers.

V. GENERAL CONSIDERATIONS ON NERVE XII AND THE SPINAL NERVES.

From a comparative standpoint the hypoglossal nerve in Anolis presents two questions for consideration: First, as to the number of spinal nerves that enter into its formation and their position in the series of spino-occipital nerves, and, secondly, as to the differentiation of its component neurons from the typical somatic-motor type from which they come. The first question appears to be answered in part by the obvious facts presented by Anolis itself, through the persistence of three distinct occipital foramina, indicating three separate segmental nerves. Only rarely have three cranial roots for XII been described in the adult saurian. Among all those described by Fische ('**52**, p. 66), three roots are mentioned for only Platydactylus; bu in Anolis not only are there three roots, but they emerge throug separate foramina. In two species he finds only one root, and i seven he finds two. In all cases XII either unites with the first spina or receives branches from it. Fischer states that, as a rule, the firs two spinal nerves are without dorsal roots and ganglia, although some times there occurs a weak dorsal root on the second spinal nerve. A in Anolis, the third is a nerve well developed in both its motor an sensory components. The relation of XII to the spinal nerves vari according to the strength and number of its roots. This fact poin to the correctness of Fischer's view that the cranial part of XII do not represent the same number of spinal nerves in all lizards. Fü bringer ('**97**, p. 501) arrives at the constant number of three roots f all sauropsida, although the first and second emerge through a comm foramen in most reptiles. Reference to Fürbringer's table (p. 54 shows his conclusion regarding the homologies of these nerves. I designates them, the first three, as *occipito-spinal* nerves, their positi being fixed through discovery in the embryo of the older *occipi* nerves (anterior to these), which have a transitory existence. The are two features in the twelfth nerve of Anolis which seem to sh that it is less completely incorporated into the head than in other r tiles: (1) the persistence of three occipital foramina, and (2) the mixed spinal and hypoglossal character of its third root. The latter condition is not described for any other lizard. There is practically no union of the hypoglossal part of the last root of XII with the first spinal nerve, a condition which is described by Fischer as general. If we imagine the cephalization process to progress further in Anolis, we should expect roots one and two of XII to merge with each other, the spinal or cervical part of root three to disappear and the first spinal nerve to be drawn more into the field occupied by it. This is practically what is represented (Fischer) in those forms where but two roots have been described. Evidence from the embryological side (Van Wijhe, **'86**, Van Bemmelen, **'89**, Hoffmann, **'79–90**) supports Fürbringer's (**'97**) generalization that the hypoglossal of reptiles represents three ventral spinal roots.

The *cervical plexus* is represented in Anolis by the combination of XII with the first spinal and the commissure between the second and third spinal nerves. The ventral ramus of the first spinal is but loosely associated, sometimes not at all, with XII. The only constant connection, then, is that of the dorsal ramus of XII (cervicalis dorsalis XII) with the same ramus of the first spinal (Fig. 6, *crv. d. XII*). This anastomosis may be considered a remnant of the closer relation of these nerves which existed before the rise of the tongue musculature.

Anolis agrees with the typical condition of reptiles in the absence of a sensory component in the first and second spinal nerves. Fischer's reference to the exceptional occurrence of a dorsal root for the second spinal is not carried farther in his descriptions. Rabl-Rückhard (**'78**, p. 342) states that in the alligator the third is the first of the spinal nerves to possess a sensory part, but in contrast to the lizards (Anolis) he third and fourth spinal nerves also have (Fischer) greatly reduced dorsal roots, indicating a less sensitive integument in the alligator. t will be seen that in Anolis the field innervated by the sensory components of the third spinal nerve extends far cephalad both on the dorsal and ventral sides, thus demanding a strong dorsal root.

In regard to the second point in the comparison, i. e., the differentia- on of the nerve itself, we have to deal with a histological problem hich cannot be profitably discussed without a complete knowledge of he histological elements involved. The fixation of my material is ot uniform enough in all parts to admit of a detailed comparison of the liber of the medullated fibers as found in different nerves. However, in Anolis the difference in the fibers of XII, as compared with those of the ventral roots of the spinal nerves, is further emphasized in the third hypoglossal root and points to a very direct correlation between the size of the fiber and its function. In this case there is no doubt that the larger fibers run the shorter distance, thus contradicting Schwalbe's (**'82**) law and confirming Dunn's (**:02**, p. 323) results in the spinal nerves of the frog. There may be, and probably are, other factors entering into this particular case. Koch (**'88**) and Brandis (**'93**) speak of a differentiation in the central nucleus of XII in the medulla of birds, where a "dorsal" portion is separated from the rest; and the suggestion is made by them that this may be correlated with the syringeal musculature. In Anolis any relation of XII to central nuclei bearing on peripheral differences must await a detailed study of the brain.

W. GENERAL SUMMARY.

1. Anolis possesses the cranial nerves typical of the amniote vertebrate with one exception; there was not discoverable any representative of the spinal accessory nerve described in other reptiles, and the muscles innervated by this nerve in other forms seemed to be supplied in Anolis wholly from spinal nerves posterior to the second cervical.

2. The ganglia of cranial nerves V, VII, IX, and X are distinct from one another and the roots of all issue from the cranium through independent foramina. The ophthalmic ganglion also shows no fusion with the other portion of the Gasserian ganglion.

3. There is a wide distribution of sympathetic ganglion cells along the afferent rami of the cranial nerves. These form definite ganglia on palatine VII (palatine ganglion) on palatine VII and nasalis V (ethmoidal ganglion), on maxillaris V (infraorbital ganglion), and on mandibular V (mandibular ganglion). The topographical facts would lead one to associate the development of these ganglia with specialization of the glands of the head. No medullated nerve fibers were found passing through the connective tissue surrounding these glands. The presence of smooth muscle fibers in the head region might also affect the development of the sympathetic. The sympathetic system of the head in the matter of the arrangement of rami and ganglia (as worked out incidentally to the study of the cranial nerves), when compared with other described forms of reptiles, points to the existence of a typical sauropsidan type of quite constant character.

4. The nerve components (excepting the sympathetic) reach their

end organs, or peripheral terminations, through the following nerve trunks; *Somatic sensory* (yellow), via nerve V, over ophthalmic (rmm. frontalis and nasalis), maxillary and manbibular rami. *Somatic motor* (light blue), via nerves III, IV, VI, and XII. *Viscero-sensory* (red), via nerve VII over the palatine ramus and the chorda tympani; via nerve IX over the pharyngeal ramus and probably Jacobson's anastomosis; via nerve X over the superior laryngeal and recurrent rami. *Viscero-motor* (dark blue), via nerve V by a number of independent rami and over the mandibular ramus; via nerve VII over hyomandibular division and ramus hyoideus; via nerve IX over the pharyngeal ramus; and via nerve X over the superior laryngeal ramus.

(a) This shows a greater reduction of the somatic sensory (as indicated by peripheral paths) in Anolis than is found in the described forms of other groups, such components not being found in nerves IX or X of Anolis although their presence in the same nerves has been reported in each of the other classes of vertebrates.

(b) Vestigial ganglia exist in a variable manner on the intracranial roots of X, which may be somatic sensory in their origin.

5. The morphological character of the fibers of different components is sufficiently differentiated to form types peculiar to each component. But the distinction in character appeared to be less than that described for the lower groups of vertebrates. However, there was considerable individual variation in the size of fibers. Nerve XII shows a marked difference in the size of the fibers going to neck muscles and those going to tongue muscles. In this case the smaller fibers have much the longer course. In at least three instances striated muscle fibers of visceral origin are innervated by nerve fibers of smaller caliber and lighter myelin sheaths than is characteristic of the other viscero-motor components of V, VII, IX, and X. These are the ciliary muscle, the protrusor oculi, and the constrictor of the jugular vein, all of which are more closely associated with visceral functions than the other striated visceral muscles.

6. The skin is well-supplied with special tactile organs, which are more abundant along the jaws than elsewhere. These organs are quite generally, if not always, covered by a thinned plate of the horny layer of the epidermis, which bears in its center a tapering "hair." The innervation of these hairs was not determined beyond the fact of the proximity of the strongly myelinated cutaneous fibers in the dermis beneath.

7. The distribution of taste buds is such as to preclude their innervation (save a very limited number in the laryngeal region) by

anything except the chorda tympani and palatine VII. A large proportion of the fibers carried by these rami are for such sense organs, their innervation fields being covered for general sensory purposes by the somatic sensory of V.

8. Anolis presents a well-balanced form for the study of the reptilian nervous system. It is an active, responsive animal with well-differentiated muscles and sense organs, yet presenting no excessively specialized features. It is small enough readily to be sectioned and large enough for experimental operations, and it is suggested that degeneration and stimulation experiments on this form would advance our knowledge of the reptilian nervous organs even more than similar anatomical work on other forms. The anatomical work already done, however, should be supplemented by the proper technique to determine the final nerve terminations.

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EXPLANATION OF PLATES.

All figures are from *Anolis carolinensis*. The projection drawings, figures 4, 5, and 6, and the drawings of transverse sections are from the same series of sections (designated "Anolis trans. 30"). In figures 4, 5, and 6 the outlines of the head, the brain and the eye are indicated. The places of passage of the nerves through bony foramina are indicated by circles. The drawing from a dissection, figure 7, is made to conform as nearly as possible to the size of the projection drawings, although it was taken from a somewhat larger specimen.

Note.— Since the nerves and muscles are readily distinguishable in the figures, the abbreviations *mu.* (for muscles), *n.* (for nerve) and *rm.* (for ramus) are omitted in text and plates. The colors used have the following meanings:—

On Plate 2 and 3		On Plates 4–7
yellow	general cutaneous	bones (cartilages).
red	viscero-sensory	muscles.
light blue	somato-motor	brain and retina.
dark blue	viscero-motor	
pale gray	brain	integument and mucous membrane.
black	contours of nerves, ciliary roots and nerves, and sympathetic rami	nerves in section.

LIST OF ABBREVIATIONS.

α, β, γ	See end of list of abbreviations.
a	anterior.
alv. if	ramus alveolaris inferior V.
alv. su	ramus alveolaris superior V.
ang	os angulare.
an'stm. lar	anastomosis between motor laryngeal nerves of right and left sides.
an'stm. pal. l	anastomosis through which the lateral division of ramus palatinus VII receives its general cutaneous fibers.
an'stm. pal. i'm	anastomosis through which the intermediate division of ramus palatinus VII receives its general cutaneous fibers.
ao	aorta.
atc	os articulare.
aur. ex	external ear.
aur. m	middle ear.
ba'hy	basihyal.

ba'occ.	basioccipital.
ba'sph.	basisphenoid.
brs.	bursalis muscle.
can. p.	posterior vertical semicircular canal.
cap. crv.	capiti cervicalis muscle.
cap. d'clav.	capiti-dorso-clavicularis muscle. (m. trapezius, m. cucullaris); nerve ramus of same.
cap. md.	capiti-mandibularis muscle.
cap. md.^{1}	nerve ramus to dorsal part of m. capiti-mandibularis.
cap. md.^{2}	nerve ramus to anterior part of m. capiti-mandibularis.
cat.	common carotid artery.
cat. ex.	external carotid artery.
cat. i.	internal carotid artery.
cd. tym.	chorda tympani.
cil.	ciliary nerve.
clav.	clavicle.
cl. gn. sy.	cells of small sympathetic ganglia at different places along viscero-sensory rami.
clml. aur.	columella auris.
cmpl.	os complementare.
cnch. na.	concha nasalis.
comn.	ramus connecting the ramus to m. depressor palpebrae inferioris with rm. palatinus VII.
comn. ex.	communicating ramus between lachrymal plexus and nerve IX uniting with rm. hyomandibularis.
comn. i.	communicating ramus between nerve IX and rm. palatinus VII.
comn. IX–X.	communicating ramus between radices IX et X.
cor.	os coronoideum.
co'st. lar.	constrictor muscle of the larynx.
co'st. vn. j. i.	constrictor muscle of the internal jugular vein.
crt. Mkl.	Meckel's cartilage.
crv. d. XII.	ramus cervicalis dorsalis XII.
crv. l. XII.	ramus cervicalis lateralis XII.
de.	os dentale; ramuli to teeth from ramus alveolaris inferior.
dep. md.	depressor mandibularis (digastric) muscle.
dep. md.^{1}	depressor mandibularis muscle, most ventrally inserted fibers.
dep. palb. if.	depressor palpebrae inferioris muscle; nerve ramus innervating it.

dt. lch	ductus lachrymalis.
e'crac	epicoracoid.
e'pt	epipterygoid (columella).
e'stn-clei-mast	episterno-cleido-mastoideus muscle (of Versluys); nerve ramus supplying it.
ex'clml	extracolumella.
f	os frontale; ramus frontalis V.
fen. ovl	fenestra ovalis.
for. if'orb	infraorbital foramen.
for. lch	foramen for the lachrymal duct.
for. na. l	" in the maxilla for passage of *na. l.*
for. na. m	" " os nasale " " " *na. m.*
for. pal	foramen in the pterygoid bone for the first branch of the palatine nerve to the taste buds and mucous membrane.
for. par	parietal foramen.
for. pt	foramen in the pterygoid bone for passage of nerve to taste buds.
for. V	notch in proötic bone in which rests the Gasserian ganglion.
for. VII	foramen for radix VII.
for. XII	foramina for radices XII.
gen-gls	genioglossus muscle.
gl. cat	carotid gland.
gl. Hard	Harderian gland.
gl. lab. ex	external labial glands.
gl. lab. i	internal " "
gl. lch	lachrymal gland.
gl. na	nasal gland.
gl. sb'lng. l	sublingual gland (lateral).
gl. sb'lng. m	sublingual gland (median).
gls-hy	glossohyal.
glt	glottis.
gl. thm	thymus gland
gl. thy	thyroid gland.
gm. gus	gustatory bud in region of larynx; nerve twigs to taste buds given off from infraorbital plexus.
gm. gus. l	lateral field of gustatory buds (both dorsal and ventral).
gm. gus. m	median field of gustatory buds (dorsal).
gn. cil	ciliary ganglion.
gn. crv	first cervical ganglion of the sympathetic.
gn. eth	ethmoidal ganglion.
gn. if'orb	infraorbital ganglion.

gn. md.	mandibular ganglion.
gn. nd.	ganglion nodosum (trunk ganglion of X).
gn. opth.	ophthalmic ganglion.
gn. pal.	palatine ganglion.
gn. rx. X.	root, or jugular, ganglion of X.
gn. spi. 3.	spinal ganglion of third spinal nerve.
gn. sy. VII	sympathetic ganglion cells of the geniculate ganglion.
gn. V.	Gasserian ganglion of V.
gn. VII	geniculate ganglion of VII.
gn. VIII.	ganglion of VIII.
gn. IX.	petrosal ganglion of IX.
gn. X.	ganglion of X. (This is the same as *gn. rx. X*).
h'hy.	hypohyal.
hy.	hyoideus muscle; ramus hyoideus VII.
hy-gls.	hyoglossus muscle (m. cerato-hyoideus).
hy-md.	ramus hyo-mandibularis VII.
if'orb.	ramus infraorbitalis V.
j.	os jugale.
ker-brn. I	cerato-branchial I.
ker-brn. II	cerato-branchial II.
ker-hy.	cerato-hyal cartilage; ramus to cerato-hyoid (= hyoglossus) muscle, a branch of the pharyngolaryngeal.
ker-md. $^{1, 2, 3}$	cerato-mandibularis muscle and its subdivisions; rami to cerato-mandibularis muscle.
lab. if. alv.	rami labiales inferiores given off from ramus alveolaris inferior V.
lab. if. md.	ramus labialis inferior from main ramus mandibularis V.
lar. lg.	longitudinal (dilator) muscle of the larynx.
lar. su.	ramus laryngeus superior X.
lax. tym.	laxator tympani muscle.
lch.	os lachrymale.
lgs. coll.	longissimus colli muscle.
lig. stp.	stapedial ligament.
lig. tym.	tympanic ligament.
lng. i'm. XII	ramus lingualis intermedius XII.
lng. l. XII	ramus lingualis lateralis XII.
lng. l. XII.^{1}	lateral division of rm. lateralis lingualis XII.
lng. l. XII.^{2}	median division of rm. lateralis lingualis XII.
lng. lg.	longitudinal tongue muscle superficial to *gen-gls*.
lng. lg.^{1}	longitudinal tongue muscle with deep insertion.

lng. lg.^{2}	longitudinal tongue muscle with superficial insertion on the mandible.
lng. m. XII	ramus lingualis medialis XII.
lng. t.	transverse tongue muscle.
lng. vrt.	vertical tongue muscle.
lng. V.	ramus lingualis of V.
lng. XII + V.	combined lingual rami of XII and V.
md.	ramus mandibularis V.
md.^{1}	first motor-sensory branch of rm. mandibularis V, supplying skin and m. mylohyoideus.
md.^{2}	second motor-sensory branch of rm. mandibularis V, supplying skin and anterior part of m. mylo-hyoideus.
mx.	maxillary bone; ramus maxillaris V.
mx.^{1}	temporal cutaneous branch of rm. maxillaris V.
mx.^{2}	branch of rm. maxillaris to part of lower lid and its posterior angle.
mx.^{3}	branch to anterior part of lower lid.
mx.^{4}	branch to suborbital region.
myl-hy.	mylo-hyoideus muscle; branches of nerve V supplying it.
na.	os nasale; ramus of nasalis V through ethmoidal ganglion to skin.
na.^{1}	cutaneous branch of rm. nasalis through the ethmoidal ganglion.
na. l.	ramus nasalis lateralis V.
na. l.^{1}	branches to the skin given off through external nasal gland.
na. l.^{2}	
na. m.	ramus nasalis medialis V.
na. m.^{1}	cutaneous branch of rm. nasalis medialis V passing through nasal bone.
ob. d.	dorsal oblique muscle; branch of nerve VI supplying same.
ob. v.	ventral oblique muscle; ramus of III supplying it.
occ. crv.	occipito-cervicalis muscle.
occ. crv. m.	occipito-cervicalis medialis.
omo-hy.	omohyoideus muscle; nerve ramus supplying it.
omo-hy. prf.	deeper part of omohyoideus muscle.
omo + stn-hy.	branches of ventral ramus of first spinal nerve to omohyoid and sternohyoidmuscles.
opt.	optic nerve.
or. lch.	opening of the duct of the lachrymal gland.

ot.	otic capsule.
p.	posterior.
pal.	os palatinum; ramus palatinus VII.
pal.^{1}, *pal.*^{2}, *pal.*^{3}	three divisions of rm. palatinus VII at beginning of infraorbital plexus.
pal. i'm.	ramus palatinus intermedius VII.
pal. l.	ramus palatinus lateralis VII.
pal. m.	ramus palatinus medialis VII.
pa'occ.	paroccipital.
par.	os parietale.
pa'sph.	parasphenoid.
p'f.	postfrontal.
phx-lar.	ramus pharygo-laryngeus IX + X.
phx-lar.^{1}	first branch given off by the combined XII and IX + X, containing most of the nerve fibres of *rm. phx-lar.*
phx. X.	small pharyngeal branch given off on distal side of trunk ganglion X.
plx. lch.	lachrymal plexus.
p'orb.	postorbital bone.
prc. pa'ot.	parotic process.
prc. pt-qd.	pterygo-quadrate process.
pref.	prefrontal.
premx.	premaxillary.
presph.	presphenoid.
pro'ot.	proötic.
protru. oc.	protrusor oculi muscle; nerve twigs supplying it.
prt. pt-qd.	error (fig. 18) for *prc. pt-qd.*
pt.	pterygoid bone, pterygoid muscle, or nerve ramus to latter.
pt.^{1}	deeper part of m. pterygoideus; nerve ramus to same.
pt-md.	pterygo-mandibularis muscle; nerve ramus to m. pterygo-mandibularis.
pt-par.	pterygo-parietalis muscle; nerve ramus to m. pterygo-parietalis.
pt-sph. p.	pterygo-sphenoidalis posterior muscle; nerve ramus to m. pterygo-sphenoidalis posterior.
qd.	quadrate.
rcr. X.	ramus recurrens laryngis X.
rm. de.	nerve fibers entering pulp cavity of tooth.
rm. tr.	ramus trachealis.
rm. vn. j.	rami of IX and X to jugular vein.

rt. a	rectus anterior muscle; ramus of III supplying it.
rt. d	rectus dorsalis muscle; ramus of III supplying it.
rt. p	rectus posterior muscle.
rtr. oc	retractor oculi muscle.
rt. v	rectus ventralis muscle; ramus of III supplying it.
rx. III, V, VII, IX, X, $XII^{1\,2\,3}$	roots of nerves III, V, VII, IX, X and XII.
rx. cil. III	radix brevis of cilary nerve.
rx. cil. V	radix longa of cilary nerve.
rx. d. spi. 3	dorsal root of third spinal nerve.
rx. v. spi. 1, 2, 3	ventral roots of first, second and third spinal nerves.
rx. $XII^{1\,2\,3}$	first, second and third roots of nerve XII.
sa'ang	supra angulare.
sac. en'lym	saccus endolymphaticus.
sa'tmp	supratemporal.
sph	os sphenoidale.
spht. coll	sphincter colli muscle.
spi. coll	spinalis colli muscle.
spi. d. 1, 2, 3	main dorsal ramus of first, second and third spinal nerves.
spi. l. 1, 2, 3	main lateral ramus of first, second and third spinal nerves.
spi. v. 1, 2, 3	main ventral ramus of first, second and third spinal nerves.
sq	squamosal.
stn-hy	sterno-hyoideus muscle; nerve ramus supplying it.
sy	sympathetic trunk posterior to union of communicating rami (internus and externus).
sy. X	communicating ramus between cervical sympathetic trunk and ramus visceralis X.
t	os transversum.
tis. tnd	tendinous tissue.
tnd	tendon.
tnd. mb. nic	tendon of nictitating membrane.
tr	trachea.
tym	tympanum.
cr. X	error in fig. *L* for *rcr. X*.
vn. j. i	internal jugular vein.
vom	vomer.
vsc. X	ramus visceralis X.
v. spi. 1, 2, 3	ramus ventralis of spinal nerves 1, 2 and 3.

I–XII	cranial nerves I–XII
$XII.^{1}$	nerve branch to posterior part of m. cerato-mandibularis 1.
$XII.^{2}$	nerve branch to m. cerato-mandibularis 3 and to anterior part of m. cerato-mandibularis 1.
$XII.^{3}$	nerve branch to m. cerato-mandibularis 2 (a few fibers to cerato-mandibularis 1).
$XII.^{4}$	nerve branch to posterior part of genioglossus muscle.
$XII.^{5}$	nerve branch of *lng. l. XII* to longitudinal tongue muscles.
α, β, γ	posterior communicating rami of the infra-orbital plexus (interpreted as sympathetic).

PLATE 1.

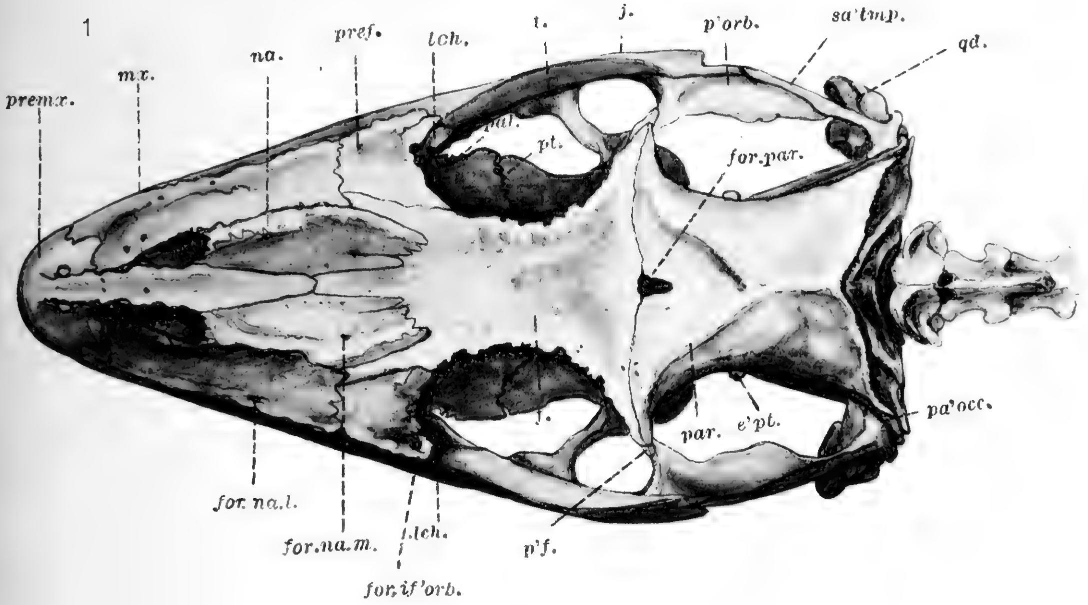
PLATE 1.

Fig. 1–3. Skull.

Fig. 1. Dorsal aspect.
Fig. 2. Left lateral aspect.
Fig. 3. Ventral aspect.

All were drawn from a specimen that had been macerated in water and then dried. The cartilaginous parts are not preserved in such a preparation.

1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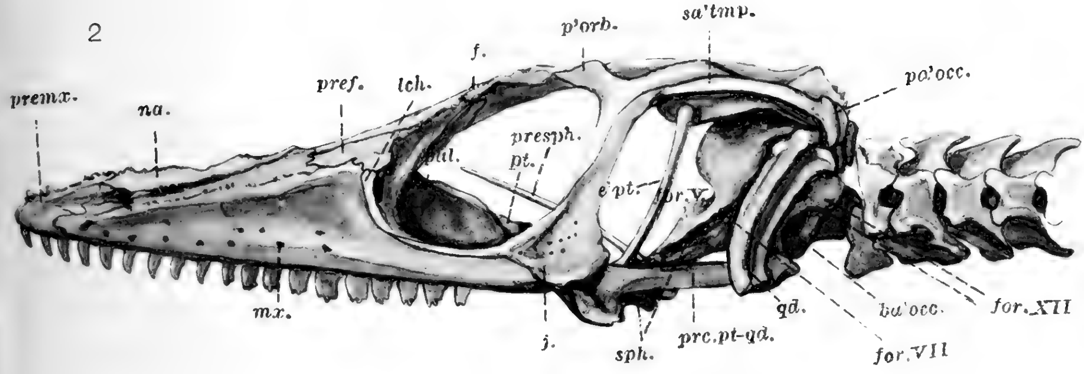
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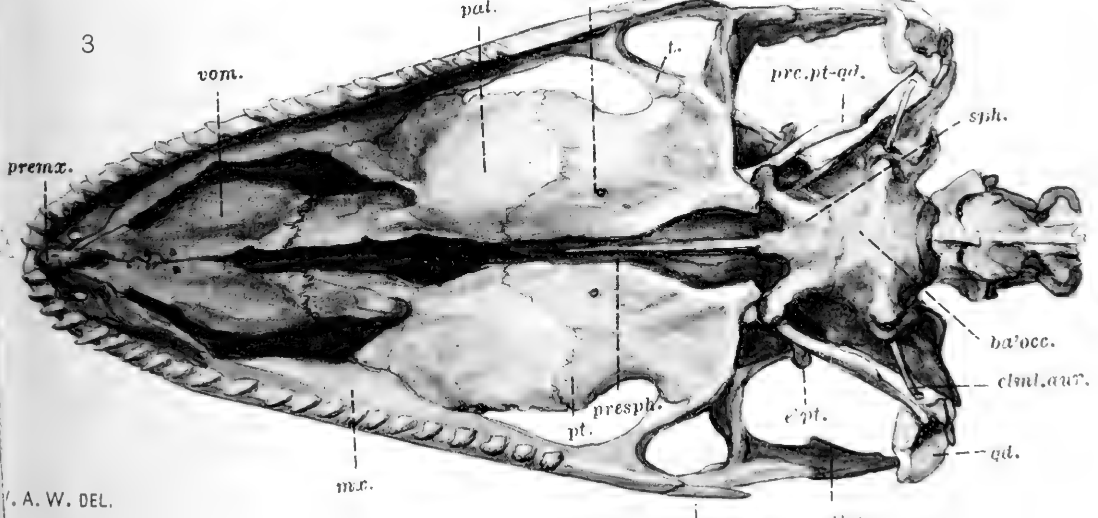
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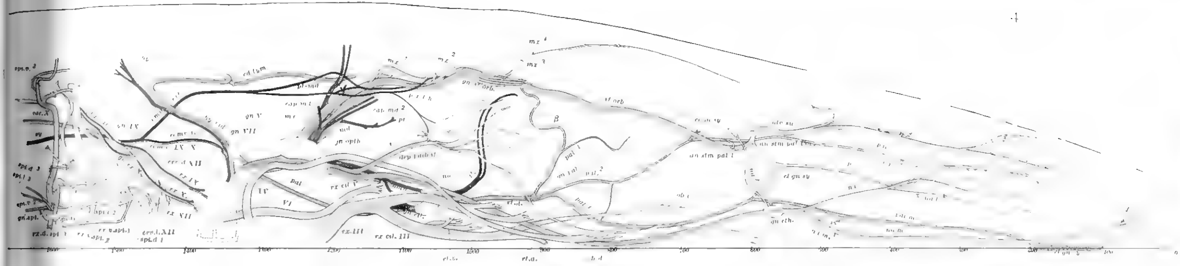
PLATE 2.

PLATE 2.

Fig. 4. Cranial and first three spinal nerves of the *left* side as projected upon a horizontal plane, *dorsal* aspect. For clearness, the nerves distributed to the ventral side of the head are shown in a separate figure (fig. 5). The connections of the viscero-sensory components with the fasciculus solitarius are shown by dotted lines. The terminal branches of some of the rami are not carried out in both the figures (4 and 6), being included only in the figure which shows them with least confusion. × 21.

Fig. 5. Continuation of the nerves shown in figure 4, showing their course and distribution in the jaw, tongue, pharynx and larynx. The terminal distribution of the combined nerves V and XII is not included in this figure. Same view and magnification as figure 4.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spl.v 2
gn.spl.
rx.d. spl 1
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rx v.spl.1
crv.l.XII
spl.d 1
spl.l 2
cd tym
bl-md
cn IX
cmr IX X
crv d XII
rx IX
rx X
rx VII
gn V
gn VII
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dep l ad d
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rx cil. III
mx 1
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mx 4
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sf orb
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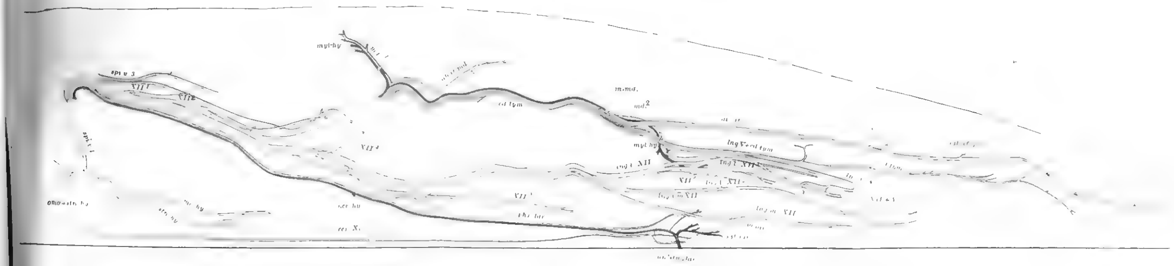
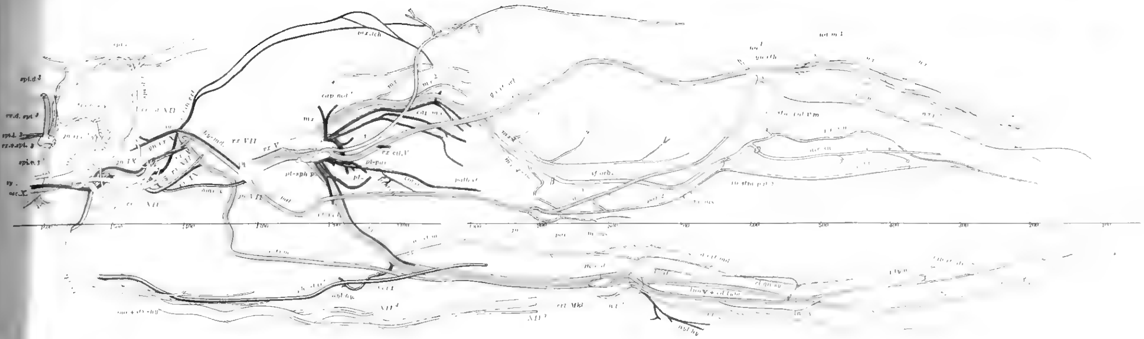

myl-hy
spl v 3
VII 1
VII 2
spl 1
cd tym
m.md.
md.2
myl hy
V
lng V+cd tym
lng XII
lng XII 2
XII 4
XII 1
XII 3
lng m XII
cer hy
thy hy
om o+stn hy
stn hy
cer X.

PLATE 3.

PLATE 3.

Fig. 6. Cranial and first three spinal nerves of the *left* side as projected upon a sagittal plane and *seen* from the *median* side. Nerves III, IV and VI with ciliary ganglion and its nerves are omitted; also the terminal rami of V and XII are omitted, because they fall so nearly in the same frontal plane.

Fig. 7. *Ventral* aspect of a dissection of the right side of the head showing about the same group of nerves as figure 4. The figure represents the dorsal portion of the head, the ventral portion, including the bony roof of the mouth, having been cut away to expose the nerves. The plane of division is carried through the tympanum, the quadrate bone and the posterior bony arch of the orbit. The whole mandibular group and ventral cervical muscles are removed, while all those related to the orbit are retained. The shaded background against which the maxillary bone is seen, represents the skin of the dorsolateral side of the head, the cut edge of which forms the margin of the figure. The two superficial sympathetic rami connecting nerve VII with the lachrymal plexus pass in part through the m. capiti mandibularis, which has been dissected away. The structures of the orbit are those immediately exposed upon the removal of the pterygoid and palatine bones. The portion of the maxillary bone forming the ventral rim of the bony orbit is cut away exposing the deeper surface of the lower eyelid. The hind brain is exposed, in the region where the last three cranial nerves show their superficial origin, by the removal of parts of the basisphenoid and basioccipital bones. The finer rootlets of nerves IX and X were nearly transparent and practically invisible under the dissecting microscope; the drawing, therefore, does not show their exact number nor connection with the lateral side of the medulla. The part of the medulla exposed is bent sharply away from the observer, making it difficult to represent the linear arrangement of the roots of nerve XII and the occipital foramina through which they emerge. The representation of the details of the muscles of the cervical region is not attempted. The m. spinalis colli and part of the m. longissimus colli are removed, but the roots of the spinal nerves are hidden by the remaining part of the m. longissimus colli. The distribution of the small nerve branch given off from X at the point where the communicating ramus (comn. IX–X.) joins IX, was not determined. It is represented too large in the figure.



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rr.d. spl. 3
spl.d. 3
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spi.v. 3
ty.
oc. X
gn. IX
hy-md.
rr VII
rr V
cap md.
mx
mr
mr 2
cap mx
rr cil.V
pl-pal
pl-sph
pl.
pal.
bul
palh.st
tf orb.
β
gn.X
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rr IX
VII
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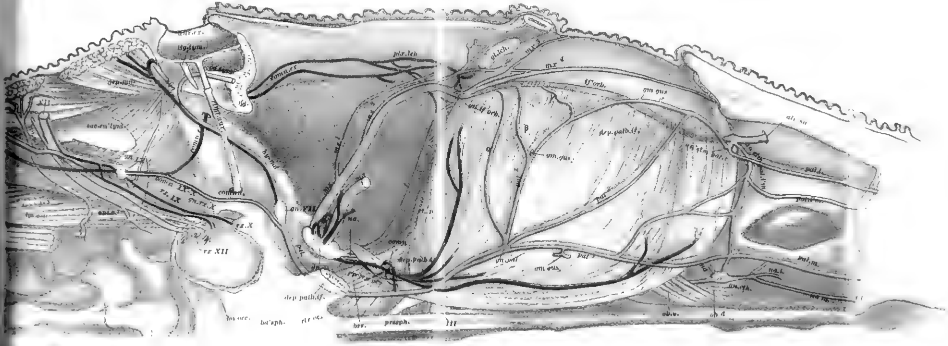
mdl hy.
XII 3
VII 4



lig.tym.
dep.md.
XII
tuo-en'lym.
gn. IX
comm. IX-X
rr. IX
gn.rr.X
comm.
rr. X
spi.
rr XII
comm. cr
plx.ich
hy-md
gn.VII
comm.
na.
pal.
dep.palb.
dep palb.tf.
bs'aph.
bro.
presph.
III
gl.ich.
mx 3
mx 4
tf orb.
gn.gus
gn.tf orb.
β
α
gn.gus.
dep-palb.tf.
pal 2
pal 3
gn.pal
gn.gus
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pal. m.
ob.v.
ob 4

PLATE 4.

PLATE 4.

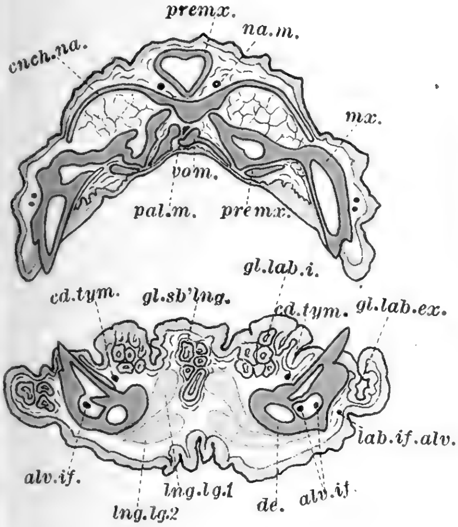
The sections represented in Plates **4–7** were selected at intervals through the series from which the projection drawings (Plates **1** and **2**, figs. 4–6) were made. The scale included in these drawings (Figs. 4, 6) shows the position of every hundredth section in the series. The planes of the sections shown in figures 8–24 may be determined by referring their numbers to this scale. Branches of minor importance which are not included in the plottings may appear in the sections. No importance can be placed on a close comparison of the relative diameters of the nerves. These have suffered shrinkage to a different degree in different parts of the head and are represented approximately as they appear in the sections, while they are for the most part enlarged and made uniform in the plottings in order to demonstrate their components. The sections were drawn as projected by the camera and are accurate in respect to those structures which are considered.

Fig. 8. Transverse section (No. 130) anterior to external nares. The space between the nasal cartilage and the premaxillary bone is filled with pericapsular vascular tissue. The median palatine rami are here united. The sublingual gland opens by three ducts (one median, two lateral) anterior to this section. Labial glands open by numerous ducts. The mucous membrane in the floor of the mouth has numerous taste buds located between the gland openings and in the epithelium just median to the upper and lower jaws.

Fig. 9. Transverse section (No. 319) through nasal organ, showing externa and internal nasal chamber and external nasal gland. The tongue is cu through the region of the greatest development of the lingual papillae, the ou lines of which are represented somewhat diagrammatically. The muscle fiber extend to the ends of these, which are provided with long protruding epithelia cells. The taste buds are seen along both upper and lower lingual gum a points indicated (*gm. gus. l.*). No taste buds were observed on the papillae A single taste bud was found near the median line in the roof of the mouth while on the floor of the mouth they appear to be limited to the lingual gum.

Fig. 10. Transverse section (No. 579), through ethmoidal ganglion an internal nares, just anterior to the orbit and the larynx. In addition to th series of taste buds found in section No. 319, they appear along the latera border of the tongue in the stratified epithelium between the openings of th tubular glands.

Fig. 11. Transverse section (No. 659) cutting into the anterior wall of th eyeball and through the Harderian gland. The muscles at the root of th tongue are diverging to each side of the larynx, which is here cut through th glottis. The two laryngeal muscles appear.



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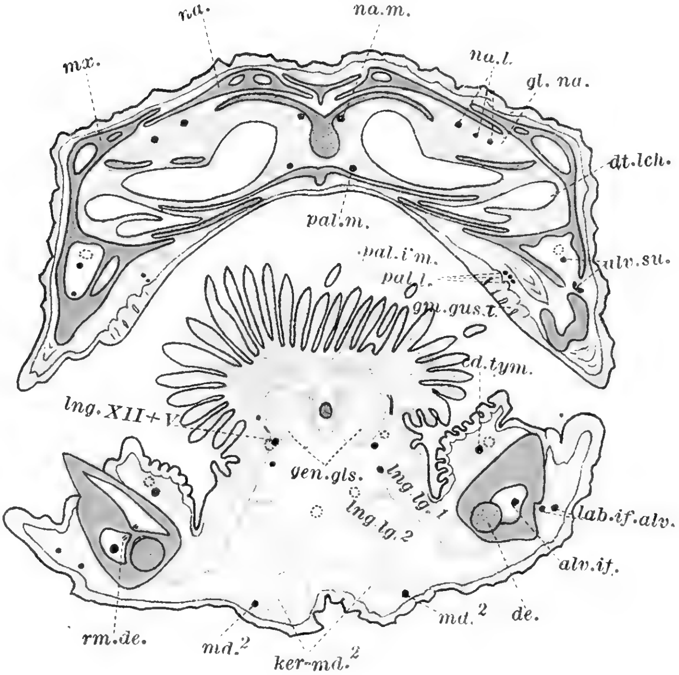

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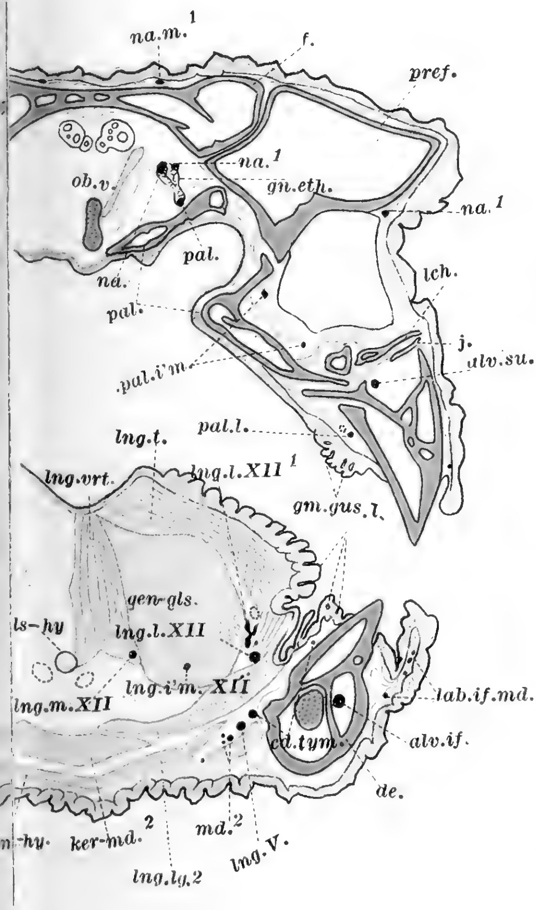

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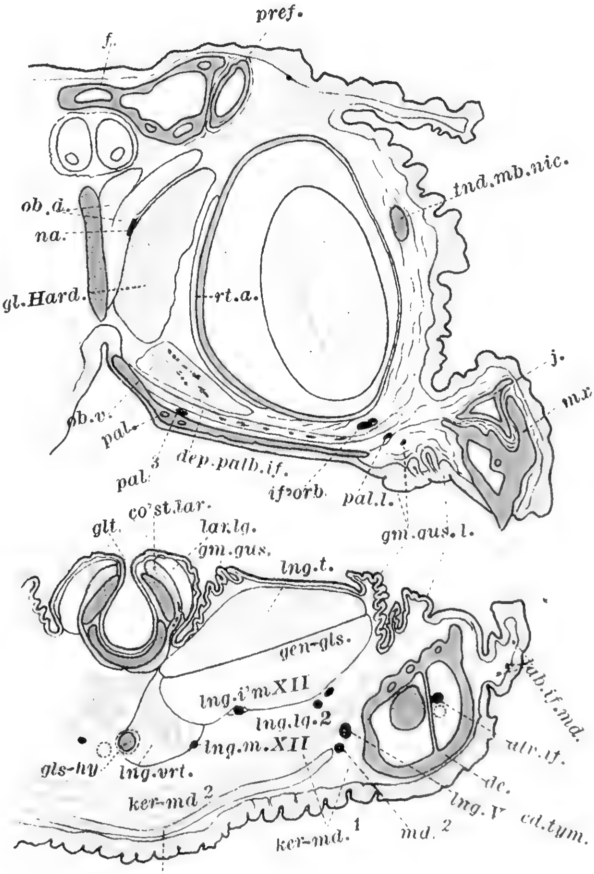
579



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DEL.

PLATE 5.

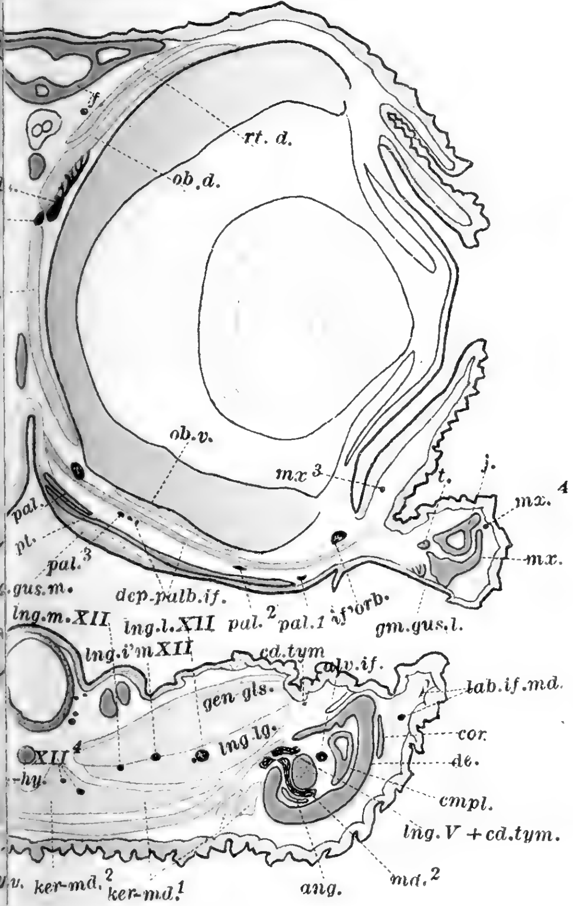
PLATE 5.

Fig. 12. Transverse section (No. 767) through the mid-orbit region. The lingual and chorda tympani nerves are leaving the alveolar canal. No taste buds are found on the floor of the mouth, but they appear in the roof of the mouth among the median palatine glands, and to a less extent along the lateral glandular area. Different parts of the infraorbital plexus appear in the floor of the orbit.

Fig. 13. Transverse section (No. 909) through orbit, showing the connection of the optic nerve with the retina. The chorda tympani is closely applied to the median side of the ramus alveolaris inferior. The muscle of the lower lid (*dep. palb. if.*) shows some of its fibers originating from the connective tissue near the median part of the roof of the mouth.

Fig. 14. Transverse section (No. 988) through the anterior part of the optic chiasma (blue tint omitted), showing entrance of ciliary nerves into the eyeball. The retina is cut tangentially; the infraorbital ganglion, the anterior part of the lachrymal gland, and the mechanism of the bursalis muscle in its relation to the ligament of the nictitating membrane, also fall in the plane of the section.

Fig. 15. Transverse section (No. 1064), posterior to the orbit, through the posterior part of the optic chiasma (not lettered). The ciliary ganglion and the lachrymal plexus around a large post-lachrymal blood sinus are shown. The columella (epipterygoid) is cut where it articulates with the pterygoid bone.



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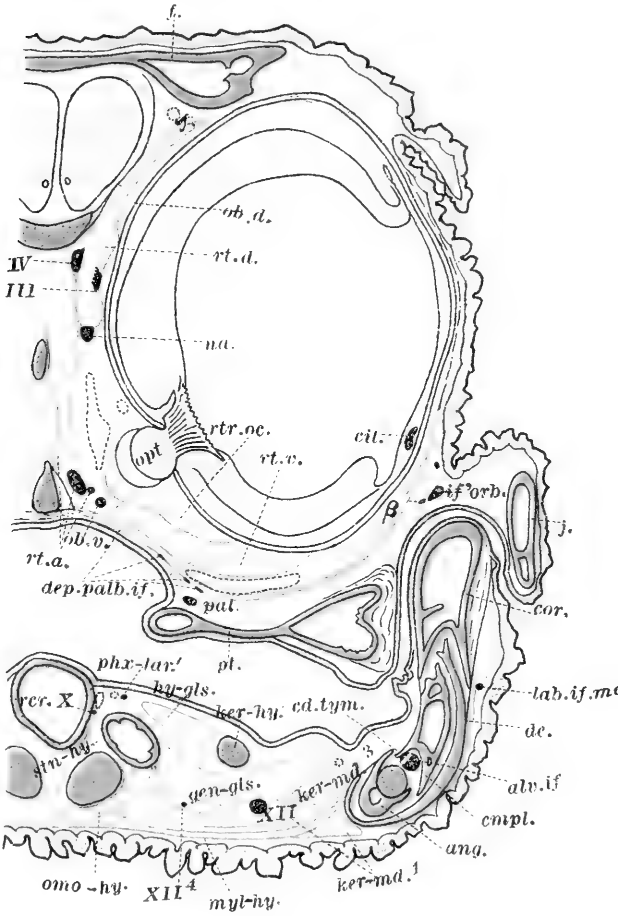

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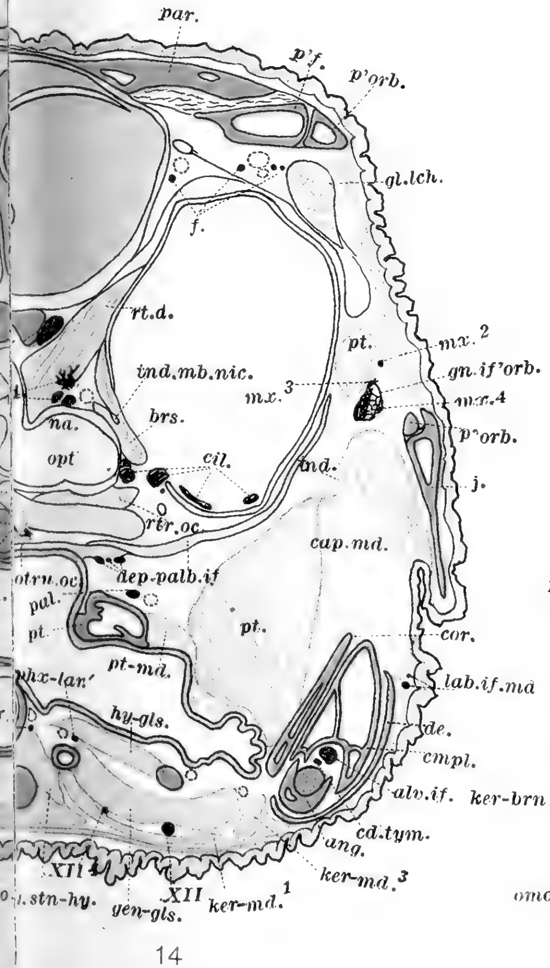

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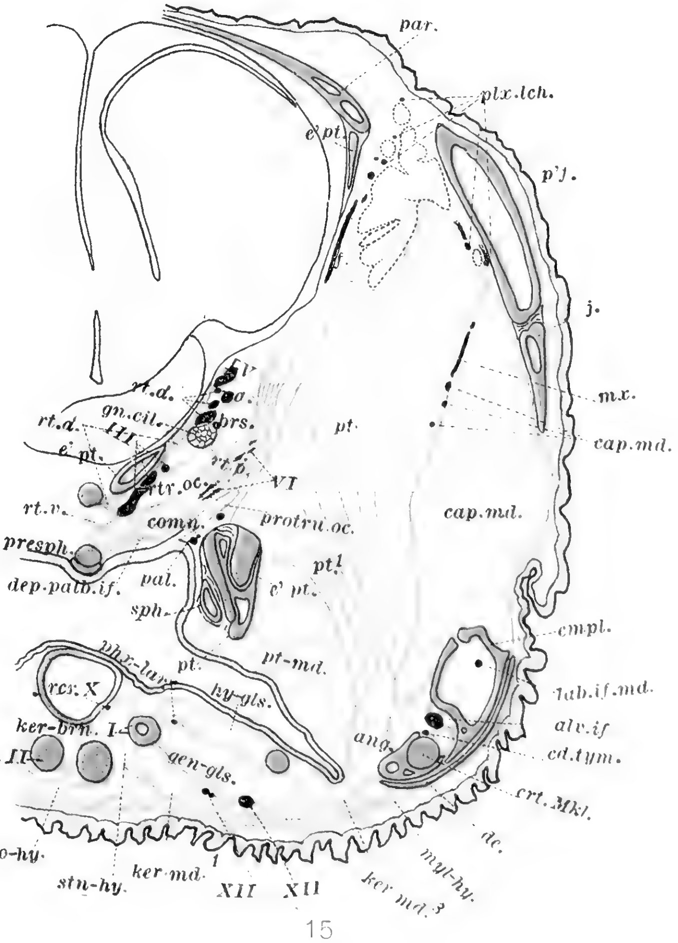

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W. DEL.

PLATE 6.

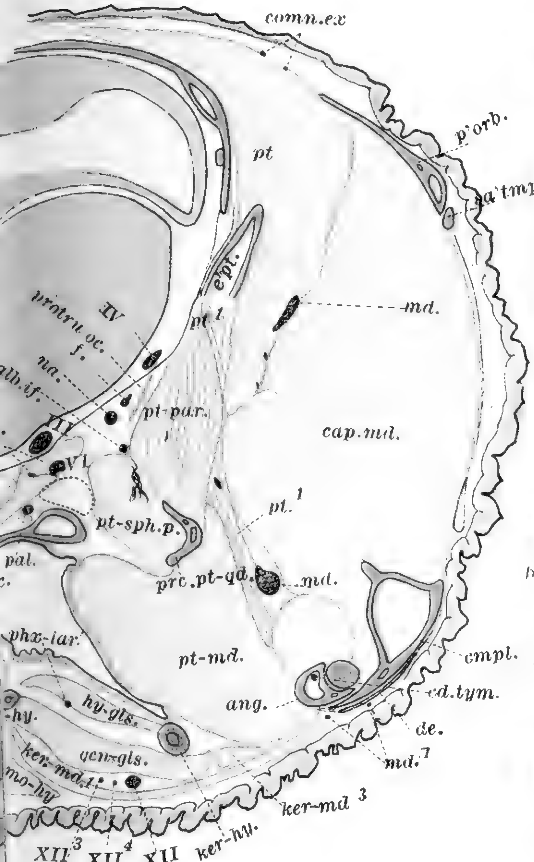
PLATE 6.

Fig. 16. Transverse section (No. 1175) through the pituitary body (not lettered) and origin of the retractor oculi and bursalis muscles. The roots of nerves III and IV here have an intracranial course. Ramus frontalis V is shown (*f.*) mesad to the origin of the protrusor oculi muscle. The insertion of the m. pterygoparietalis on the pterygoid bone is shown.

Fig. 17. Transverse section (No. 1226). This falls in a plane where few main nerve rami are cut, as reference to the plotting will show. The ophthalmic ganglion is shown as completely separate from the mandibular-maxillary part of the Gasserian ganglion. Nerve IV is labelled V by mistake.

Fig. 18. Transverse section (No. 1320) through the geniculate ganglion and also showing a portion of the ganglion of nerve VIII. The otic capsule and the tympanic chamber are just appearing. The insertion of m. pterygosphenoidalis posterior on the pterygo-quadrate process (*prt. pt-qd.*) is shown.

Fig. 19. Transverse section (No. 1399) through the inner, middle and outer ear, showing the root of nerve IX about to emerge from the cranium. The chorda tympani, which is shown in this and preceding sections occupying a position in the lower jaw, is here cut at a second place, where it is still in combination with the motor part (*hy-md.*) of nerve VII, although its components are distinctly segregated on the lateral side of the hyomandibular ramus.



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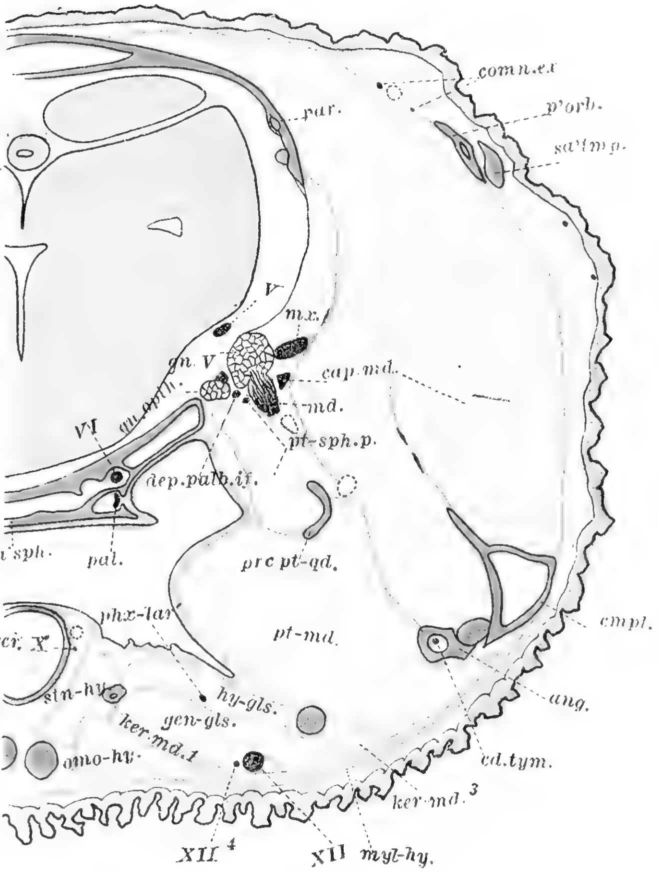

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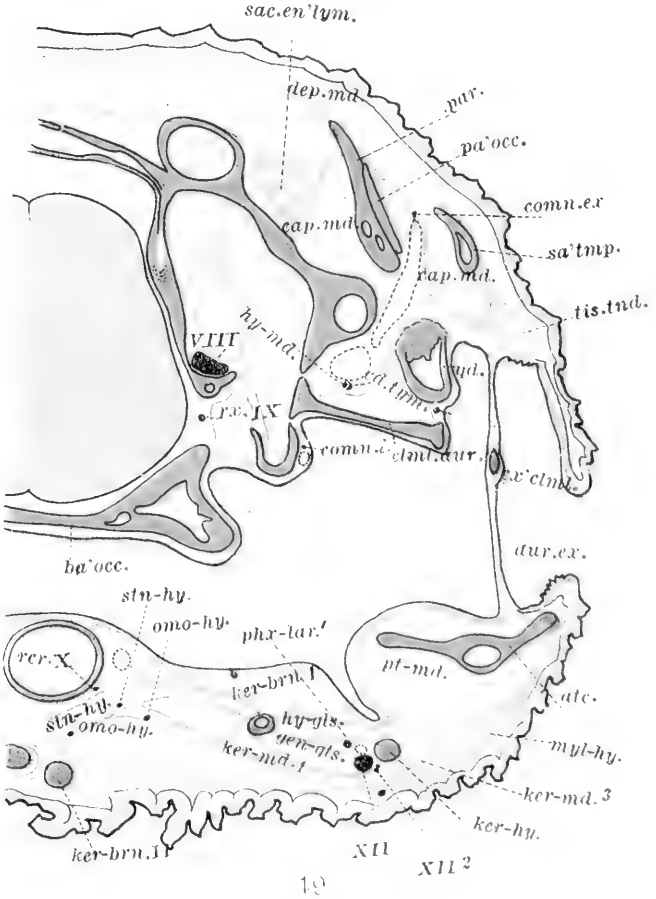

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PLATE 7.

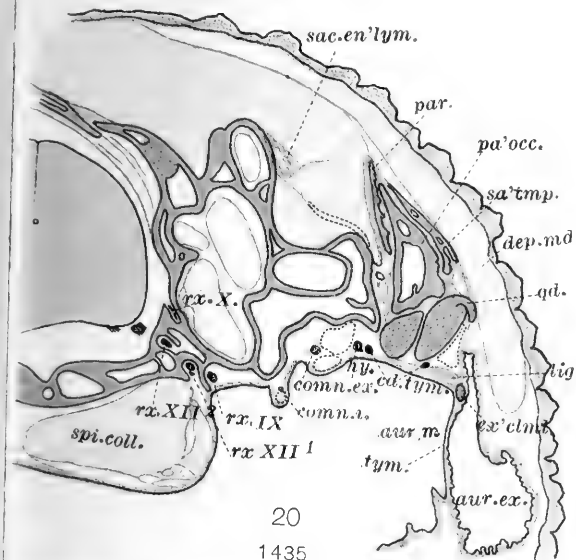
PLATE 7.

Figs. 20 and 21. Transverse sections (Nos. 1435 and 1441) through the posterior part of the middle ear cavity, showing the relation of the chorda tympani to the ligament of the extra-columella (*lig. tym.*). Fig. 20 shows also foramina for nerve X and the second root of nerve XII. Fig. 21 shows the laxator tympani muscle continuing caudad from the place of insertion of the ligament.

Fig. 22. Transverse section (No. 1453) through the ganglion of nerve X and the three roots of nerve XII before their union, and immediately anterior to the juncture of Jacobson's anastomosis with the main sympathetic trunk.

Fig. 23. Transverse section (No. 1480) through the anterior end of the petrosal ganglion. The skeletal attachment of the constrictor of the internal jugular vein is shown, also the root and distribution, in part, of the first spinal nerve.

Fig. 24. Transverse section (No. 1595) showing ganglion of the third spinal nerve and the position of the sympathetic trunk and ramus visceralis X on the dorsal side of the thymus gland.



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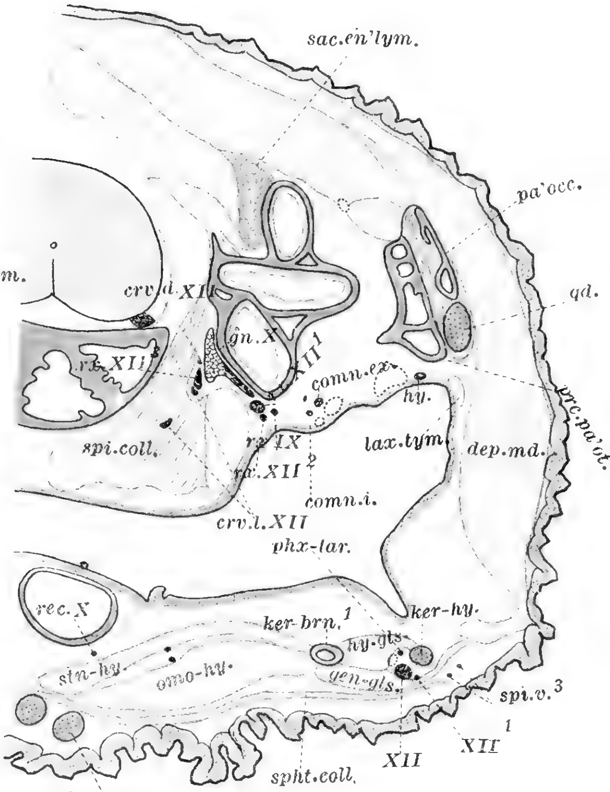

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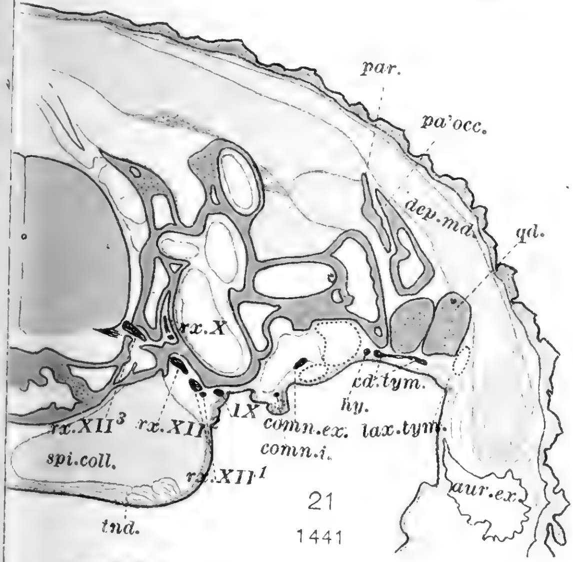

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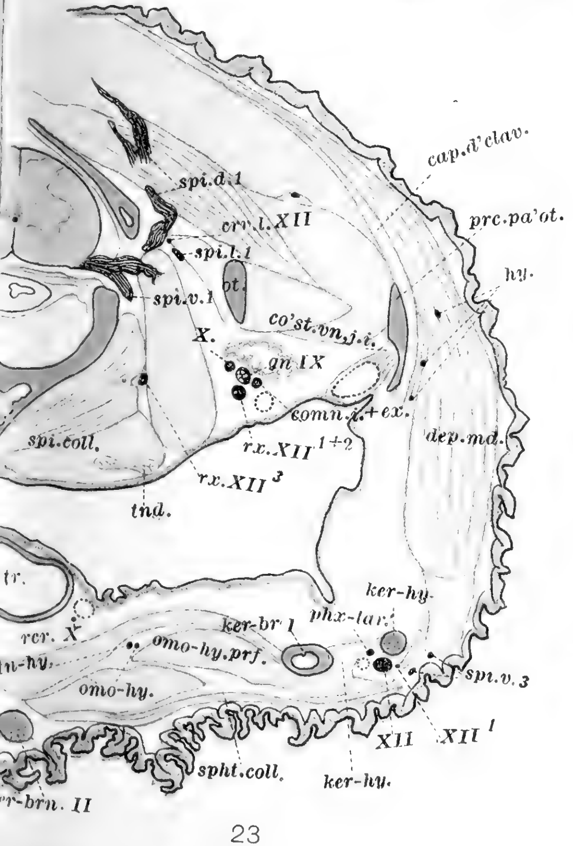

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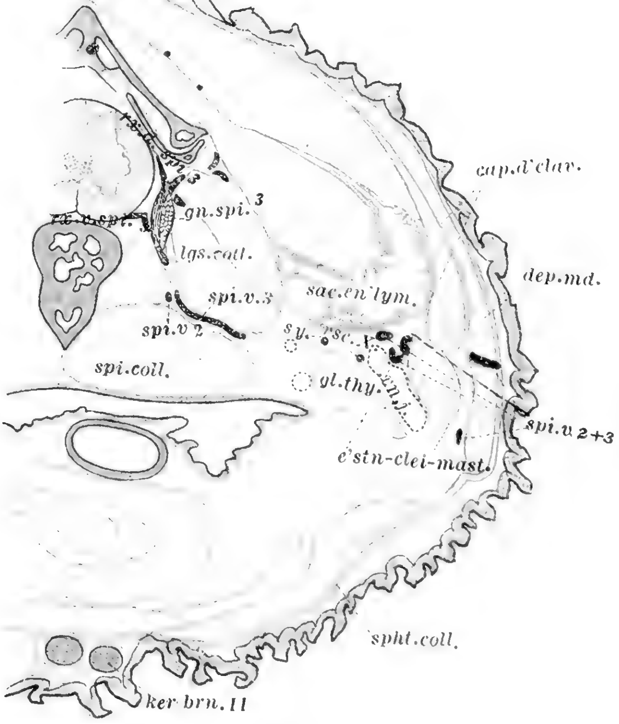

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A.W. DEL.

Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

Vol. LIX. No. 3.

RELICS OF PEALE'S MUSEUM.

By Walter Faxon.

CAMBRIDGE, MASS., U. S. A.:
PRINTED FOR THE MUSEUM.
July, 1915.

No. 3.— *Relics of Peale's Museum.*

By WALTER FAXON.

THE zoölogical collection of the Boston Museum, which had been given to the Boston Society of Natural History in 1893 and 1899, was transferred in 1914 to the Museum of Comparative Zoölogy at Cambridge. It is generally understood that this collection consisted chiefly of the moiety of the old Philadelphia or Peale Museum property purchased by Moses Kimball in 1850, after the dissolution of that institution in 1846. Since the Peale Museum was the repository of a large number of the types of species described by C. L. Bonaparte, Richard Harlan, George Ord, Thomas Say, and Alexander Wilson, it would seem that a careful study of this material might reveal some of these much-desired types. I have lately examined the North American birds in the collection, with a view to the recovery of specimens described and figured by Wilson in his "American Ornithology," 1808–1814. On account of the total loss of the original Peale Museum labels, the task has been a difficult one, and the results achieved are meagre and often vitiated by uncertainty; but such as they are, they are placed on record in this paper.

Since Wilson had no training as an artist, he found it expedient to draw a bird after it had assumed a definite form and attitude by being stuffed and mounted, often by his own hands. We know this not only by tradition but also by the written testimony of the artist Charles R. Leslie. In his "Autobiographical Recollections,"[1] **1**, p. 245 (Amer. ed., p. 163), Leslie says:—

> "Wilson was engaged by Mr. Bradford as tutor to his sons, and as editor of the American edition of 'Ree's Cyclopædia'; while at the same time he was advancing his Ornithology for publication. I assisted him to colour some of its first plates. We worked from birds which he had shot and stuffed, and I well remember the extreme accuracy of his drawings, and how carefully he had counted the number of scales on the tiny legs and feet of his subject."

Wilson usually refers to a Peale Museum specimen by its catalogue number at the beginning of his description of each species. Seventy-one out of about eighty-five of the birds described by him under new

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[1] Autobiographical Recollections. By the late Charles Robert Leslie, R. A. Edited by Tom Taylor. In two volumes. London: John Murray, 1860. American Edition in one vol., Boston: Ticknor and Fields, 1860.

names[1] are thus definitely associated with specimens in the Peale Museum. That the specimens thus referred to by number were in all cases the subjects that he drew and described cannot be affirmed, but is highly probable because even in the case of an extremely abundant bird, like the Robin, of which there must have been several specimens in the Peale Museum, he cites but one specimen or rarely two.

Wilson's custom of drawing from a mounted specimen affords a clew in some instances for tracing the subject of his pencil. In the absence of original data, we are forced, like Polonius, to find directions out by indirections. When Wilson drew his bird in a simple, conventional attitude, agreement between his drawing and a mounted specimen in the old collection will obviously be of slight significance,—an accidental co-incidence, perhaps, since the same correspondence will in all likelihood hold true of birds in divers museums, the work of divers taxidermists. When, on the other hand, he depicts a bird in an unusual or singular posture, conformity of specimen and figure may fairly be taken as evidence that they bear to each other the relation of subject and copy; the weight of the evidence being in strict proportion to the preciseness of the similitude. In a few cases, individual peculiarities of plumage may assist in identifying the originals of Wilson's figures.

It does not follow conversely that specimens which do not conform to Wilson's figures are not the subjects that he drew: the exigencies arising from the arrangement of the figures might often compel him to adapt the posture of the bird to the requirements of the plate. With the disappearance of the original Peale labels the chance of recovering most of Wilson's types vanished for ever.

Can types ascertained by intrinsic evidence, in the absence of lawful credentials in the form of original labels, be of any practical use? I think they can. Let us suppose, in the way of argument, that it is found convenient to separate a species, *Mniotilta varia* for example, into two races or subspecies, differing from each other in size or plumage. In the synonymy of this species stands *Certhia maculata* Wilson. Will the name *maculata* be usable for the supposed new subspecies? In order to decide this, it seems to me that it would be incumbent upon the reviser of the species to examine, in the absence of a more authentic type, a specimen in the Boston Museum collection which exactly agrees with Wilson's drawing of *Certhia maculata;* for we know it was a habit of Wilson's to draw from a mounted specimen; that his

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[1] Names borrowed by Wilson from William Bartram (Travels through North and South Carolina, etc., 1791) are allotted to Wilson, since their validity depends on his adoption of them.

type was in the Peale Museum; and that one half of the Peale Museum came to the Boston Museum.

It is generally believed that little was added to the Boston Museum collection of birds after the accession of the Peale collection in 1850. It is equally probable that the nucleus of the Boston Museum collection antedating 1850 was very slight and unimportant. At least four primitive shows of the early nineteenth or late eighteenth centuries were the springs which fed the first exhibition of the Boston Museum in 1841. Oldest of these was the Columbian Museum, a collection first exhibited in the American Coffee-House in State Street, Boston, in 1791, by Daniel Bowen.[1] Removed afterward to the corner of Bromfield and Tremont Streets, where in 1795 it assumed the name of the Columbian Museum, it was destroyed by fire in 1803, but was afterward revived at the corner of Milk and Oliver Street, and in 1806 the exhibition, under the management of Bowen and W. M. S. Doyle, was moved to a new five-storey building on Tremont Street, near King's Chapel; this building again was burned in 1807 and rebuilt as the "Columbian Hall" during the same year. The Columbian Museum collections were sold Jan. 1, 1825, to the proprietors of the New England Museum for about $5000.

Woods's Boston Museum, also known as the Market Museum, was opened by Philip Woods in 1804 in Market (Faneuil Hall) Square, Boston. This museum, like the Columbian, was sold at auction in 1822 to the proprietors of the New England Museum.

The New England Museum, E. A. Greenwood, manager, was chartered by the Massachusetts Legislature and opened July 4, 1818, in the block of buildings on Court Street, Boston, occupying the space between Brattle Street and Cornhill. It commenced with the collection of Edward Savage called the New York Museum, which was opened in 1812 in Boylston Hall, over the Boylston Market. J. Mix's New Haven Museum was added in 1821, and, as we have seen above, Woods's or the Market in 1822, and the Columbian in 1825. In 1839 Moses Kimball became the proprietor of the New England Museum, and in 1841 it passed into the Boston Museum, located at first on the corner of Tremont and Bromfield Streets, afterward, in 1846, further down Tremont toward Court Street. In 1850 Mr. Kimball bought one half of the collections of the Peale or Philadelphia Museum, the

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[1] For facts relating to the old museums of Boston, the reader is referred to Old Landmarks and Historic Personages of Boston, p. 41, 42, 132. By Samuel Adams Drake. Boston: James R. Osgood and Company, 1873. Woods' Boston Museum. By Arthur W. Brayley. < *The Bostonian*, **2**, No. 2, May, 1895, p. 125–130. Boston Museum: The Passing of an Historic Playhouse. By John Bouvé Clapp. < *Boston Evening Transcript*, April 25, June 13, 1903.

other half going to P. T. Barnum's American Museum, New York, where it was consumed by fire on the thirteenth of July, 1865.

That little of value in the shape of natural history specimens accrued to the Boston Museum up to the time of the Peale Museum purchase scarcely admits of a doubt. The stuff received before that time was contributed by museums that partook partly of a dime museum, partly of a vaudeville show.[1] Among the announcements made by the proprietor of the Columbian Museum in the *Boston Centinel* newspaper in 1797 I find the two following, which will serve to show the character of those primitive places of amusement whose property went to form the nucleus of the Boston Museum collection:—

[Nov. 29, 1797.]

LATE ADDITIONS TO THE

Columbian Museum,

Head of the Mall, Boston.

Mr. Bowen informs the Public, That, he has purchased Mr. *Paff's* much admired Exhibition of CONCERT CLOCKS, which are placed at the head of the *Museum Hall*, as a valuable and pleasing addition to that very extensive Repository of Curiosities.

1. Canary Bird, which sings a variety of beautiful Songs, Minuets, Marches, &c. as natural as life. 2. A company of Automaton Figures, which dance to the music of a Harpsichord. 3. Three figures which play the Organ and Clarinet, in Concert. 4. Three figures which play the Harpsichord and Hautboys in concert. 5. King Herod beheading John the Baptist, and his daughter holding a charger to receive the head. 6. A Chimney Sweep, and his boy, on the top of a chimney. 7. Three figures which strike the hours and quarters. 8. A butcher killing an Ox.

The above CONCERT CLOCKS have been exhibited in New-York, with universal applause, and are well worthy the attention of the Citizens of Boston, and the public in general.

The Museum also contains the most extensive Collection of ELEGANT PAINTINGS, that ever was exhibited in the United States, some of which are 10 by 12 feet, elegantly framed, and valued from 500 to 1000 Dollars each.

Also, a collection of upwards of

50 elegant Figures of WAX-WORK, large as life, among which are the following (the most interesting) viz.

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[1] The lack of appreciation of natural history by the American public during the early part of the last century appears in Scudder's avowal to Wilson that the "Witch of Endor" and "Potiphar's Wife" brought ten dollars to his museum where the natural history brought one. Scudder was the founder of the old American Museum of New York (Dunlap's History of the Rise and Progress of the Arts of Design in the United States, 1834, **2**, p. 199).

The late King of France, taking an affectionate leave of his family, just before he suffered under the guillotine: The Queen appears in a rage of distraction: The King's sister deeply affected. The young Princess is fainting: And the Dauphin is embracing his unhappy father: The Queen's Maid of honor also appears in great distress: A guard of soldiers are waiting to conduct him to the place of execution. This is an affecting scene, which appears natural as life, and is the most interesting group of WAX FIGURES that ever was exhibited in the United States.

GEORGE WASHINGTON, late President of the United States, is elegantly situated in the centre of the Museum Hall, surrounded by four beautiful Wax Figures, representing LIBERTY, with the staff and cap; — JUSTICE, with the sword and balance; — PEACE, with the olive branch extended; — And PLENTY, with a cornucopia, or horn of Plenty, loaded with fruit. The President is drest in an elegant suit of black, and his figure is 6 feet and one inch in height, with exact proportion, and the likeness is universally allowed to be the most perfect of any ever offered to the public view. With a great variety of

Natural and Artificial Curiosities,—

Among which are, a variety of Birds, Beasts, Reptiles, Serpents, one of which is a Rattle Snake, 9 years of age, and 4 feet in length, Insects, Diamond Beetle, Glass Frigates, two feet in length, completely rigged and mounted with Glass Guns, Live Owls, &c.

The Museum has lately received the principal Additions for this season.— It is opended every Day (except Sundays) and illuminated every Tuesday, Thursday, and Friday Evenings.

Tickets, Half a Dollar; 25 Cents for Children.

Nov. 29.

[July 8, 1797.]

On Tuesday next, 11th inst.

At BOWEN's *COLUMBIAN MUSEUM,*

Messrs. Chalmers and Williamson, respectfully inform the Ladies and Gentlemen of Boston and its vicinity, that they intend giving their entertainment of

JUST IN TIME,

With Mr. BARRETT'S EVENING LOUNGE,

being an antidote for the Spleen; such things have been; Such things are; such things may be.

Mirth, Song and Sentiment,

Consisting of Readings, Lectures, Recitations and Songs, as performed at Dibden's, Vauxhall, and the Theatres in Europe: — Being a Comic, Satirical, Whimsical, Humourous, Moral, Illustrative Dissertation and display of Heads, Hearts, Passions, Humours, Whims, Oddities and Characters.— To "*Catch* *the living maners as they rise*" Has ever been held, not only allowable, but meritorious; so it is to be hoped the same wish to please and entertain, will in the present case, be viewed at least with candor.

Mr. Philip Woods of the older Boston or Market Museum advertised, March 24, 1805:[1] —

> A Monstrous Crocodile, which measured when alive 12 feet in length and 4 feet around the body — was killed in Egypt, when devouring a black boy; which is naturally represented with Mungo in his mouth.

On June 29, 1805, he designates among the attractions added to his show:[1] —

> The Philadelphia, New York, and Salem beauties and a number of other figures, also a number of natural curiosities, among which is the skin of the sea-elephant in natural preservation, which measured eighty feet in length and six feet around the body.

The Boston Museum thus derived by direct inheritance the unique position which it afterward held among American theatres. Even after its dramatic company came to be one of the best in the United States, it still offered to its patrons its side-shows of picture-galleries, stuffed animals, and chambers of horror in wax-work. Many an old Bostonian remembers his Saturday afternoons as a child at the "Múseum," — afternoons ending with ice-creams at Copeland's or oysters at Higgins's, and followed by a restless night perturbed by strange dreams of wax images, boa constrictors, and "Aladdin," or "The Forty Thieves," fused into one composite horror such as never was on sea or land. Perhaps some may recall the taxidermic "artist" who stood ready to set up a pet canary-bird or kitten "as natural as life," while its owner was assuaging his grief for his lost pet by "seeing Warren." And all this, except the supper and the kitten, for fifteen cents! I doubt if children of the present time can get so much for their mothers' money.

Peale's Museum was an institution of a very different kind from its Boston contemporaries,— at least during its earlier period under the management of its founder. Charles Willson Peale[2] — artist, soldier,

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[1] Brayley, *l. c.*

[2] See Biographical Sketch of Charles Willson Peale. [By Rembrandt Peale].< Doughty's Cabinet of Natural History, **1**, p. i-vii, portr., Philadelphia: 1830. Lieber's Encyclopædia Americana, **9**, p. 571–572, Philadelphia: 1832. Dunlap's History of the Rise and Progress of the Arts of Design in the United States, **1**, p. 136–142, New York: 1834. Peale's Museum. By Harold Sellers Colton.< *Popular Science Monthly*, **5**, Sept., 1909, p. 221–238.

and founder of the Philadelphia Museum — was born of English parents in Chestertown, Md., in 1741. His museum had its modest origin in 1784, in a Paddle Fish from the Allegheny River, some bones of a Mastodon from Ohio, and his pictures, at first stored in a frame building annexed to his dwelling at the southwest corner of Lombard and Third Street. In 1794 his collection was moved to the Hall of the Philosophical Society and in 1802 the State of Pennsylvania granted a part of the old State House (Independence Hall) for the exhibition of Peale's accumulations. The active management of the Museum devolved upon Peale's sons in 1808, and in 1820 the property was divided into shares and a stock company incorporated by act of the Pennsylvania Legislature, the official title of the corporation being the Philadelphia Museum Company. The collection was transferred in 1828 to the Arcade on Chestnut Street above Sixth Street and again in 1838 to a building in Ninth and Sansom Street. Eight years after, the Museum Company came to grief, the collections were sold off by auction, but the natural history collection was still kept together and exhibited in Masonic Hall till 1850, when it was bought for $5000 or $6000 by Moses Kimball and P. T. Barnum.

The scientific importance of Peale's Museum arose from several causes. The records show that the institution was in touch not only with the contemporary museums in the United States, such as the Columbian of Boston, the New York Museum, and Mix's New Haven Museum, but also with the great scientific establishments of Europe, in Paris, London, Stockholm, etc. Peale and his sons were in correspondence, moreover, with many of the most prominent naturalists of Europe; as, Geoffroy Saint-Hilaire, Cuvier, Lamarck, Maximilian, Prince of Wied, and John Latham. I believe that a part of the Leverian Museum [1] found its way into Peale's Museum; certainly the booty of the Lewis and Clark Expedition (1804–1806) was deposited there in December, 1809, and the collections made by the Expedition of Major Long to the Rocky Mountains in 1819–1820 were added on March 23, 1821. Peale's son Titian R. was Assistant Naturalist of the latter expedition, Thomas Say being the head naturalist. But the chief cause of the importance ascribed to Peale's collection lay in the use made of it by that remarkable coterie of naturalists who made Philadelphia the metropolis of natural history n America during the early part of the nineteenth century; as ob-

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[1] Sir Ashton Lever's famous collections were disposed of by lottery in 1788 to James Parkinson, and were finally dispersed at public auction sale in London in 1806, he sale numbering 7,879 lots and lasting sixty-five days.

served at the beginning of this paper, the Peale Museum became the depository of a very large number of the types of animals described by the Philadelphia naturalists.

At length the venerable collection was given by the Boston Museum to the Boston Society of Natural History. The bulk of it was transferred to the Society's rooms in Berkeley Street in 1893, the residue in 1899, after the fire that damaged the upper part of the Boston Museum building in May. After the collection came into the possession of the Boston Society of Natural History some of the specimens were destroyed, but most of them were sold in 1900 to Mr. C. J. Maynard. The following notice appeared in the *Boston Evening Transcript* newspaper of April 13, 1900:—

> "At the rooms of the Appalachian Mountain Club this afternoon and evening, Walter R. Davis exhibits his collection of .... birds.... Two of the most valuable birds in the collection are an English Skylark, from the old Charles Willson Peale collection made in 1784 in Philadelphia, and a Golden Pheasant presented to Mr. Peale by George Washington. These specimens have recently been discovered by C. J. Maynard of Newtonville, after having been lost for over fifty years. When the Peale Museum was sold, a portion was bought by P. T. Barnum, much of the remainder was purchased by Moses Kimball of the Boston Museum, and its identity became lost. When this museum was broken up a few years since, the collection was given to the Boston Natural History Society, who sold the birds to Mr. Maynard, not knowing their origin. Many of Alexander Wilson's types are in the collection."

What is said in the above-quoted passage about the Boston Society's ignorance of the origin of the Boston Museum collection is not true: in his report at the annual meeting of the Boston Society of Natural History, May 2, 1894,[1] the Curator, Alpheus Hyatt, narrated at some length the history of this collection and its connection with the historic Peale Museum.

After Mr. Maynard bought the collection it was sent to his residence in Newtonville, Mass., and stored for a while in his barn. It was subsequently redeemed by the Boston Society, all of the specimens, or nearly all of them, being recovered. Then the birds, with exception of a few of the larger kinds, were wrenched from their stands and packed into tin cases, to the great detriment of their legs and plumage. This should have been done, if at all, only after the collection had been submitted to a careful study.

Mr. J. D. Sornborger was then employed by the Society to examine

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[1] Proc. Boston Soc. Nat. Hist., **26**, p. 275–276.

the collection and report upon it; but nothing resulted from this endeavour except the deplorable loss of such of the original Peale Museum labels as still remained, pinned to or tucked under the wings of some of the birds. These labels were removed from the specimens and put into a paper envelope which was afterward lost. The tickets which now accompany the specimens were probably printed after the collection passed into the custody of the Boston Museum; they consist merely of the name and habitat of the animals, without any data. I believe the only surviving labels which probably go back to the Peale Museum are two wooden ones belonging to a pair of Golden Pheasants presented to Charles Willson Peale by George Washington.[1]

I now proceed to my notes made during an examination of the North American birds in this collection, premising that heretofore the originals of only three of Wilson's birds have been located; *viz.*: —

SYLVIA MARITIMA Wils., *Type*. **6**, 1812, p. 99, pl. 54, fig. 3.

[=*Dendroica tigrina* (Gmel.), 1788].

In coll. Vassar College, Poughkeepsie, N. Y. See ORTON, Amer. Nat., **4**, 1871, p. 714.

FALCO MISSISSIPPIENSIS Wils., *Type*. **3**, 1811, p. 80, pl. 25, fig. 1.

In coll. Academy of Natural Sciences of Philadelphia. See STONE, Proc. Acad. Nat. Sci. Phila., 1899, p. 11; Auk, **16**, 1899, p. 169.

FALCO PENNSYLVANICUS Wils., *Type*. **6**, 1812, p. 92, pl. 54, fig. 1.

Nom. praeoc. = *Sparvius platypterus* Vieill., 1823; *Falco wilsonii* Bonap., 1824; *alco latissimus* Ord, 1824].[2]

In coll. Acad. Nat. Sci. Phila. See STONE, *ut supra*.

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[1] Mr. Maynard tells me that there were also two groups of mounted birds arranged two glass cases, presented by Washington to the Peale Museum; these were transred with the rest from the Boston Museum to the rooms of the Natural History ciety, but they had been disposed of before Mr. Maynard purchased the collection.

[2] See Faxon, *Auk*, **18**, April, 1891, p. 217.

Notes on some of the North American Birds in the Boston Museum Collection, now in the Museum of Comparative Zoölogy.

Alle alle (Linn.).

In a foot-note on page 94 of the ninth volume of Wilson's "American Ornithology," Philadelphia, 1814, Ord refers to one specimen of *Alca alle* in the Peale Museum that differs from the rest in having a white spot *below* as well as above each eye. One of the three specimens in the Boston Museum collection (M. C. Z., No. 67811) has this spot and is very likely the specimen Ord alluded to. Wilson's figure (pl. 74, fig. 5) shows a white mark both above and below the eye and may have been drawn and coloured from the same specimen.

Gelochelidon nilotica (Linn.).

Sterna aranea Wils., **8**, 14, p. 159.

According to Ord (2d. ed. of Wilson, **8**, 1824, p. 159), Wilson's type of *Sterna aranea* in the Peale Museum was lost. Titian R. Peale succeeded in procuring another specimen which became the subject of Bonaparte's remarks on this species in his "Observations on the Nomenclature of Wilson's Ornithology," Philadelphia, 1826. The single specimen in the Boston Museum collection (M. C. Z. No. 67812) is very probably the bird examined by Bonaparte.

Rhynchops nigra Linn.

M. C. Z. No. 67813. One specimen, which I think is without doubt the original of Wilson's figure, **7**, 1813, pl. 60, fig. 4.

Oceanodroma leucorrhoa (Vieill.).

M. C. Z. No. 67814. Probably the specimen drawn by Titian R. Peale to illustrate *Procellaria leachii* Temm. for Bonaparte's paper "An Account of four Species of Stormy Petrels," Journ. Acad. Nat. Sci. Phila., **3**, 1824, p. 229, pl. 9.

OCEANITES OCEANICUS (Kuhl).

Procellaria pelagica Wils., **7**, 1813, p. 90, pl. 60, fig. 6. *Nec* Linn.
Procellaria wilsonii Bonap., Journ. Acad. Nat. Sci. Phila., **3**, 1824, p. 231, pl. 9.

M. C. Z. No. 67815. A specimen of Wilson's Petrel agrees so well with the figure drawn by T. R. Peale for Bonaparte that I have no doubt of its being the figured type of *Procellaria wilsonii* Bonap.

ANHINGA ANHINGA (Linn).

Plotus melanogaster Ord, Wils. Amer. Orn., **9**, 1814, p. 82, pl. 74, fig. 2. *Nec* Gmel.

M. C. Z. Nos. 67816, 67817. A pair, the female (No. 67817) without doubt the one figured by Wilson (pl. 74, fig. 2). In a MS. in the possession of the Pennsylvania Historical Society entitled "A Walk through the Philadelphia Museum, by C. W. Peale," a pair of Anhingas are referred to on page 94,— one as collected at Elk Ridge, on the Pelapsewa River, the other in Georgia. Mr. J. D. Sornborger made extracts from this manuscript when he was in Philadelphia a few years ago.

MERGELLUS ALBELLUS (Linn.).

M. C. Z. No. 67818. One specimen, without question the original of Wilson's figure of *Mergus albellus*, **8**, 1814, pl. 71, fig. 4. Audubon was convinced that Wilson copied this bird from a European specimen in Peale's Museum (Ornithological Biography, **4**, 1838, p. 350, Birds of America, **6**, 1843, p. 408).

AIX SPONSA (Linn.).

M. C. Z. No. 67819. Probably the original of Wilson's figure of *Anas sponsa*, **8**, 1814, pl. 70, fig. 3.

SOMATERIA DRESSERI Sharpe.

Anas mollissima Wils., **8**, 1814, p. 122, pl. 71, fig. 2. *Nec* Linn.

M. C. Z. No. 67820. Perhaps the original of Wilson's figure.

ERISMATURA JAMAICENSIS (Gmel.).

Anas rubidus Wils., **8**, 1814, p. 128, pl. 71, fig. 5.

M. C. Z. No. 67821. Very probably Wilson's type, although the head is turned to one side, which is not the case in the figure.

CHEN HYPERBOREUS NIVALIS (Forst.).

Anas hyperborea Wils., **8**, 1814, p. 76, pl. 68, fig. 5. *Nec Anser hyperboreus* Pall.

M. C. Z. No. 67822. Original of Wilson's drawing, without much doubt.

CHEN CAERULESCENS (Linn.).

Anas hyperborea (Young) Wils., **8**, 1814, p. 89, pl. 69, fig. 5. *Nec Anser hyperboreus* Pall.

M. C. Z. No. 67823. Original of Wilson's figure. Supposed by him to be the young of the Snow Goose.

BRANTA BERNICLA GLAUCOGASTRA (Brehm).

Anas bernicla Wils., **8**, 1814, p. 131, pl. 72, fig. 1. *Nec.* Linn.

M. C. Z. No. 67824. Probably the specimen figured by Wilson.

PHOENICOPTERUS RUBER Linn.

M. C. Z. No. 67825. Wilson's Plate 66, fig. 4 (**8**, 1814)? Neck differently disposed, and foot uplifted in the figure.

AJAIA AJAIA (Linn.).

M. C. Z. No. 67826. Wilson's pl. 63, fig. 1, **7**, 1813. Even the artificial colours on the bill and bare parts of the head are copied in the figure. This specimen (Peale Mus. No. 3553) was killed in the neighbourhood of Natchez, Tenn. (Wilson, **7**, p. 123).

PLEGADIS AUTUMNALIS (Linn.).

Tantalus mexicanus? Ord, Journ. Acad. Nat. Sci. Phila., **1**, 1817, p. 53. *Nec* Gmel.
Ibis falcinellus (Linn.) Bonap., Amer. Orn., **4**, 1833, p. 23, pl. 23, fig. 1.
Ibis ordi Bonap., Geogr. & Compar. List, 1838, p. 49.

Coll. W. Brewster No. 48861. This is without question the specimen described and figured in Bonaparte's "American Ornithology" as *Ibis falcinellus,* and afterward considered by Bonaparte to be a new species, *Ibis ordi.* Whether it is the same specimen as the one described at an earlier date by Ord, as *Tantalus mexicanus?,* is not clear from Bonaparte's narrative. The latter author says that Ord's specimen (which was shot at Great Egg Harbour, N. J., in May, 1817) was well preserved in Peale's Museum. Our specimen is more probably the one presented to the Peale Museum by Bonaparte on Oct. 10, 1827, as entered in the MS. Records of the Museum, now in the possession of the Pennsylvania Historical Society. There are two more examples of the Glossy Ibis in the Boston Museum collection.

Mr. Brewster bought the Bonaparte specimen of Mr. Maynard when the Boston Museum collection was in his possession in Newtonville, Mass. (see page 126).

ARDEA HERODIAS HERODIAS Linn.

M. C. Z. No. 67827. This specimen appears to be the bird represented on Wilson's plate, **8**, 1814, pl. 65, fig. 2.

GRUS AMERICANA (Linn.).

M. C. Z. No. 67828. Making allowance for bad drawing, I think this is the bird figured by Wilson as *Ardea americana,* **8**, 1814, pl. 64, fig. 3. In the figure the wings are more closely applied to the sides than they are in the specimen. Wilson's drawing in this instance is very poor; the conspicuous tertials look as if they sprang from the middle line of the body, like a Cock's tail.

Wilson's bird was no. 3704 of the Peale Museum. According to Dr. Mease[1] the Peale Museum specimen came from the Capes of the Delaware.

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[1] The Picture of Philadelphia. By James Mease, M. D. Philadelphia: 1811, p. 312.

RALLUS ELEGANS Aud.

M. C. Z. No. 67829. Wilson's account of the Clapper Rail, *Rallus crepitans* Gmel., relates to that species, but his figure, **7**, 1813, pl. 62, fig. 2, is a King Rail, *R. elegans* Aud., as Audubon pointed out. There are two large Rails in the Boston Museum collection, both of them *R. elegans,* although one is labelled *Rallus crepitans,* a name probably copied from the original Peale Museum label. This is very probably the individual that served as a model for Wilson, although its attitude is vitalized in the drawing.

STEGANOPUS TRICOLOR Vieill.

M. C. Z. No. 67830. Wilson saw but one specimen of this Phalarope, in Trowbridge's Museum, Albany, N. Y. He left after his death an imperfect sketch and description of this specimen which were published by Ord in the ninth volume of Wilson's Ornithology, p. 72–74, pl. 73, fig. 3, 1814, as "*Phalaropus lobata.*" In the second edition of the ninth volume, p. 234–235, 1825, Ord added a fuller description of a new specimen in Peale's Museum, shot by T. R. Peale near Philadelphia, May 7, 1818. In 1833 Bonaparte described the same specimen again and gave a coloured figure of it, in the fourth volume of his continuation of Wilson's Ornithology, p. 66, pl. 24, fig. 1, under the name *Phalaropus wilsoni* Sabine. I am convinced that the specimen in the Boston Museum collection is the one described by Ord and Bonaparte. Its bill unluckily has been badly shattered.

RECURVIROSTRA AMERICANA Gmel.

M. C. Z. Nos. 67831, 67832. Two specimens, probably collected by Wilson on their former breeding-ground in Cape May Co., N. J. (Amer. Ornithology, **7**, 1813, p. 126). One of these (No. 67831) seems to be the specimen figured by Wilson, pl. 63, fig. 2.

HIMANTOPUS MEXICANUS (Müll.).

Recurvirostra himantopus Wils., **7**, 1813, p. 48, pl. 58, fig. 2. *Nec Charadrius himantopus* Linn.

M. C. Z. Nos. 67833, 67834. There are likewise two specimens of this bird which probably have the same origin as those of the preceding species (see Amer. Orn., **7**, p. 48). One of them (No. 67833) is probably the specimen drawn by Wilson.

PELIDNA ALPINA SAKHALINA (Vieill.).

Tringa alpina Wils., **7**, 1813, p. 73, pl. 59, fig. 6. *Nec* Linn.

M. C. Z. No. 67835. A headless specimen, probably the remnant of the bird figured by Wilson.

OXYECHUS VOCIFERUS (Linn.).

M. C. Z. No. 67836. Perhaps the original of Wilson's figure, **7**, 1813, pl. 59, fig. 6.

AEGIALITIS SEMIPALMATA (Bonap.).

Tringa hiaticula Wils., **7**, 1813, p. 65, pl. 69, fig. 3. *Nec Charadrius hiaticula* Linn.
Charadrius semipalmatus Bonap., Journ. Acad. Nat. Sci. Phila., **5**, 1825, p. 98.

M. C. Z. Nos. 67837, 67838. An adult and a young. The former I believe to be Bonaparte's type, and the individual figured by Wilson as *Tringa hiaticula* on his 69th plate. The young is probably the specimen afterward described and figured by Bonaparte in his "American Ornithology," **4**, 1833, p. 92, pl. 25, fig. 4.

OCHTHODROMUS WILSONIUS (Ord).

Charadrius wilsonia Ord, Wils. Amer. Orn., **9**, 1814, p. 77, pl. 73, fig. 5.

M. C. Z. Nos. 67839, 67840. Male and female. Probably the types of the species, the male being the one figured by Wilson, and both described by Ord in the accompanying text. If I am right as to their identity, they were both shot by Wilson at Cape Island, N. J., May 13, 1813.

HAEMATOPUS OSTRALEGUS Linn.

M. C. Z. No. 67841. There is scant room for doubt that this is the individual figured by Wilson, **8**, 1814, pl. 64, fig. 2, whatever the original of his *description* may have been. It is a European Oyster-Catcher, not *palliatus*. There is also a specimen of *H. palliatus* in the collection. In C. W. Peale's MS. "A Walk through the Philadelphia Museum," page 113, a pair of Oyster-Catchers in the Museum are referred to:— "the darkest of this pair is from England, and the other from Cape May."

MELEAGRIS GALLOPAVO SILVESTRIS (Vieill.).

M. C. Z. No. 67842. This is without much doubt the original of T. R. Peale's beautiful figure of the Wild Turkey Cock in Bonaparte's "American Ornithology," **1**, 1825, pl. 9.

ECTOPISTES MIGRATORIUS (Linn.).

M. C. Z. No. 67843. A fine specimen of this extinct species conforms so well to Wilson's figure, **5**, 1812, pl. 44, fig. 1, that I incline to think it is the subject he drew.

CATHARISTA URUBU (Vieill.).

Vultur atratus Ord, Wils. Amer. Orn., **9**, 1814, p. 104, pl. 75, fig. 2.

M. C. Z., No. 67844. Wilson's figure was very likely drawn from this specimen, with some adaptation to the life attitude of feeding on the carcass of a sheep.

BUTEO LINEATUS LINEATUS (Gmel.).

M. C. Z. No. 67845. Probably the model for Wilson's figure, **9**, 1812, pl. 53, fig. 3.

HALIAEETUS LEUCOCEPHALUS LEUCOCEPHALUS (Linn.).

M. C. Z. Nos. 67846, 67847. One of these birds, a fine adult in full plumage, is the one shown on Wilson's plate 36 (**6**, 1812). Its attitude is the same as in the plate, but it grasps in its talons an Hudsonian Curlew instead of a fish. I well remember the old Peale Museum label (since lost) which accompanied this bird after it came into the custody of the Boston Society of Natural History, with the inscription "Presented by A. Wilson." This Eagle was shot near Great Egg Harbour, N. J., in January, 1812, or earlier.

The other specimen, in immature plumage, is the original of Wilson's plate 55, figure 2 (**7**, 1813, p. 16). Although Wilson suspected that it was the young of *H. leucocephalus*, it stands in his work as the Sea Eagle, *Falco ossifragus*, which is in reality the young of the Old World *Haliaeetus albicilla*.

FALCO PEREGRINUS ANATUM (Bonap.).

Falco peregrinus Ord, Wils. Orn., **9**, 1814, p. 120, pl. 76. *Nec* Tunstall.
Falco anatum Bonap., Geogr. & Compar. List., 1838, p. 4.

M. C. Z. No. 67848. Although this specimen is mounted with its wings differently placed from those of Wilson's beautiful drawing, I am persuaded by a careful perusal of Ord's description and scrutiny of Wilson's plate that it is the original of both. Wilson's bird was shot near Great Egg Harbour, N. J., Dec., 1812.

TYTO PERLATA PRATINCOLA (Bonap.).

Strix flammea Wils., **6**, 1812, p. 57, pl. 50, fig. 2. *Nec* Pontoppidan *nec* Linn.
Strix pratincola Bonap., Geogr. & Compar. List, 1838, p. 7.

M. C. Z. No. 67849. Appears to be the original of Wilson's figure.

ASIO WILSONIANUS (Less.).

Strix otus Wils., **6**, 1812, p. 73, pl. 51, fig. 3. *Nec* Linn.

M. C. Z. No. 67850. Very probably the specimen drawn by Wilson.

OTUS ASIO NAEVIUS (Gmel.).

M. C. Z. No. 67851. Perhaps the original of Wilson's figure, **3**, 1811, pl. 19, fig. 1.

BUBO VIRGINIANUS VIRGINIANUS (Gmel.).

M. C. Z. No. 67852. Very probably the bird drawn by Wilson, **6**, 1812, pl. 50, fig. 1.

CONUROPSIS CAROLINENSIS (Linn.).

M. C. Z. No. 67853. Original of Wilson's figure, **3**, 1811, pl. 26, fig. 1.

ASYNDESMUS LEWISI Riley.

Picus torquatus Wils., **3**, 1811, p. 31, pl. 20, fig. 3. *Nomen praeoccupatum.*

M. C. Z. No. 67854. A single venerable looking specimen, probably either the type, which was No. 2020 of the Peale Museum (Lewis and Clark Expedition), or else one of the two individuals shot by T. R. Peale near the Rocky Mountains, on the Long Expedition, I presume (see Bonaparte, Journ. Acad. Nat. Sci. Phila., **3**, 1824, p. 370).

CHORDEILES VIRGINIANUS VIRGINIANUS (Gmel.).

Caprimulgus americanus Wils., **5**, 1812, p. 65, pl. 40, fig. 1. *Nomen praeoccupatum.*

M. C. Z. No. 67855. Without doubt Wilson's figured type, male, mounted in the attitude of "booming," like the figure. When I first saw this specimen, after it had reached the Boston Society of Natural History rooms, the open mouth was lined with pinkish sealing-wax, just the colour of this part in Wilson's plate. Wilson probably copied the colour of the wax instead of the inside of a living bird's mouth.

OTOCORYS ALPESTRIS ALPESTRIS (Linn.).

Alauda alpestris Linn., Wils., **1**, 1808, p. 85, pl. 5, fig. 4.
Alauda cornuta Wils., **1**, 1808, p. 87.

M. C. Z. No. 67856. Perhaps the original of Wilson's figure.

COTURNICULUS SAVANNARUM AUSTRALIS (Mayn.).

Fringilla passerina Wils., **3**, 1811, p. 76, pl. 24, fig. 5. *Nomen praeoccupatum.*

M. C. Z. No. 67857. Very probably Wilson's type.

SPIZELLA PASSERINA PASSERINA (Bechst.).

Fringilla socialis Wils., **2**, 1810, p. 127, pl. 16, fig. 5.

M. C. Z. No. 67858. The chestnut crown has the dusky spots of the winter plumage, similar to Wilson's figure. A possible type.

SPIZELLA PUSILLA PUSILLA (Wils.).

Fringilla pusilla Wils., **2**, 1810, p. 127, pl. 16, fig. 5.

M. C. Z. No. 67859. Very likely the type.

MELOSPIZA MELODIA MELODIA (Wils.).

Fringilla melodia Wils., **2**, 1810, p. 125, pl. 16, fig. 4.

M. C. Z. No. 67860. This specimen is one of those large, heavily marked Song Sparrows, of a pronounced rufous tint, such as pass through eastern Massachusetts in small numbers in the spring, along with the Fox Sparrows. It agrees well with Wilson's figure, if some allowance is made for adapting the bird to its place on the plate. Mr. Outram Bangs (Proc. N. E. Zoöl. Club, **4**, 1912, p. 86) is quite confident that it is the individual figured by Wilson.

MELOSPIZA GEORGIANA (Lath.).

Fringilla palustris Wils., **3**, 1811, p. 49, pl. 22, fig. 1.

M. C. Z. No. 67861. In the same plumage as the one described and figured by Wilson, with a great deal of blackish colour on the nape. Probably the type.

ZAMELODIA LUDOVICIANA (Linn.).

Loxia rosea Wils., **2**, 1810, p. 135.

M. C. Z. No. 67862, 67863. Wilson describes the adult male and female and a young male in the first spring plumage, citing three corresponding specimens in the Peale Museum, 5806, male; 5806 A, male one year old; 5807, female. This is the sole instance of his referring to more than two specimens of a kind in the Museum. The species is represented in the Boston Museum collection by two specimens, a female and a young male of the first spring in the plumage described by Wilson. The presence of the young male in this peculiar plumage makes it extremely probable that we have here two of the three Peale specimens. Both of the males described by Wilson were shot late in April a few miles from Philadelphia.

As I am reading the proof of these pages, Mrs. L. C. Kimball sends to the Museum a few specimens from the Boston Museum collection which had been retained by the Kimball family. Among them is the missing Rose-breasted Grosbeak, — the adult male, mounted with the wings half spread, as in Wilson's plate 17, figure 2, substantiating the surmise ventured in the preceding paragraph. This specimen, now M. C. Z. No. 67864, may, I think, be accepted without doubt as the figured type of *Loxia rosea* Wils.

PETROCHELIDON LUNIFRONS LUNIFRONS (Say).

M. C. Z. No. 67865. Mounted to simulate a flying bird, like Bonaparte's figure of "*Hirundo fulva* Vieill." (Amer. Orn., **1**, 1825, pl. 7, fig. 1, Peale Mus. No. 7624), and probably the specimen drawn. According to Bonaparte the Cliff Swallow had not at that time advanced further east than western New York, and it is possible that his drawing was made from one of Say's types from the Long Expedition, which were in the Peale Museum.

VIREOSYLVA GILVA GILVA (Vieill.).

Muscicapa melodia Wils., **5**, 1812, p. 36, pl. 42, fig. 2.

M. C. Z. No. 67866. Posed as in the act of singing, with open bill and swelling throat, like Wilson's figure, but with the tail more depressed. A probable type.

VIREO GRISEUS GRISEUS (Bodd.).

Muscicapa cantatrix Wils., **2**, 1810, p. 166, pl. 18, fig. 6.

M. C. Z. No. 67867. Although badly battered, this specimen appears to me to be the original of the portrait of *Muscicapa cantatrix* Wils. Even the ghastly stare of the white glass eye is caught in Wilson's copy. The gape of the beak, too, is exactly the same.

MNIOTILTA VARIA (Linn.).

Certhia maculata Wils., **3**, 1811, p. 23, pl. 19, fig. 3.

M. C. Z. No. 67868. Wilson's figured type, I doubt not.

WILSONIA PUSILLA PUSILLA (Wils.).

Muscicapa pusilla Wils., **3**, 1811, p. 103, pl. 26, fig. 4.
Sylvia wilsonii Bonap., Journ. Acad. Nat. Sci. Phila., **4**, 1824, p. 179.

M. C. Z. No. 67868. Probable type.

SIALIA SIALIS SIALIS (Linn.).

M. C. Z. No. 67870. This specimen looks as if it had served as the pattern for Wilson's beautiful and oft-copied portrait of the Bluebird, **1**, 1808, pl. 3, fig. 3.

LIST OF THE NORTH AMERICAN BIRDS (NORTH OF MEXICO) IN THE BOSTON MUSEUM COLLECTION.

NOTE.— Synonyms imposed by Wilson, Bonaparte, or Ord, are added, because so many of the types of these authors were deposited in the Peale Museum. The numbers in parentheses indicate the number of specimens called for by the Boston Museum labels and show the loss of specimens since the birds were removed from their stands.

		No. of Specimens.	
1.	Colymbus auritus Linn.	2	
2.	Podilymbus podiceps (Linn.)	4	
3.	Gavia immer (Brünn.)	2	
4.	" stellata (Pont.)	2	
5.	Fratercula arctica arctica (Linn.)	2	
6.	Cepphus grylle (Linn.)	2	
7.	Uria troille troille (Linn.)	2	
8.	Alca torda Linn.	3	
9.	Alle alle (Linn.)	3	
10.	Stercorarius parasiticus (Linn.) Coast of New Jersey	1	
11.	Rissa tridactyla tridactyla (Linn.)	1	
12.	Larus argentatus Pont.	7	
13.	" delawarensis Ord	2	(3)
14.	" atricilla Linn.	3	
15.	" philadelphia (Ord)	2	(3)
16.	Gelochelidon nilotica (Linn.) (Sterna aranea Wils.)	1	
17.	Sterna caspia Pall.	1	
18.	" sandvicensis acuflavida (Cabot)	1	
19.	" forsteri Nutt. Young	1	
20.	" hirundo Linn. (Sterna wilsoni Bonap.)	2	
21.	Sterna antillarum (Less.)	3	(4)
22.	Hydrochelidon nigra surinamensis (Gmel.) (Sterna plumbea Wils.)	2	
23.	Anous stolidus (Linn.)	2	
24.	Rhynchops nigra Linn.	3	
25.	Oceanodroma leucorrhoa (Vieill.)	1	
26.	Oceanites oceanicus (Kuhl) (Procellaria wilsonii Bonap.)	1	

		No. of Specimens.	
27.	Sula leucogastra (Bodd.)	1	(2)
28.	“ bassana (Linn.)	1	(2)
29.	Anhinga anhinga (Linn.)	2	
30.	Phalacrocorax carbo (Linn.)	1	
31.	“ auritus auritus (Linn.)	1	
32.	Pelecanus erythrorrhynchos Gmel.	2	
33.	“ occidentalis Linn.	2	
34.	Mergus americanus Cass. ♂ & ♀	4	
35.	“ serrator Linn. ♂	4	
36.	Lophodytes cucullatus (Linn.) ♂ & ♀	2	(3)
37.	Mergellus albellus (Linn.) ♂	1	
38.	Anas boscas Linn. ♂	1	
39.	“ rubripes Brewst. ♀	1	
40.	Mareca americana (Gmel.) ♂ & ♀	2	
41.	Nettion carolinense (Gmel.) ♂ & ♀	3	
42.	Querquedula discors (Linn.) ♂ & ♀ (1 albino)	3	(4)
43.	Spatula clypeata (Linn.) ♂	1	
44.	Dafila acuta (Linn.) ♂ & ♀	2	
45.	Aix sponsa (Linn.) ♂ & ♀	3	
46.	Marila americana (Eyt.) ♂ & ♀	2	
47.	“ vallisneria (Wils.) ♂ & ♀	3	
48.	“ marila (Linn.) ♂	1	
49.	“ affinis (Eyt.)	1	
50.	“ collaris (Don.) ♂	1	
	(Anas rufitorques Bonap.)		
51.	Clangula clangula americana (Bonap.) ♂ & ♀	2	(3)
52.	Charitonetta albeola (Linn.) ♂ & ♀	2	
53.	Harelda hiemalis (Linn.) ♂ & ♀	2	
54.	Histrionicus histrionicus (Linn.) ♂ & ♀	3	
55.	Somateria dresseri Sharpe ♂ & ♀	2	
56.	Oidemia americana Swains. ♂	1	
57.	“ deglandi Bonap. ♂ & ♀	2	(3)
58.	Erismatura jamaicensis (Gmel.)	3	
	(Anas rubidus Wils.)		
59.	Chen hyperboreus nivalis (Forst.)	1	
60.	“ caerulescens (Linn.)	1	
61.	Branta canadensis canadensis (Linn.)	2	
62.	“ bernicla glaucogastra (Brehm)	2	
63.	Olor columbianus (Ord)	1	
64.	Phoenicopterus ruber Linn.	2	

		No. of Specimens.
65.	Ajaia ajaia (Linn.)	2
66.	Guara alba (Linn.)	1
67.	Plegadis autumnalis (Linn.) (Ibis ordi Bonap.)	3 (1 in coll. W. Brewster)
68.	Botaurus lentiginosus (Mont.) (Ardea minor Wils.)	1
69.	Ixobrychus exilis (Gmel.) ♂ & ♀	2
70.	Ardea herodias herodias Linn.	1
71.	Herodias egretta (Gmel.)	3
72.	Egretta candidissima candidissima (Gmel.) (Ardea carolinensis Ord)	3
73.	Hydranassa tricolor ruficollis (Gosse) (Ardea ludoviciana Wils. *Nom. praeoc.*)	2
74.	Florida caerulea (Linn.)	4
75.	Butorides virescens virescens (Linn.)	3 (4)
76.	Nycticorax nycticorax naevius (Bodd.) (Nycticorax americanus Bonap.)	3
77.	Nyctanassa violacea (Linn.)	2
78.	Grus americana (Linn.)	1
79.	Rallus elegans Aud.	2
80.	Porzana carolina (Linn.) Young & albino	3
81.	Ionornis martinicus (Linn.)	1
82.	Gallinula galeata (Licht.)	1
83.	Fulica americana Gmel.	2
84.	Steganopus tricolor Vieill.	1
85.	Recurvirostra americana Gmel.	2
86.	Himantopus mexicanus (Müll.)	2
87.	Philohela minor (Gmel.)	1 (2)
88.	Gallinago delicata (Ord.)	1
89.	Tringa canutus Linn. (Tringa rufa Wils.)	2
90.	Pelidna alpina sakhalina (Vieill.)	1 (2)
91.	Calidris leucophaea (Pall.)	1
92.	Limosa fedoa (Linn.)	1
93.	Totanus melanoleucus (Gmel.) (Scolopax vociferus Wils.)	2
94.	Bartramia longicauda (Bechst.) (Tringa bartramia Wils.)	1
95.	Tringites subruficollis (Vieill.)	1
96.	Numenius americanus Bechst. (Numenius longirostris Wils.)	1

		No. of Specimens.	
97.	Squatarola squatarola (Linn.) Summer & winter plumage	2	
98.	Charadrius dominicus dominicus (Müll.)	1	(2)
99.	Oxyechus vociferus (Linn.)	3	
00.	Aegialitis semipalmata (Bonap.)	2	
01.	" meloda (Ord)	2	
02.	Ochthodromus wilsonius (Ord) ♂ & ♀	2	
03.	Haematopus ostralegus Linn.	1	
04.	" palliatus Temm.	1	
05.	Canachites canadensis canace (Linn.) ♀	1	
06.	Bonasa umbellus umbellus (Linn.)	2	
07.	Lagopus rupestris rupestris (Gmel.)	1	
08.	Tympanuchus americanus americanus (Reich.) ♂	2	
09.	Meleagris gallopavo silvestris (Vieill.) ♂ & ♀	2	
0.	Ectopistes migratorius (Linn.)	1	
1.	Zenaidura macrura carolinensis (Linn.)	3	(4)
2.	Geotrygon chrysia Salv.	2	
3.	Cathartes aura septentrionalis (Wied)	2	
4.	Catharista urubu (Vieill.) (Vultur atratus Ord)	2	
5.	Ictinia mississippiensis (Wils.)	2	
6.	Circus hudsonius (Linn.)	2	
7.	Accipiter velox (Wils.) Young (Falco velox Wils., vol. 5, young; Falco pennsylvanicus Wils., vol. 6, adult)	3	(4)
1.	Accipiter cooperii (Bonap.)	5	
1.	Astur atricapillus atricapillus (Wils.)	2	
1.	Buteo borealis borealis (Gmel.) (1 albino)	3	
1.	" lineatus lineatus (Gmel.)	4	
1.	Archibuteo lagopus sancti-johannis (Gmel.) (Falco niger Wils., dark phase)	6	
1.	Haliaeetus leucocephalus leucocephalus (Linn.) Mature & immature	6	
12	Falco peregrinus anatum (Bonap.)	4	
12	" columbarius columbarius Linn.	3	
12	" sparverius sparverius Linn. ♂ & ♀	4	
12	Pandion haliaëtus carolinensis (Gmel.)	1	
12	Tyto perlata pratincola (Bonap.)	1	
12	Asio wilsonianus (Less.)	2	
13	" flammeus (Pont.)	3	
13	Scotiaptex nebulosa nebulosa (Forst.)	1	
13	Otus asio naevius (Gmel.) Gray phase & rufous phase	2	

			No. of Specimens.	
133.	Bubo virginianus virginianus (Gmel.)		4	
134.	Nyctea nyctea (Linn.)		4	
135.	Speotyto cunicularia hypogaea (Bonap.)		2	
136.	Conuropsis carolinensis (Linn.)		2	
137.	Coccyzus americanus americanus (Linn.) (Cuculus carolinensis Wils.)		2	
138.	Coccyzus erythrophthalmus (Wils.)		1	
139.	Streptoceryle alcyon alcyon (Linn.)		3	
140.	Campephilus principalis (Linn.)	♂ & ♀	2	
141.	Dryobates pubescens medianus (Swains.)	♂	1	(2)
142.	Sphryrapicus varius varius (Linn.)	♂	1	
143.	Phloeotomus pileatus abieticola (Bangs)	♂ & ♀	3	
144.	Asyndesmus lewisi Riley (Picus torquatus Wils. *Nom. praeoc.*)		1	
145.	Centurus aurifrons (Wagl.)	♂	2	
146.	Colaptes auratus luteus Bangs	♂ & ♀	3	
147.	Antrostomus carolinensis (Gmel.)	♀	1	
148.	Chordeiles virginianus virginianus (Gmel.) (Caprimulgus americanus Wils. *Nom. praeoc.*)	♂	1	
149.	Chaetura pelagica (Linn.)		2	
150.	Tyrannus tyrannus (Linn.)		2	
151.	" dominicensis (Gmel.)		2	
152.	Myiarchus crinitus (Linn.)		2	
153.	Sayornis phoebe (Lath.) (Muscicapa nunciola Wils.)		1	(2)
154.	Myiochanes virens (Linn.) (Muscicapa rapax Wils.)		2	
155.	Empidonax flaviventris (W. M. & S. F. Baird)		1	
156.	" minimus (W. M. & S. F. Baird)		1	
157.	Otocoris alpestris alpestris (Linn.) (Alauda cornuta Wils.)		2	
158.	Pica nuttallii Aud.		1	(2)
159.	Cyanocitta cristata cristata (Linn.)		1	(2)
160.	Perisoreus canadensis canadensis (Linn.)		1	
161.	Corvus corax, subsp. indet.		2	
162.	" brachyrrhynchos brachyrrhynchos Brehm		2	
163.	" ossifragus Wils.		1	
164.	Dolichonyx oryzivorus (Linn.)	♂ & ♀	5	
165.	Molothrus ater ater (Bodd.)	♂ & young	3	(5)
166.	Xanthocephalus xanthocephalus (Bonap.)	♂	1	

		No. of Specimens.	
167.	Agelaius phoeniceus phoeniceus (Linn.) Albino (Sturnus predatorius Wils.)	1	
168.	Sturnella magna magna (Linn.)	4	
169.	Icterus spurius (Linn.) ♂ & ♀ (Oriolus mutatus Wils.)	4	(5)
170.	Icterus galbula (Linn.) ♂	2	(4)
171.	Euphagus carolinus (Müll.)	4	
172.	Megaquiscalus major major (Vieill.) ♂ & ♀	6	
172*a*.	" " macrurus (Swains.) ♂	1	
173.	Carpodacus purpureus purpureus (Gmel.) ♂	2	
174.	Loxia curvirostra minor (Brehm) (Curvirostra americana Wils. *Nom. praeoc.*)	2	
175.	Acanthis linaria linaria (Linn.)	1	(2)
176.	Astragalinus tristis tristis (Linn.) ♂	3	
177.	Plectrophenax nivalis nivalis (Linn.)	2	
178.	Coturniculus savannarum australis (Mayn.) (Fringilla passerina Wils. *Nom. praeoc.*)	1	
179.	Ammodramus caudacutus (Gmel.)	1	
180.	Zonotrichia albicollis (Gmel.) (1 albinistic)	2	(3)
181.	Spizella passerina passerina (Bechst.) (Fringilla socialis Wils.)	2	
182.	Spizella pusilla pusilla (Wils.)	2	
183.	Junco hiemalis hiemalis (Linn.) (Fringilla nivalis Wils. *Nom. praeoc.*)	2	
184.	Melospiza melodia melodia (Wils.)	3	
185.	" georgiana (Lath.) (Fringilla palustris Wils.)	2	
186.	Passerella iliaca iliaca (Merrem) (Fringilla rufa Wils.)	1	
187.	Pipilo erythrophthalmus erythrophthalmus (Linn.) ♂ & ♀	3	
188.	Cardinalis cardinalis cardinalis (Linn.) ♂	2	
189.	Zamelodia ludoviciana (Linn.) ♂ & ♀ (Loxia rosea Wils.)	3	
190.	Passerina ciris (Linn.) ♂ & ♀	4	
191.	Spiza americana (Gmel.)	1	
92.	Piranga erythromelas Vieill. ♂	1	
193.	" rubra rubra (Linn.) ♀	1	
194.	Progne subis subis (Linn.) ♂	2	(3)
95	Petrochelidon lunifrons lunifrons (Say)	2	
96.	Hirundo erythrogastra Bodd. (1 albino) (Hirundo americana Wils. *Nom. praeoc.*)	3	

		No. of Specimens.	
197.	Iridoprocne bicolor (Vieill.)	3	
	(Hirundo viridis Wils.)		
198.	Riparia riparia (Linn.)	1	
199.	Bombycilla cedrorum Vieill.	1	
	(Ampelis americana Wils.)		
200.	Vireosylva olivacea (Linn.)	1	
201.	“ gilva gilva (Vieill.)	2	
	(Muscicapa melodia Wils.)		
202.	Lanivireo flavifrons (Vieill.)	1	
	(Muscicapa sylvicola Wils.)		
203.	Lanivireo solitarius solitarius (Wils.)	1	
204.	Vireo griseus griseus (Bodd.)	1	
	(Muscicapa cantatrix Wils.)		
205.	Mniotilta varia (Linn.) ♂	2	
	(Certhia maculata Wils.)		
206.	Helminthophila pinus (Linn.)	2	
	(Sylvia solitaria Wils.)		
207.	Compsothlypis americana usneae Brewst.	1	
	(Sylvia pusilla Wils. *Nom. praeoc.*)		
208.	Dendroica aestiva aestiva (Gmel.) ♂ & ♀	2	
	(Sylvia citrinella Wils.)		
209.	Dendroica caerulescens (Gmel.) ♂ & ♀	2	
	(Sylvia pusilla Wils. *nom. praeoc.*, Sylvia leucoptera Wils., Sylvia sphagnosa Bonap.; female)		
210.	Dendroica coronata (Linn.) ♂	2	
211.	“ magnolia (Wils.) ♂	1	
212.	“ pennsilvanica (Linn.)	2	
213.	“ castanea (Wils.) ♂	1	
214.	“ striata (Forst.) ♀	1	
215.	“ fusca (Müll.)	2	(3)
	(Sylvia parus Wils. Young)		
216.	Dendroica virens (Gmel.) ♂	3	
217.	“ vigorsii (Aud.)	1	
	(Sylvia pinus Wils. *Nom. praeoc.*)		
218.	Dendroica palmarum hypochrysea Ridgw.	1	
219.	“ discolor (Vieill.)	1	
	(Sylvia minuta Wils.)		
220.	Seiurus aurocapillus (Linn.)	2	
221.	“ noveboracensis noveboracensis (Gmel.)	1	(2)
	(Turdus aquaticus Wils.)		

		No. of Specimens.	
222.	Oporornis philadelphia (Wils.) ♂	1	
223.	Geothlypis trichas trichas (Linn.) ♂ & ♀ (Sylvia marilandica Wils.)	2	
224.	Icteria virens virens (Linn.) (Pipra polyglotta Wils.)	2	
225.	Wilsonia citrina (Bodd.)	1	
226.	“ pusilla pusilla (Wils.) (Sylvia wilsonii Bonap.)	1	(2)
227.	Wilsonia canadensis (Linn.) ♀ (Sylvia pardalina Bonap.)	1	
228.	Setophaga ruticilla (Linn.) ♂	1	(2)
229.	Mimus polyglottos polyglottos (Linn.)	1	
230.	Dumetella carolinensis (Linn.) (Turdus lividus Wils.)	2	
231.	Toxostoma rufum (Linn.)	3	
232.	Troglodytes aëdon Vieill. (Sylvia domestica Wils.)	1	
233.	Cistothorus stellaris (Naum.)	1	
234.	Telmatodytes palustris palustris (Wils.)	1	
235.	Certhia familiaris americana (Bonap.)	1	
236.	Sitta canadensis Linn. (Sitta varia Wils.)	1	
237.	Baeolophus bicolor (Linn.)	1	
238.	Regulus satrapa satrapa Licht. ♂	1	
239.	Polioptila caerulea caerulea (Linn.)	2	
240.	Hylocichla mustelina (Gmel.) (Turdus melodus Wils.)	1	
241.	Hylocichla guttata pallasii (Cab.) (Turdus solitarius Wils. *Nom. praeoc.*)	1	
242.	Planesticus migratorius migratorius (Linn.) (4 albinistic)	7	
243.	Sialia sialis sialis (Linn.) (1 albino)	5	

In order to complete the record of the North American birds in the Boston Museum collection, I append a list of twenty species called or by the *labels*, but not found. The names of these lost birds are f course given just as they appear on the labels.

1.	Glaucous Gull, variety. Young. Larus glaucus Brünn.	1
2.	Fulmar Petrel. Procellaria glacialis Linn.	1
3.	Virginia Rail. Rallus virginianus Linn.	1

		No. of Specimens.
4.	Ground Dove. Chaemepelia passerina Linn.	3
5.	Blue-headed Ground Pigeon. Starnaenas cyanocephala Linn.	1
6.	Ring-tailed Eagle. Young. Aquila chrysaëtos Linn.?	1
7.	Canada Woodpecker. Picus leucomelas Bodd.	1
8.	Black-chinned Woodpecker. Melanerpes formicivorus Swains.	1
9.	Red-shafted Woodpecker. Colaptes rubricatus Licht.	2
10.	Whip-poor-will. Caprimulgus vociferus Wils.	1
11.	Florida Jay. Cyanocorax caerulescens Vieill.	1
12.	Crimson-winged Troopial. Agelaius gubernator Wagl. Female.	1
13.	Purple Grakle. Quiscalus purpureus Licht. Young & albino.	2
14.	Pine Grosbeak. Strobilophaga enucleator Linn.	1
15.	Tree Sparrow. Zonotrichia monticola Gmel.	1
16.	Blue Grosbeak. Guiraca caerulea Linn.	1
17.	Townsend's Mocking Bird. Mimus montanus Towns.	2
18.	Black-capped Titmouse. Parus atricapillus Linn.	1
19.	Wilson's Thrush. Turdus fuscescens Shaw	2
20.	Arctic Bluebird. Sialia arctica Swains.	1

Four relics of the Peale Museum were contained in the oölogical collection of Dr. T. M. Brewer which came to the Museum of Comparative Zoölogy in 1880. They consist of eggs collected by Alexander Wilson and obtained by Dr. Brewer from Moses Kimball in 1850, the year in which Mr. Kimball bought one half of the collections of the Peale Museum. These eggs, according to the Brewer MS. catalogue, are as follows:

			No. of Specimens.
1.	Recurvirostra americana Gmel.	Coll. T. M. Brewer No. 57	1
2.	Cathartes aura septentrionalis (Wied)	“ “ “ 4	1
3.	Haliaeetus leucocephalus leucocephalus (Linn.)	Coll. T. M. Brewer No. 38	1
4.	Bubo virginianus virginianus (Gmel.) New Jersey	Coll. T. M. Brewer No. 40	1

Of these eggs I find two, the Turkey Vulture's and the Eagle's; the other two are perhaps temporarily misplaced, since the collection is now undergoing a re-arrangement. The Avoset's egg is probably one of those taken by Wilson from a nest on this bird's old breeding-ground on the coast of New Jersey. See "American Ornithology," **7**, 1813, p. 126.

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EXPLORATION OF THE COAST WATER BETWEEN NOVA SCOTIA AND CHESAPEAKE BAY, JULY AND AUGUST, 1913, BY THE U. S. FISHERIES SCHOONER GRAMPUS. OCEANOGRAPHY AND PLANKTON.

BY HENRY B. BIGELOW.

WITH TWO PLATES.

CAMBRIDGE, MASS., U. S. A.:
PRINTED FOR THE MUSEUM.
SEPTEMBER, 1915.

No. 4.— *Exploration of the Coast Water between Nova Scotia and Chesapeake Bay, July and August, 1913, by the U. S. Fisheries Schooner Grampus. Oceanography and Plankton.*

By Henry B. Bigelow

CONTENTS.

ITINERARY.

Oceanographic and plankton studies were carried on by the Grampus during the summer of 1913 from Nova Scotia to Chesapeake Bay. The success of the cruise was largely due to the skill with which Mr. W. W. Welsh, of the Bureau of Fisheries, handled the oceanographic apparatus. It is a pleasure to acknowledge the assistance of Dr. C. O. Esterly for identifying the copepods; Dr. H. J. Hansen the schizopods; Dr. C. McLean Fraser the hydroids; Mr. W. F. Clapp the heteropods, pteropods, and Salpae, and to Capt. John McFarland of the schooner Victor for taking tows and water-samples.

We sailed southward from Gloucester on July 7; occupied the first station off Cape Cod, and then ran across the northwest part of Georges Bank to Nantucket light-ship, to commence the first line to the Gulf Stream. Some thirty miles southward from the light-ship, floating patches of Gulf weed, and the brilliant blue color of the water showed that we were approaching the Stream; but the sea and wind were rising so rapidly meanwhile, that we made the station at the outer edge of the shelf. And even as it was, the nets were badly torn, though water-bottles and thermometers were handled successfully. The wind continued to rise during the afternoon and evening, and by the time we had sailed northward again as far as the 40 fathom curve, there was a very heavy sea running. Nevertheless by using a hemp rope, instead of the wire, for the large plankton net, the work (Station 10062) was carried out without mishap.

From Station 10062 we turned off shore again, occupying the second Gulf Stream station 80 miles south of Montauk Point, at the 500 fathom curve.

The next run was to New York; and it was at one of the Stations on this line (10065) that the extensive beds of sea scallops (*Pecten magellanicus*) which promise great commercial value, were discovered; and I may forestall the narrative by stating that scallops were found in considerable numbers, between the 25 and 50 fathom curves, as far south as the latitude of Cape Charles (Stations 10070, 10072, 10073, 10074, 10077).

Remaining in New York long enough to restock the larder and replenish the supply of gasoline, on the 17th we ran down the coast as far as Barnegat (Station 10069), thence eastward across the shelf to the Gulf Stream (Station 10071). From this point we worked southerly, in a zigzag course, past the mouth of Delaware Bay, to Cape Charles, then off shore once more, for the last complete section of the shelf and so to Norfolk, arriving there on July 24th. The courses and stations are shown on the chart (Plate **1**).

Current measurements were made at three stations between Cape Cod and Norfolk; off Long Island, off Cape May (Station 10072), and off Chincoteague (Station 10074); observations being taken hourly for six hours at each station, both at the surface and on the bottom; the data is given below (p. 225). At Stations 10065 and 10074, the work was done from the dory, but at Station 10072 the Grampus herself was anchored for the purpose.

Refitting in Norfolk until July 29th, the voyage was resumed northward, following the coast, and locating stations to fill the gaps left on the way south. On August 3 the GRAMPUS reached Woods Hole, on the 4th, sailed through Vineyard Sound; and arrived in Gloucester on the 5th after a most successful voyage.

On August 9th we put to sea again for the Gulf of Maine, sailing eastward from Cape Ann to the sink at the mouth of Massachusetts Bay (Station 10087), thence to the centre of the Gulf (Station 10090), crossing the western basin where the deepest Gulf Station (10088, 150 fathoms) was located, Jeffrey's Bank was the next objective (Station 10091), where a strong northwest wind was encountered, though work under shortened sail was possible. We then ran toward Cape Sable, making the same stations as the year before, two in the basin, one on the coast slope, and one on German Bank. And, as in 1912, the sudden cooling of the surface as we approached the Bank was a striking phenomenon. In 1912 the GRAMPUS was wrapped in a blanket of fog day after day in this part of the Gulf, feeling her way about by soundings. But in 1913 the most delightfully clear, calm, weather imaginable, with light northwest breezes, was enjoyed; and so transparent was the air that the whole coast, from Cape Sable to Yarmouth, was plainly visible, though we were nowhere within 20 miles of the land.

We took surface temperature and water-samples close to Lurcher Shoal light-ship on the 12th, and then stood across the mouth of the Bay of Fundy to the Maine coast (Station 10098), making a Station (10097) in the north end of the basin *en route*; and thence followed the outer islands southward to Mt. Desert Rock (Station 10100). The weather now grew foggy, and the Grampus crossed the mouth of Penobscot Bay in the fog, passing close to Matinicus Island (Station 10101). Three stations were made between Monhegan and Cape Ann, two in the trough west of Jeffrey's Ledge, and on August 15th the Grampus returned to Gloucester.

During the cruise oceanographical observations were taken at 50 stations; and, thanks to an ample supply of water-bottles, samples were taken at three to five levels at every station. One hundred and sixty-five tows were made with the various plankton nets; the quantitative net was used at fifteen stations in the Gulf of Maine; the otter trawl employed at ten stations. The distance sailed was about 2100 miles.

The Grampus lay in Gloucester until the 20th, to refit; and on the 20th, sailed southward once more, in charge of Mr. Welsh, for a detailed survey of the scallop beds, a report of which has already been published by the U. S. Bureau of Fisheries (1914).

EQUIPMENT AND METHODS.

The general equipment of the Grampus has been described (1914a, p. 35). In 1913 a second Ekman current-meter, several more Negretti and Zambra reversing deep-sea thermometers, and two more stop-cock water-bottles, were added; the latter so arranged that any number could be used simultaneously, in series, on the wire rope, and tripped by a messenger. The outfit was further enlarged by the addition of a Helgoland "shear board" tow-net (Steuer, 1910, p. 131), which proved to be most effective, a 1-meter tow-net of the Michael Sars pattern (Murray and Hjort, 1912), and a Lucas sounding machine. On the other hand the Sigsbee water-bottle, which was unreliable, was discarded and an otter trawl was substituted for the beam-trawl.

The salinities listed below were all obtained by titration by the ordinary method, and are probably correct to ±.02 of salinity. The subsurface temperatures are reliable to ±.3°F; the surface temperatures to ±.5°F (1914a, p. 40). All temperatures are Fahrenheit.

OCEANOGRAPHY.

1. TEMPERATURE, CAPE COD TO CHESAPEAKE BAY.

Surface temperature. Surface temperature was taken hourly, day and night, during the cruise (Fig. 1, 2).

Off Cape Cod (Station 10057) the surface temperature, early in July, was 62° to 63°; and similar readings prevailed on the southerly run until the southwest part of George's Bank (Station 10059) was reached where a sudden chilling to 55° and 56° was noted;

FIG. 1.— Surface temperature for the waters south of Cape Cod in July, and for the Gulf of Maine in August, constructed from the hourly readings. Temperatures below 50°, dotted: 65° to 75°, single hatched; over 75°, cross hatched; dotted curves, July 30–Aug. 1, 75°, 70°.

Low temperature (55° to 56°), characterized the surface waters very generally as Nantucket Shoals were crossed, though with occasional readings of 60° or 61°, irregularities associated with the violent tidal currents of that region. But when the deeper water to the south was reached the temperature rose to 65° and higher. The coldest surface water west or southwest of Nantucket was just off New York (62°–63°) the warmest off the mouth of Chesapeake Bay (79°–80°). And in a general way we found a rise of temperature over the continental shelf from north to south (Fig. 1). Thus it was 64°–67° between Nantucket Shoals and the edge of the continental shelf, rising to 69° and 70° abreast of Long Island, 70 miles off shore. Near New York, however, it was much colder, as pointed out above; though it rose again to 66° and 67° off Barnegat. Off shore on the line from Barnegat to the Gulf Stream, the surface temperature rose to 74° at Station 10071. Off Delaware Bay it was 75°; 76° close in shore off Cape Charles, and 78° off the mouth of the Chesapeake. In general, on the several lines across the continental shelf, the surface water was slightly warmest at the off shore station, *i. e.*, nearest the Gulf Stream, as shown in the following table:—

Line A.	Station 10063	67°	Line C.	Station 10069	69°
	10062	67°		10070	74°
	10061	68°		10071	76°
Line B.	10067	63°	Line D.	10078	78°
	10066	69°		10077	77°
	10065	69°		10076	76°
	10064	70°			

but this was reversed off Chesapeake Bay (Line D), where the off shore station was 76°, the in shore one 78°. Short though the stay in the Chesapeake was, it was long enough for a decided warming of the surface water to take place. On July 29, the surface temperature of the Bay had risen 2° to 80°, and as we sailed northward, a considerably greater discrepancy between our two sets of readings was noted. Thus when the northerly line approached our previous course, south of Cape Henlopen, the temperature had risen from 75° to 78°: off Barnegat from 66° to 75°; and off Fire Island light-ship, where the lines cross, the surface had warmed 4°, (69° to 73°) during the two weeks interval. Since the salinity showed that no shoreward movement of the surface waters of the Gulf Stream had taken place, this rise of surface temperature was no doubt the result of solar warming.

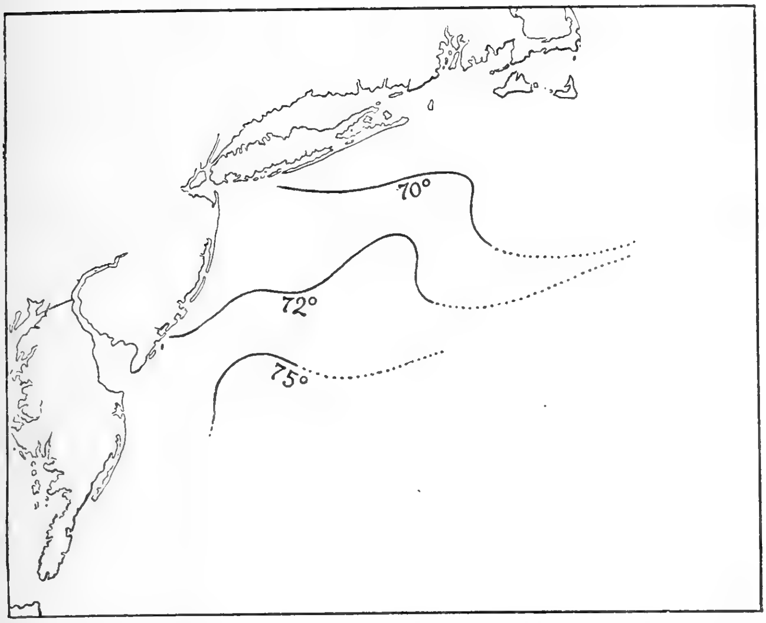

FIG. 2.— Surface temperature south of Cape Cod, Aug. 20–Sept. 1.

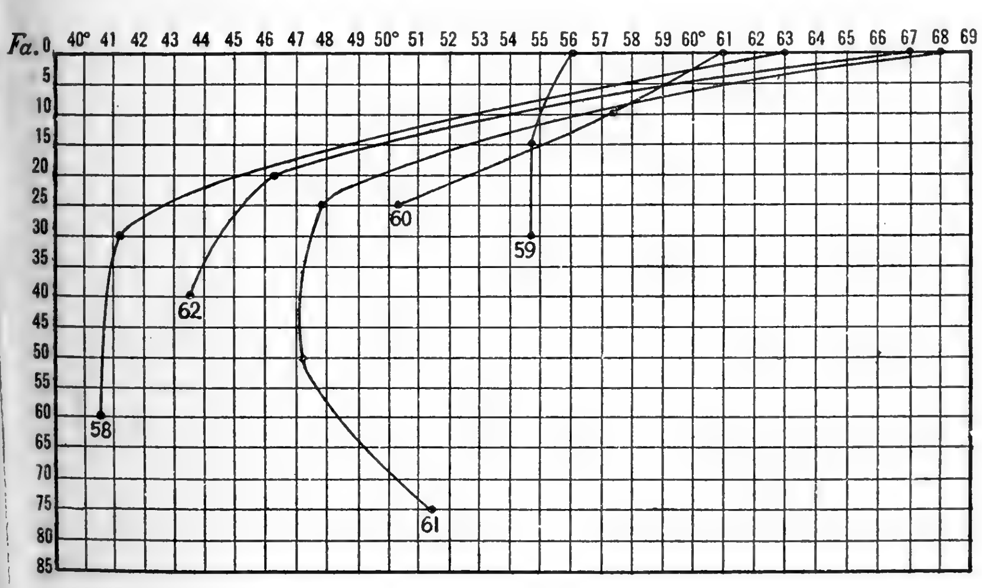

FIG. 3.— Temperature sections in the southern part of the Gulf of Maine (Station 10058); on George's Bank (Station 10059), and on the continental shelf south of Nantucket (Station 10060, 10061, 10062).

And it is probable that the surface was at or near its warmest by the end of July.

The surface temperature off Long Island on August 1st (Station 10083) was 68°; 69° off Block Island; and 72° thence to the entrance of Vineyard Sound, though at the westerly end of the Sound it fell to 68°, no doubt influenced by the violent tide. Two days later the surface water was 72° from Woods Hole to the east end of the Sound. But it was much colder (61°) off Monomoy; and only 50° on Pollock Rip, this last being evidence, of course, of thorough vertical mixing

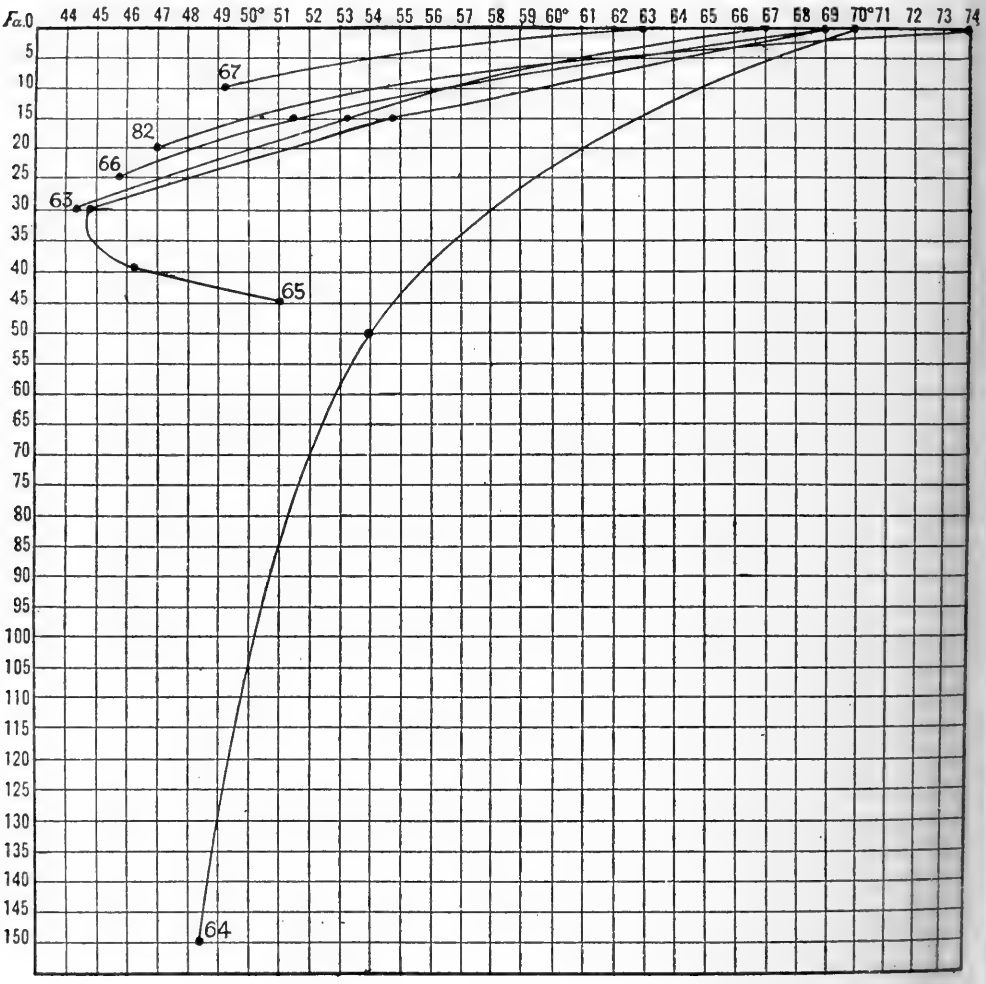

FIG. 4.— Temperature sections on the continental shelf off New York and Long Island (Stations 10063, 10065, 10066, 10067, 10082) and at the edge of the Gulf Stream, Lat. 39° 55′ (Station 10064).

by the tidal currents. When this dangerous channel was left, the surface temperature rose to 63°, the normal figure for the southern half of the Gulf of Maine at this time of year. Late in August, when the GRAMPUS came southward again (p. 154) the temperature was practically unchanged off Block Island and over the shelf south of

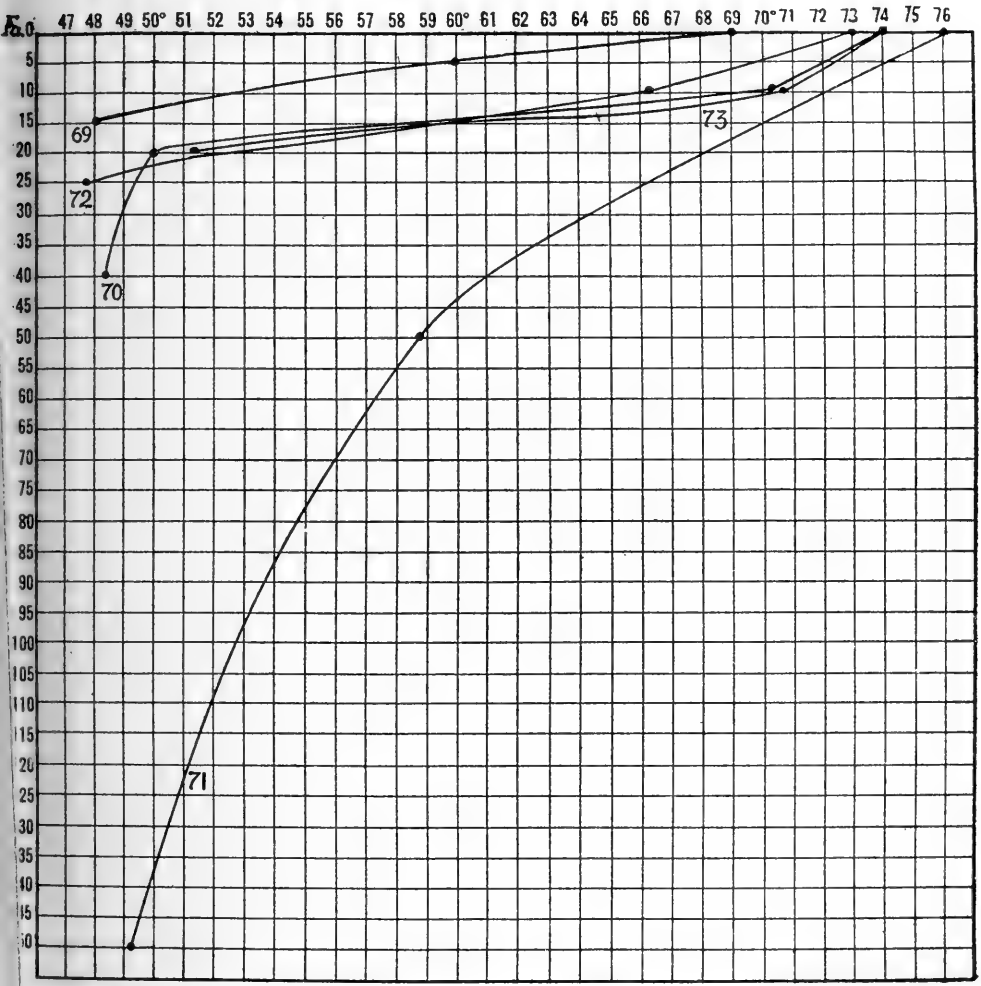

FIG. 5.— Temperature sections on the continental shelf south of New York (Stations 10069, 10070, 10072, 10073) and at the edge of the Gulf Stream in Lat. 38° 56′ (Station 10071).

Iarthas Vineyard; but near shore south of New York, the water ad cooled to 71°–72°; immediately off Cape May to 74° (Fig. 2). n the other hand, the surface south of Nantucket Shoals was several egrees warmer than it was in July, the temperature having risen from

61° to about 67.5° at Nantucket light-ship; and the curves for 70° and 72° reveal a tongue of warm water extending from the outer edge of the shelf south of Long Island northeastward toward Nantucket. Probably it was Gulf Stream water driven northward over the shelf by the southerly gale of August 23; but no salinities were taken. For a list of the surface temperatures taken by Mr. Welsh, see p. 350.

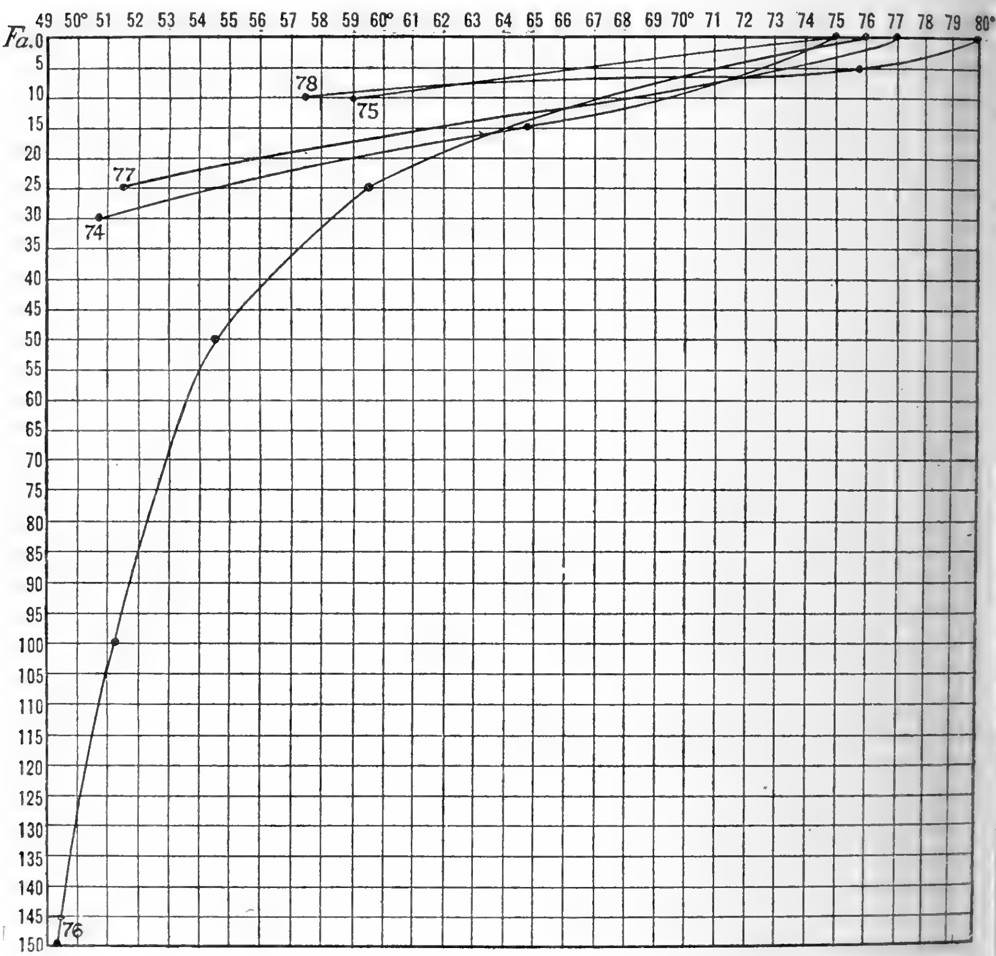

Fig. 6.— Temperature sections on the continental shelf south of Delaware Bay (Stations 10074, 10075, 10077), at the mouth of Chesapeake Bay (Station 10078) and at the edge of the Gulf Stream opposite Chesapeake Bay (Station 10076).

Temperature sections (Table, p. 344). In general there was a rapid fall in temperature from the surface downward, all over the continental shelf, from Cape Cod to Chesapeake Bay; and the sections show that depth for depth the temperature was lowest in the northwest corner of the broad bight formed by the coast line, off New York; warmest, as might be expected, along the edge of the continental slope, next the Gulf Stream. Over Nantucket Shoals as a whole, there was probably very little difference between bottom and surface water, the surface, in July, often being as cold as 55°; and this rather cold water apparently showed its effect as far westerly as Station 10062 (Fig. 3), which was 1–3° colder at all depths down to 25 fathoms than the next station to the westward (Station 10063). Over the outer part of the continental shelf south of Long Island, the temperature was comparatively uniform, station for station, down to 30 fathoms (Fig. 4) cooling rapidly from the surface downward. But the curves for Stations 10061 and 10065 reveal a warm layer of water on the bottom. The water was very much colder close to the shore near New York than it was further off shore (p. 156), and the same was true along the New Jersey coast, for though by the time we came north, the surface had warmed to about 75°, a rise of about 7°, the bottom water in ten fathoms was still only about 52.6°. Off Barnegat the temperatures increase regularly at all depths from the coast eastward (Fig. 5). The ten fathom temperatures for these stations are successively 52°, 58.5°, 70°, 71°; while the fact that at twenty fathoms there was a difference of 17° between Stations 70 and 71 (50° and 67°) only fifteen miles apart, and that the latter, lying

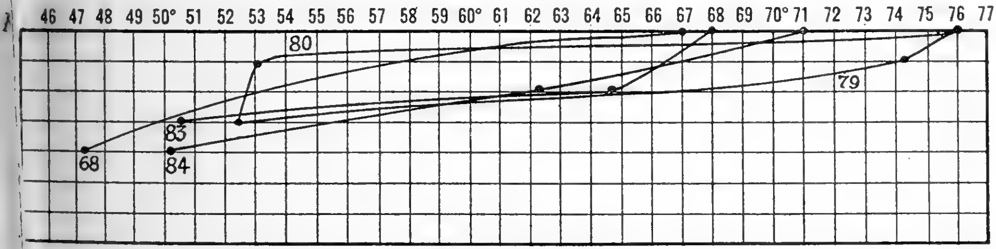

Fig. 7.— Temperature sections close to the land, south of New York (Stations 10068, 10079, 10080) and off Long Island (Stations 10083, 10084).

ver the 500 fathom curve, is much warmer than any of the stations n the continental shelf, shows how sudden the temperature transi- on between coast and ocean water was. Our only station abreast the mouth of Delaware Bay (Station 10073, Fig. 5) was consider- bly warmer above twenty fathoms than the station next north of it 0072); and several degrees warmer, at all depths, except for the sur- ce layer of five fathoms or so, than the water south of it (Station

10079). And as the high surface temperature of the latter was almos certainly due to the seasonal warming which had taken place durin the interval between our two visits, it is safe to say that at Statio 10073 a mass of water warmer than the water either north or south o it was crossed. South of Delaware Bay the water was also found coldes next the coast (the warm surface at Station 10078 was the result of th unusually hot weather of the preceding three or four days). And th curves show, further, that the two stations abreast of Chesapeak Bay (10078 and 10077) were from 1.5° to 3.5° colder, depth for depth at the lower levels than the two stations immediately north of them a fact of interest in connection with the salinity of the region.

FIG. 8.— Chart of bottom temperature on the continental shelf for July; and in the Gulf of Maine for August. Temperature below 41°, cross hatched; 41°–45°, single hatched. The dotted line, ... , is the 100 fathom curve.

Station 10071 was considerably the warmest at all depths above 150 fathoms of the three stations outside the continental shelf (Figs. 4, 5, 6) and presented a fairly typical Atlantic curve; the temperature falling rapidly at first from 76° at the surface to 58.8° at fifty fathoms; then more and more slowly until at the lowest level, 250 fathoms, a reading of 43.6 was obtained. Station 10064 was some 6° colder at the surface, the difference gradually decreasing downward; but even at 250 fathoms it was 2° colder (41.6°). Station 10076 was the most southerly of the three, and might, therefore, have been expected to be the warmest, as it lay at about the same relative position on the slope. But as a matter of fact the temperature (49.3°) at 150 fathoms (the deepest reading) was about the same as that of Station 10071: and above this level, Station 10076 was considerably the colder of the two.

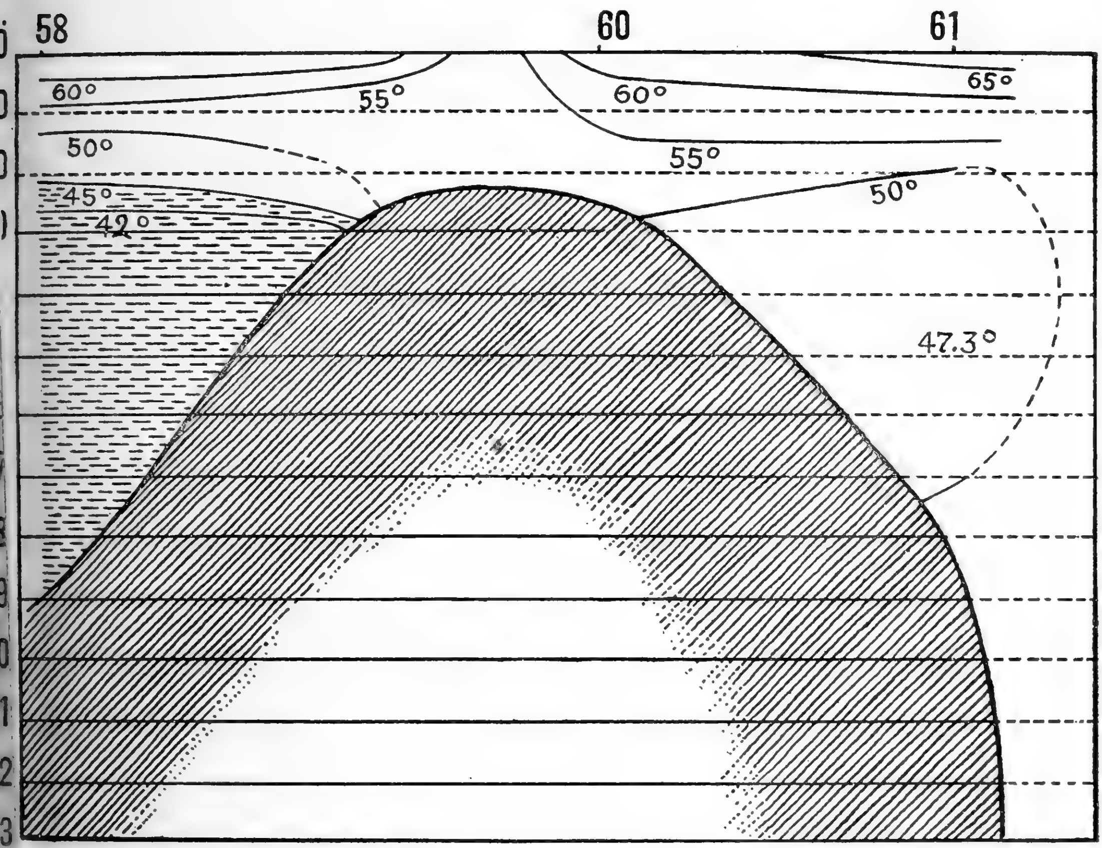

FIG. 9.— Temperature profile from the southern end of the basin of the Gulf of Maine (Station 10058) across Nantucket Shoals to the continental slope south of Nantucket (Station 10061).

Bottom temperature. The chart of bottom temperature (Fig. 8) illustrates the localization of cold bottom water on the mid-zone of the continental shelf south of Long Island and Marthas Vineyard in July, the southern boundary of which must have been somewhere between the latitude of New York and the line off Barnegat. Shoreward as well as seaward, the bottom water was warmer than 45°. That this should have been the case nearer land was to be expected, because of the steady shoaling of the water. But the fact that the bottom water was warmer (50°–51°) between 50 and 125 fathoms than at 35–50 fathoms, would have been a surprise had not a similar phenomenon been encountered by Libbey (1891) south of Marthas Vineyard in 1889 (p. 241). As pointed out (p. 165) this cold bottom water was not continuous with the cold water in the Gulf of Maine, being interrupted on Nantucket shoals, where the bottom temperature is raised, and the surface correspondingly chilled, by vertical tidal mixing. But no doubt, in winter, the cold water is continuous across the shoals. On the continental slope the temperature was 45° at about 200 fathoms.

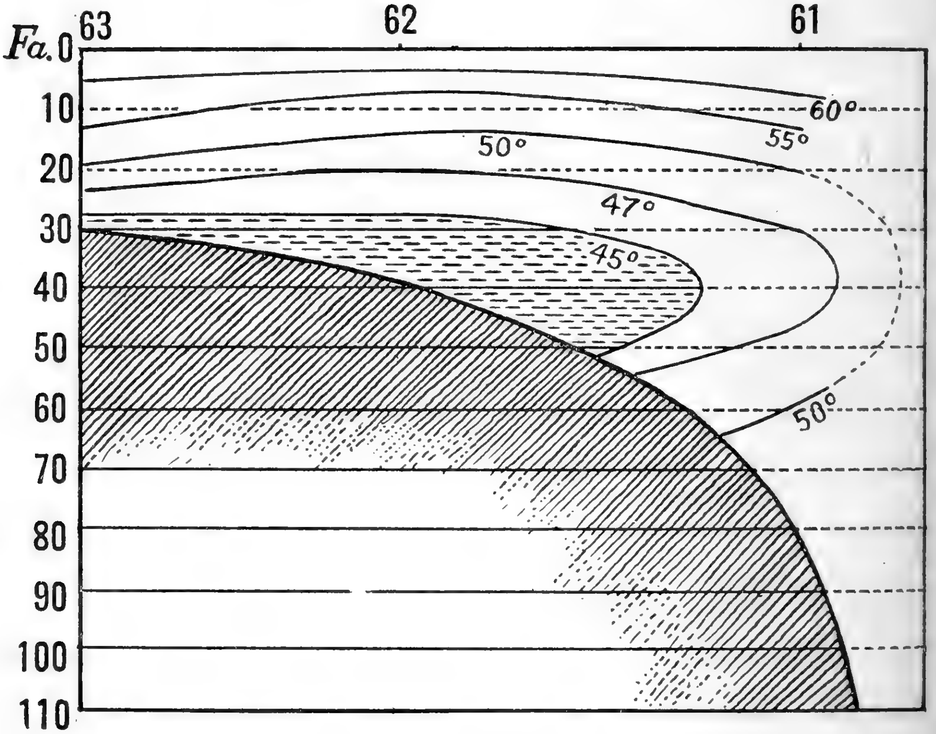

FIG. 10.— Temperature profile across the outer part of the continental slope southwest of Nantucket (Stations 10063, 10062, 10061).

The bottom temperature was higher south than north of Delaware Bay, and instead of being coldest over the mid-zone of the continental shelf, decreased from the shore seaward, with increasing depth.

Temperature profiles. The lines were planned to afford three complete profiles across the continental shelf, one abreast of Montauk, one off Barnegat, and one opposite the mouth of Chesapeake Bay respectively, besides several incomplete ones in intermediate positions, and a complete profile from the deep basin of the Gulf of Maine to the Gulf Stream via Georges and Nantucket Shoals. The latter (Fig. 9) shows that there was a marked temperature contrast between the waters on either side of the Shoals which form the southern boundary of the basin of the Gulf. On the north, the deep basin, below twenty-five fathoms, was filled with water of 42° or colder, with a rapid rise in the upper twenty fathoms to the surface temperature of 62°–63°. On the southern side, the coldest water was about 47°, at sixty fathoms, while the surface temperature was some 6° warmer at the off shore end of the profile (Station 10061) than in the Gulf (68°). Over the Shoals in the centre of the profile there are local regions of complete vertical mixing by the tidal currents, as for instance on the southwest side of George's Bank (Station 10059) where the temperature was practically uniform from surface to bottom (54.7°). On outer edge of the continental shelf the coldest water (47.3°) was not on the bottom, but at fifty fathoms, with warmer water (51.5°) below it. And as Gulf Stream water was to be expected only a few miles further off shore, it is fair to assume that this water colder than 50° indented the warmer ocean water like a tongue, as represented by the curve for 50°. The fact that there was no water on this line colder than 47° shows that the cold bottom water (45°) west of Nantucket Shoals (Fig. 10) was not continuous with the still colder water of the Gulf of Maine.

The next profile (Fig. 11), running from the neighborhood of New York to the 500 fathom curve in Lat. 39° 55′, shows the cold water on the shelf at 20–40 fathoms, indenting into the warmer water over the slope. The temperature was much higher, depth for depth, outside the edge of the shelf, than over the latter, as is shown by the sharp seaward dip of all the curves. And at the shore end of the profile the same was the case, the curves rising as the land is approached, with equal temperatures about five fathoms nearer the surface at Station 10067 than at Station 10066. In the central part of the profile (Station 10065 to 10066) there was little horizontal change in temperature from east to west.

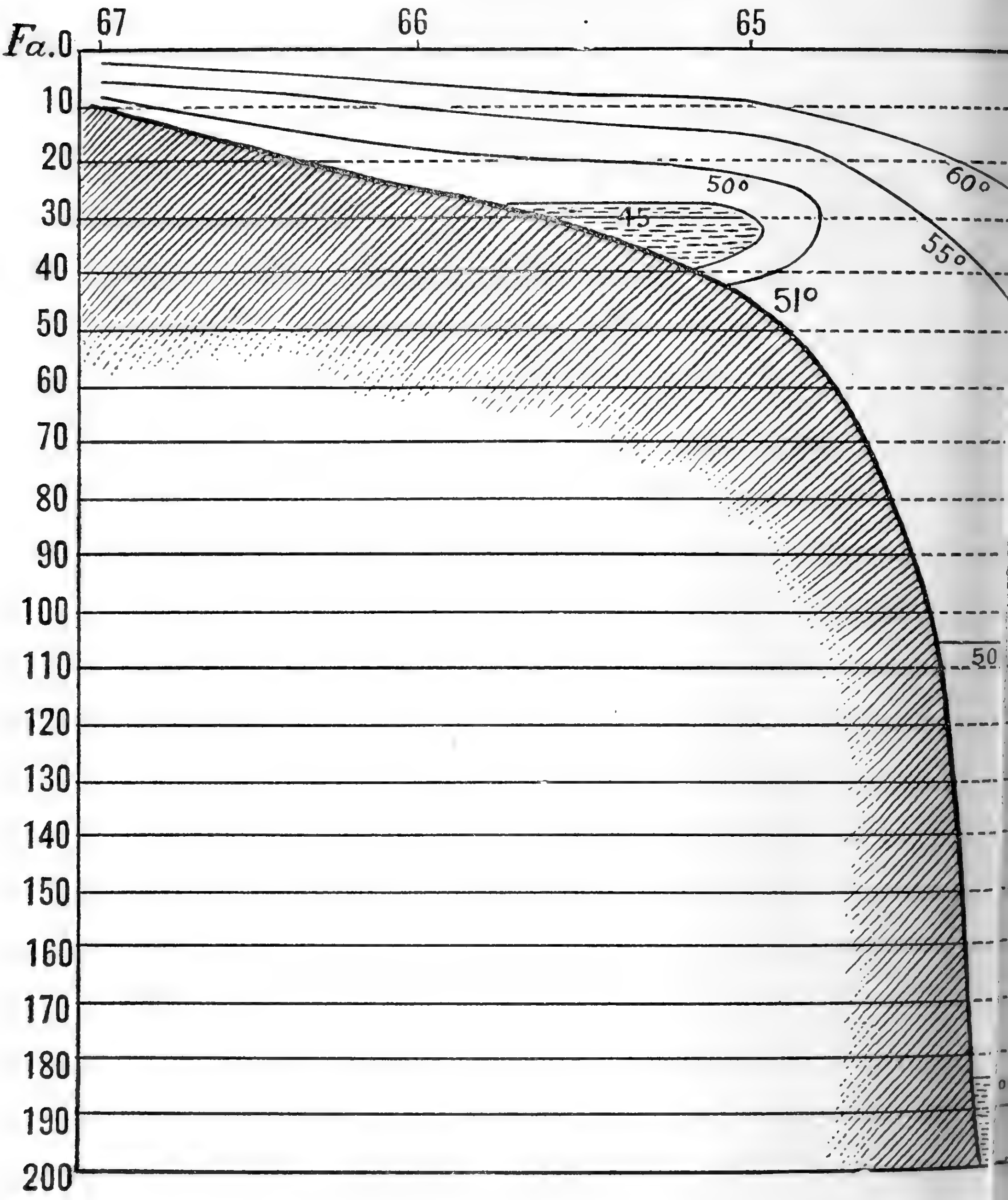

Fig. 11.— Temperature profile across the continental shelf from New York to the edge of the Gulf Stream in Lat. 39° 55′ (Stations 10067, 10066, 10065, 10064).

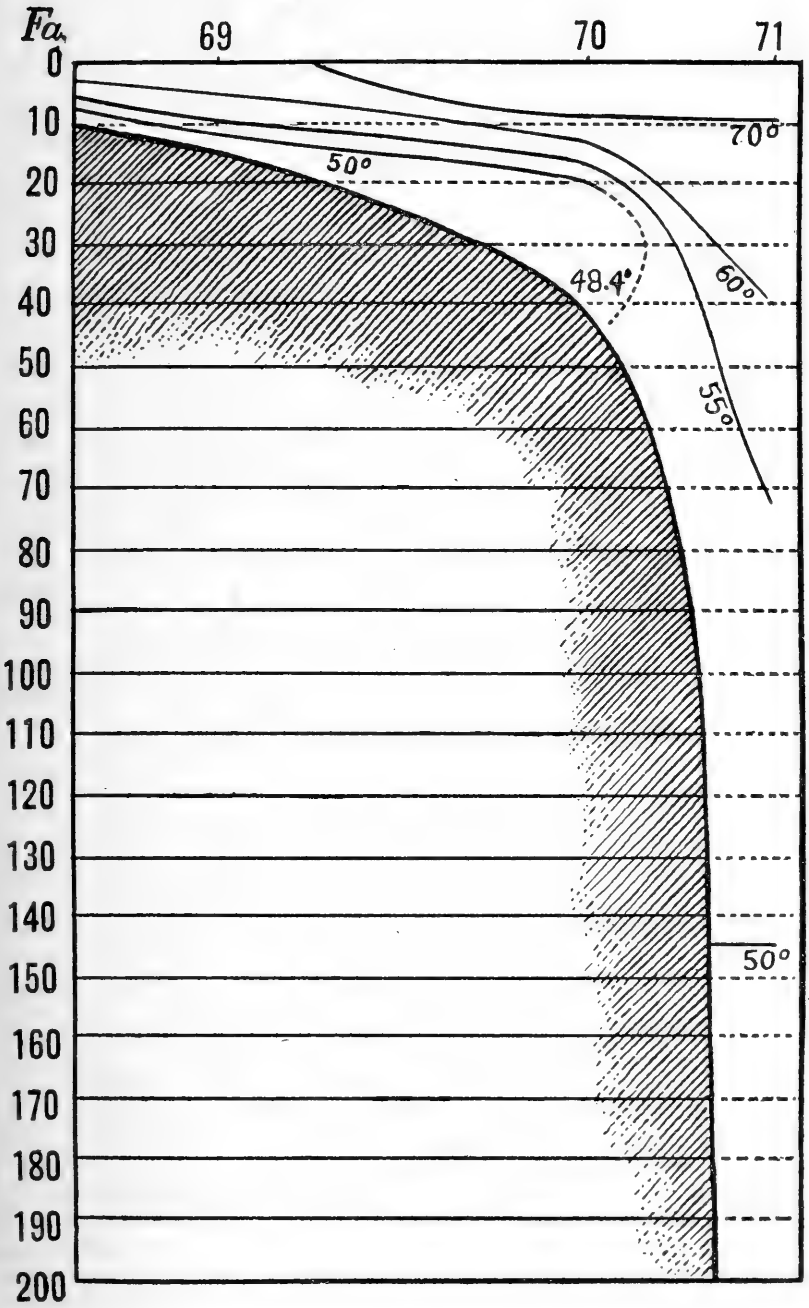

FIG. 12.— Temperature profile across the continental shelf abreast of Barnegat (Station 10069), to the Gulf Stream in Lat. 38° 56′. The immediate shore end of the profile is reconstructed from the temperature section a few miles further north (Station 10068).

In the fourth profile, off Barnegat (Fig. 12), the water on the shelf was warmer, its minimum being 48° on the bottom at 40–50 fathoms. But on the slope it was only below 150 fathoms that the water was as cold as this. And probably there was a belt of bottom water of 50°–55° at about 100 fathoms, to judge from the other profiles. But there is no bottom reading at this level. In the upper part of the profile

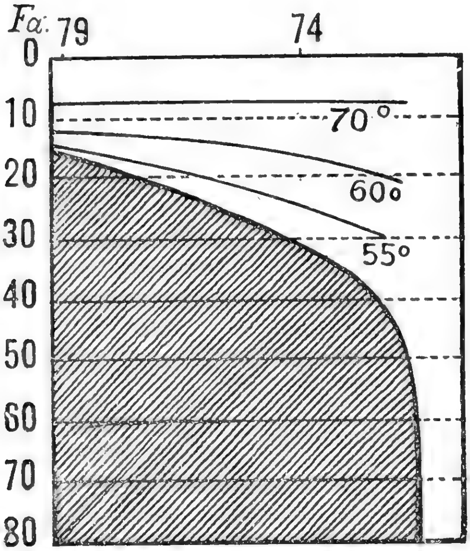

Fig. 13.

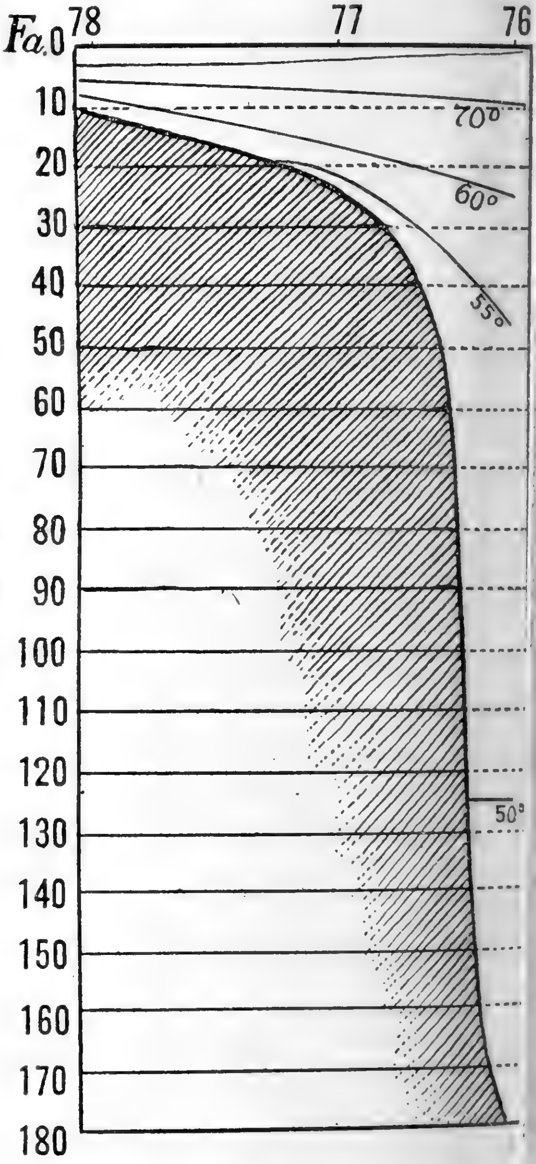

Fig. 14.

Fig. 13.— Temperature profile across the continental shelf 45 miles south of Delaware Bay (Stations 10079 and 10074).

Fig. 14.— Temperature profile across the continental shelf to the edge of the Gulf Stream abreast of Chesapeake Bay (Stations 10078, 10077, 10076).

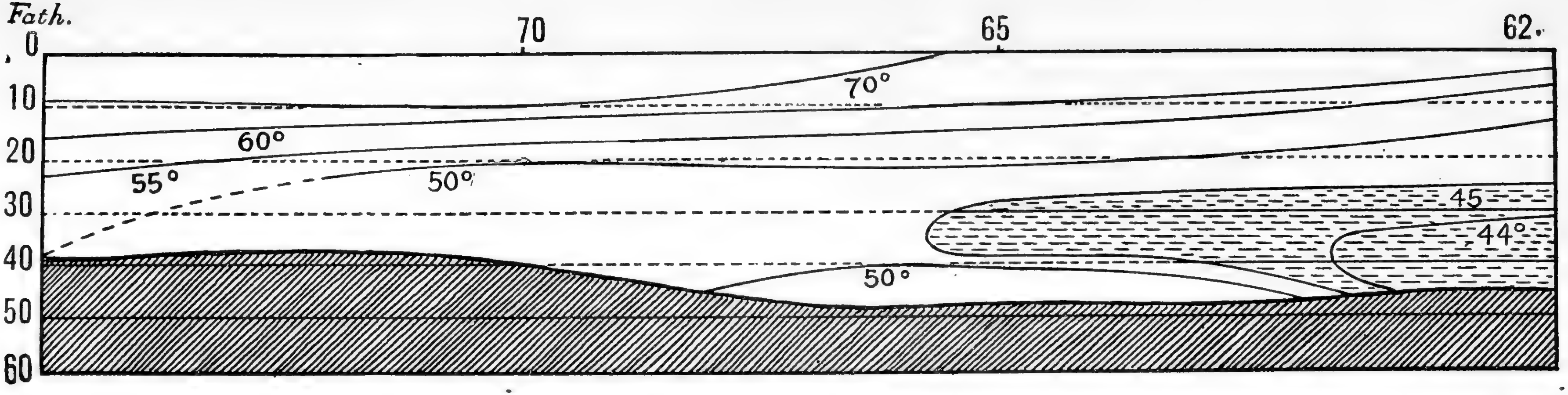

Fig. 15.— Temperature profile along the 40–50 fathom contour from abreast of Delaware Bay to a point south of Nantucket (Stations 10070, 10065, 10062).

the temperature rises, depth for depth, from the land seaward, as in the preceding one. Two partial profiles, one just north, the other just south of Delaware Bay, connect the Chesapeake Bay profile with the one just described. The stations composing the first of these (Stations 10080 and 10072) were, unfortunately, occupied at an interval of two weeks; but other observations have shown that it is only the intermediate surface layer which had warmed up appreciably in the interval. At the outer of the two stations the bottom temperature was 47.8° at twenty-five fathoms; and corresponding to the steepness of the shelf, this cool water was found nearer shore, though at about the same depth, than further north.

Just south of Delaware Bay (Fig. 13) there was no water colder than 50° on the shelf; the lowest temperature being 50.8° at thirty fathoms (Station 10074). But the curves show the progressive warming, depth for depth, from land to sea, which characterize the preceding profiles; the reading (52.5°) being the same at fifteen fathoms at the shore end as at twenty-seven fathoms at the offshore end of the profile.

Off Chesapeake Bay (Fig. 14) the slope was bathed with water of 50°–52° from twenty-five fathoms down to 130 fathoms. There the surface water cooled from the shore seaward instead of warming as it does further north (p. 165). But though the temperature above five fathoms was highest at the shoreward end of the profile, the ten fathom (bottom) temperature was lower (57.6°) there than further off shore.

The general rise in temperature on the shelf from north to south is illustrated by a profile parallel with the coast at about the forty fathom curve (Fig. 15). Below twenty-five fathoms the curves are distorted by the intrusion of warm water (51°) on the bottom near Station 10065, resulting in the extension of cold water southward over warm. The lowest temperature is at the northerly end at forty-five fathoms.

TEMPERATURE IN THE GULF OF MAINE.

Surface temperature. The distribution of surface temperature in the Gulf of Maine was the same in general as in 1912, the northeastern part being coldest, the southwestern warmest. The surface water (Fig. 1) abreast of Massachusetts Bay, along shore from Cape Cod to Cape Elizabeth, and eastward nearly to German Bank was 60° or warmer, usually 60°–62°; and although the surface was considerably warmer (64°–66°) northeast of Cape Cod and in the neighborhood of Cashes Bank, this was the result of solar warming, not of Gulf Stream water, as proved by the low salinity (p. 200). The northern, western, and eastern limits of this warm region can be defined with some accuracy from the hourly temperatures; but how far it extended to the south is doubtful. It is not likely, however, that it was directly continuous with the warm surface water south of Georges Bank, for the surface temperature on the latter is lowered by the violent tidal currents (p. 155).

At the eastern side of the Gulf a sudden transition from the high temperature of the basin to cold surface water on German Bank was noted, the temperature dropping from 60° to 48°, the coldest surface reading of the cruise. Off the Nova Scotia coast the surface temperature was 52°–53°, rising to 54°–56° abreast of the mouth of the Bay of Fundy. Off Mt. Desert Rock Station 10100 showed that the zone of 54°–56° water was of considerable breadth. Near the northeast coast of Maine the surface temperature was 50°–52°; rising to 54°–56° off Mt. Desert Island.

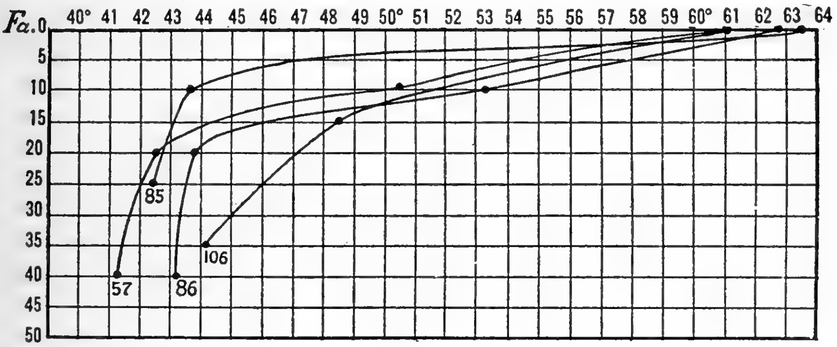

FIG. 16.— Temperature sections off Cape Cod in July (Station 10057) and in August (Stations 10085, 10086) and in Massachusetts Bay in August (Station 10106).

Temperature sections. The temperature curves off Cape Cod (Station 10057, Fig. 16; Station 10058, Fig. 3) and off Cape Ann (Station 10087, Fig. 17); near Platt's Bank (Station 10089, Fig. 18) and near Cashes Ledge (Station 10090, Fig. 18) show a very rapid cooling from the surface down to about thirty fathoms, followed by a layer, reaching down to the bottom, in which the temperature was almost uniform. In 1912, the temperature of the uniform bottom water was 40.3° at all the stations off Cape Ann and Massachusetts Bay; in 1913 it was 43.9° near Cashes Ledge, 41.3° near Platt's Bank; 40.3° in the southern part of the trough between Jeffrey's Ledge and the mainland. In the northern part of the trough (Station 10104), it was 39.8° at eighty fathoms.

In the summer of 1912, the water of the Gulf was invariably coldest at the bottom; but in 1913 the western basin and two stations in the eastern basin (Stations 10092, 10093, Fig. 17) were coldest in the intermediate depths; the minimum in the former being 41.3° at fifty fathoms, *i. e.*, precisely the same as the uniform bottom water nearer shore, rising to 43.3° at 100 fathoms, below which level it was uniform down to the bottom (150 fathoms). On the western

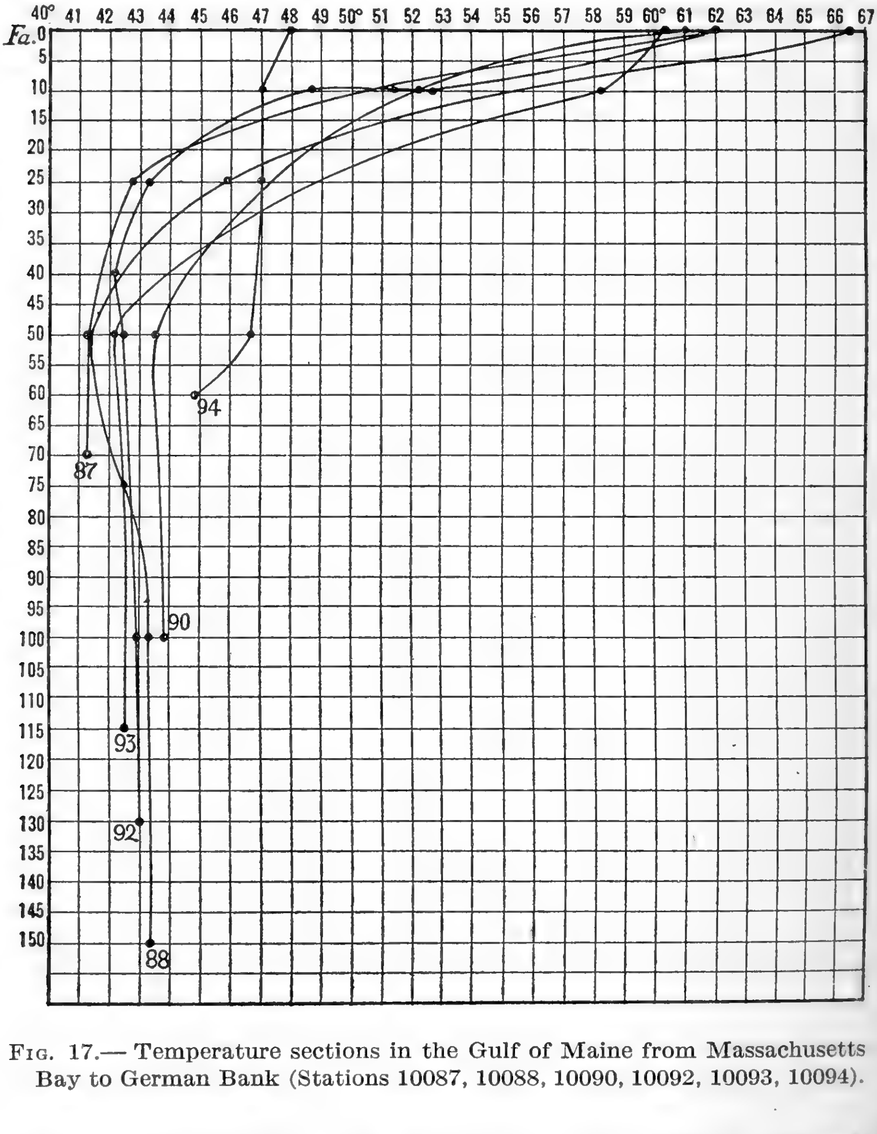

Fig. 17.— Temperature sections in the Gulf of Maine from Massachusetts Bay to German Bank (Stations 10087, 10088, 10090, 10092, 10093, 10094).

side of the eastern basin (Station 10092) the upper layers were colder, but the minimum was warmer (42.2° at forty fathoms), with about 43° at 100 fathoms, below which it was practically uniform to the bottom (130 fathoms). At the eastern side of the eastern basin (Station 10093) the minimum (41.1° at fifty fathoms) was about the same as in the western basin, though the upper layers, and the bottom water (41.6° at 115 fathoms) were both colder than the latter.

All these temperature curves are characterized by a sudden change in direction at about the 30–40 fathom level, corresponding to the point at which the fall of temperature ceases to be rapid. And in 1912 this was true of the trough west of Jeffrey's Ledge. But in 1913 the temperature sections at the two Stations in the latter (Stations 10104 and 10105, Fig. 18) show a steadily decreasing rate of cooling from the surface downward. And this is true in general of the Stations off the coast of Maine (Stations 10098, 10099, 10101, 10102, Fig. 19, and 10103) and of the northern end of the eastern basin (Stations 10097, 10100, Fig. 20). The water next the coast was, progressively,

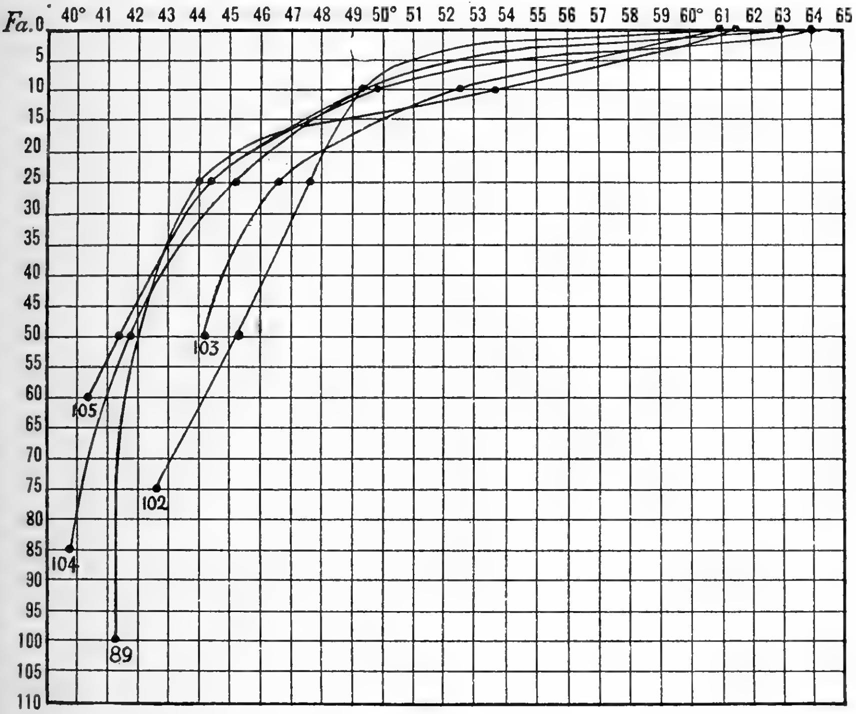

FIG. 18.— Temperature sections in the Gulf of Maine near Platt's Bank (Station 10089) and north of Cape Ann (Stations 10102, 10103, 10104, 10105).

colder on the surface, warmer on the bottom, from Cape Ann toward the Bay of Fundy, for example the surface and fifty fathom temperatures were 64° and 41.05° at Station 10105; 61° and 44° at Station 10103; 54° and 47.5° at Station 10101. And though this change was interrupted off Mt. Desert (Station 10099), the difference between surface (50.5°) and bottom (48.3°) off the Grand Manan Channel (Station 10098) was only 2°.

At Stations 10097 and 10100 the temperature agreed at the surface (55°) and at 100 fathoms (43.2°); but from about ten fathoms down to about fifty fathoms, Station 10100 was the colder of the two, with a difference of 3° at twenty fathoms, a fact probably due to an upwelling of cold water from below.

On the Nova Scotia slope, off Lurcher Shoal (Station 10096), the temperature curve (Fig. 19) agrees very closely with that for Station 10097 from the surface down to fifty fathoms, cooling from 54° to about 47°, and although the seventy fathom reading (43°) was colder than the water at the corresponding level in the northern part of the basin, it was almost precisely the same as the bottom water there (Stations 10097 and 10100). The temperature was practically uniform from the surface downward, on German Bank; and even over the seventy fathom curve on its western slope (Station 10094, Fig. 17) the difference between surface and bottom was only about 3° (48°–44.9°).

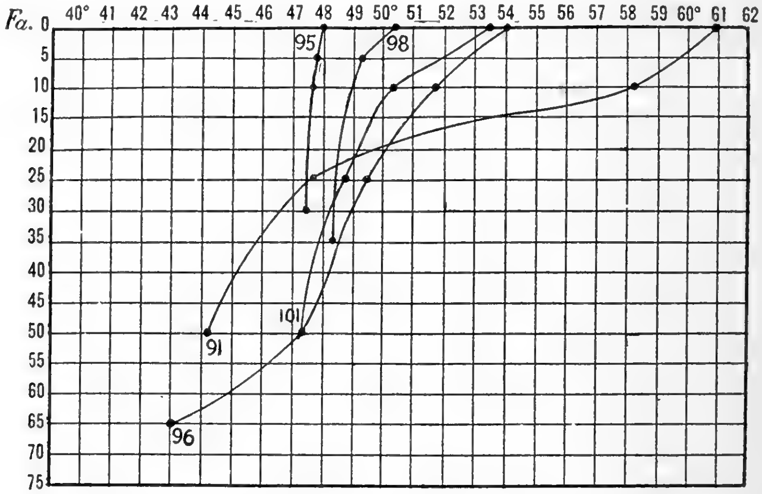

FIG. 19.— Temperature sections in the Gulf of Maine, on Jeffrey's Bank (Station 10091); off Matinicus Island (Station 10101); off the coast of Maine near the Grand Manan Channel (Station 10098); near Lurcher Shoal (Station 10096); and on German Bank (Station 10095).

At the one Station in Massachusetts Bay (Station 10106, Fig. 16) the upper part of the temperature curve agreed almost exactly with the water off Cape Ann, (Station 10087) and near Platt's Bank (Station 10089), cooling from 61° at the surface to 48.5° at fifteen fathoms. But at thirty-five fathoms (bottom) it was 2° warmer (44.1°) than either of these.

All the temperatures described so far for the Gulf were taken in August, during a week's period: and hence directly comparable with one another. But three Stations, one off Cape Cod (Station 10057, Fig. 16) at the same location as Station 10086, one over the southern part of the basin (Station 10058, Fig. 3), the third on George's Bank (Station 10059, Fig. 3), were made a month earlier. The surface temperature of the first (61°) is exactly the same as it was at the same locality in August (Station 10086); but below the surface the July section is colder at all depths, the greatest difference being on the

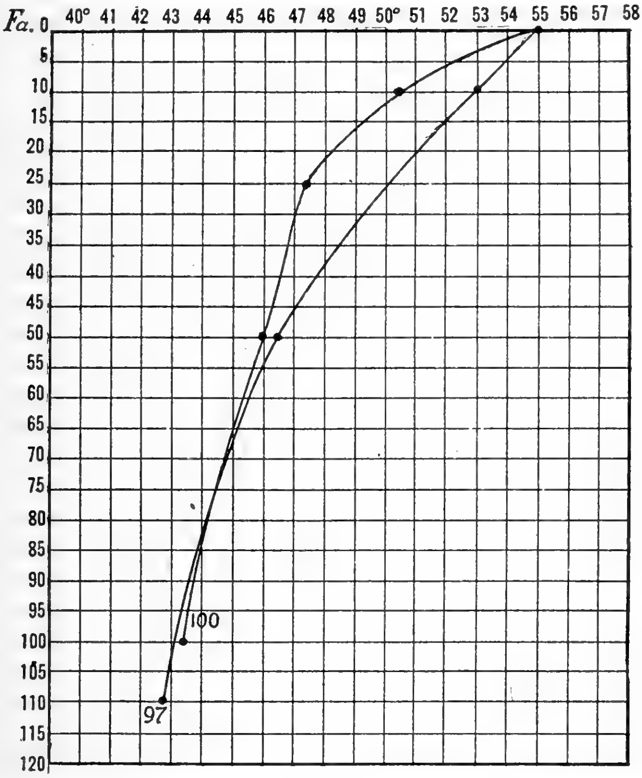

Fig. 20.— Temperature sections in the northeastern part of the basin of the Gulf of Maine (Stations 10097, 10100).

bottom (forty fathoms), where the water was 41.2° as against 43.2° a month later. Station 10058 was about 2.5° warmer than the Cape Cod stations down to twenty fathoms; but at thirty fathoms it was about .5° colder (41.1°); with a minimum of 40.6° at sixty fathoms, below which it warmed slightly; and its curve is almost exactly parallel with that of the nearest August Station (10085), though about 3° warmer at all depths.

The water on the southwestern part of George's Bank (Station 10059) was nearly uniform from the surface downward, in temperature as well as in salinity (p. 188).

Mean temperature. If all the temperature curves in the Gulf were parallel, a direct comparison between them would show which regions were potentially warmest, which coldest. But they are so distorted by greater or less active vertical circulation, that it is only by calculating the mean temperatures for each station that light can be obtained on this subject. The mean temperatures for the zone between the surface and the fifty fathom level are given in the following table:—

Station	Mean tem.	Station	Mean tem.
10087	46.3°	10096	50.2°
10088	49.4°	10097	50.3°
10089	47°	10100	48.4°
10090	47.5°	10101	49°
10091	50°	10102	48.5°
10092	46.5°	10103	48.4°
10093	50°	10104	47.2°
10094	47.1°	10105	47°

The mean between the surface and forty fathoms, was 46° at Station 10057; 48.5° at Station 10086; 48.8° at Station 10106; the thirty fathom mean was 47.6° at Station 10095; 55° at Station 10059. Thus the upper fifty fathoms was coldest, as a whole, on the western side of the Gulf. Passing northeastward along the coast, the mean temperature rose from 46.3° near Cape Ann to 48.4° off Cape Elizabeth, 49° off Penobscot Bay, 48.4° off Mt. Desert Rock and 50.3° over the northern end of the basin. In the centre of the Gulf it was generally 49°–50°, except for one cold Station (10092). Off the mouth of the Bay of Fundy the mean (50.3° at Station 10096) was as high as anywhere in the Gulf. But the upper fifty fathoms over the slope of German Bank (Station 10094), and the whole column of water on the Bank itself

Station 10095), was distinctly colder (47.1°–47.5°) than the corresponding layer of water either west, north or northwest of it (Stations 10093, 10096, 10097, 10100). Consequently vertical mixing of the upper fifty fathoms of water immediately surrounding the Bank could not reproduce the temperature observed on the latter; there must have been either an influx of cold water from elsewhere, or some upwelling.

The mean temperature of the layer of water between 50 and 100 fathoms was:—

Station	Mean tem.	Station	Mean tem.
10088	42.4°	10093	42.4°
10089	41.3°	10097	44.5°
10090	43.7°	10100	44.5°
10092	42.6°		

At Station 10087, 50–70 fathoms, the mean was 41.2°; at Station 10104, 50–85 fathoms, 40.5°.

Thus the bottom water of the deeper parts of the Gulf, like the upper layers was warmest in the northern part of the eastern basin (Stations 10097, 10100); coldest, next the western shore (Stations 10087, 10104).

In the preceding sentences the differences in mean temperature have been emphasized; but in reality the striking result of the calculation is the uniformity of the Gulf, the extreme divergence of the mean of the upper fifty fathoms being only about 4°, that of the mean between fifty and 100 fathoms about the same, over an area of about fourteen thousand square miles.

The mean temperature of the upper 15 fathoms, *i. e.*, of the zone most subject to solar warming, shows a much greater range (about 11.2°), as illustrated in the following table:—

Station	Mean tem.	Station	Mean tem.
10087	54.5°	10096	52.3°
10088	58.5°	10097	53.5°
10089	55.1°	10098	49.3°
10090	55.5°	10100	52°
10091	55.1°	10101	51.5°
10092	53.7°	10103	55.2°
10093	58°	10104	53.2°
10094	47.3°	10106	55°
10095	47.7°		

The distribution of the fifteen fathom mean, highest in the central part of the Gulf (Stations 10088 and 10093), falling to about 54°–55° over the western half of the Gulf generally, and lowest in its northeast corner and on German Bank, corresponds with the distribution of surface temperature, and with the proportional strength of the tidal currents, just as might be expected, solar warming being most effective where vertical circulation is least active.

Temperature profiles. The general distribution of temperature across the Gulf, from east to west, is illustrated by a profile from Massachusetts Bay to German Bank (Fig. 21, Stations 10106, 10087, 10088, 10090, 10092, 10093, 10094, 10095), its most interesting feature being its illustration of the fact (p. 172) that in the central part of the Gulf the water was coldest at about fifty fathoms, not on the bottom. Water of 41°–43° filled the sink at the mouth of Massachusetts Bay, rising there to within twenty-five fathoms of the surface; and projected eastward, like a shelf, over the western basin, without any rise in temperature at fifty fathoms as far east as Station 10088; warming to 43.5° in the middle of the Gulf (Station 10090). In the eastern half of the profile, the coldest water extended from shore, westward into the centre of the Gulf. But on this side there was no water colder than 42°, the lowest reading being 42.°, and the cold mass of water was not horizontal but oblique, rising from a depth of 80–100 fathoms on the shore slope, to 40–60 fathoms at its western end, with the coldest water (42°) limited to a very thin layer 40–50 fathoms. The cold layer was interrupted in the middle of the Gulf (Station 10090) by water 1°–2° warmer at the fifty fathom level. The temperature of the water underlying the cold zone ranged from 43° to 43.9°, coldest at the eastern side of the Gulf, depth for depth, warmest in the centre (Station 10090), *i. e.*, just the reverse of the temperature at fifty fathoms.

Above thirty fathoms the water was warmest at Station 10088, coldest on German Bank and off the mouth of Massachusetts Bay (Station 10087), where the temperature was below 43° at a depth of only twenty-five fathoms. The profile shows the spreading of the curves over German Bank (Station 10095) which characterized that region in 1912 (1914a, p. 56); caused by vertical mixing by the tides. And there is a similar phenomenon in Massachusetts Bay (Station 10106); limited in this case to depths below ten fathoms.

A profile running northeast from the mouth of Massachusetts Bay to Station 10089 (Fig. 22) shows that water colder than 42° extended unbroken across the northern end of the western basin, to the south-

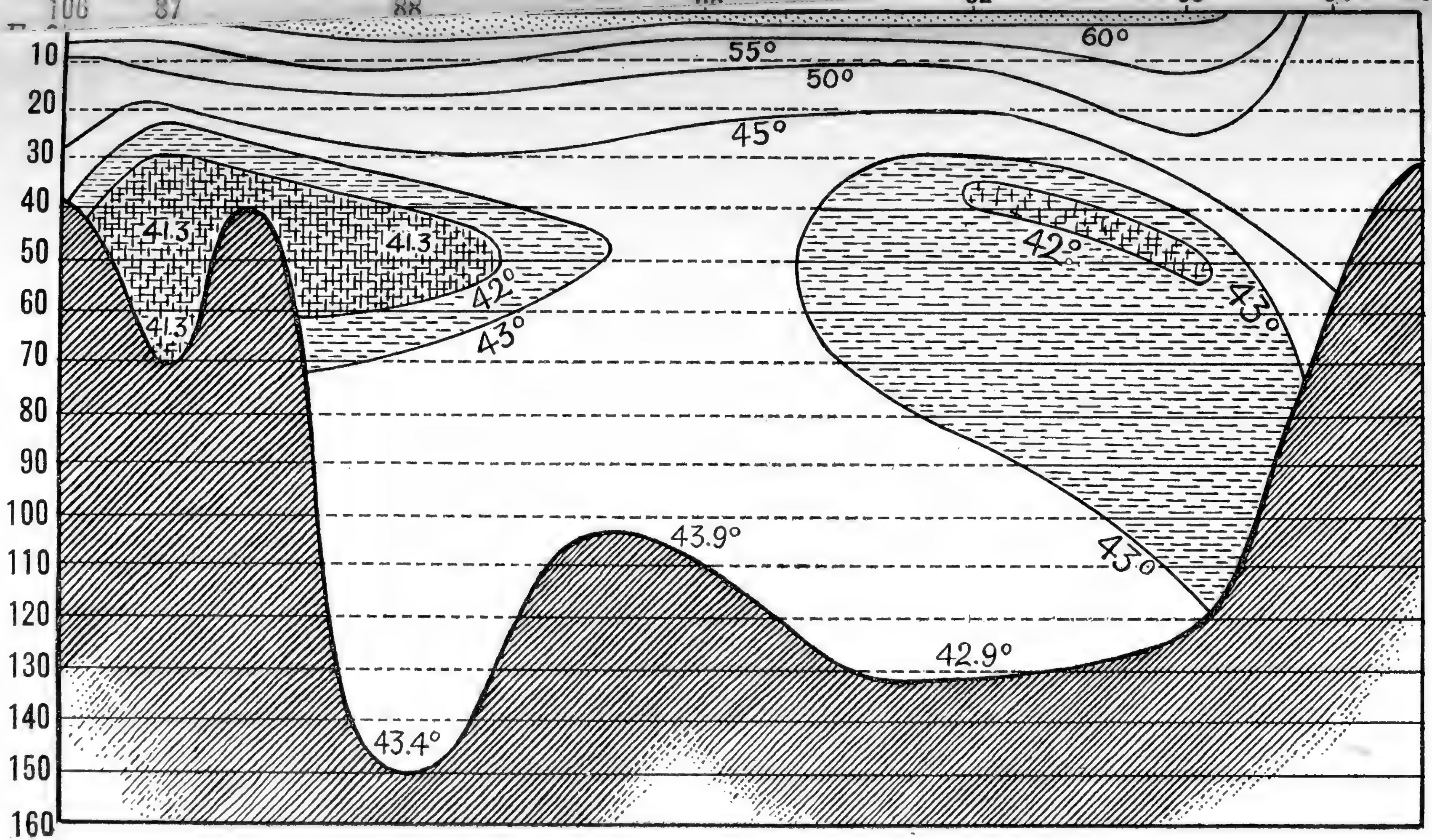

FIG. 21.— Temperature profile across the Gulf of Maine from Massachusetts Bay to German Bank (Stations 10106, 10087, 10088, 10090, 10092, 10093, 10094, 10095).

western slope of Jeffrey's Bank. But it gradually receded from the surface, passing toward the northeast, the curve of 42° dipping from thirty fathoms at Station 10087 to forty fathoms at Station 10089, and to the bottom, in about sixty fathoms, on the slope of the Bank. And there was no water as cold as 42° on the northeast side of the bank. Whether the 42° water was underlaid by warmer water in the northern end of the western basin, as it was further south (Station 10088), is uncertain; but this was probably the case.

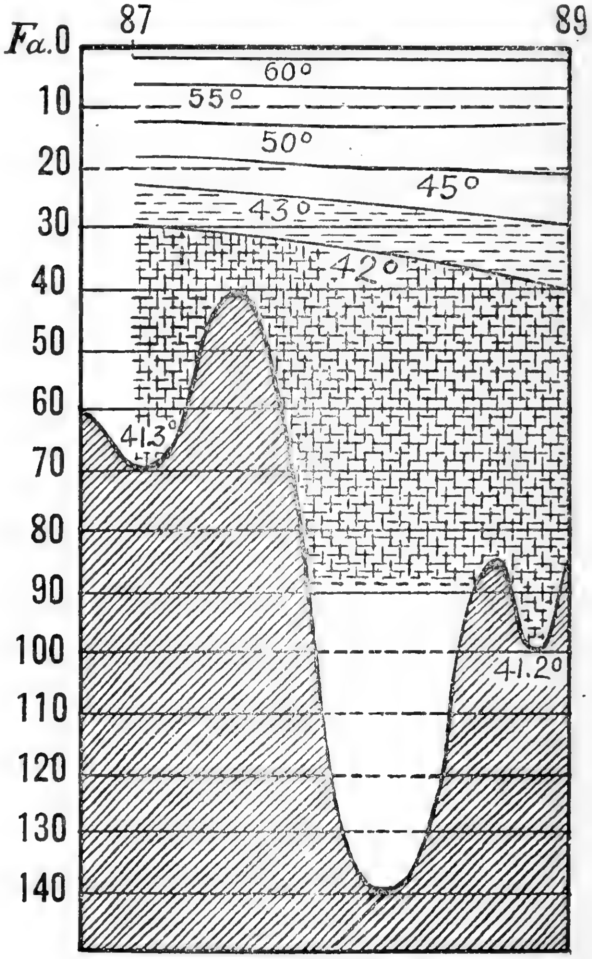

Fig. 22.— Temperature profile running northeastward from off Cape Ann (Station 10087) toward Platt's Bank to Station 10089.

Profiles running off shore from the western side of the Gulf further delimit the 42° water. The first of these, from the trough between Jeffrey's Ledge and the mainland (Station 10104) to the centre of the

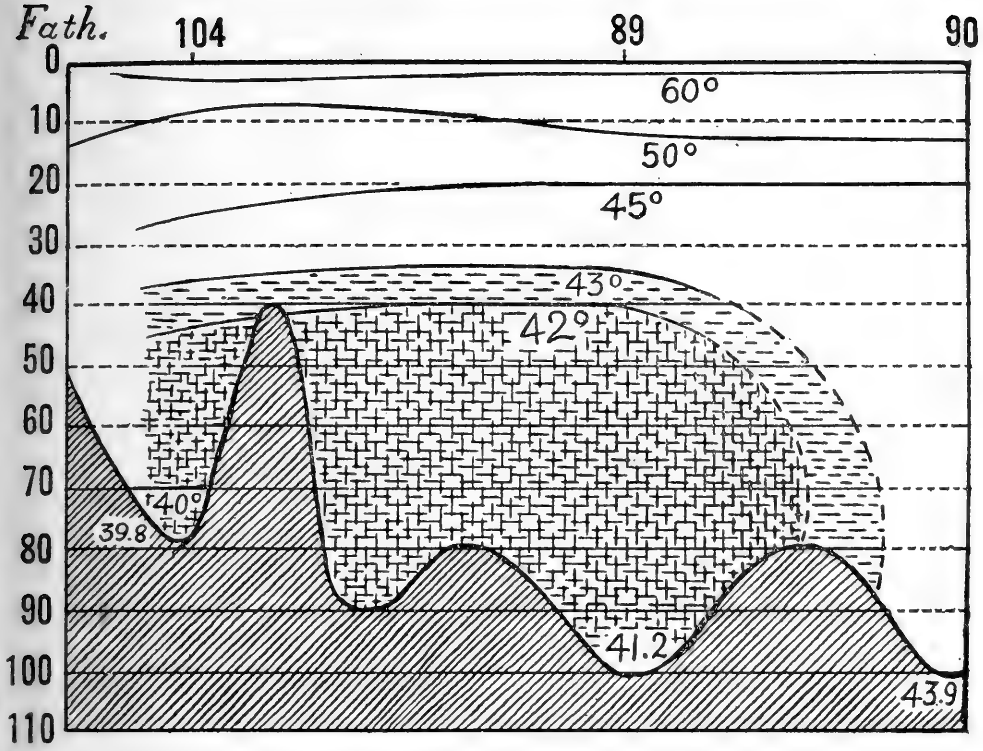

FIG. 23.— Temperature profile from the trough between Jeffrey's Ledge and the coast (Station 10104) toward the centre of the Gulf (Station 10090) via Station 10089.

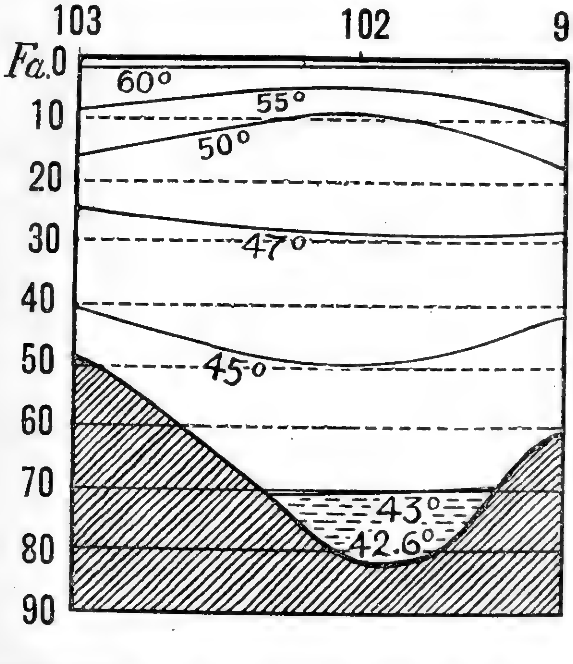

FIG. 24.— Temperature profile from the neighborhood of Cape Elizabeth (Station 10103) to Jeffrey's Bank (Station 10091) via Station 10102.

Gulf (Station 10090, Fig. 23), shows that below forty fathoms the trough was filled with water colder than 42°: and this was also true as far off shore as the ridge which is crowned by Cashes Ledge. But, as already pointed out, 42° water did not extend to Station 10090. And the fact that at the latter the lowest temperature (43.5°) was at fifty fathoms, not on the bottom, suggests a slight shelf-like projection of the 42° water. It is safe to say that Jeffrey's Ledge rises above the coldest water locally, for in places it is covered by less than thirty fathoms. And tidal currents may be expected to cause temperature disturbances over it. Between the thirty fathom level and the surface the temperature was nearly uniform, depth for depth, from one end of the profile to the other.

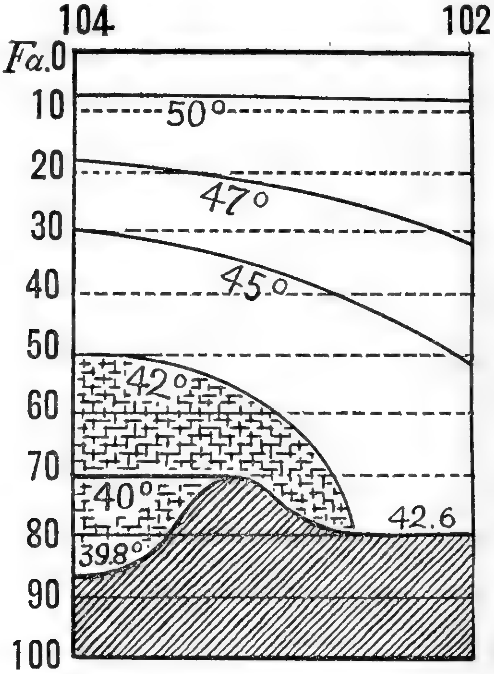

Fig. 25.— Temperature profile lengthwise of the trough between Jeffrey's Ledge and the mainland (Stations 10104, 10102).

A profile (Fig. 24) parallel to the last, but some twenty-five miles further north, from Cape Elizabeth (Station 10103) to Jeffrey's Bank (Station 10091) is warmer at all depths, except the immediate surface, than the preceding one, with water colder than 43° limited to depths greater than seventy fathoms, and a minimum of 42.6° at eighty fathoms. Between five and fifteen fathoms the difference between the two profiles is slight; but below that level it grows progressively greater and greater, as shown by the following table: —

Depths *A*	Temperature	Depths *B*
5 fathoms	55°	5 fathoms
10	50°	12–15
18	47°	about 30
22	45°	40–50
35	43°	70

(*A* is the profile across the Ledge, and *B* the profile off Cape Elizabeth).

The temperature was almost precisely the same, depth for depth, off Cape Elizabeth (Station 10103) as on Jeffrey's Bank (Station 10091).

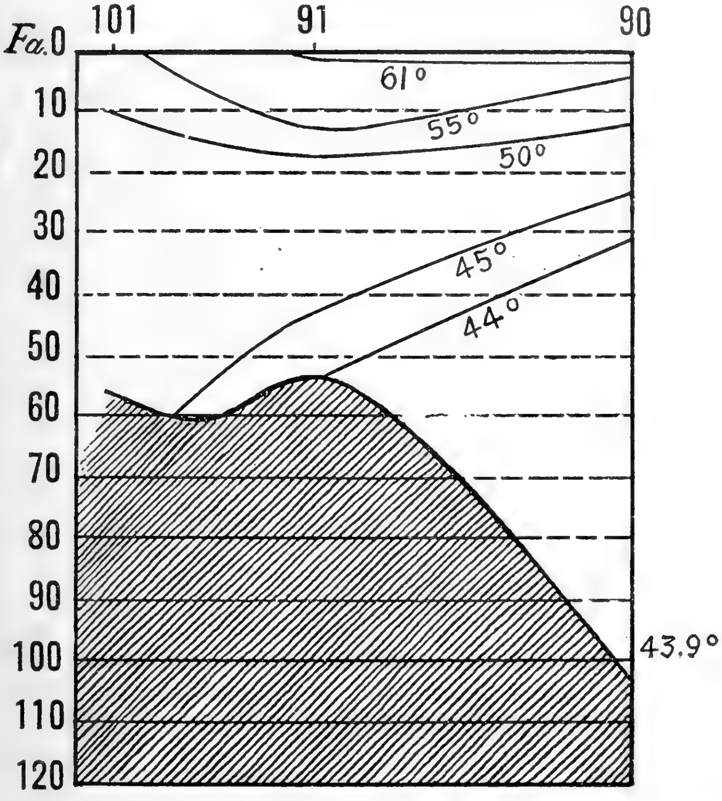

Fig. 26.— Temperature profile from the neighborhood of Matinicus Island (Station 10101) across Jeffrey's Bank (Station 10091) toward the centre of the Gulf (Station 10090).

But in the middle of the profile (Station 10102) there is a pronounced spreading of the curves between ten and fifty fathoms, which, however, is limited to the mid-depths; it is probably an evidence of local disturbances. A profile (Fig. 25) running parallel to the coast (Stations 10104–10102) connecting the preceding two, shows that the 42° water can hardly have extended beyond the northern end of Jeffrey's Ledge, while water colder than 40° (p. 178) was confined to the deeper parts of the trough. A profile (Fig. 26) running off shore from the neighborhood of Matinicus Island to the centre of the Gulf shows that the bottom water was distinctly warmer on Jeffrey's Bank (Station 10091) than in the centre of the Gulf (Station 10090). And a profile from Station 10102, off Monhegan, to Station 10089, would show an even greater temperature-difference between the two ends

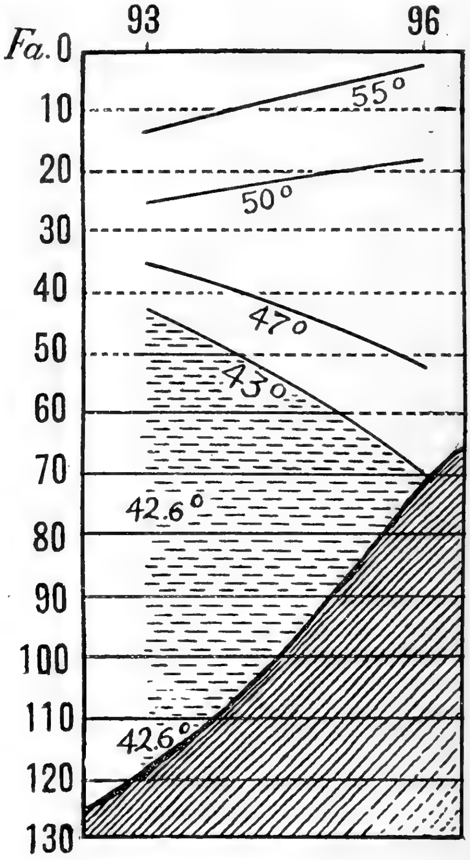

FIG. 27.— Temperature profile from the eastern basin of the Gulf (Station 10093) toward the mouth of the Bay of Fundy (Station 10096).

Evidently then, the immediate coast water from Cape Elizabeth to and across the mouth of Penobscot Bay was distinctly warmer than the coast water further south, or than the water off shore, water colder than 42° being limited, on the northeast by the slope of Jeffrey's Bank. We have no means of knowing how far south water colder than 42° may have extended in August. But the fact that in early

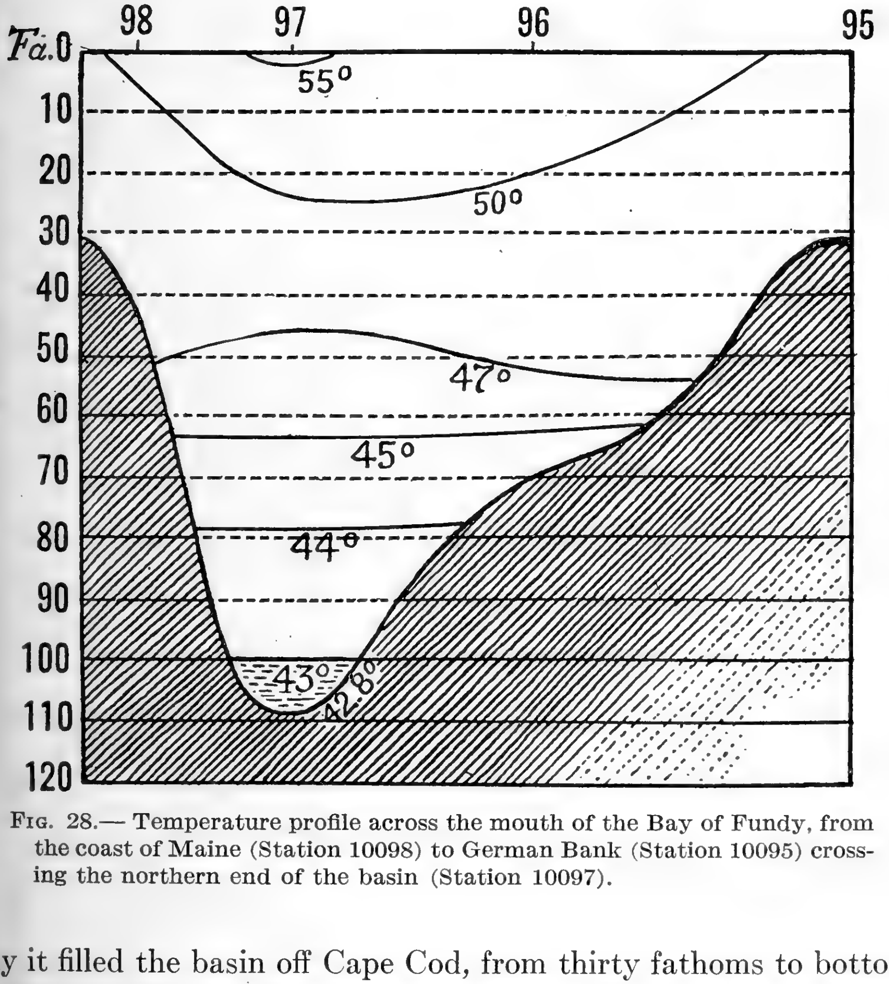

FIG. 28.— Temperature profile across the mouth of the Bay of Fundy, from the coast of Maine (Station 10098) to German Bank (Station 10095) crossing the northern end of the basin (Station 10097).

uly it filled the basin off Cape Cod, from thirty fathoms to bottom, uggests that it reached the northwestern side of Georges Bank, though robably underlaid by warmer water in the southern part of the basin, ust as at Station 10088.

A profile from the basin toward the Bay of Fundy (Fig. 27) shows hat vertical tidal mixing was effective from German Bank to Lurcher hoal, diminishing toward the north, to reappear again off the coast of aine (Fig. 28).

SALINITY, CAPE COD TO CHESAPEAKE BAY.

1. *Surface salinity.* The surface salinity (Plate **2**) from Cape Cod to the southern edge of Nantucket Shoals was 32.2‰–32.6‰. And the record of 32.3‰ at the eastern end of Vineyard Sound agrees so well with Sumner, Osburn, and Cole's (1913) records for the surface waters of that region in August, 1906 (32.2‰ to 32.3‰) that we can assume that value as normal for summer. The few stations in this region suggest that the curve of 32.3‰ swings westward toward the mouth of Vineyard Sound, which agrees with their statement (1913, p. 36) that there is a dominant westerly movement of the water through the Sound of about two knots per day.

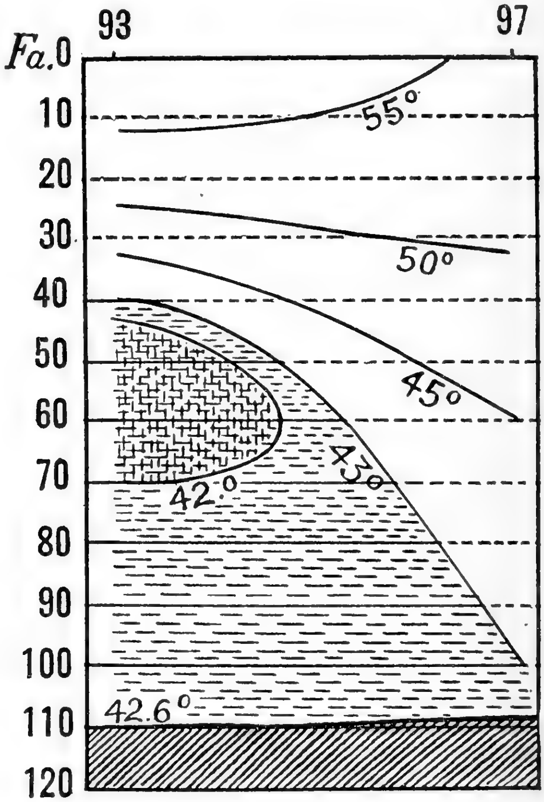

FIG. 29.— Temperature profile lengthwise of the northeastern part of the basin from south to north (Stations 10093, 10097). For 42° read 42.5°.

From Nantucket light-ship out to the edge of the continental shelf there was a steady, and fairly uniform rise in salinity to about 33.4‰

over the seventy-five fathom curve; and there is every reason to assume that by a run of a very few miles further to the south Gulf Stream water of 35‰ would have been found. Close to the shore of Long Island the salinity was only about 31.2‰, with an expansion of water fresher than 32.2‰ off its eastern end. And there was a second tongue of comparatively low salinity abreast of Barnegat. On the other hand Gulf Stream water (35‰) was encountered on the surface at the outer edge of the continental slope off New Jersey, with a rise of salinity from 32.4‰ to 35.25‰ in a distance of only twenty miles (Station 10070 to Station 10071).

Close to the New Jersey coast the salinity rose, north to south, from 31.2‰ near New York to 32.2‰ off Cape May. And the importance of Delaware Bay, like that of the Connecticut and Hudson Rivers, as a source of land water, was shown by the pronounced off shore swing of the curve of 32.2‰ abreast of its mouth. At the time of our visit its influence was evident for at least fifty miles from Cape May (Station 10072). The curves show a tongue of comparatively salt water approaching the shore north of Delaware Bay; and a much more pronounced one just south of it, where the curve of 33.5‰ lies only thirty miles from land, good evidence that the Delaware water had but little effect either south or north of the Bay in July. The approach of water of high salinity toward the coast south of New York is further illustrated by the fact that off Cape Henlopen the curve of 33‰ was within thirty-five miles of land instead of at a distance of eighty miles, as was the case abreast of Long Island. And while this phenomenon is in part a concomitant of the steadily decreasing breadth of the continental shelf, the water was salter over the twenty-five fathom curve off Cape Henlopen than over the 100 fathom curve off Long Island.

The freshening effect of Chesapeake Bay on the surface is unmistakable; the water fifteen miles off its mouth being the freshest (29.25‰) water encountered during the cruise. And the surface salinity was only 32.2‰ over the 100 fathom curve, though 33.5‰ water occupied this relative position on the shelf only thirty miles further north. But the water from the Bay had little effect further seaward, for in the next fifteen miles the salinity rose to 33.5‰, *i. e.*, to practically the same saltness as at the same relative position off Barnegat.

The work south of Cape Cod occupied only about three weeks time; hence it is hardly to be expected that any considerable change in salinity would have taken place. And as a matter of fact the stations on the way north show no clear evidence of any. But water samples collected by Mr. Welsh on August 22, near the sixty fathom curve off Block Island (Station 10112) proved to be very much salter (surface salinity 34‰) than the water in this region during the first of July; salter, in fact, than any water on the shelf at that time, showing that an indraught of ocean water took place in August.

During the spring of 1913, Captain McFarland, of the schooner VICTOR, collected water samples at nine localities between Nantucket and Delaware Bay, seven at the surface, four from 15–25 fathoms, which show that early in June the surface salinity was 32.9‰ thirty miles south of Marthas Vineyard, 32.6‰ over the southwest slope of Nantucket shoals twenty miles west of Nantucket light-ship; and that it was practically unchanged at the latter locality on June 21 (p. 351). Thus the water was salter in June than in July; but while the difference was considerable off Marthas Vineyard (32.9‰ as against 32.2‰) it was very slight over Nantucket Shoals (June 6, 32.65‰; June 21, 32.68‰, July 9, 32.5‰).

Off Cape May, a few miles south of the location of our Station 10072, Capt. McFarland encountered water of 34.18‰ on the surface, and near the bottom at twenty-five fathoms, on May 3 and May 9, which is much salter than it was there in July (about 32.4‰ on the surface). But as the curves show (Plate **2**), 34‰ water would have been reached only fifteen miles further off shore at that season. Apparently, then, the coast water, from Cape Cod to Chesapeake Bay, is freshest in July; and hence, since the outrush of river water is at its maximum in May, seaward expansion must be a slow process. After July, ocean water once more has the upper hand.

Salinity sections. The water is usually freshest on the surface, saltest on the bottom, over the continental shelf south and west of Cape Cod, as, indeed, is the general rule in coastal waters in summer. But at three Stations, 10073, 10074, and 10077, all south of Delaware Bay between the 20 and 30 fathom curves, the intermediate layers, were saltest (Fig. 31, 34). The remaining, more normal, sections fall into several distinct classes. There is, to begin with, one Station (10059) with only a very slight rise in salinity from the surface downward (surface 33.06‰; 30 fathoms, 33.1‰), a type familiar in the northeast part of the Gulf of Maine in regions of strong tidal currents; its location on George's Bank, where the currents are proverbially violent, and where temperature like salinity was practically uniform at all depths, shows that it is a similar example of vertical circulation. Judging from the tidal currents, it is probable that more or less similar conditions obtain locally on Nantucket Shoals; but on their

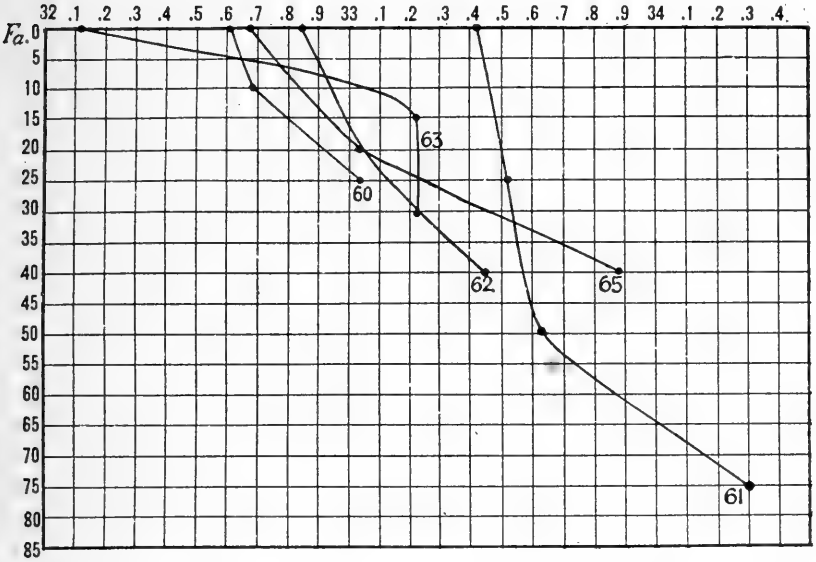

FIG. 30.— Salinity sections on the continental shelf south of Nantucket and Long Island (Stations 10060, 10061, 10062, 10063, 10065).

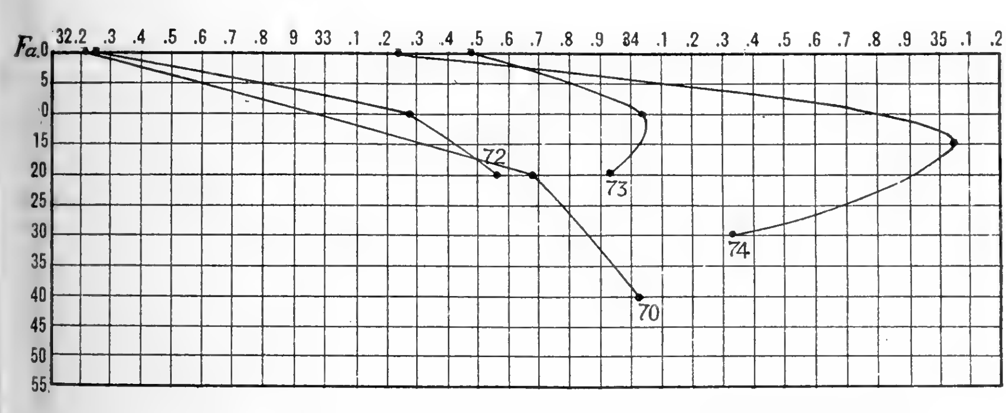

FIG. 31.— Salinity sections on the continental shelf south of New York (Stations 10070, 10072, 10073, 10074).

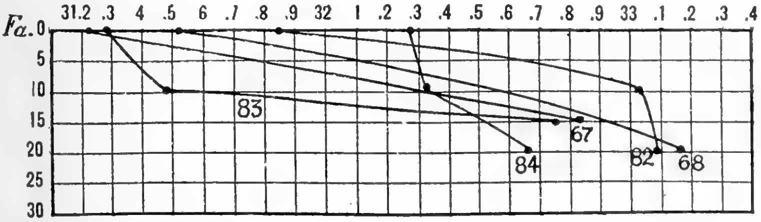

FIG. 32.— Salinity sections close to land off New York (Stations 10067, 10068, 10082) and Long Island (Stations 10083, 10084).

southern slope the vertical range of salinity was greater (Station 10060, Fig. 30). A considerable vertical range in salinity, with more or less regular increase from the surface downward, characterized Stations 10062, 10065, (Fig. 30), 10066, 10070, 10072, (Fig. 31), 10075 (Fig. 33), and probably 10067, and 10068 (Fig. 32). And though there was a good deal of variation from station to station in the precise rapidity of increase, as a whole the difference between surface and bottom increased from northeast to southwest. At Stations 10063 (Fig. 30), 10066, 10069 (Fig. 33) and 10082 (Fig. 32), there was a rapid rise immediately below the surface, followed by a bottom zone of uniform salinity, 10–20 fathoms thick. The curves for Stations 10081, 10083, 10084, 10060, 10061, are the reverse, the surface layer being nearly uniform with a rapid rise below. As a whole the water was freshest near shore, saltest over the outer part of the continental shelf, with a progressive rise in salinity from northeast to southwest at stations occupying the same relative positions on the shelf.

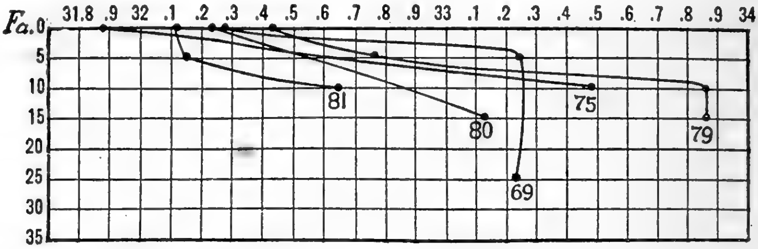

Fig. 33.— Salinity sections close to land, New York to Chesapeake Bay (Stations 10069, 10075, 10079, 10080, 10081).

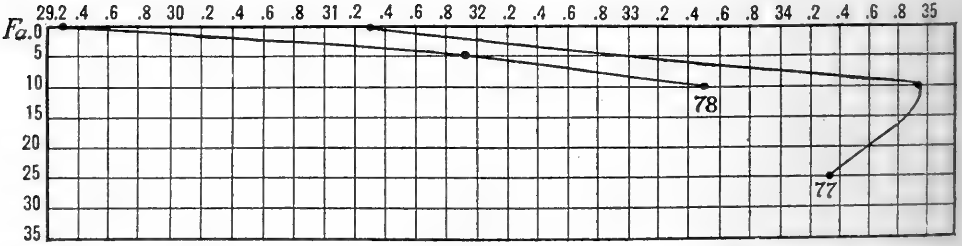

Fig. 34.— Salinity sections on the continental shelf abreast of Chesapeake Bay (Stations 10077, 10078).

The salinity sections at the three Stations outside the 100 fathom curve (10064, 10071, 10076, Fig. 35) are all of one type, fresh at the surface, saltest in the intermediate layers, and growing slowly fresher once more below 100 fathoms or so. Station 10064 is the freshest of the three, with 10071 the saltest, 10076 is intermediate between these two. And they approach one another so closely below 150 fathoms as to suggest that they would have been all alike below that depth, had the stations been located a few miles further off shore.

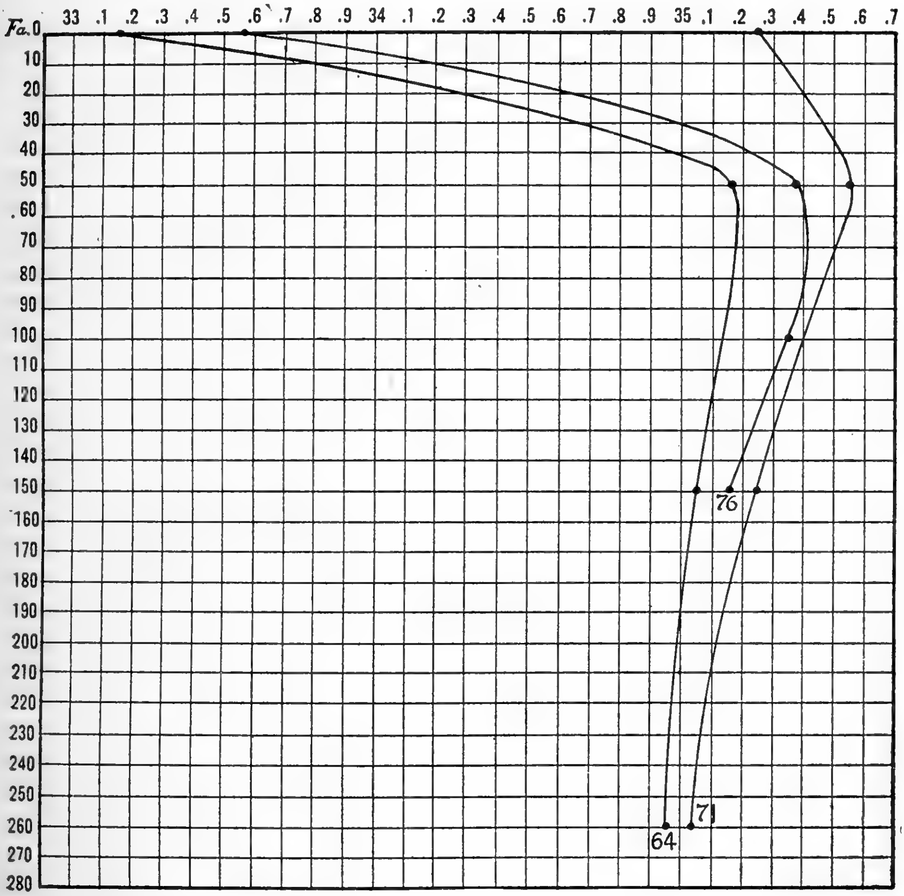

FIG. 35.— Salinity sections at the edge of the Gulf Stream at Lat. 39° 55′ (Station 10064); Lat. 38° 56′ (Station 10071) and abreast of Chesapeake Bay (Station 10076).

Of the three, Station 10071 most nearly approaches a typical oceanic section; but even here the effect of coast water is evidenced by the fact that the surface salinity is lower than that of the intermediate layers, while Stations 10064 and 10076 both give a similar result though to a greater degree.

Salinity on the bottom. The salinity on the bottom of the shelf

(Fig. 36) is of comparatively little importance in oceanography, because so largely dependent on depth; but it can not be neglected because of the part it plays in the biology of the bottom fauna. South and west of Cape Cod the bottom salinity (leaving out of consideration the zone between the shore line and the fifteen fathom contour), ranged from about 32.6‰ to 35‰, lowest along the south shore of Long Island, and off Block Island, highest, as might be expected, along the outer edge of the shelf. In a general way, it corresponded to depth; but there was also an unmistakable increase, independent of depth, from northeast to southwest. Thus a bottom salinity of 34‰ was found at about the seventy fathom curve south of Nantucket,

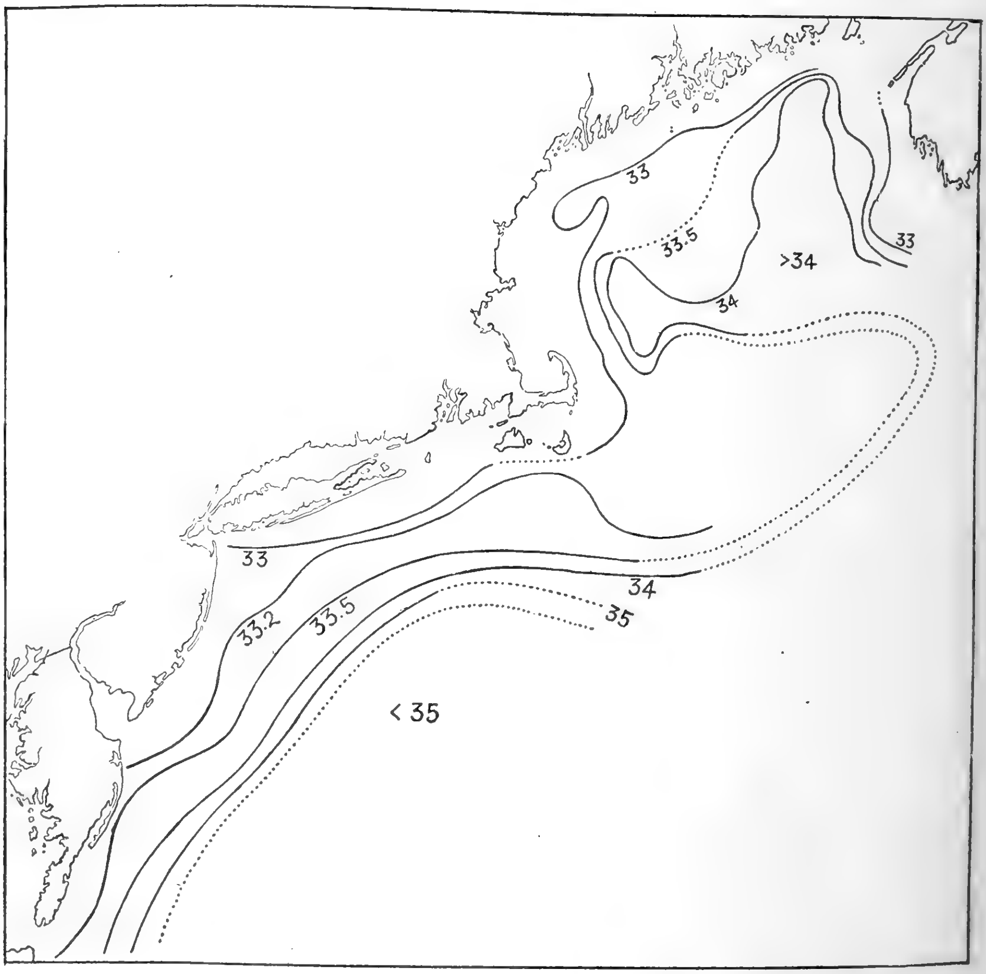

Fig. 36.— Chart of bottom salinity on the continental shelf between Cape Cod and Chesapeake Bay in July, and in the Gulf of Maine for August.

at about the forty-five fathom curve off Cape May, and at about the eighteen fathom curve off Chesapeake Bay; and 33.5‰ water at the forty, thirty, and ten fathom contours at the same localities. Bottom water fresher than 33‰ was restricted to a narrow coastal zone north of Delaware Bay; and the curves for this value and for 33.5‰ show evidence of water from the Bay, by swinging seaward off its mouth. But the outflow from Chesapeake Bay has no apparent effect on the curves, although it probably does reduce the bottom below what would otherwise obtain. The chart (Fig. 36) represents July conditions only; earlier as well as later in the season, the bottom water was much salter at the few localities where water-samples were taken (34.18‰ off Cape May, May 9; 35.17‰ in 60 fathoms, southwest of Nantucket August 22).

Salinity profiles. A profile (Fig. 37) running from the southern edge of the basin of the Gulf of Maine (Station 10058) across Nan-

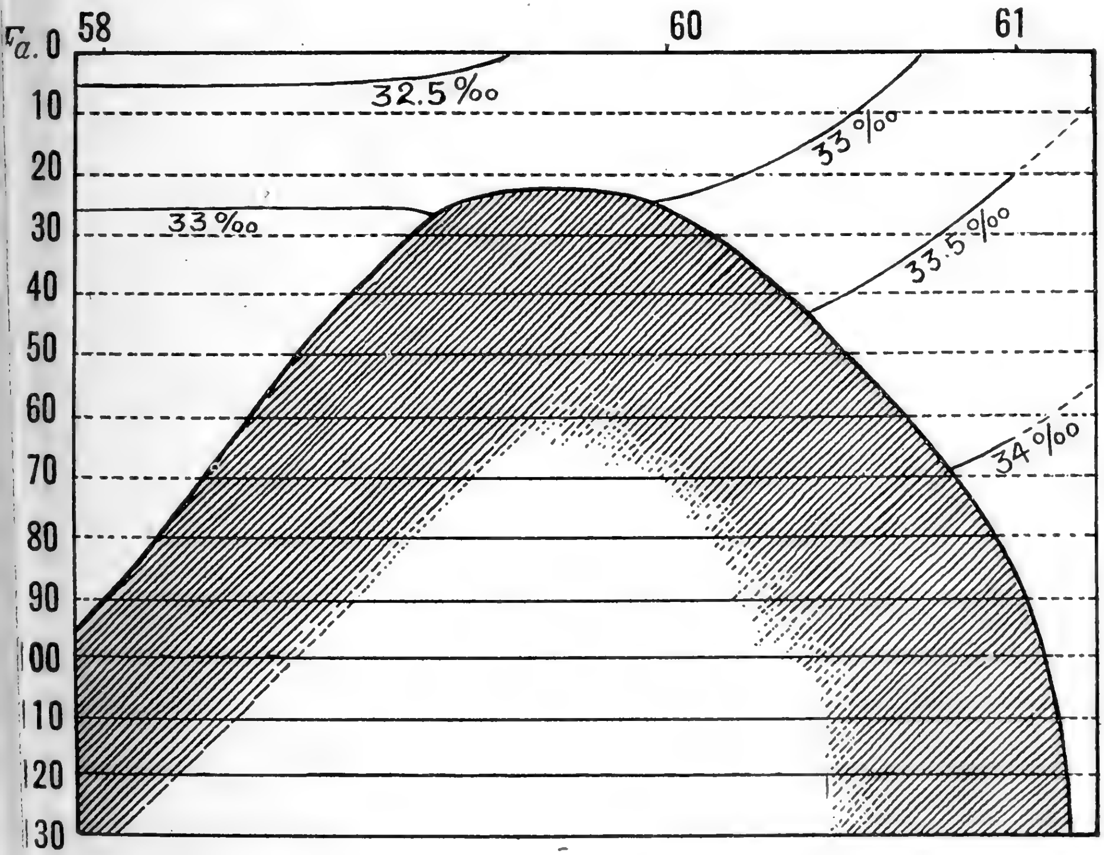

FIG. 37.— Salinity profile from the southern part of the basin of the Gulf of Maine (Station 10058) across Nantucket Shoals to the outer edge of the continental shelf south of Nantucket (Station 10061).

tucket Shoals (Station 10060) to the edge of the continental slope (Station 10061), shows that the water was much salter south than north of the Shoals, early in July. In the southern part of the Gulf there was comparatively little increase in salinity with depth below thirty fathoms, and the bottom salinity was about the same on the Shoals as at the same depth further north; but the surface shows the influence of the salter southern water by a steady, though slight, rise in salinity from Station 10058 to Station 10060, as well as in the fact that the average salinity for the upper ten fathoms was higher at Station 10060 (32.65‰) than at Station 10058 (32.5‰).

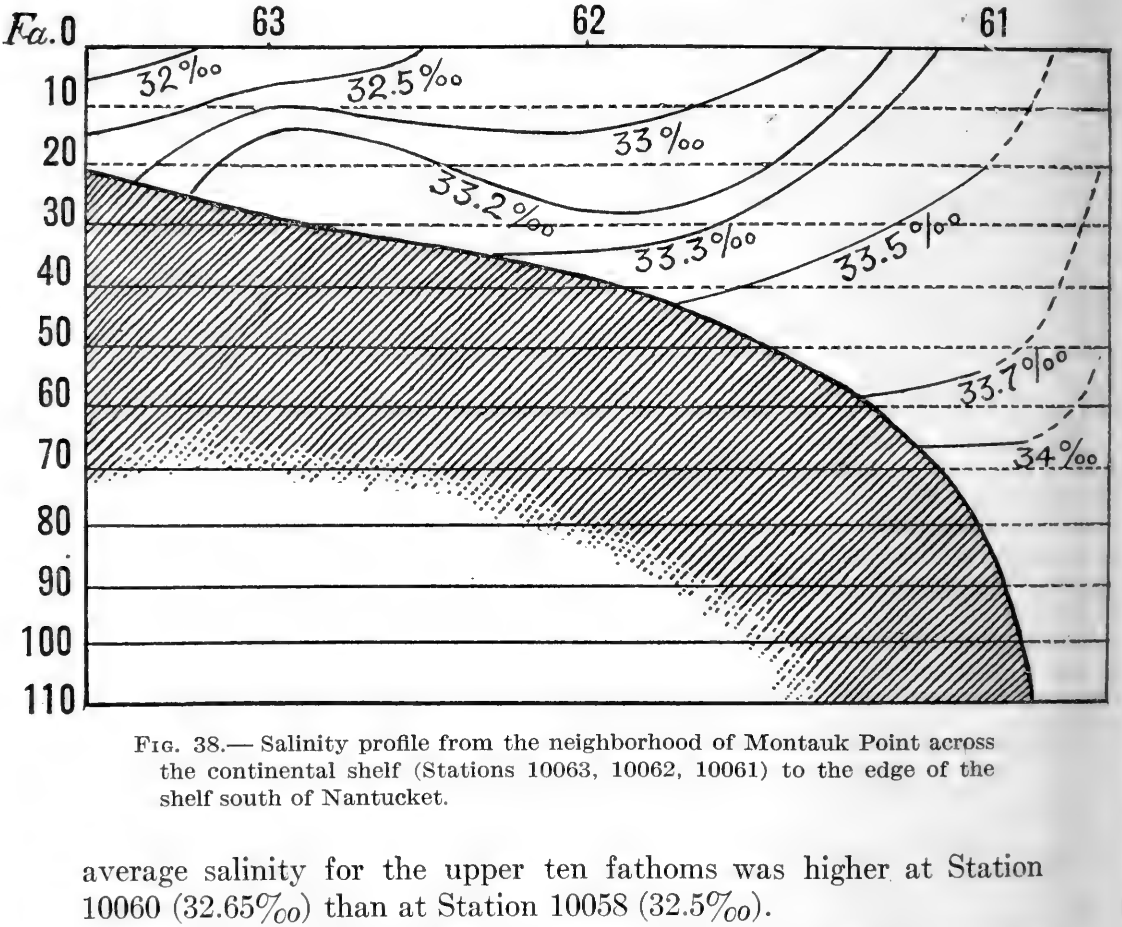

FIG. 38.— Salinity profile from the neighborhood of Montauk Point across the continental shelf (Stations 10063, 10062, 10061) to the edge of the shelf south of Nantucket.

South of the Shoals there was a rapid rise in salinity, depth for depth, from north to south across the continental shelf. But the Shoals are an effective barrier to any active mixing of water on the two sides below about thirty fathoms.

The next profile (Fig. 38) runs across the continental shelf from Montauk Point (between Station 10083 and Station 10087) to the continental slope south of Nantucket Shoals (Station 10061). Its

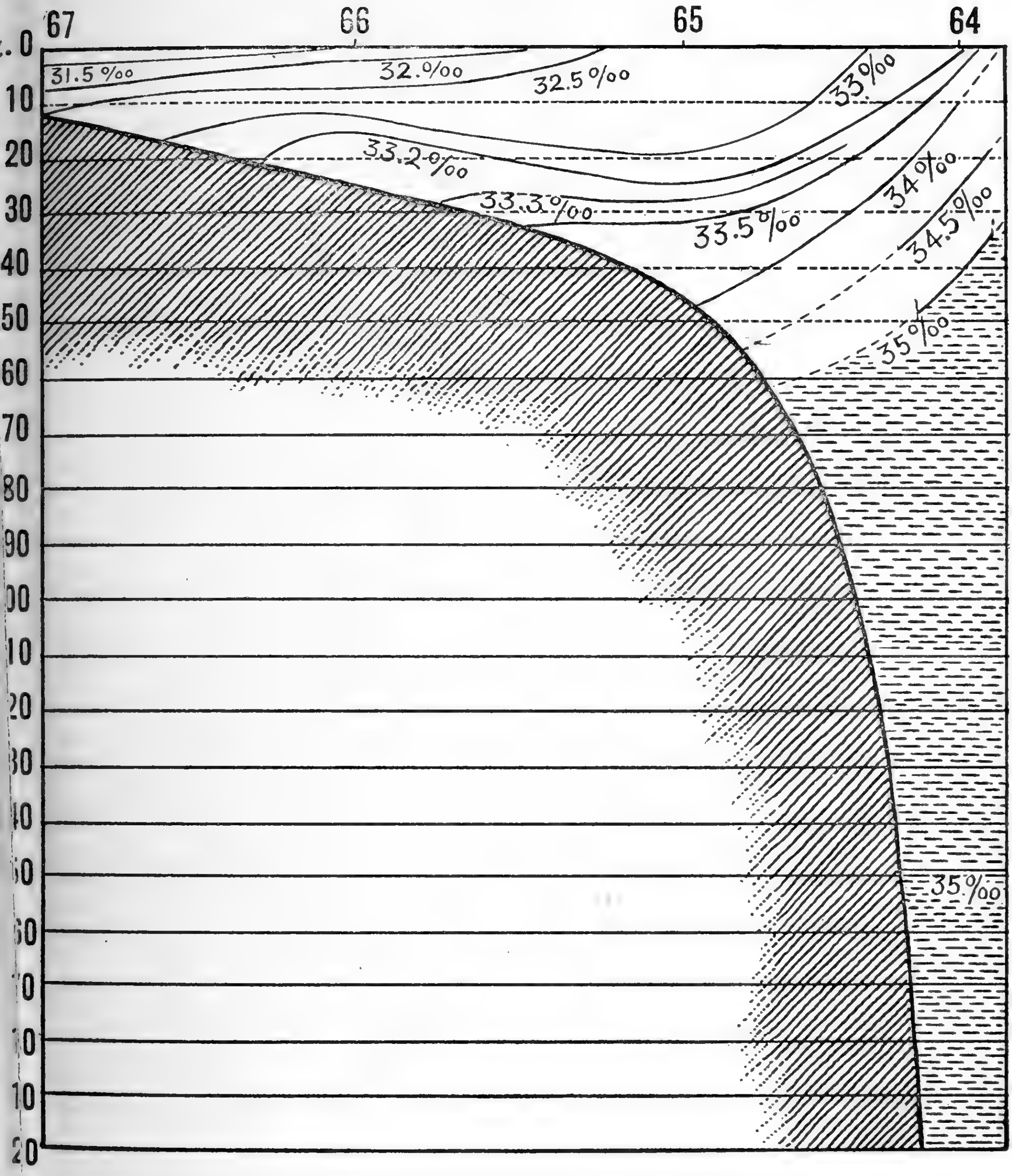

FIG. 39.— Salinity profile across the continental shelf from New York to the edge of the Gulf Stream in Lat. 39° 55′ (Stations 10067, 10066, 10065, 10064).

most striking feature, apart from the separation into comparatively fresh water on the continental shelf, and much salter oceanic water on the slope, is a succession of zones of comparatively uniform salinity alternating with zones in which there is a rapid change in salinity both vertical and horizontal. Next the shore there is first a mass of bottom water of 33.2‰, fifteen fathoms thick (Station 10063), separated by a zone of rapid transition from a much fresher though hardly less uniform surface zone of about 33‰ (Station 10062), some twenty-five fathoms thick. This, in turn, gives place to much salter water, over the edge of the shelf (Station 10061), where salinity increases only by .2‰ (33.41‰–33.62‰) from the surface down to fifty fathoms; below which there is a sudden rise. Since some of these masses of uniform water reappear in other profiles, it is convenient to designate them from the shore seaward, as A, B, and C.

On the profile from the neighborhood of New York to the slope, in about latitude 40° (Fig. 39), the salt ocean water is much more in evidence than it is further east, water of 35‰ bathing the slope nearly to the fifty fathom curve, although the surface water at the shore end is about the same salinity as in the last profile (Station 10067, 31.2‰). Two of the bands, which were noted in the preceding profile, reappear here, *i. e.*, A and B, with about the same salinities which characterized them further east. Band A is as well defined as in the preceding profile, occupies the same relative position on the shelf; and has the same salinity (33.2‰). But in the present profile the transition to the fresher water near shore is less sudden than it was further east. Band B is less clearly defined than in the preceding profile, and its salinity is less uniform, both vertically and transverse to the continental shelf, though of the same general value (about 33‰); nor does it so nearly reach to bottom, but overlies a layer of much salter water. Nevertheless the band is distinctly more uniform than the water immediately below, or on either side of it; hence its individuality still deserves recognition. But the third band, C, which characterized the outer part of the preceding profile, can not be distinguished in this one. As a whole the surface is fresher along this profile than the preceding; and this is true even of its off shore end, although the bottom water near the edge of the shelf is much salter than further east. And not only is water salter than 33.2‰ nearer the surface over the middle of the shelf, but water with salinity of 33‰ and higher washes the bottom to the fifteen fathom, instead of only to the twenty-five fathom curve. All this shows that off New York shore water was more in evidence on the surface, Atlantic water on

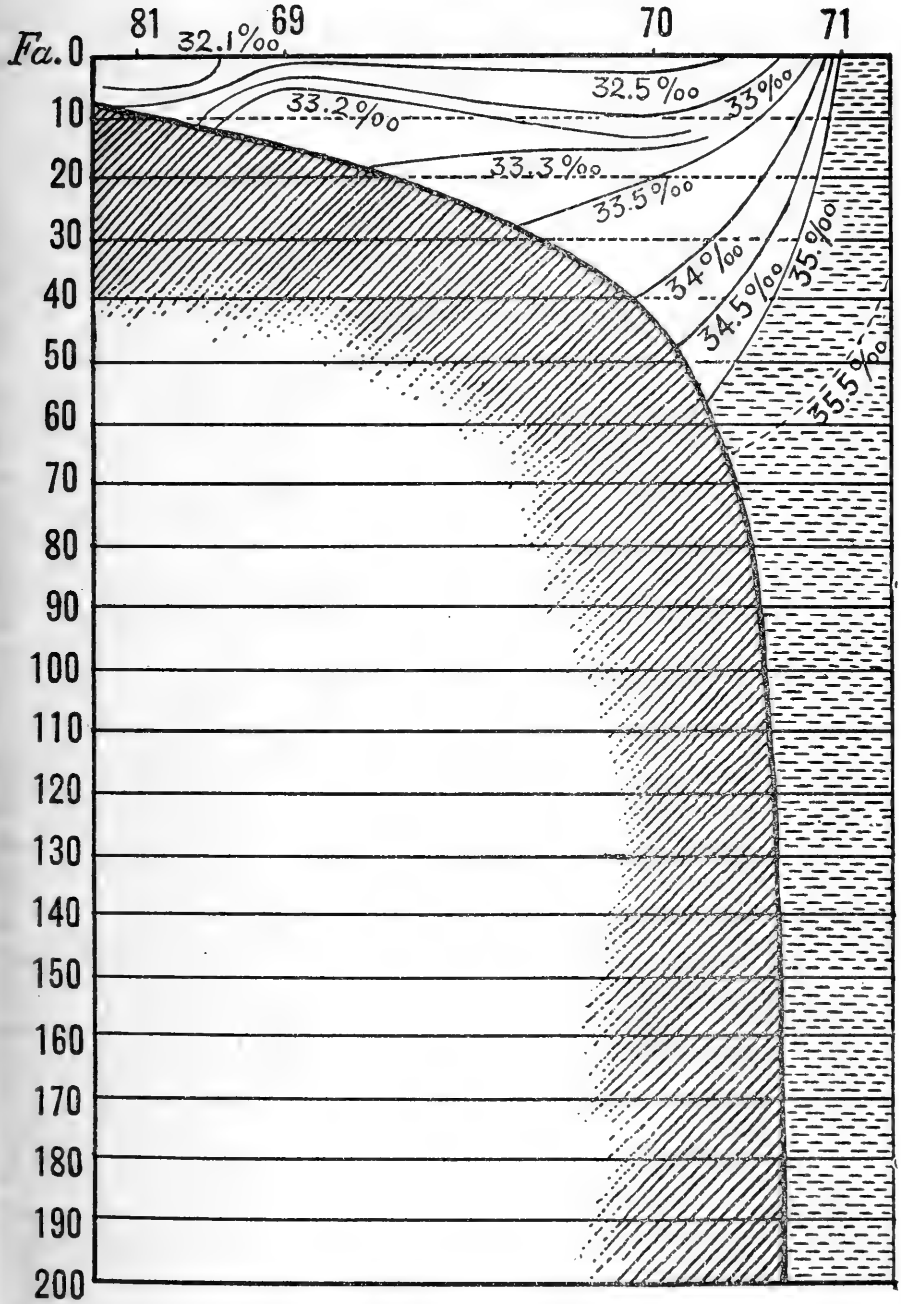

FIG. 40.— Salinity profile across the continental shelf abreast of Barnegat to the edge of the Gulf Stream in Lat. 38° 56′ (Stations 10081, 10069, 10070, 10071).

the bottom, than off Montauk or south of Nantucket Shoals; and that the transition between the two waters was very sudden. In the profile from off Barnegat to the continental slope in about latitude 39° (Fig. 40), water of 35‰ washes the slope below about sixty fathoms, and the curve of 35‰, which may be taken as an arbitrary division between coast and Gulf Stream water, is almost vertical. Generally speaking, too, the surface water was salter along this whole profile than in the preceding one, except at Station 10070; an exception explained by the fact that this part of the profile cut the southerly tongue of surface water fresher than 32.4‰, noted above (p. 187, Plate 2). Neither band B nor C can be traced as far south as this profile. But Band A is still evident, with precisely the same salinity (33.2‰) as in the two preceding profiles, washing the bottom rather nearer shore than was the case further north, and gradually merging into the Gulf Stream water of 35‰ on its off shore side, instead of being limited seaward by a sudden transition zone. On the other hand there is a great difference in salinity between it and the surface water over it, and also between it and the zone of water closer to shore.

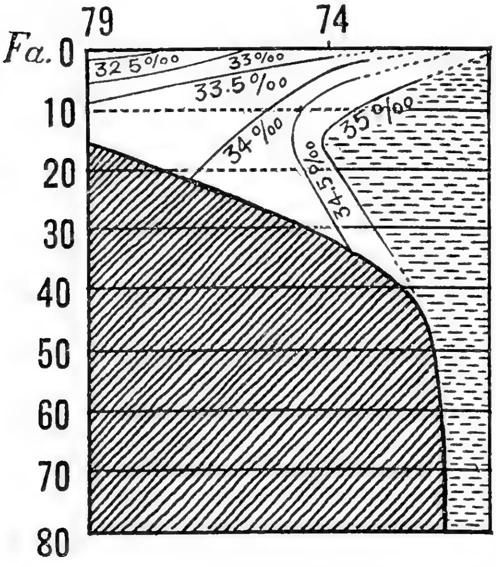

Fig. 41.— Salinity profile across the continental shelf south of Delaware Bay (Stations 10079, 10074).

The partial profile off Cape May is instructive chiefly because it shows no sign of band A; hence it is safe to conclude that the latter comes to an end north of Delaware Bay. The profile is otherwise so much like the preceding one, that I have not thought it necessary to reproduce it here. But the next one (Fig. 41), which is south of Delaware Bay, reveals an entirely new phenomenon, namely, a tongue of salt off shore water with salinity of 35‰ or more, intruding into the intermediate depths over the continental shelf, with fresher water both above and below it. Its landward end lies about over the thirty fathom curve, where the bottom water has a salinity of about 34.3‰, with 33.24‰ on the surface. Apart from the salt tongue, the salinity as a whole is higher than in the preceding profile, the bottom salinity in fifteen fathoms being 33.86‰ as against 33.14‰, with 34‰ as against 33.5‰ on the bottom at the twenty-five fathom curve. The shallower layers, too, are salter, depth for depth, than north of Delaware Bay.

A similar shoreward intrusion of 35‰ water into the intermediate

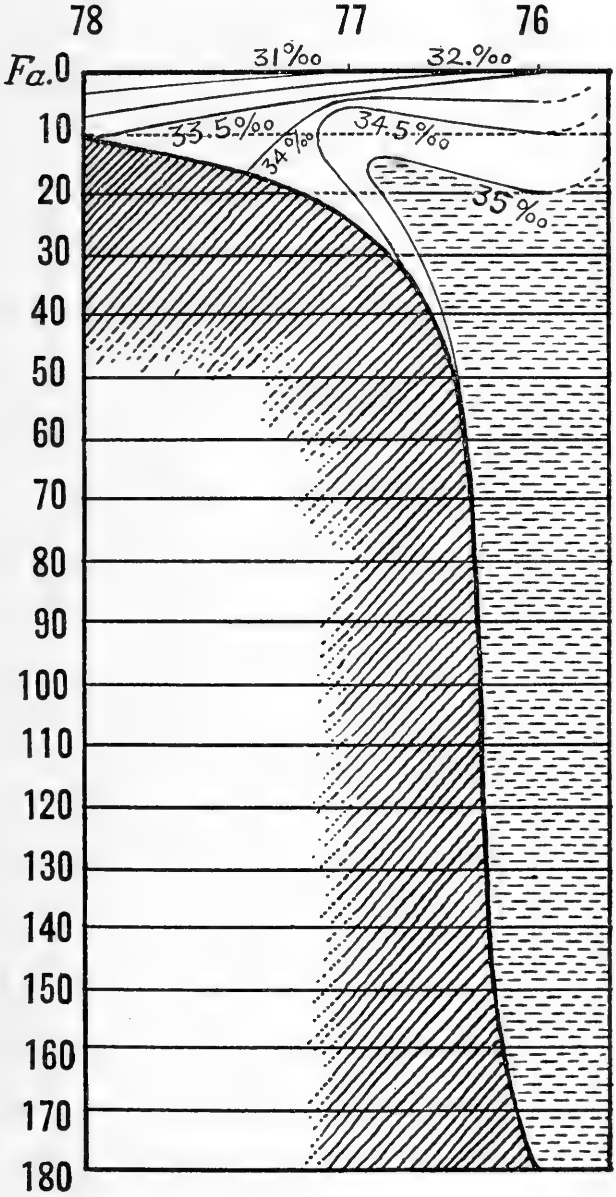

Fig. 42.— Salinity profile across the continental shelf to the edge of the Gulf Stream, abreast of Chesapeake Bay (Stations 10078, 10077, 10076).

depths over the shelf is also to be seen in the profile abreast of Chesapeake Bay (Fig. 42); and it has about the same extent and conformation there as further north, the curve of 35‰ rising from the sea floor at about the fifty fathom curve, with fresher water underneath it. But here the water near shore was much fresher down to five fathoms than in the preceding profile; the immediate surface layer fresher than any water we encountered further north, as might be expected from the volume of river water which debouches from the Bay in spring. And though this layer was very thin, the salinity rising from 29.25‰ on the surface to 33.5‰ on the bottom in ten fathoms at the shore end of the profile, its influence is unmistakable out to the edge of the continental shelf. At the outer end of the profile (Station 10076) the water was saltest at 50–100 fathoms (about 35.4‰), just as at the other deep water stations; below that level salinity decreased very slowly, as it does over the north Atlantic as a whole.

The change in salinity from north to south over the shelf north of Delaware Bay is illustrated by a profile following the forty fathom contour from Nantucket Shoals (Station 10060) to Station 10070 (Fig. 43). Below about ten fathoms there is a general increase in salinity, depth for depth, from northeast to southwest. But the surface water is freshest at the southern end of the profile (32.2‰), saltest at Station 10062 (32.86‰), and fresher once more (32.63‰) over the slope of Nantucket Shoals.

Salinity in the Gulf of Maine.

Surface Salinity. Early in July the surface salinity (Plate **2**) of Massachusetts Bay, immediately off Gloucester, was about 31.56‰, a rise of about .5 since the middle of May (1914b, p. 393), and it was 31.9‰ off Cape Cod (Station 10057, p. 205) with 32.4‰ over the southern part of the basin (Station 10058), and 33‰ on the southwest side of George's Bank (Station 10059). When we returned to the Gulf of Maine a month later, the water was slightly salter along the eastern shore of Cape Cod (32.05‰, Station 10085; 32.09‰, Station 10086), while a greater increase of salinity had taken place off Gloucester (to 32.03‰). And by the 25th of August it had risen to 32.16‰ in the mouth of Massachusetts Bay (Station 10106). The water immediately abreast of the Bay and along Cape Cod (Plate **2**) was 32–32.2‰, the curve for the latter value swinging eastward from the mouth of Vineyard Sound, and then northerly, toward Penobscot Bay.

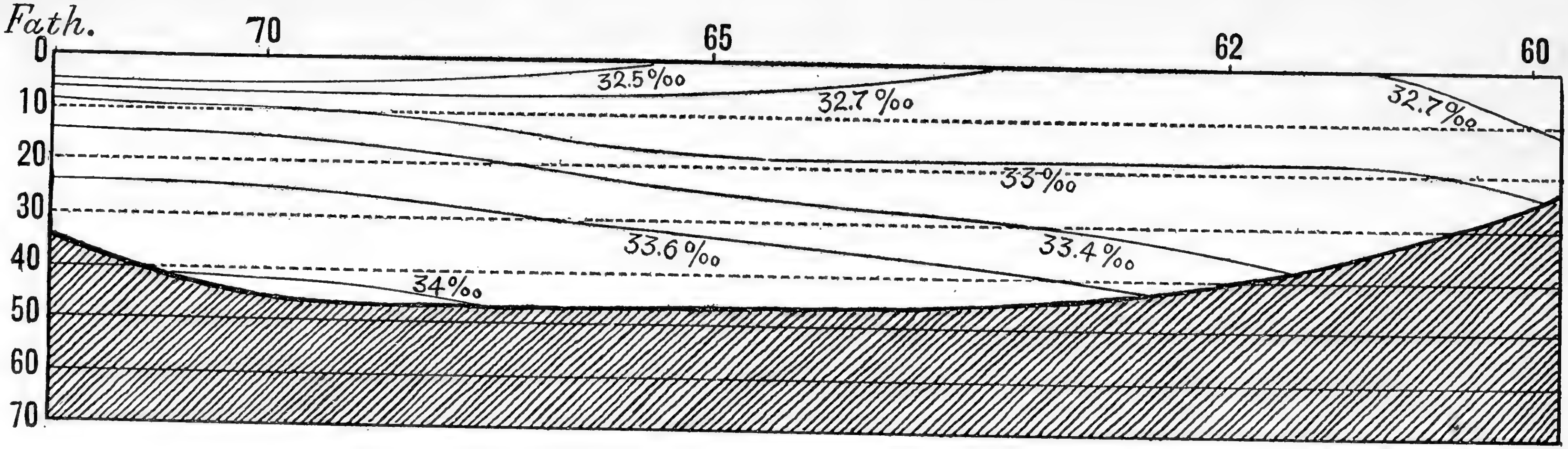

Fig. 43.— Salinity profile parallel to the shore, along the 30–45 fathom contour from Delaware Bay to Nantucket Shoals (Stations 10070, 10065, 10062, 10060).

Water fresher than 32‰ was restricted to a narrow zone close to shore, extending from just north of Cape Ann to Monhegan Island, broadest (twenty-five miles) off Cape Elizabeth.

In general there was a rise of surface salinity from west to east across the Gulf, the water being 32.5‰ some sixty miles off Cape Cod; 32.6‰ in the centre of the Gulf, and 32.7‰ near the Nova Scotia coast bank. But the increase was far from uniform, the course of the curves being distorted by an outrush of comparatively fresh water (32.2‰ to 32.5‰) off the west mouth of Penobscot Bay, and by a

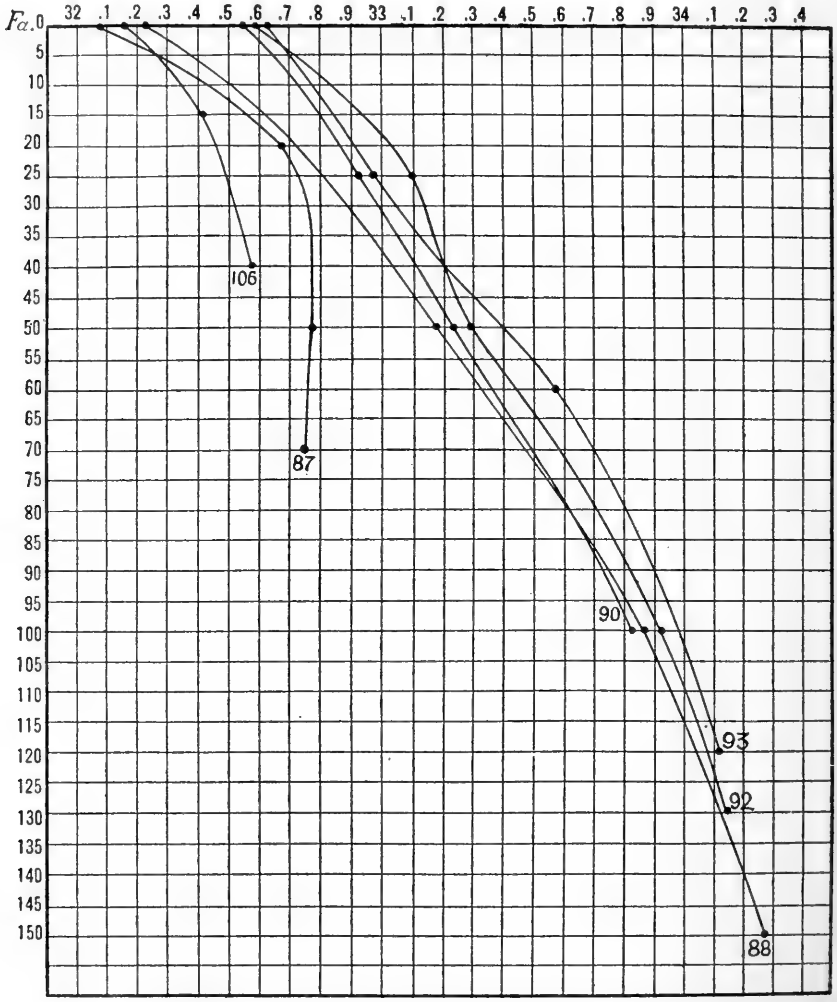

FIG. 44.— Salinity sections in the Gulf of Maine, from Massachusetts Bay to the eastern basin (Stations 10087, 10088, 10090, 10092, 10093, 10106).

band of water of the same low salinity extending thence along the coast of Maine to the Grand Manan Channel. The salinity was 32.5‰ or less over the coast bank west of Nova Scotia; and it is probable that the surface of the Bay of Fundy was even fresher than this. The curve for 34.4‰ shows that the direct effect of Penobscot water did not extend further south than Jeffrey's Bank (Station 10091), south of which it runs in an S, roughly parallel with the coast, crossing the southern end of the basin, and thence westward across Nantucket Shoals. The surface of the eastern half of the Gulf as a whole was salter than 32.6‰; the curve for that value outlining a tongue some sixty miles broad, with an eddy-like curve from southeast to northwest. Water as salt as this lay close to the land east of Mt. Desert Island, and indented westward, as far as Matinicus Island, into the fresher Penobscot water. The curve of 32.6‰ probably crossed the mouth of the Bay of Fundy. At any rate it paralleled the western shore of Nova Scotia, where it was separated from the land by fresher water (32.45‰ on Lurcher Shoal).

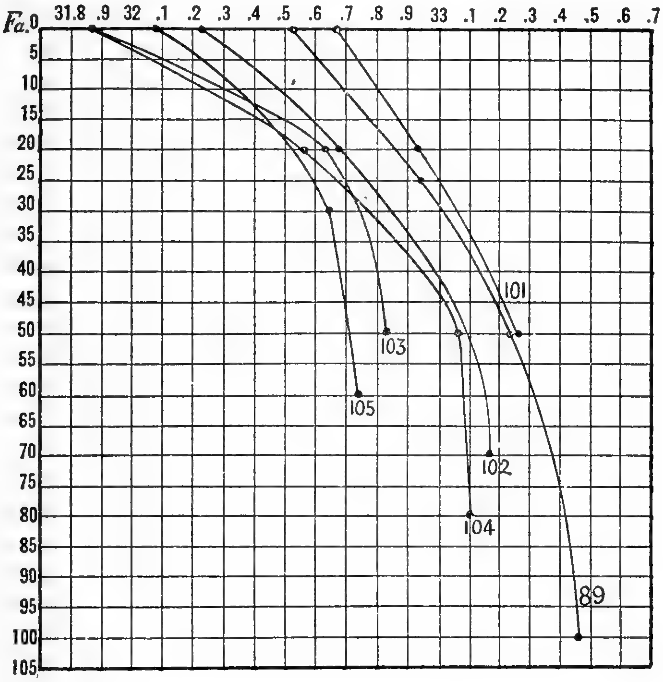

FIG. 45.— Salinity sections in the Gulf of Maine near Platt's Bank (Station 10089); along shore between Cape Ann and Penobscot Bay (Stations 10102, 10103, 10104, 10105) and near Matinicus Island (Station 10101).

The only record from George's Bank was considerably salter (about 33‰). And judging from the strong tidal currents of the Bank, from the few previous records (1914b) and from the proximity of the Gulf Stream, the general surface salinity over the bank is probably above 32.5‰.

The saltest surface water which we found in the Gulf was 32.79‰ on German Bank (Station 10045); but this is an abnormal value, caused by vertical circulation (p. 178). And though even salter water may have spread from the south across George's Bank into the southeastern part of the Gulf in August, there is no actual evidence that such was the case.

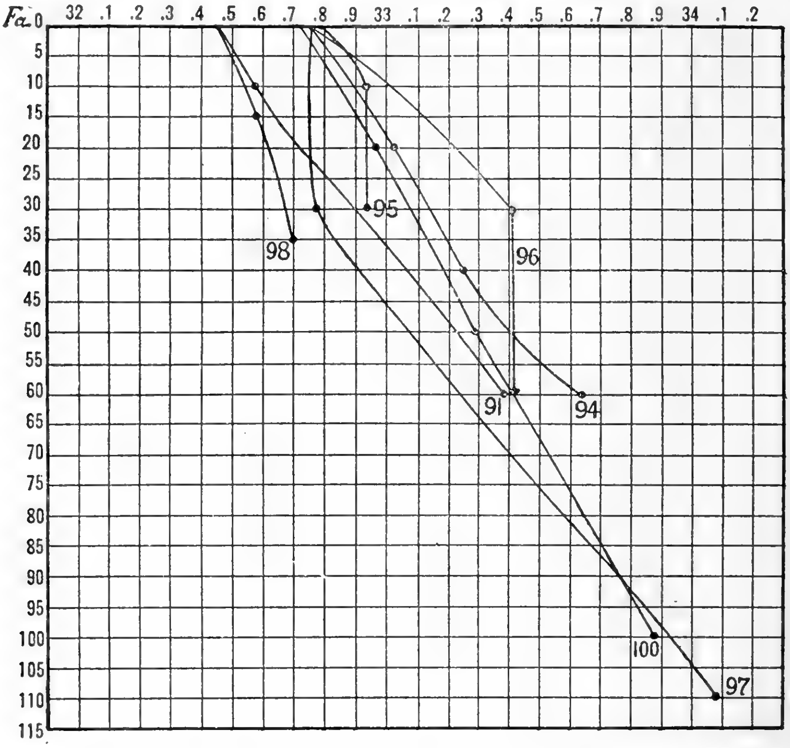

Fig. 46.— Salinity sections in the northeastern end of the basin of the Gulf of Maine (Stations 10097, 10100); on Jeffrey's Bank (Station 10091); German Bank (Stations 10094, 10095), near Lurcher Shoal (Station 10096) and off the coast of Maine near Grand Manan Channel (Station 10098).

Salinity sections. The waters of the Gulf of Maine were freshest at the surface, saltest at the bottom, just as in 1912 (1914a). In its central part (Stations 10088, 10090, 10092, 10093, Fig. 44), the rate of increase with depth was comparatively constant over the whole column of water; with a maximum difference of about 2.1‰ between surface and bottom salinity at the deepest Station (10088, surface 32.1‰; bottom 34.2‰); and this same type of curve likewise characterized the deep water off Mt. Desert (Station 10100, Fig. 46). The salinity curves at the Stations near shore, north and east of Cape Ann, (10101, 10102, 10103, 10104, 10105 Fig. 45), are of rather different type, the vertical increase in salinity being most rapid near the surface. In the northeast corner of the Gulf (Fig. 46), on the Nova Scotian Banks, and again off Cape Cod and on George's Bank, the salinity curves show unmistakable evidence of vertical tidal disturbance. Thus at Station 10098 the total vertical range of salinity, in thirty-five fathoms, was only about .2‰ (Fig. 46); off Lurcher Shoal (Station 10096, Fig. 46) there was a rise of .6‰ from the surface down to thirty fathoms (32.75‰–33.4‰); but below that depth the salinity was uniform down to the bottom in sixty fathoms. On German Bank the total range was only .1‰ (32.79‰–32.92‰), and on George's Bank (Station 10059) the water was practically uniform from surface to bottom. The upper layers in the northern end of the eastern basin (Station 10097) must likewise be disturbed by vertical currents, because the salinity was uniform from the surface down to thirty fathoms, with a sudden increase below that depth (Fig. 46). But there was no evidence of vertical mixing on Jeffrey's Bank.

In general the upper fifty fathoms of water was freshest off Cape Cod (Stations 10086, 10087), in Massachuetts Bay (Station 10106),

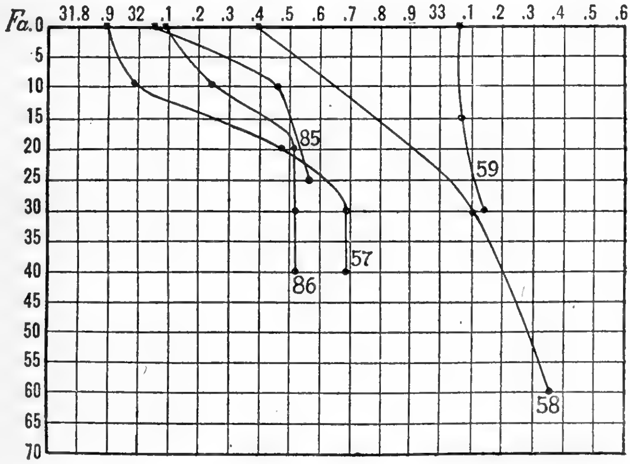

FIG. 47.— Salinity off Cape Cod in July (Station 10057) and in August (Stations 10085, 10086); in the southern part of the basin of the Gulf (Station 10058) and George's Banks (Station 10059) in July.

just north of Cape Ann (Station 10103), and close to the coast of Maine east of Mt. Desert (Station 10098); saltest in the centre of the Gulf and over the eastern basin (Stations 10092, 10093, and 10100), and over the edge of the Nova Scotian slope (Stations 10094, and 10096). And this is further illustrated by the following table of the mean salinity of the upper 50 fathoms:—

Station	Mean sal.	Station	Mean sal.
10058	32.9	10095[2]	32.9
10086[1]	32.4	10096	33.2
10087	32.6	10097	32.8
10088	32.7	10098[1]	32.5
10089	32.9	10100	33.
10090	32.9	10101	33.
10091	32.8	10102	32.7
10092	33.	10103	32.5
10093	33.	10104	32.6
10094	33.1	10105	32.5
		10106[1]	32.4

The mean salinity between 50 and 100 fathoms was lowest at Station 10089, highest in the eastern basin (Station 10093), as follows:—

Station	Mean sal.	Station	Mean sal.
10088	33.5	10093	33.7
10089	33.35	10097	33.5
10090	33.55	10100	33.6
10092	33.6		

Salinity on the bottom. The bottom salinity of the Gulf (Fig. 36) depended chiefly on depth, the bottom water of the basins being from 34‰ to 34.27‰. The bottom salinity of the coastal zone surrounding the whole Gulf was below 33‰ (32.5‰–32.9‰), the curve of 33‰ agreeing, roughly, with the fifty fathom contour of the bottom. But there were various local anomalies, already pointed out, especially the abnormally low bottom salinities of the several circumscribed sinks on the western side of the Gulf.

Salinity profiles. The profile from Massachusetts Bay to German Bank (Fig. 48, Stations 10106, 10087, 10088, 10090, 10092, 10093, 10094, 10095), shows that the water was salter in general, depth for

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[1] Mean for 40 fathoms.

[2] Mean for 30 fathoms.

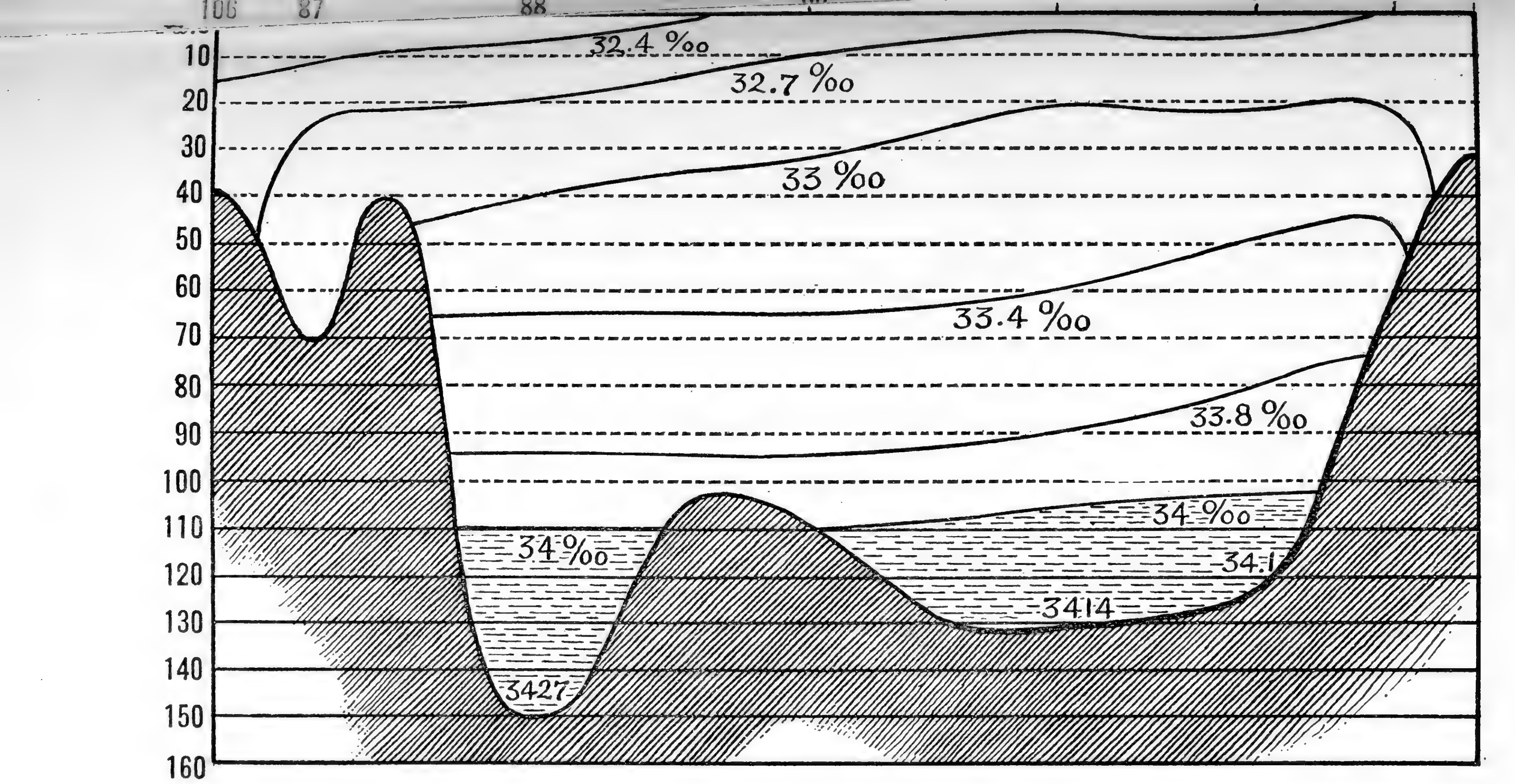

Fig. 48.— Salinity profile across the Gulf of Maine from Massachusetts Bay to German Bank in August (Stations 10106, 10087, 10088, 10090, 10092, 10093, 10094, 10095).

depth, at the eastern than at the western side of the Gulf, down to about 100 fathoms, equal salinities being found about 15–20 fathoms deeper on the Massachusetts Bay than on the Nova Scotia side. Below 100 fathoms there was much less variation in salinity from west to east, depth for depth, the curve of 34‰ following the 110 fathom level right across the western basin. At 130 fathoms the salinity was almost precisely the same (34.1‰) in the two basins.

The water was much fresher at the mouth of Massachusetts Bay than further east, especially at the bottom, while the very sudden dip of the curve of 32.7‰ suggests that vertical circulation was active in the Bay. And this may well have been the case, as the tidal currents are of some strength in the neighborhood of Station 10106. The eastern end of the profile shows a sudden spreading of the curves over the coast bank, such as we found in 1912 (1914a), the range of salinity for the entire column of water on German Bank being only from 32.79‰–32.94‰. The only exception to the rule that salinity increased from west to east is afforded by Station 10093, where the

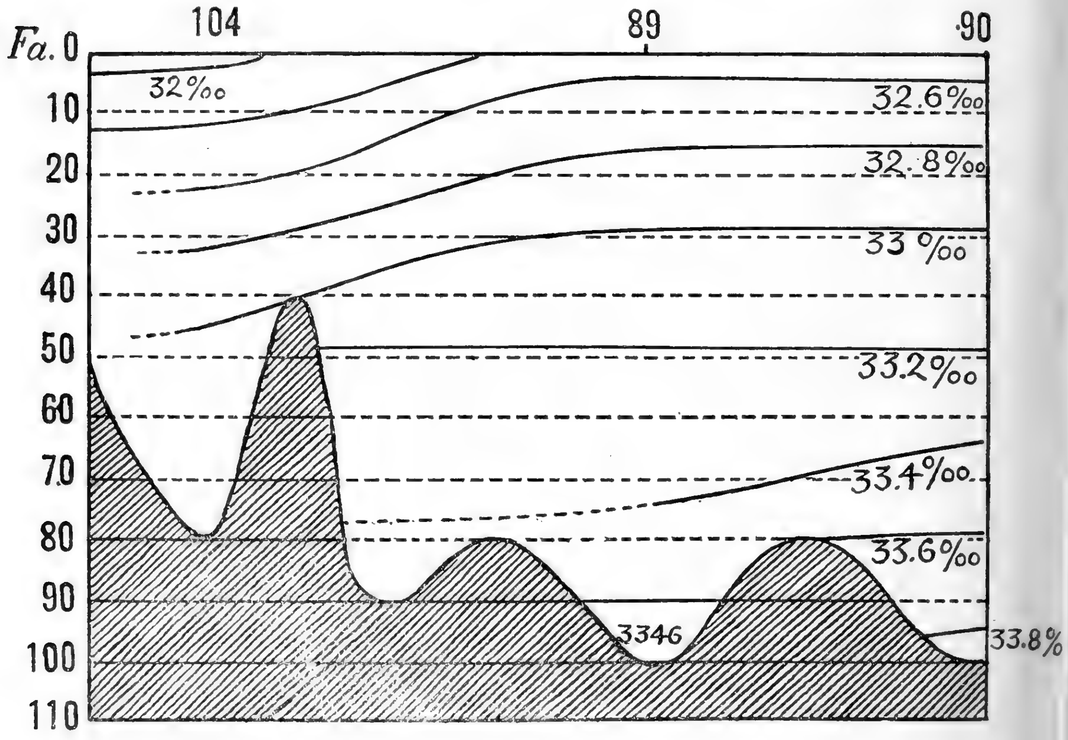

FIG. 49.— Salinity profile from the trough between Jeffrey's Ledge and the mainland (Station 10104) to the centre of the Gulf of Maine (Station 10090).

salinity of the water between five and twenty fathoms was slightly lower than at Stations 10092 and 10094, on either side of it.

Successive profiles from near shore toward the centre of the Gulf, at right angles to the last, show that the water was fresher along the western coast than off shore. In the profile (Fig. 49), from Cape Porpoise, across the northern end of Jeffrey's Ledge, to Station 10090, the salinity curves all dip toward the land; but in the eastern half of the profile (Stations 10089 to Station 10090), they are practically

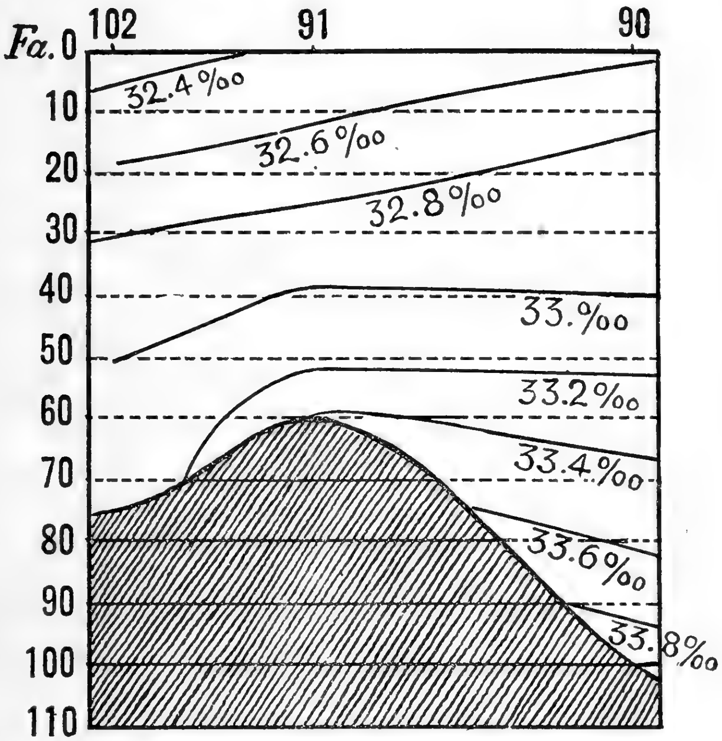

Fig. 50.— Salinity profile from Station 10102, off the mouth of Penobscot Bay, across Jeffrey's Bank (Station 10091) to the centre of the Gulf of Maine (Station 10090).

orizontal, *i. e.*, the salinity in the upper fifty fathoms was uniform orizontally; though below that depth the off shore water (Station 0090) was slightly saltest. The fact that the salinity was precisely he same (33.4–33.5‰) on the bottom in the sink where Station 10089 vas located, as at seventy fathoms in the basin to the east of it, shows hat its rim, which rises to a general level of about seventy-five fathoms, nd is crowned by the much shallower Cashes Ledge, is an effective barrier to the entrance of the salt bottom water from the centre of the Gulf. And Jeffrey's Ledge evidently acts in the same way, for though it leaves an open entrance on the north to the trough west of it, the fact that the salinity was the same at eighty fathoms in the trough as at forty fathoms east of the Ledge, shows that little if any salt water flows in across the latter.

In the profile (Fig. 50) from the mouth of Penobscot Bay (Station 10102) to the centre of the Gulf (Station 10090) via Jeffrey's Bank (Station 10091), the salinity curves all dip shoreward between the surface and forty fathoms. This is true for the whole column of water between Jeffrey's Bank (Station 10091) and the mouth of the Bay Station 10102). But between Station 10090 and the Bank, the reverse is the case below forty fathoms. The curve of 33.2‰ is espe-

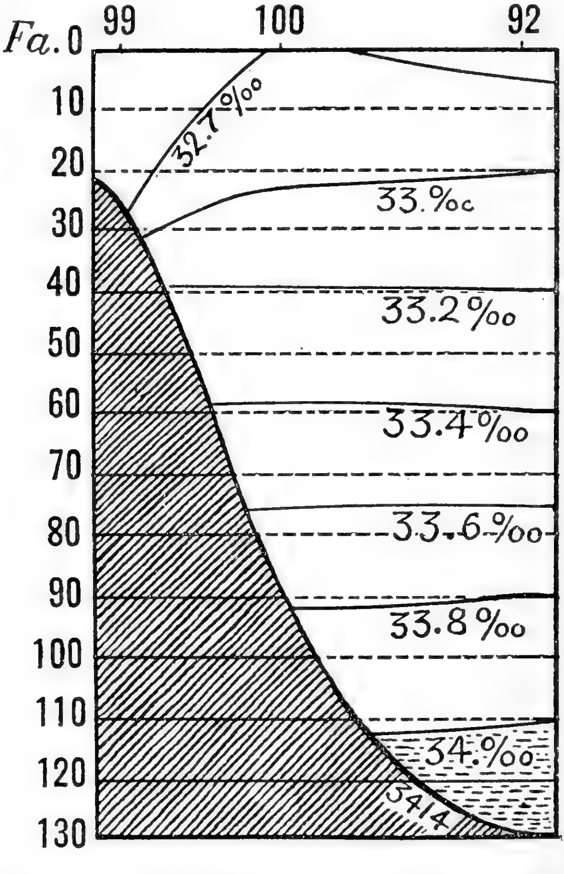

FIG. 51.— Salinity profile from the neighborhood of Mt. Desert Island (Station 10099) to the eastern basin of the Gulf of Maine (Stations 10100, 10092).

cially interesting because while it runs almost horizontal at about fifty fathoms from Station 10090 to and across Jeffrey's Bank, it must then dip to bottom in about seventy fathoms, the bottom salinity at Station 10102 being only 33.17‰, suggesting a shoreward movement of salt bottom water across the Bank.

The next profile (Fig. 51) is parallel to the last, some 30 miles further east (Station 10099, 10100, 10092). Here the slope of the bottom is an even one, consequently the salinity curves do not show the anoma-ies noted for the profiles further west; but they agree with the latter n dipping shoreward between the surface and thirty fathoms.

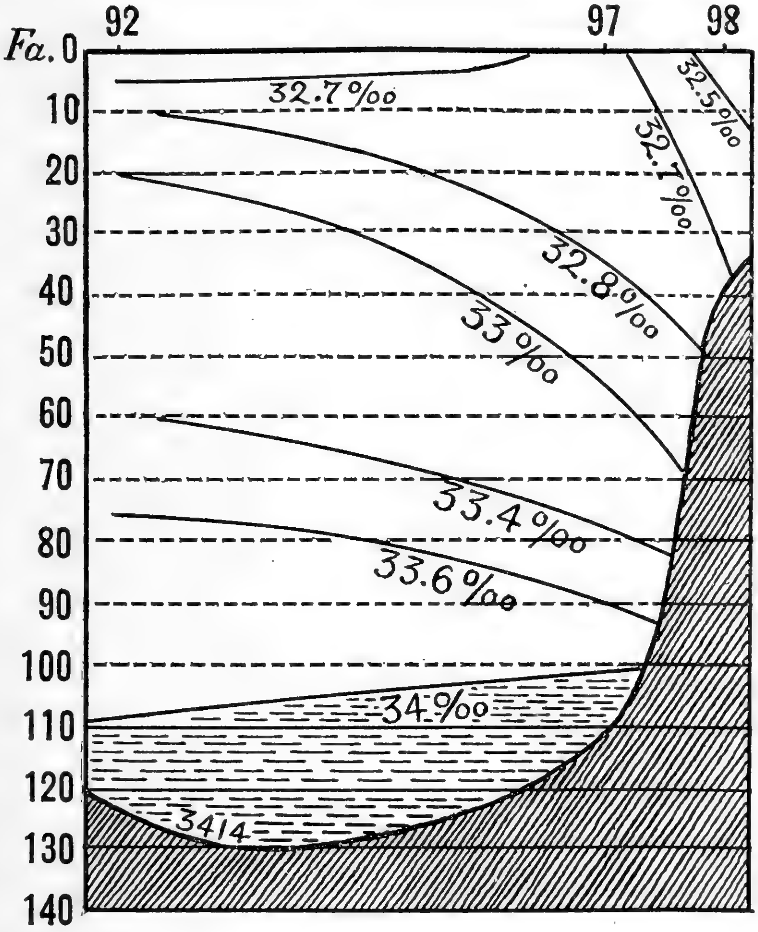

Fig. 52.— Salinity profile lengthwise of the northeastern part of the Gulf of Maine from south to north (Stations 10092, 10097, 10098).

The water close to the surface was slightly salter at Station 10100 han at Station 10092, though the former is the nearer shore; but this does not invalidate the thesis of a general freshening near land, because the profile crosses the long-shore tongue of 32.7‰ surface water (Plate 2). Below forty fathoms there was practically no change in salinity, depth for depth, along the profile. Comparison between this profile and the one off Penobscot Bay (Fig. 50) shows that the off shore water was slightly salter off Mt. Desert, than off Penobscot Bay, the difference being greatest at 10–40 fathoms, where equal salinities are found 10–20 fathoms deeper at the former than at the latter.

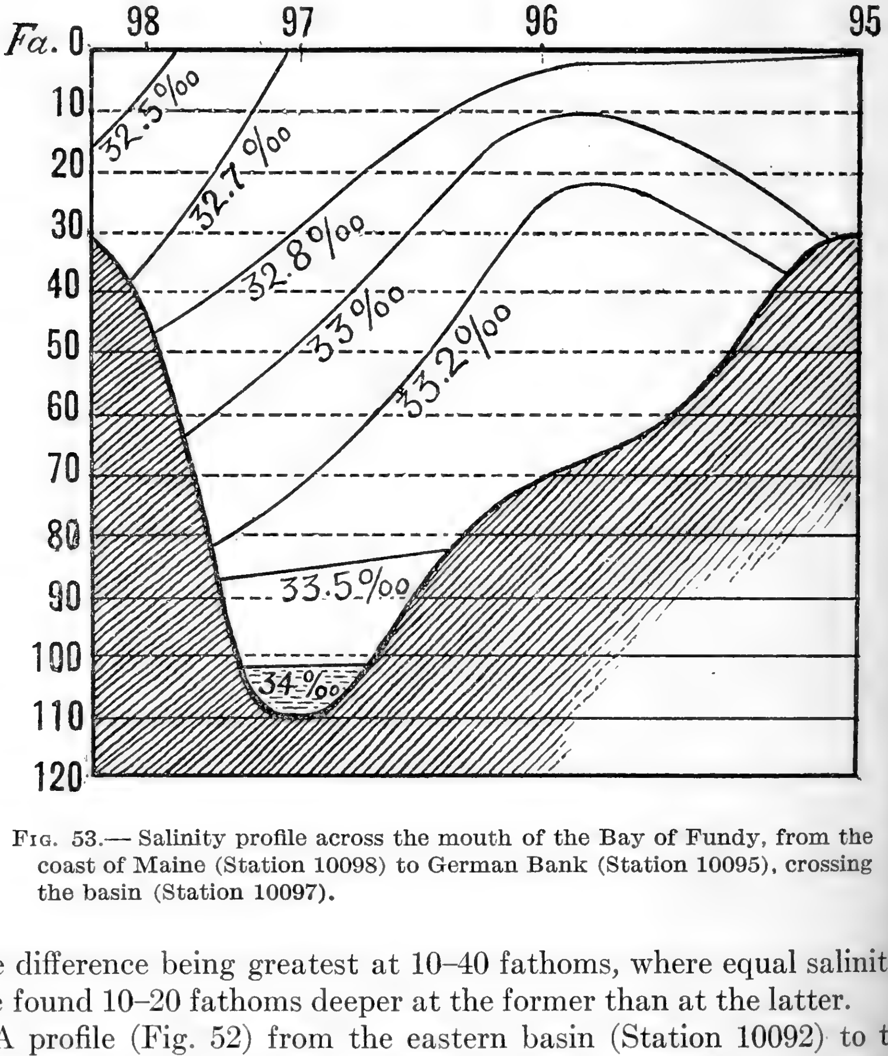

Fig. 53.— Salinity profile across the mouth of the Bay of Fundy, from the coast of Maine (Station 10098) to German Bank (Station 10095), crossing the basin (Station 10097).

A profile (Fig. 52) from the eastern basin (Station 10092) to the coast of Maine near the entrance to the Grand Manan Channel (Station 10098) shows an even more pronounced freshening toward the land, down to about ninety fathoms, the curve of 33‰ dipping from the twenty fathom level at Station 10092, to seventy fathoms on the shore slope. But below one hundred fathoms the dip of the curves is reversed, *i. e.*, the water was saltest, depth for depth, next the land, suggesting a movement of bottom water up the slope. The general rule that the salinity of the upper layers rose steadily passing off shore was broken at Station 10097; but this was probably due to local vertical circulation, as evidenced by the vertical uniformity of salinity for the upper thirty fathoms.

The profile crossing the mouth of the Bay of Fundy from the coast of Maine to German Bank (Stations 10098, 10097, 10096, and 10095, Fig. 53) shows the same comparatively fresh shore water off the coast of Maine, and the water was only slightly salter on German Bank, at the southern end of the profile. But the salinity was much higher in the centre of the profile, where 33‰ water came up to within ten fathoms of the surface, though the immediate surface was slightly fresher there than on German Bank. The course of the curves over the outer part of the Nova Scotia slope (Station 10096) is especially instructive because they reveal the existence of a zone of uniform water, between thirty fathoms and the bottom (sixty fathoms) the salinity of which agrees with the eighty fathom level over the basin (Station 10097). And this, of course, suggests an up-draught of bottom water over the slope. Vertical circulation was active in the shallow water at each end of the profile; slightly more so on German Bank than next the Maine coast, as shown by the fact that the difference between surface and bottom salinity in thirty fathoms on the latter was only 13‰, as against .23‰ in forty athoms at Station 10098.

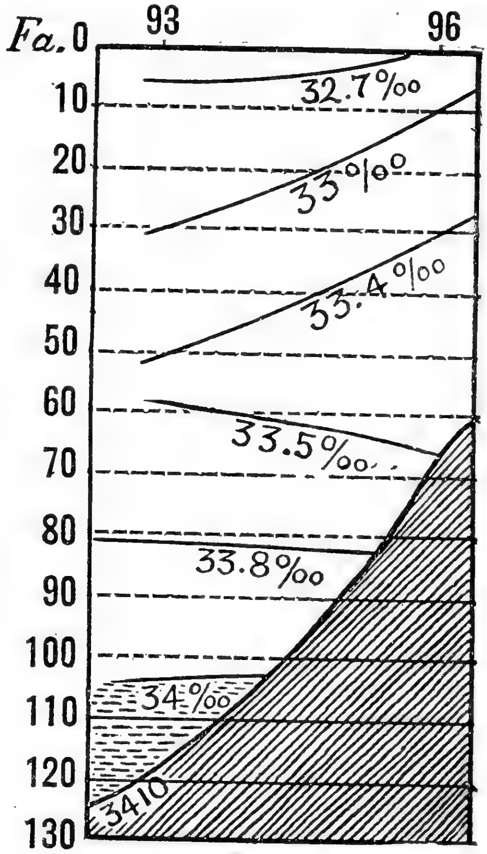

Fig. 54.— Salinity profile from the eastern basin of the Gulf of Maine (Station 10093 toward the mouth of the Bay of Fundy (Station 10096).

A profile from the basin (Station 10093) toward the mouth of the

Bay of Fundy (Fig. 54), shows that the upper layers at Station 10096 are salter than the water at corresponding depths further off shore. And this is true whether Station 10092 or Station 10093 be taken as the outer end of the profile, though the difference is slightly greater in the case of the latter. The uniform water between thirty and sixty fathoms at Station 10096 is slightly salter (33.4‰) than the mean (33.27‰) of the corresponding column of water at Station 10093. Station 10096 was likewise considerably salter as a whole than the water over the slope of German Bank (Station 10094), especially in the mid-depths; and though the latter was the salter of the two on the surface this does not invalidate the general statement, because its high surface salinity was due to local vertical mixing by tidal currents (p. 204). In short, the upper thirty fathoms of water was salter off the mouth of the Bay of Fundy (Station 10096) than on the coast bank to the south, the eastern basin, or for that matter, anywhere else in the Gulf; probably due to an updraught from the mid-depths off shore. And the profile is further interesting because the spreading of the curves for 33.4‰ and 33.5‰ over the coast slope at 50–80 fathoms suggests that vertical mixing, which in the Gulf is synonymous with tidal currents, was active on the bottom at Station 10096, though not on the surface.

DENSITY, AT THE TEMPERATURE IN SITU, CAPE COD TO CHESAPEAKE BAY.

The chart of density on the surface south of Cape Cod (Fig. 55), for the first half of July, is less significant in detail than the chart of surface salinity, because surface density was constantly falling, with the seasonal rise in surface temperature (p. 156). The off shore water was as a whole heaviest, the coast water lightest. But on our voyage south we encountered a secondary area of low density over the central part of the continental slope off New Jersey (Station 10070), as outlined by the curve for 1.0220, with heavier water (1.0227) between it and the coast, a phenomenon caused by the rapid warming of comparatively fresh surface water (p. 187) by warm southerly winds from the Gulf Stream, which prevailed at that time. And by the end of July the rise of surface temperature (p. 156) caused even lower densities next the coast (Station 10080, density 1.0215; Station 10081, density 1.02145). The density was lowest (1.0184) at the mouth of Chesapeake Bay, highest outside the continental shelf (Station 10071);

but as noted (p. 221) the water was even denser on George's Bank and in the Gulf of Maine. In general, the density rose from southwest to northeast, corresponding to the general decline of surface temperature (Fig. 1).

At all our stations south of Cape Cod the water was heaviest at the bottom, *i. e.*, it was in stable equilibrium, as is the rule everywhere, in temperate regions in summer. But it varied so much, level for level, at different stations, as to suggest a potent cause for circulation. To facilitate comparison with salinity and temperature, density is reproduced here by corresponding profiles.

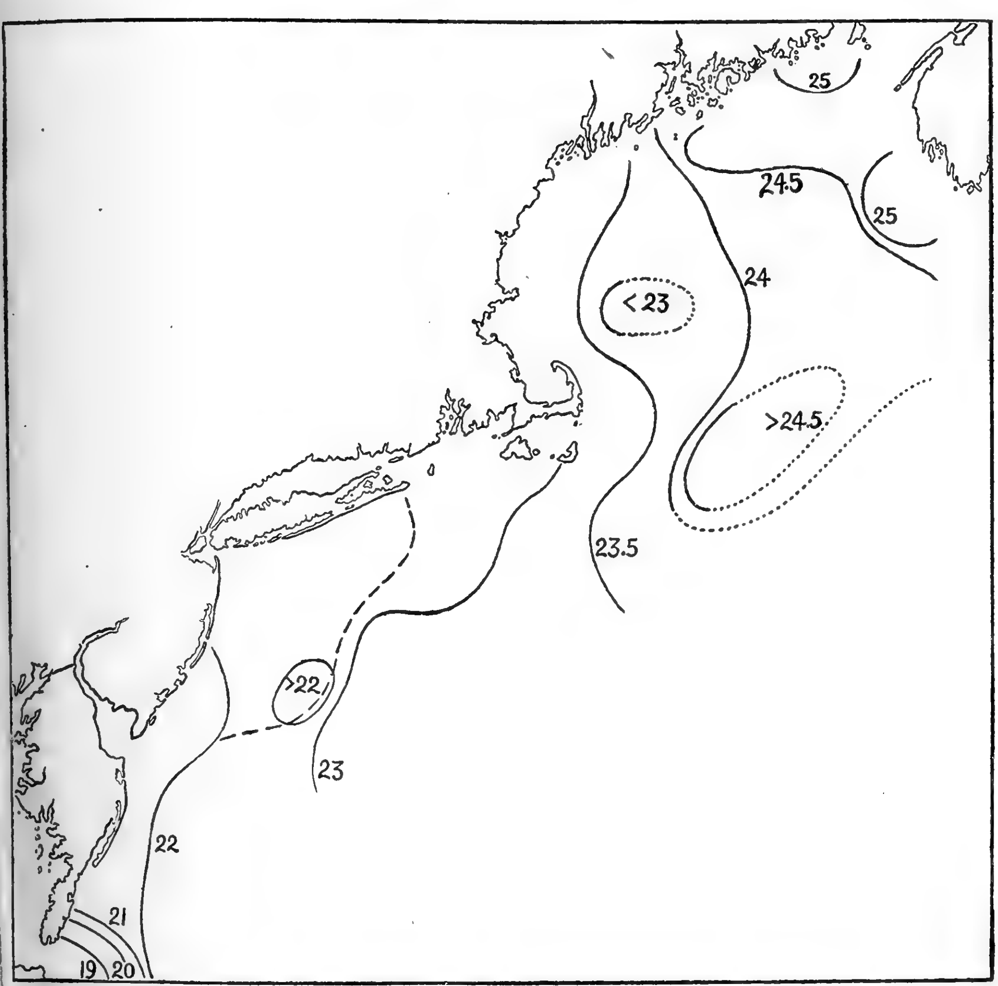

FIG. 55.— Chart showing surface density of the water south and west of Cape Cod in July, and of the Gulf of Maine in August. Curve - - - - -, July 29–Aug. 1.

The first (Fig. 56), from the southern part of the basin of the Gulf of Maine (Station 10058), to the outer edge of the continental shelf (Station 10061) shows that there was very little difference in density, depth for depth, on the two sides of Nantucket Shoals, above the level of the latter (about thirty fathoms). Below that level the water was distinctly lighter on the south than on the north side of the Shoals; and the vertical stability of the water was very slight over the outer part of the shelf between the thirty-five and fifty fathom levels.

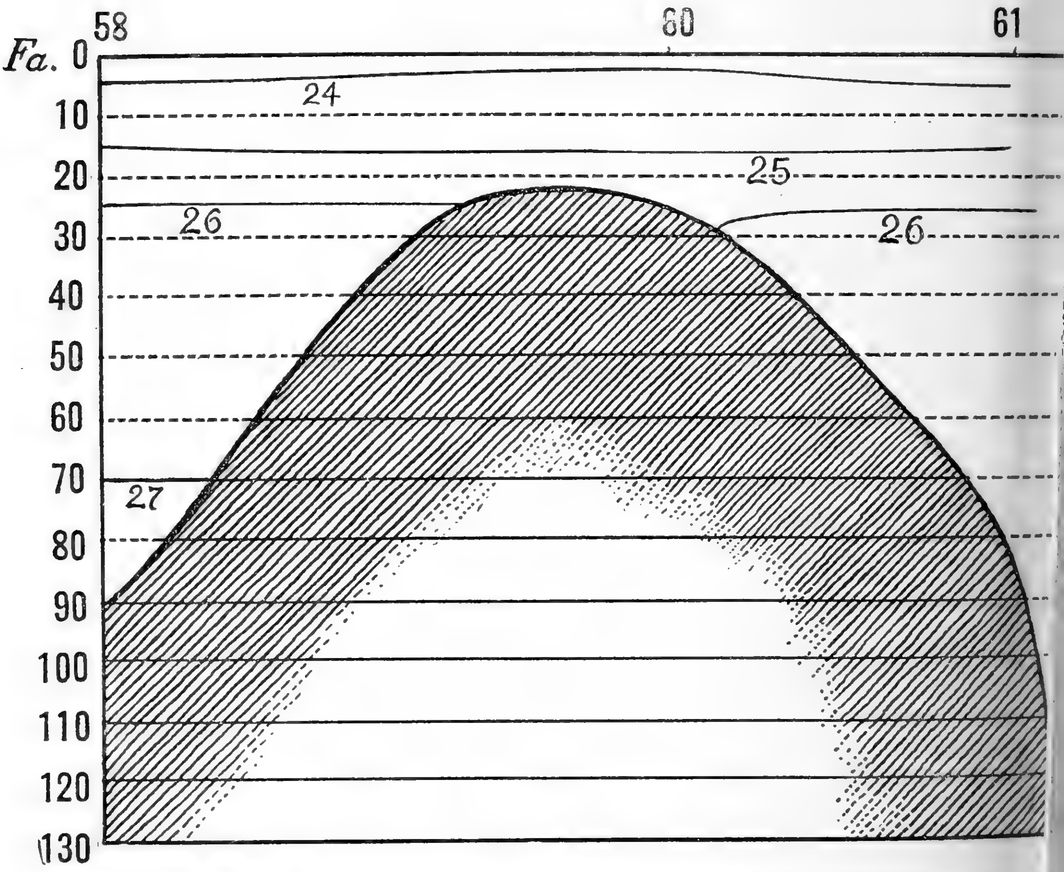

Fig. 56.— Density profile from the southern part of the basin of the Gulf of Maine (Station 10058) across Nantucket Shoals, to the continental slope south of Nantucket (Station 10061) July 8–10.

The next profile (Fig. 57) from Station 10063, off Nantucket, to the edge of the continental shelf (Station 10061), shows that down to about twenty fathoms the water was considerably lightest at the shore end. Below thirty fathoms the density curves dip seaward, especially at the outer edge of the shelf, coincident with the cold tongue (p. 165). But this condition must have been limited to a narrow east and west zone, for in the profile off New York (Fig. 58) the dip of the curves in the same relative position, is just the reverse, being steepest at the level (fifty fathom contour) where the slope of the bottom becomes rapid, *i. e.*, just below the cold tongue. At about thirty fathoms the density curves are generally horizontal, and they are probably horizontal below 100 fathoms. The next, off Barnegat (Fig. 59), shows a similar distribution of density, except that the surface, as well as the deeper water was densest at the seaward end, the dip of the curves being especially pronounced in the upper fifteen fathoms or so, and again at 40–50 fathoms over the continental slope.

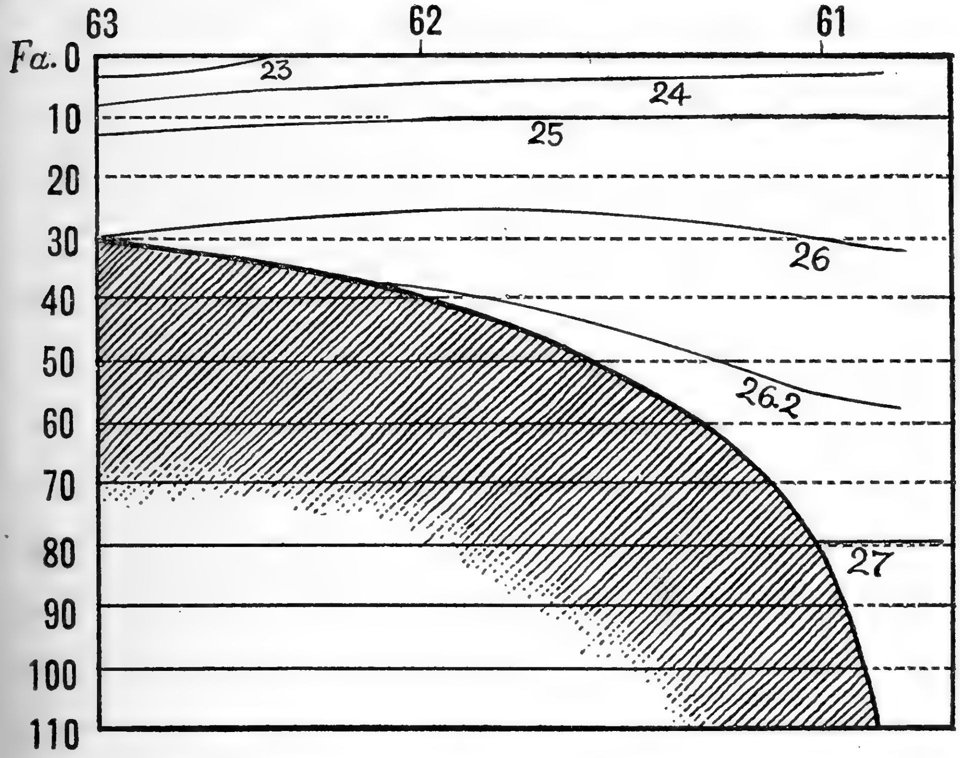

FIG. 57.— Density profile across the continental shelf southwest and south of Nantucket (Stations 10063, 10062, 10061) July 10–11.

A profile running from Station 10079 to Station 10074 (Fig. 60). shows that just south of Delaware Bay where the surface water was lightest next the coast, the reverse was true below about twelve fathoms, the bottom water being heaviest, depth for depth, next the land, while the seaward dip of the curve of 1.026, suggests a seaward

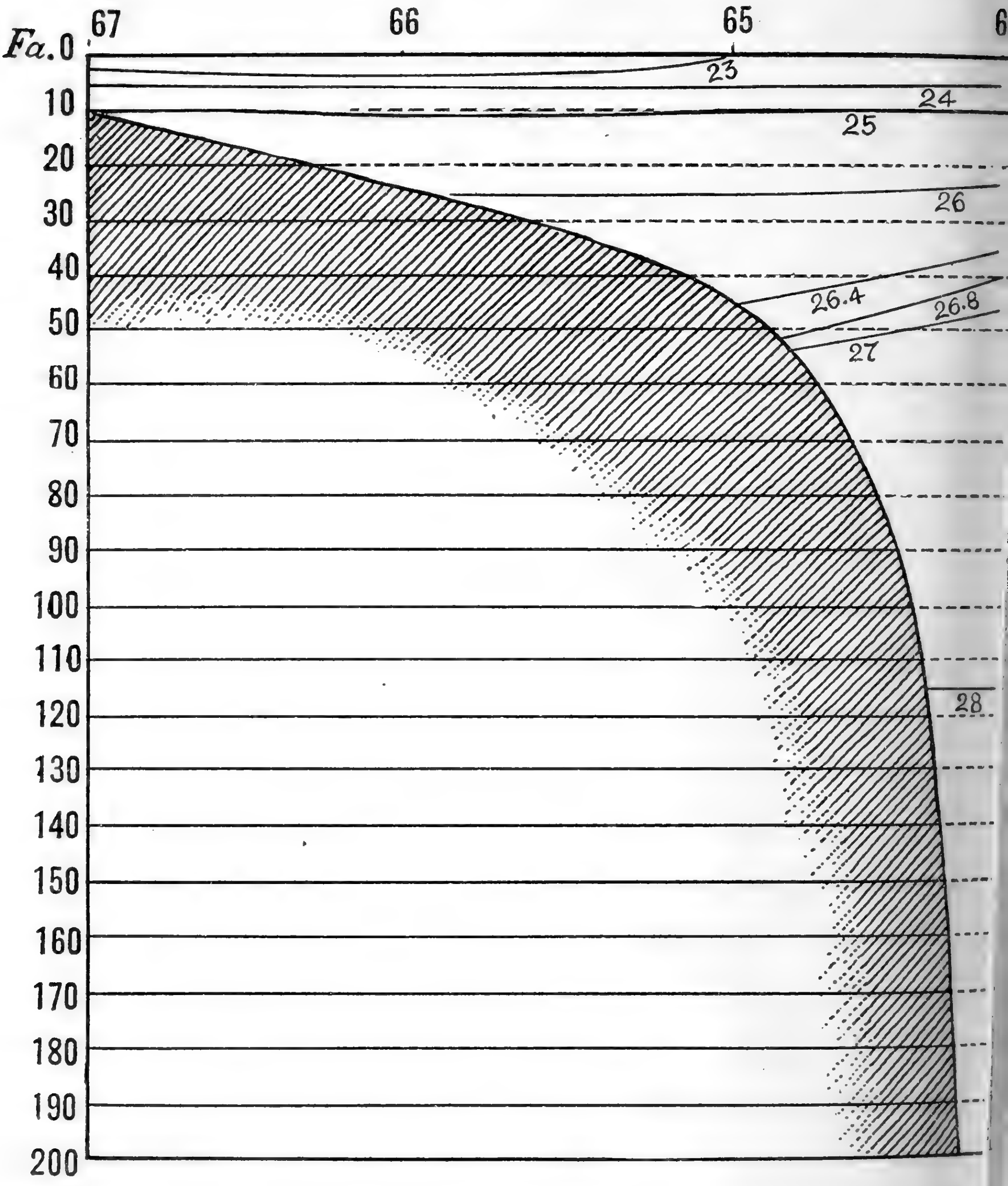

Fig. 58.— Density profile from New York to the edge of the Gulf Stream in Lat. 39° 55′ (Stations 10067, 10066, 10065, 10064) July 11–13.

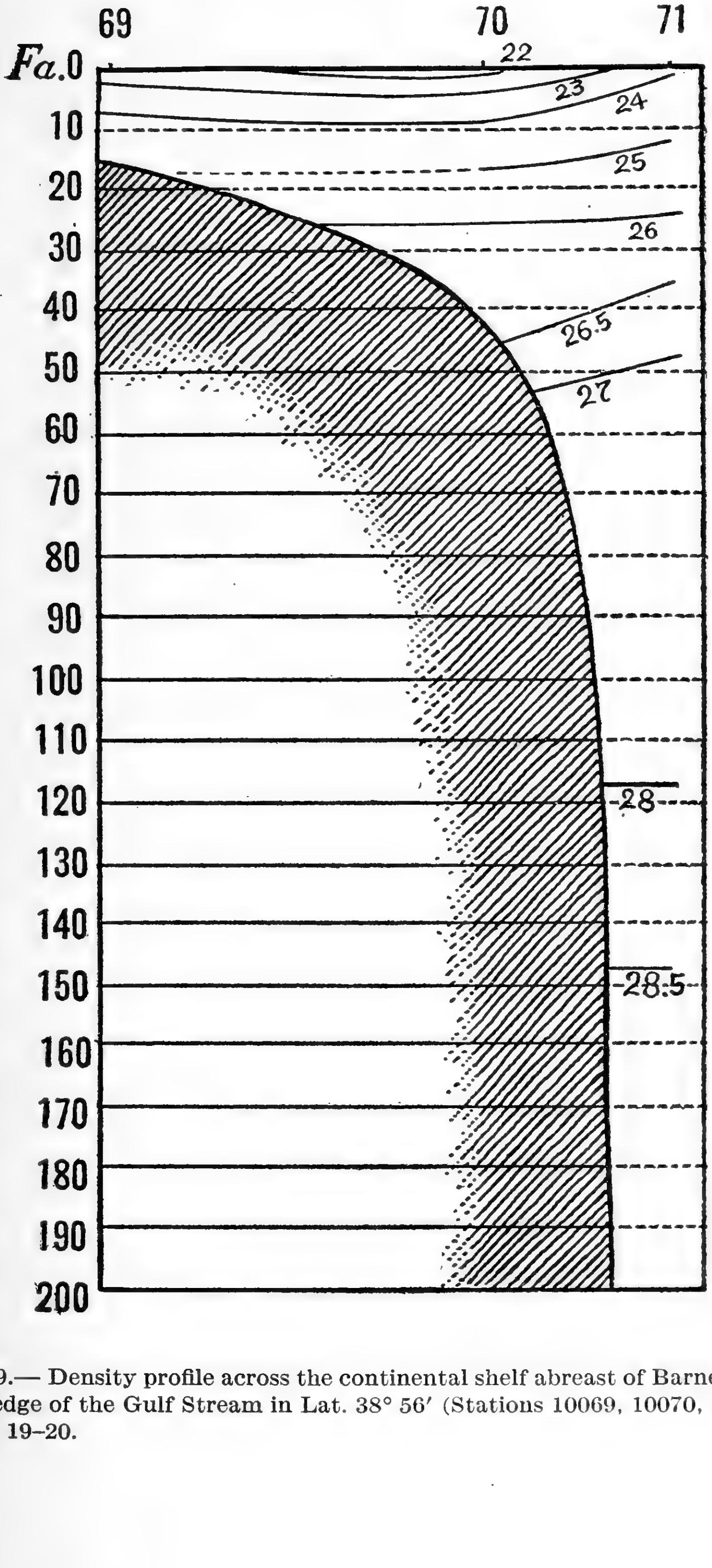

Fig. 59.— Density profile across the continental shelf abreast of Barnegat to the edge of the Gulf Stream in Lat. 38° 56′ (Stations 10069, 10070, 10071) July 19–20.

flow over the bottom. And the level at which density is uniform, horizontally (twelve fathoms) exactly coincides with the salt tongue (p. 198). The profile abreast of Chesapeake Bay (Fig. 61) shows a similar distribution of density over the inner part of the continental shelf. But the seaward rise of density on the bottom is less rapid than it is further north; and density is uniform, horizontally, below twenty-five fathoms.

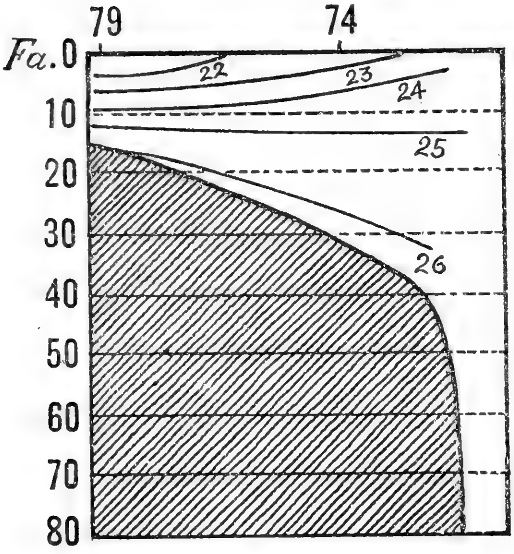

Fig. 60.

Fig. 60.— Density profile across the continental shelf south of Delaware Bay (Stations 10079–10074) July 22–30.

Fig. 61.— Density profile across the continental shelf abreast of Chesapeake Bay (Stations 10078, 10077, 10076) July 24–29.

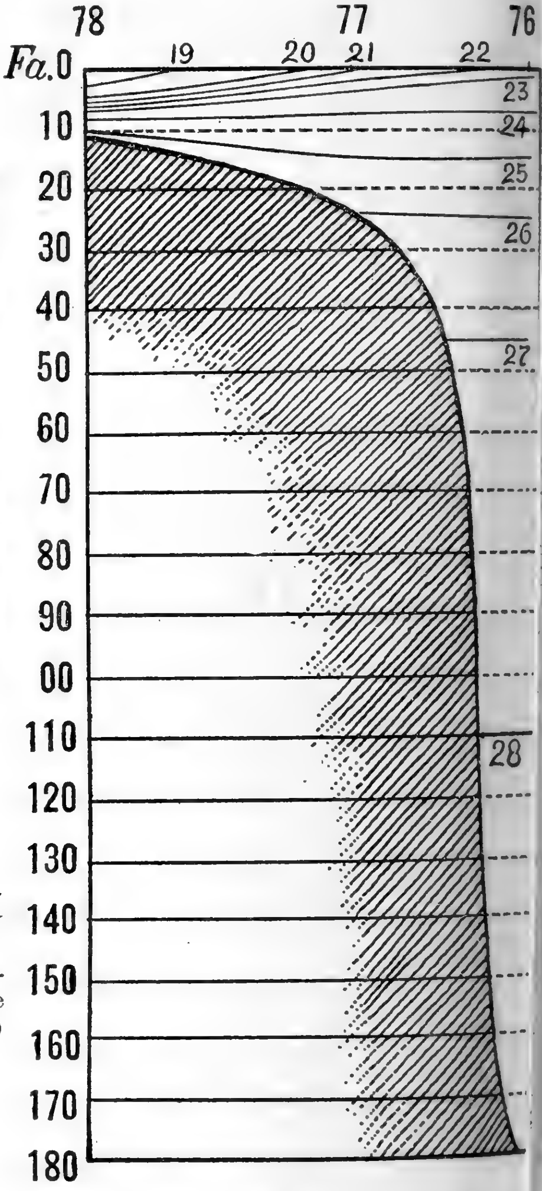

Fig. 61.

DENSITY IN THE GULF OF MAINE.

In the Gulf, in August (Fig. 55) the surface water was lightest close to shore north of Cape Ann (1.0231), off Cape Cod (Station 10085, 1.0231), and, in an isolated region, over the western basin (Station 10088, 1.0229); the latter was a local phenomenon, due to high surface temperature. Surface density was highest on German Bank (1.0254) and along the northern part of the coast of Maine (1.025), *i. e.*, in those regions where tidal currents cause the most effective vertical mixing of the water. And the surface was only slightly less dense off Lurcher Shoal, owing to its low surface temperature. We likewise encountered surface water of high density off Matinicus (Station 10101, 1.0248); And no doubt many other anomalies of this kind might be found in the Gulf, caused by local surface cooling by tide rips and vertical currents.

The surface density of most of the Gulf was 1.0236–1.0248, increasing from southwest to northeast; *i. e.*, considerably higher than over the continental shelf south of Cape Cod a month earlier; had the observations been taken simultaneously the discrepancy would have no doubt been greater, it being only reasonable to assume that the surface of the Gulf would have been cooler early in July than early in August, but with nearly the same salinity (1914a).

The table of density (p. 344) shows that the water was lightest at the surface, heaviest on the bottom, *i. e.*, was in stable equilibrium, everywhere in the Gulf. Where vertical and tidal circulation is active, as on German Bank, the stability was so slight as to offer little resistance to vertical overturning of the water. But where tides are weak, as for example off Massachusetts Bay, over the western basin, and in the trough west of Jeffrey's Ledge, the difference between surface and bottom density, and hence the vertical stability, is great. In the western parts of the Gulf in general there was a very rapid rise of density from the surface down to about 20–30 fathoms, corresponding to the rapid rise of salinity and fall in temperature in this zone; followed by a very much slower, though continuous increase, down to the bottom. But the density curves, like those for temperature are progressively straighter and straighter, passing across the Gulf from southwest to northeast. And in the northern end of the eastern basin, as well as on the Nova Scotian and Maine banks, the rise in density, whether great or little, was nearly uniform in rate, from surface to bottom; most nearly so where the stability of the water was slightest (*i. e.*, German Bank).

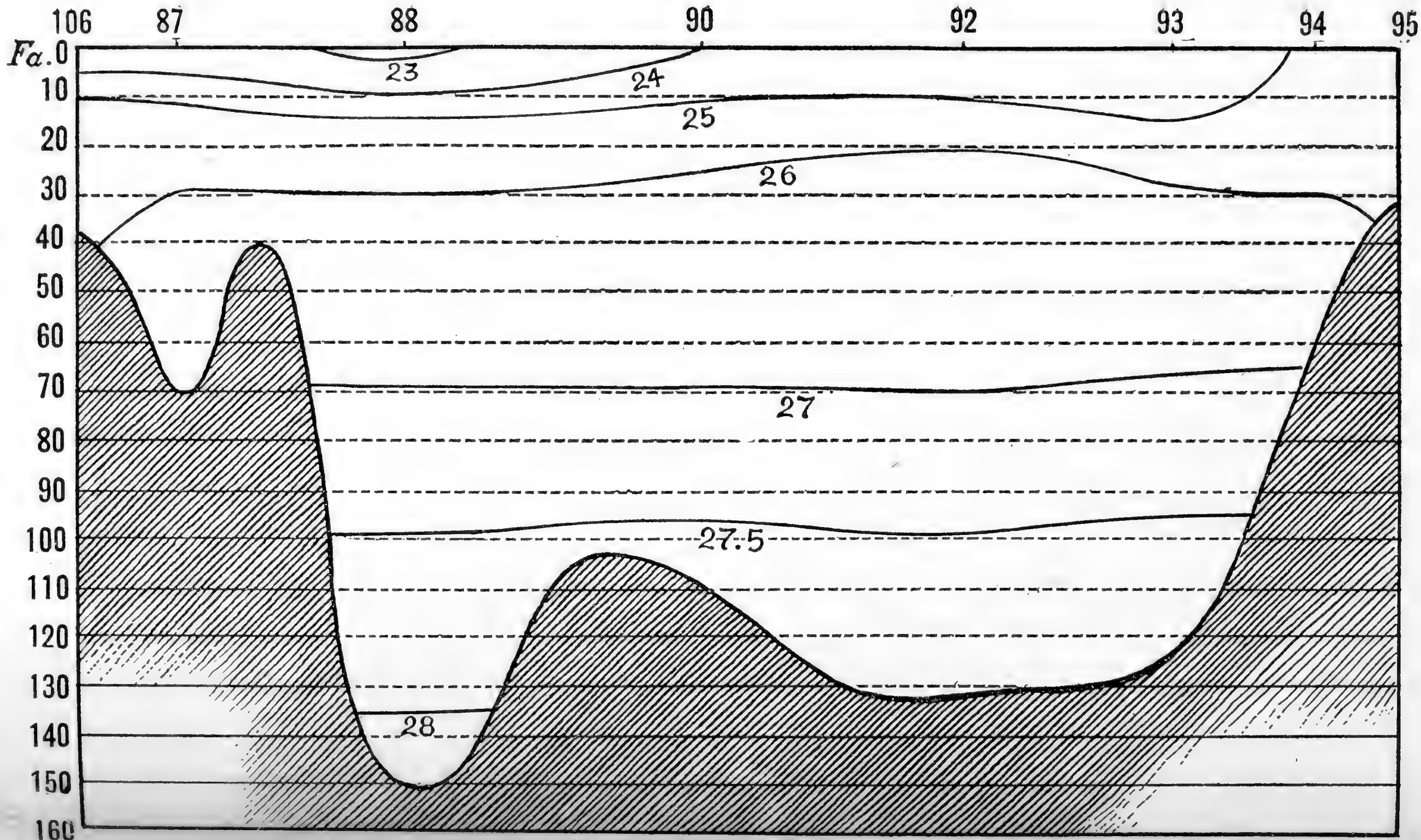

Fig. [illegible].—Density profile across the Gulf of Maine from Massachusetts Bay to German Bank (Stations 10106, 10087, 10088, 10090, 10092, The density profile (Fig. 62) crossing the Gulf from Massachusetts Bay (Station 10106) to German Bank (Station 10095) shows that the water was nearly uniform horizontally, depth for depth, below seventy fathoms. In the mid-depths the water was densest at Station 10092. Over German Bank there is a distinct spreading of the curves reminiscent of, and due to the same cause, as the spreading of the temperature and the salinity curves in that region. And the same condition prevails below twenty fathoms in Massachusetts Bay, just as described for salinity (p. 208).

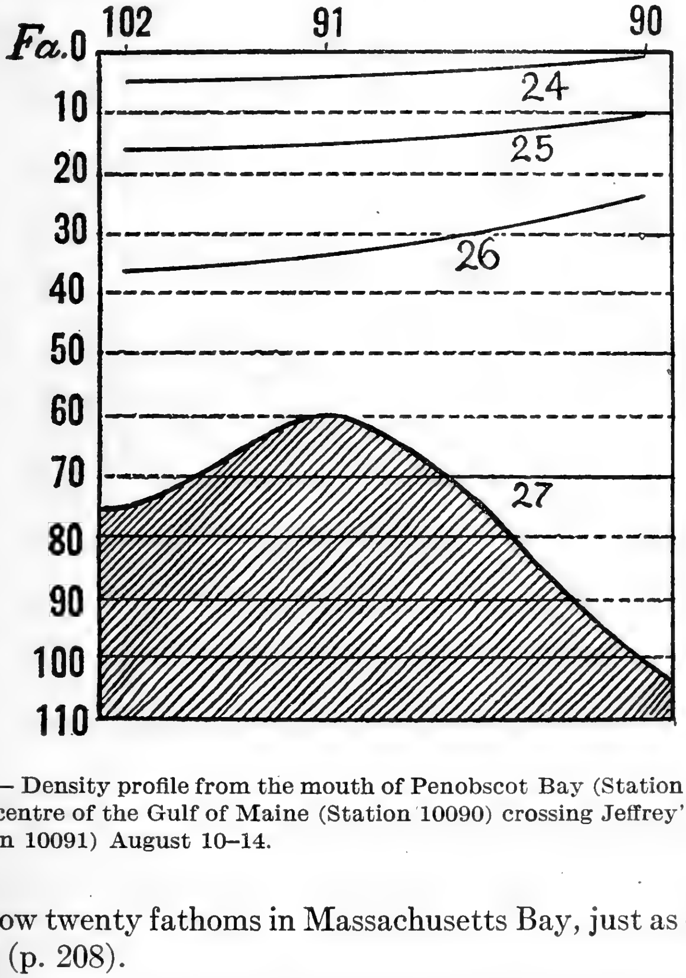

Fig. 63.— Density profile from the mouth of Penobscot Bay (Station 10102) to the centre of the Gulf of Maine (Station 10090) crossing Jeffrey's Bank (Station 10091) August 10–14.

A profile from Station 10102, near Penobscot Bay, across Jeffrey's Bank to the centre of the Gulf (Fig. 63) shows a slight rise in density passing off shore, the difference being greatest in the mid-depths. But a parallel profile further east would be exactly the reverse, the surface density being higher at Stations 10101, 10100, and 10098 than at either Station 10092 or 10093.

COLOR OF THE SEA.

The observations on color, tabulated below, are interesting chiefly because there is very little precise information as to the color of the water over the continental shelf south of Cape Cod.

Color, in % of yellow, according to the Forel scale (Steuer, 1910).

Station	Color	Station	Color	Station	Color	Station	Color
10057	27	10070	5	10083	20	10096	20
10058	9	10071	2	10084	27	10097	—
10059	20	10072	9	10085	27	10098	20
10060	5	10073	2	10086	27	10099	27
10061	2	10074	5	10087	14	10100	27
10062	9	10075	20	10088	—	10101	35
10063	20	10076	2	10089	—	10102	20
10064	2	10077	9	10090	9	10103	—
10065	5	10078	14	10091	20	10104	20
10066	—	10079	14	10092	9	10105	20
10067	54	10080	14–20	10093	—	10106	—
10068	54	10081	9	10094	27		
10069	27	10082	—	10095	27		

The water was very green (27% yellow) along Cape Cod both in July and in August, and this was also the case on the western side of George's Bank (20%). But it was distinctly bluer (9% yellow) over the southern end of the basin of the Gulf and after crossing Nantucket Shoals the water grew visibly blue to the eye, being almost pure blue (2% yellow) at the 80 fathom curve south of Nantucket (Station 10061).

In general the water was greenest near land, bluest off shore, as might be expected, the water being greenest of all near New York (Stations 10067, 10068). The color was 20–27% yellow along the coast of New Jersey; that of the coast water south of Delaware Bay 14–20% yellow. The water was nearly pure blue (2% yellow) at all the stations outside the edge of the continental shelf.

The water of the Gulf of Maine was considerably greener, most so along Cape Cod (27% yellow), over German Bank (27% yellow), and along the coast of Maine between Mt. Desert and Penobscot Bay (27–35% yellow). The water was considerably bluer (9%) over the deep basins; but nowhere in the Gulf did we find the beautiful ultramarine water which washes the continental slope.

South of Cape Cod the general rule is that the water is bluest where saltest, greenest where freshest; though this does not exactly cover the case, because the water was bluer close off Chesapeake Bay than off New York, although the salinity was lower. But in the Gulf of Maine this rule did not hold either in 1912 (1914a) or in 1913, the greenest water being intermediate in salinity, while the saltest water was not the bluest.

CURRENT MEASUREMENTS.

Measurements of surface and bottom currents with the Ekman Current meter (Ekman, 1905b) were taken at three stations between Cape Cod and Chesapeake Bay, with hourly readings for six hours at each station. The directions are the compass bearings (magnetic) toward which the current flows. Velocity in knots per hour is to the nearest tenth of a knot.

I. STATION 10065, JULY 12.

High water at Fire Island Inlet at 2.05 P.M.

Hour	Depth	Duration	C. C. per sec.	Direction	Knots per hour
9 A.M.	0	4′ 58″	19.1	WNW.	.4
9 "	40	5′ 10″	10.2	NW. by N.	.2
10 "	0	5′	9.3	WNW.	.2
10 "	40	2′ 20″	22.1	W. by N.	.4
11 "	0	5′ 18″	10.7	W. by N.	.2
11 "	40	5′ 10″	3.2	NW.	Trace
12.30 P.M.	0	5′ 5″	26.9	NNW.	.5
12.30 "	40	5′ 45″	27.9	S. by E.	.5
2 "	0	4′	24.	NE.	.4
2 "	40	4′ 45″	24.9	S. by E.	.5
2.45 "	0	5′	33.3	NE.	.6
2.45 "	40	5′ 5″	15.1	S.	.3

II. STATION 10072, JULY 21.

Low water Barnegat Inlet at 4 A.M.

1.46 A.M.	24	5′	10.	S. by E.	.2
2.15 “	4	5′	12.4	S. by W.	.2
2.30 “	0	5′	7.3	SSW.	.14
3 “	24	5′	7.2	WSW.	.14
3.15 “	4	5′	7.3	S. by W.	.14
3.20 “	0	5′	7.2	SSW.	.14
4 “	24	5′	7.3	NNW.	.14
4.15 “	4	5′	7.7	W.	.15
4.20 “	0	5′	27.3	SSW.	.5
5 “	24	5′	25.3	S. by W.	.5
5.15 “	4	5′	34.3	W. by S.	.7
5.25 “	0	5′	38.2	S. by W.	.74
6 “	24	5′	17.3	N. by W.	.3
6.15 “	4	5′	36.8	W.	.7
7 “	24	5′	14.1	N. by E.	.3
7.15 “	4	5′	36.3	W. by N.	.7
7.30 “	0	5′	36.3	W. by S.	.7
8 “	24	5′	13.2	NE. by N.	.3
8.15 “	4	5′	28.	WNW.	.54

III. STATION 10074, JULY 22.

High water Cape May 11 A.M.
High water Barnegat 10.35 A.M.

7.45 A.M.	30	5′	5.9	S. by E.	.1
8 “	0	5′	30.	W.	.6
8.45 “	30	5′	2.8	?	Trace
9 “	0	5′	28.8	W.	.55
9.45 “	30	5′	9.7	SSE.	.2
10 “	0	5′	20.	NW. by W.	.4
10.45 “	30	5′	9.7	S. by E.	.2
11 “	0	5′	9.7	NNW.	.2
11.45 “	30	5′	16.3	SSE.	.3
12 “	0	5′	10.5	N. by W.	.2
1.10 P.M.	30	5′	7.7	S½W.	.15
1.20 “	0	5′	4.	NNE.	.1
2 “	30	5′	9.9	S.	.2
2.10 “	0	5′	18.3	ENE	.35
3 “	30	5′	5.6	SSE.	.1
3.10 “	0	5′	14.3	E½N.	.3

At Station 10065, over the 45 fathom curve, fifty miles south of Long Island, the first reading was taken about five hours before high water at Fire Island Inlet, the nearest shore station for which tidal data is available. The surface current ran northwesterly for the first three hours; and then veered to the north and northeast, in which direction it flowed, till the end of the set. Of course the observation does not show conclusively whether or not there was a dominant drift in any direction, because it did not cover the last half of the ebb; but it goes far enough to show that the flood current ran about northwest; the first half of the ebb to the northeast, the strength of the flood being .2–.6 knots, of the ebb .4–.7 knots per hour (Fig. 64).

The total drift for the part of the tide covered by the set is about 1.8 knots north. And it seems hardly probable that the last few hours of the ebb would wholly nullify this, the general trend of the coast in this region being such that it is safe to assume that the last part of the ebb flows about east, the first part of the flood westerly. And even if the late ebb ran southeast with a velocity of .5 knots, there would still remain a net northerly drift of nearly .5 knots. It is therefore fair to conclude that there was a slight dominant northerly movement of the surface water over this part of the continental shelf.

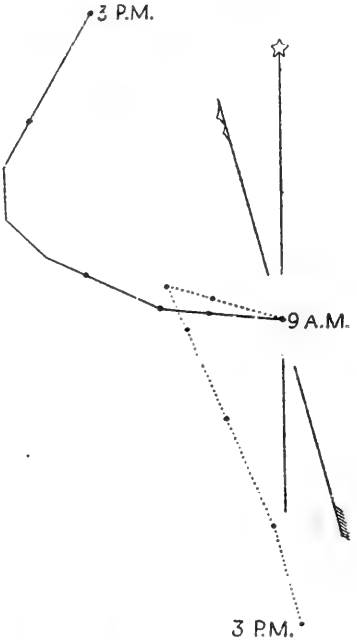

FIG. 64.— Surface current ———, and bottom current . . . . . . at Station 10065; hourly from 9 A.M. to 3 P.M., July 12. The distance between dots (.) shows the drift for each hour; 2.25 cm. = 1 sea mile. The compass arrows are true and magnetic.

The bottom current turned an hour earlier than the surface current. During the last three hours of the flood the flow on the bottom was toward the northwest, with a velocity diminishing from .4 knot to zero. It then veered to the south by east, and south, running in that direction for three hours with the considerable velocity of .35–.5 knot per hour. The total set showed a net movement of water of about 1.4 knot toward the south-southwest; but it is a question whether there was any dominant flow on the bottom, for if the current veered to the southeast and east during the last of the ebb, with a northwest current throughout the flood, as is not unlikely, the net drift would be neutralized.

Fifty miles off Cape May (Station 10072) readings were taken at zero, four, and twenty-four fathoms, from 1–46 A.M. to 8–15 A.M., the time of low water being 4 A.M. at Barnegat Inlet (Fig. 65). The surface current ran southwest during the entire set, veering toward the west (S. S. W. to W. by S.) with velocities ranging from .15 knot at the beginning to .7 knot at the end, showing that the tide started to flood shortly before we began work. The total drift was about 3 knots southwest. At four fathoms the current veered from S. by W. through west, to W. W., N. the velocity ranging from .14 knot to .7 knot, the net drift 3 knots west, *i. e.*, toward shore. The bottom current at twenty-four fathoms veered irregularly from S. by E., through S. W. west, and northwest to northeast, with velocities

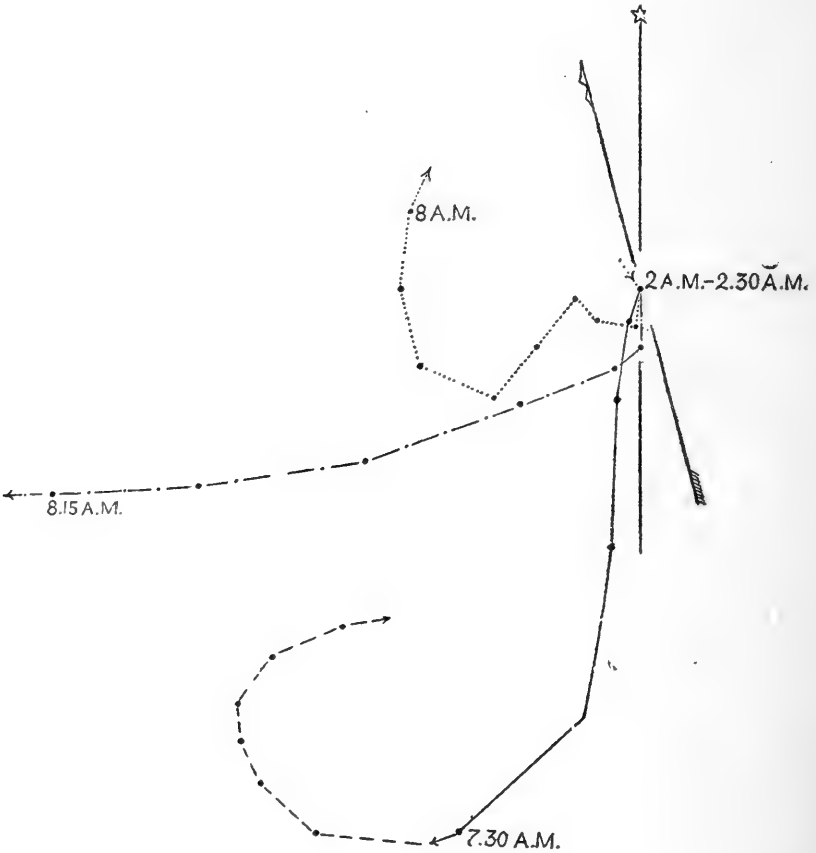

Fig. 65.— Surface current ———, 4 fathom current — · — · — ·, and bottom current. . . . , at Station 10072; hourly from 2 A.M. to 8 A.M., July 21. The surface current of Station 10074,. . . . , is combined with Station 10072 to show total drift for an entire tide. 2.25 cm. = 1 sea mile.

ranging from .14 knot to .5 knot, greatest when the flow was southwesterly and northwesterly. The total drift was about 1 knot toward the northwest. These three sets were planned to cover the last half of the ebb, and the first half of the flood. But the observations show that the flood current had begun to run one to two hours earlier than the time of low tide at Barnegat. Hence, the set must have been confined to the flood, and therefore can not show whether there was any dominant drift. To remedy this defect it would have been necessary to continue the set for six hours more, but this was impracticable, owing to a sudden squall. Consequently a third set of current measurements was made the next day at Station 10074, so timed as to

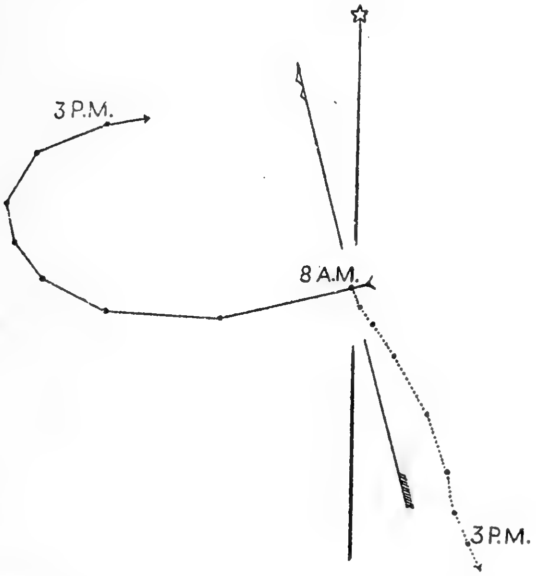

Fig. 66.— Surface current ———, and bottom current. . . . , at Station 10074, for each hour from 8 A.M. to 3 P.M., July 22. 2.25 cm. = 1 sea mile.

over the last of the flood and most of the ebb (Fig. 66). The surface urrent at Station 10074 set westerly for the first two hours, *i. e.*, uring the last of the flood. It then veered gradually through northvest, north, and northeast to east, in which direction it was running vith a velocity of .3 knot at the end of the set. The velocities were .6 not for the first two hours; .1 knot to .4 knot after that. The total et drift was about 1.5 knot to the northwest.

The bottom readings were less satisfactory than those on the surface, ecause of the weakness of the current. In general the flow was oward the south and south-southeast, varying irregularly between these two bearings, the total drift being about 1.2 knot toward the south by east. On combining the stations, omitting the first hour of 10074 to compensate for the advance of the tide during twenty-four hours, a southwesterly surface drift of 2.2 knots and a southwesterly bottom drift of about 1 knot results.

The last two hours of the ebb are still to be accounted for; the regular veering of the surface current suggests that it continues to swing toward the east and southeast, and general knowledge of similar tidal currents suggests a diminishing velocity. These two stations, then, taken together, indicate a dominant southwesterly current with a velocity on the surface, of two to three knots for an entire tide, *i. e.*, four to six knots in twenty-four hours. Of course the validity of this conclusion depends on whether a combination of these two sets of observations, as though they had been made at one station, is justified, and there is no apparent objection to so doing, either in the contour of the bottom, the course of the shore line, or in the amplitude of the tide at the two stations. Nor was there anything in the weather conditions to suggest that the surface current was a wind drift at either, because Station 10074 was occupied during a calm, and after a calm night; Station 10072 likewise after a calm night, and in a moderate breeze. And so far as the observations go, the velocity of the tidal currents was apparently about the same at the two stations, being about .7 knots per hour for the fifth hour of the flood at Station 10072, .6 knot at Station 10074. The bottom currents likewise suggest a slight southwesterly drift.

Circulation over the continental shelf, July, 1913.

Our current measurements, salinities, and densities allow a tentative reconstruction of the movements of the water over the continental shelf at the time of our visit. During the spring there must have been off shore surface currents opposite four main sources of fresh land water, *i. e.*, Long Island Sound, the Hudson River, Delaware Bay, and Chesapeake Bay, to produce the tongues of low salinity which we encountered there (Plate **2**). These currents must have been at their height at least a month earlier, *i. e.*, at the time of the greatest river freshets; the Delaware current reaching its maximum after the middle of May, because the salinity was higher off the Bay on May 9 (p. 188) than we found it (p. 198). The drift, as indicated by salinity, was easterly off the mouth of Long Island Sound, and there must have been a similar, but more pronounced off shore current opposite Chesapeake Bay, much as it is represented on the current chart of the North Atlantic (Soley, 1911), and surface density suggests that the fresh water from the Bay spreads out, fan-like, to the north, as well as over the heavier ocean water. The salter water which alternates with these comparatively fresh tongues is in part a contrast phenomenon; but the salinity curves immediately south of Delaware Bay can only be explained as due to an actual shoreward drift of water of high salinity (p. 187). And the current data at Station 10074 suggest, though they do not prove, that this salt tongue was swinging, eddy-like, toward the southwest. Just north of Delaware Bay, there seems to have been a similar eddy-like movement which, added to the southerly flow of coast water, produced the strong southwest current which was found at Station 10072. Surface salinities, like the current measurements at Station 10064 suggest traces of a northerly movement, or "banking up" of the ocean water south of Long Island, a process which had progressed so far by the end of August as to raise the surface salinity from about 32.8‰ (Station 10062) to about 34‰ (Station 10112).

Surface density, being practically the same off Cape Cod as over the outer part of the continental shelf south of Nantucket, does not indicate any general flow across Nantucket Shoals into the Gulf of Maine in July, or *vice versa;* nor does surface salinity afford any unmistakable evidence of a dominant current in that region, though the curve of 33% suggests a possible southeasterly drift. Salinities show that there must have been an indraught of ocean water into the eastern side of the Gulf, which is consistent with the fact that the surface density of the northern and eastern parts of the Gulf was very much higher than that of the ocean water outside George's Bank. To compensate for this tongue of ocean water, there was an outflow of land water off Penobscot Bay; and the salinity curves suggest a general southward drift of surface water along the western coast of the Gulf (Plate **2**).

The salinity curves, and our actual current measurements, agree very well with the earlier data, as summarized in the U. S. Coast Pilot (1912). According to the latter the prevailing drift over Nantucket Shoals is easterly, which agrees so well with our salinity curves as to make it a fair assumption that there is actually a dominant easterly current in this region in summer. The few current measurements which have yet been made on George's Bank (U. S. Coast Pilot, 1912, Mitchell, 1881) indicate a similar easterly drift, veering northward near the eastern edge of the Bank. And although the observations are insufficient for any definite mapping of currents in a region where the tides are so strong, it is certainly suggestive that this northerly trend near the eastern end of the Bank corresponds with the salt tongues which were found in the eastern side of the Gulf in both 1912 and 1913. But an easterly and northeasterly movement of water on the Shoals and over George's Bank, does not mean that there is a general easterly long-shore current, both because there is no dominant drift at Nantucket light-ship (U. S. Coast Pilot, 1912, p. 10), and because the various records agree in crediting the coast waters south of Marthas Vineyard as a whole with a westerly, southwesterly, or northwesterly drift. In short, present indications point to the conclusion that the movements of surface water are tidal there, in the form of an irregular, perhaps intermittent eddy, which receives greater or less accessions of Gulf water on its northern side, and of ocean water along its southern and southeastern edge. The latter is an important factor in summer when it must influence hydrographic conditions on the banks profoundly, just as it does over the continental shelf further west (p. 198). And it exerts an unmistakable influence on the oceanography and plankton of the Gulf of Maine as well.

The outrush of comparatively fresh water from Long Island Sound, shown by the salinity curves, is substantiated by current records; and the northwesterly current over the forty fathom curve south of Block Island, represented on the current chart in the Coast Pilot, corresponds with our current records over the same part of the shelf a few miles further west. But the changes which take place in the surface salinity of this region at different seasons show that it is by no means a permanent phenomenon, probably being reversed in spring by the outrush of shore water.

The combined evidence of the various records of ocean currents, our own included, points to the conclusion that the dominant drift over the continental shelf, south of New York, is to the southwest; and this is certainly the prevalent opinion of practical navigators and hydrographers. But it does not necessarily follow that this drift is a simple, long-shore current, as has so often been suggested. On the contrary, surface salinity shows that it is interrupted by outpourings of comparatively fresh water off the rivers and bays, at least in spring and summer, and, conversely, by shoreward movements of salt ocean water. Furthermore little evidence was found of any appreciable southerly flow on the bottom, even in water as shallow as twenty-four fathoms, though there was an unmistakable southwesterly current on the surface. The correct explanation is that the movement of the surface waters over the shelf is chiefly a series of great eddies, receiving water, on the one hand from the Gulf Stream off shore, on the other, from the land. The accompanying chart (Plate **2**) shows an attempt to reconstruct the surface currents, for the summer months; but so intricate is the problem, and so scanty the reliable information yet at hand, that it is only tentative.

It is even more difficult to reconstruct the movements of the subsurface water, because we must rely almost wholly on the GRAMPUS observations. These current measurements do not prove any dominant flow on the bottom north or south of Delaware Bay (p. 230), and it is questionable whether any general flow can be deduced from them south of Long Island. But salinity, density, and temperature show that the bottom and intermediate waters over the shelf are far from being stagnant, though their movements, other than tidal currents, are probably slow as compared with the surface currents.

The density profile across Nantucket Shoals does not suggest any flow into, or out of the Gulf of Maine in this region at any depth; nor does the density of the bottom water of the Gulf suggest any influx of ocean water from the zone between fifty and 130 fathoms, via the Eastern Channel.

The seaward dip of the density curves south of Nantucket together with the cold tongue (p. 165) shows that the bottom water was flowing seaward down the shelf from the fifty fathom curve, indenting into and mixing with the ocean water over the slope (Fig. 10); and this agrees with the salinity curves. But south of Long Island, the fact that the density curves are just the reverse, together with the sudden rise of salinity immediately below the cold tongue, suggests that here the ocean water was sinking, obliquely, toward the land below the cold, fresh coast water. And to judge from the densities, a similar movement of water must have been taking place over the outer part of the shelf off Barnegat also.

The salt tongue which indents the fresher coast water in the middepths over the continental shelf between Delaware Bay and Chesapeake Bay (p. 198) is as interesting as the cold tongue off Long Island. Just south of Delaware Bay, there seems to have been an actual movement of surface water toward the coast (Fig. 60), gradually mixing with and sinking below the much fresher, hence lighter coast water. At twelve fathoms, *i. e.*, the axis of the salt tongue, the density was uniform, east and west; below twelve fathoms, the density gradient dipped from land to sea. Thus ocean water must have been coasting, as it were, down the density gradient, from near the surface over the 100 fathom contour to about twelve fathoms over the thirty-five fathom contour, with the heavier, though fresher, bottom water of the shelf moving seaward below it. Density points to a similar type of circulation off Chesapeake Bay. But this phenomenon must be transitory, because as the coast water grows warmer with the advance of the season its density on the bottom must fall as low as that of the salter water off shore.

The band of uniform salinity which we traced from Station 10063 to Station 10069 (p. 194) was not the result of vertical mixing; had it been temperature like salinity would have been equalized. Its origin is obscure.

Neither density, salinity, nor temperature indicates any general longshore movement of the bottom waters on the shelf.

PREVIOUS RECORDS OF TEMPERATURE AND SALINITY CAPE COD TO CHESAPEAKE BAY.

The existence of a band of cold water between the Gulf Stream and the coast has been recognized since the days of the early voyages to these shores. By 1850 its general geographic limits were well understood (Maury, 1855), since which time a vast body of surface temperature readings has been taken over the continental shelf by vessels entering the ports of New York, Philadelphia, and Chesapeake Bay, as well as by various expeditions and government services. But most of these have never been published; and since, in any event, the general range of summer temperature is now well known, I need refer here to only a few of the more important sets of observations. The data obtained by the U. S. Fish Commission south of Marthas Vineyard between 1880 and 1882, (Tanner, 1884a, 1884b; Verrill, 1880–1884b), show the general rise of temperature passing off shore from the southern coast of New England. And records have constantly been kept at Woods Hole since that time, so that there are very satisfactory data of the temperature close to shore in that region. The more recent of these are summarized by Sumner, Osburn, and Cole (1913), who find that the monthly surface mean for a five year period, at the Woods Hole Station, is 31° in February, 43.9° in April, 68.8° in July, 69.7° in August, 48.2° in November. In Vineyard Sound the mean surface temperature, August, 1907, was 64.7°, November, 1907, 50.9°; March, 1908, 36.6°; June, 1908, 56.5°. The surface temperatures of the water close to the coast south of New York are likewise well known for all months in the year (Rathbun, 1887) owing to the extensive series of temperatures taken at various light-houses and light-ships, notably "Winter quarter Shoal," and "Five fathom bank" off Cape May from 1881–1885. At the former, on July 25, *i. e.*, about the time the GRAMPUS passed there, the temperature was 74° in 1881, 72° in 1882 and 1883, 69° in 1884, and 74° in 1885. Our records, a few miles away, July 21, were 74°–75°. But by July 30, a surface temperature of 76° close to the light-ship was noted. At "Five fathom bank" the temperature, on July 25, 1881, was 71°; 73° in 1882; 71° in 1883; 74° in 1885: on July 21, 1913, it was 73°–74°, a few miles to the east, rising to 77° close to the light-ship on July 31. Off Sandy Hook, July 19, the surface temperature was 71° in 1881 and 1882; 74° in 1883; 65.5° in 1884; 69° in 1885. On July 17, 1913, it was 68°–69°. On Nantucket Shoals, 40° 54′ N., 69° 49′ W., *i. e.*, some seventeen miles north of the present location of the light-ship, the surface temperature, July 10, ranged from 55° to 60° for the five-year period. On July 9, 1913, it was probably about 56°, *i. e.*, about the same; but the GRAMPUS did not visit this exact spot; and the surface temperature varies with the greater or less violent tides over the shoals.

The general summer temperature of the water over the outer part of the continental shelf is now well known for the region south of Martha's Vineyard, thanks to Verrill (1880–1884b) and Libbey (1891, 1895).

In July and August, 1881, the surface temperature south of Marthas Vineyard was slightly cooler than in 1913, from 63° over the forty fathom curve, to 66° over the fifty fathom curve, and 72° over the 100 fathom curve (Verrill, 1881, 1884b), whereas on July 11, 1913, a few miles further east, it ranged from 65°–67° between the forty and the seventy-five fathom curves. Over the 100 fathom curve, on the other hand, the 1913 temperatures are a little the lower (69°–70°, as against 72°). Unfortunately Verrill's data for 1882 are not directly comparable, because taken in August. But during that month the surface water outside the sixty fathom curve south of Marthas Vineyard was constantly warmer than 70°, *i. e.*, about as much warmer than the year before for that month, as 1913 was warmer than 1881 in July. In 1889 Libbey (1891) took an extensive series of surface temperatures south of Block Island and Marthas Vineyard, affording the most complete temperature survey of a limited locality yet attempted off the American coast. Any analysis of these records would require a study of diurnal warming and nocturnal cooling, to make them comparable with one another. But this is not necessary here, because, after all, they are not strictly comparable with our observations, having been taken from three to six weeks later in the season, and hence may be expected to be higher. They suggest that the surface water in that year may have been rather cooler than we found it, for Libbey (1891) found much the same temperature at the end of July that was observed in the first half of the month; *i. e.*, July 24, 1881, 62.8° at the 25 fathom curve south of Nantucket; 66°–67° over the outer half of the shelf; 68° at the 100 fathom curve.

A large number of surface temperatures have been collected by Dickson (1901) for the years 1896, 1897. In July 1896, according to his charts, the surface temperature from Marthas Vineyard to New York was between 60° and 68°, above 68° off New Jersey. By August it had risen to 68°, the greater number of the records having been taken, no doubt, along the direct steamship line from Nantucket light-ship to Fire Island light-ship. In 1897 the water was warmer, being upwards of 68° from Nantucket to New York. According to the British Meteorological office (Sumner, Osburn, Cole, 1913, p. 438) the mean surface temperature, some thirty miles south of Marthas Vineyard, is 67° in July, 69° in August: 66° and 70° respectively in Long Island Sound; 71° and 73° in the mouth of Delaware Bay; 75° for both months over the 100 fathom curve off Chesapeake Bay. Hautreux (1911) gives the average surface temperature, for a five-year period, off Fire Island light-ship, as 66.2° for both July and August. How closely the temperatures obtained in July, 1913, agree with Sumner's averages is illustrated by the fact that we had precisely the same reading off Fire Island light-ship; off Marthas Vineyard (Station 10063, 67°); off the edge of the continental slope abreast of Cape May (73°); and the difference off Chesapeake Bay was only 1°–2°. And they lie within the range for 1896, as given by Dickson, but are colder than his records for 1897. On the other hand the water was warmer off New York in 1913 than the five-year average given by Hautreux, 69° instead of 66.2°.

The summer temperatures outlined above are enough to show that 1913 may be considered a perfectly normal year; 1881, 1884, and 1889 were cooler, and 1897 warmer. And in view of the fact that in summer the surface temperature over the continental shelf depends largely on the wind, it is doubtful whether the very slight differences between these years have any general significance.

The general range of surface temperature over the continental shelf between Cape Cod and Chesapeake Bay, so far as known, may be summarized as follows: — in February, the coldest season of the year, the temperature of the water is very low indeed close to the coast and in the bays and sounds, 31°–36° near Woods Hole, rising, toward the southwest, to about 35° near New York (Rathbun, 1887); about 36° off Cape May, 37°–38° at Winter Quarter Shoal; and even south of New York, freezing temperatures may occur near shore during very cold weather. But such low temperatures are limited to a very narrow belt, the winter temperature over the continental shelf as a whole being 40°–45°, rising suddenly to about 50° over the continental slope. And, of course, the surface water is still warmer further to the east and southeast, *i. e.*, in the Gulf Stream. With the advance of spring the temperature of the shore water rises steadily, until by the first part of July, the water over the continental shelf ranges, in temperature, from 75° off Chesapeake Bay to 68°–70° south of Marthas Vineyard. During mid-summer the temperature is locally higher next the coast than it is over the shelf, often even higher than the surface water of the Gulf Stream in these latitudes. For instance, the temperature immediately off Chesapeake Bay, in July, 1913, rose to 80°; off New York to 75°; off Long Island to 70°–71°. And the summer warming of such enclosed waters as Woods Hole and Nantucket Sound outstrips the rise of temperature over the shelf, until, as the summer advances, the shoreward movement of Gulf Stream water may obliterate this difference by raising the surface temperature over the shelf as a whole to 70° or over. And Gulf Stream water, with its characteristic plankton, often floods Narragansett Bay and Vineyard Sound in late summer, though the extent to which this happens differs from year to year, depending on the direction of the wind. The surface temperature of the coast water reaches its maximum in August.

To the student of ocean circulation one phenomenon in this annual cycle is of great importance, namely, the fact that where the water cools most rapidly, and to the greatest degree, in autumn and winter, *i. e.*, close to the shore, there it warms up most rapidly in spring and summer.

A large number of subsurface temperatures have been taken in the waters south of Marthas Vineyard, beginning with a series of bottom readings, by the vessels of the U. S. Bureau of Fisheries, in 1880, 1881, and 1882; and continued by Libbey (1891, 1895), who took several thousand readings at intermediate depths in 1889, 1890, and 1891. But these were all made in summer and early autumn; and our knowledge of subsurface temperatures on the continental shelf at other seasons, and at any season elsewhere than in the region studied by Libbey and Verrill, is limited to a few bottom readings taken by the Fish Hawk (Tanner, 1884a, 1884b), Blake (Smith, 1889) and Albatross (Townsend, 1901). Verrill's observations were located at successive points across the zone between the fifty and 150 fathom contours, and they are especially valuable, because they were taken before and after the extraordinary mortality of the tile fish, *Lopholatilus chamaeleonticeps,* of 1882 (p. 266). On July 21, 1880, the Blake ran a line across the continental shelf from Montauk Point, getting the following bottom temperatures: 24 fathoms, 60°; 43 fathoms, 49°; 71 fathoms, 51°; 129 fathoms, 51°; and 732 fathoms, 39.5°. Although these readings were taken with the Miller-Casella (maximum-minimum) thermometer, and hence register merely the coldest water at each station, which may not have been on the bottom, they show that the cold water on the shelf was separated from the even lower temperature of the abyss by a warmer belt at 75–130 fathoms, just as it was in July, 1913; and that this condition obtained as far east as the northeast end of George's Bank, where the bottom temperature, following down the continental slope, rose from 42° at seventy fathoms to 44° at 139 fathoms, and then fell to 40.5° at 300 fathoms. This "warm belt" was certainly distinguishable as late as August 17, 1880, when the Fish Hawk found bottom temperatures of 40°–48° in about thirty fathoms off Block Island. In September and October of the same year, the Fish Hawk took a considerable number of bottom temperatures on the shelf south of Block Island with deep-sea thermometers of the reversing type, finding about the same temperature (51°–53°) at 100–142 fathoms as in July, with colder water deeper down the slope (Verrill, 1880, Tanner, 1884a). But no readings were taken on the inner part of the shelf except in the very shallow water close to shore. The Blake records suggest that the water on the shelf south of Block Island was several degrees warmer, depth for depth, in 1880 than in 1913; but the discrepancy may be due to the fact that the observations were taken two weeks later in the former year.

The Fish Hawk temperatures for 1881 (reversing thermometers), again demonstrate the existence of the "warm belt" bathing the bottom at 70–100 fathoms, with lower bottom temperatures in the shallower water near shore (Verrill, 1881, 1884a, Tanner, 1884b), much the same distribution of temperature as in 1913. Thus on a line S 1/2 W from Marthas Vineyard, the bottom temperature rose from 42° at forty-four fathoms to 52° on the bottom between the sixty-seven and ninety-eight fathom curves, below which it fell slowly to 42° at 229 fathoms, as illustrated by the following table, constructed from Verrill's data.

Line S 1/2 W from Marthas Vineyard, July 16, 1881.

Fathoms	Bottom temperature
44	42°
46	45°
53	42.5°
63	49°
67	52°
98	52°
164	44.5°
199	44°
229	42°

The absolute temperatures of 1881 closely parallel those of 1913, *i. e.*, Verrill found a bottom temperature of 52° at seventy-seven fathoms, August 14, close to the location of Station 10061, where the bottom reading was 51.5° in seventy-five fathoms. Near Station 10062 Verrill's bottom reading was 42° in forty-four fathoms, 43.6° that of the GRAMPUS in forty fathoms, five days earlier in the season.

The records for 1881 and 1913 are not directly comparable outside the 100 fathom curve because the former were made six weeks later in the season than the latter, at the one location visited in both years. And the seasonal difference shows its effect in higher temperatures for 1881. Thus, near Station 10064 Verrill's readings, September 8, were 47.5° and 45° at 182 and 216 fathoms, depths at which the temperatures, on July 11, 1913, were 45.7° and 43°. In October, 1881, the FISH HAWK took a series of temperatures off Delaware Bay, finding 51° on the bottom at about 100 fathoms (Verrill, 1882a; Tanner, 1884b). And on November 16, of the same year, she found the bottom temperature 56° in 31 fathoms, 55° in 56 fathoms and 48° in 157 fathoms, off Cape Charles (Tanner, 1884b).

In 1882 the bottom water on the continental shelf was decidedly colder than it was the year before (Tanner, 1884c; Verrill, 1882, 1884a). And even more important is the fact that Verrill found no trace of the warm belt at 75–100 fathoms. On the contrary the bottom readings grew colder and colder seaward from the seventy fathom curve, as follows: —

Bottom temperatures south of Marthas Vineyard, August 22, 1882.

Fathoms	Temperatures	Fathoms	Temperatures
65–70	49°	145–155	46°
89	48°–49°	171	43°
100	47°–48°	245	43°
116	48°	300	40°
124	47°		

And the fact that the temperatures of 1882 were taken when the water was at its warmest (a month later than those of 1881) suggests that the discrepancy for the two years would have been even greater had both sets of readings been taken at the same season. The only one of our stations directly comparable with the above is Station 10112, over the sixty fathom curve south of Marthas Vineyard, August 22, where the temperature was 58.9° at sixty fathoms, *i. e.*, nearly 10° warmer than in 1882. The deep waters of the Gulf of Maine were likewise unusually cold in 1882 (p. 244), and the remarkable mortality of fish which took place in the spring of that year has usually been accounted for by the abnormally low temperature (p. 266).

The only records available for the next year (1883) are a few scattered observations by the ALBATROSS (Townsend, 1901), unfortunately all outside the 100 fathom curve. They show that the temperature south of Marthas Vineyard was 48° at 131 fathoms in May, and 49° at 117 fathoms in September. In September, 1884, the ALBATROSS took a series of bottom temperatures south of Nantucket, extending from the eighteen fathom curve out to the continental slope, with the following results:

Bottom temperatures, south of Nantucket, September 26–28, 1884.

Fathoms	Temperature	Fathoms	Temperature
18	55.9°	58	52.9°
25	54.4°	78	51.9°
38	50.3°	98	50.9°
43	50.2°	122	48.8°
46	51.4°		

This series was taken a month later in the season than our 1913 stations, which perhaps explains the high temperatures on the inner part of the shelf in 1884. And the fact that our one Station (10112) at the end of August was considerably warmer than the 1884 records shows how difficult it is to compare scattered records, owing to fluctuating influences on the part of the Gulf Stream. Nevertheless the ALBATROSS temperatures are instructive because they show that in 1884 the cool water which bathes the shelf was once more separated from the cold water of the depths by a warm belt; *i. e.*, that the normal distribution of temperature was reëstablished.

We know nothing about the subsurface temperatures of the next four years. But in 1889 Libbey took no less than 1600 temperatures on the surface and at depths, over the region south of Marthas Vineyard and Block Island. These records are so arranged as to show the distribution of temperature in great detail for the region studied; and they are so extensive that I can only summarize them here. Full tables, with charts and profiles, have been published by the U. S. Bureau of Fisheries (Libbey, 1891). Libbey's profiles show a cold tongue projecting southward into the warm off shore layers, in the mid-layers, such as we found south of Marthas Vineyard (p. 165, figs. 9, 10). The course of the curve of 50° in most of his profiles suggests that the cold bottom water of the shelf was directly continuous with the cold water of the depths under the Gulf Stream, instead of being separated from it by a zone of warm bottom water. But his own tables show that the few bottom readings which he took in the zone bounded by the seventy and ninety fathom contours were warmer than the bottom water either in shallower or in greater depths. And although his profiles off Nantucket, (Longitude 70°–71°) even more strongly suggest a continuity between the cold bottom water of the shelf and of the deeper part of the slope, this is chiefly because a 10° interval between the curves is too great to illustrate the actual conditions, the temperatures on which his profile D (Longitude 70° to 70° 20′) was constructed showing that the coldest water on the shelf (42°, 50 fathoms) was underlaid by warmer water (45.3° to 47.4°). And the bottom temperature was even higher at ninety fathoms. In short, the cold coast water was separated from the cold water of the abyss by a warmer zone, in 1889, with a temperature of about 47°–51° at 70–100 fathoms. And the same was also true in 1890 (Libbey, 1895).

In 1889 the absolute temperature of the cold tongue was 46°–47° off Block Island, falling to about 42°–43° south of Nantucket, which agrees fairly closely with our observations at Stations 10065 and 10061, in July, 1913. But the facts that Libbey's temperatures were taken late in August, by which time the water was much warmer in 1913 (Station 10112), and that the cold tongue projected much further seaward in 1889 than in 1913, are good evidence that the water as a whole over the continental shelf was colder in that year. Judging from his profiles, 1890 seems to have been intermediate between 1889 and 1913.

Libbey continued his survey of subsurface temperatures in subsequent years; but the results have never been published, nor, except in a few instances, have the various bottom temperatures taken by the vessels of the U. S. Bureau of Fisheries on collecting trips south of Marthas Vineyard. Hence it is not possible to draw any comparison between 1913 and any year since 1890.

There are no records of subsurface temperatures for winter, or spring, except in the water close to the coast, *e. g.* at Woods Hole.

The temperatures taken in the Gulf of Maine by Verrill are summarized elsewhere (1914a); but the records obtained by the SPEEDWELL (Smith, 1887), the FISH HAWK (Verrill, 1882, 1884a, Tanner, 1886) and by Dawson, (1905), were omitted there. The SPEEDWELL took bottom and serial temperatures in various parts of the Gulf in the summers of 1877, 1878, and 1879; but those of 1877 are of little value, because taken with Miller-Casella thermometers, two instruments often differing by as much as 6° when used simultaneously at the same depth. In 1878 and 1879, however, the Negretti and Zambra reversing thermometers were employed. Sixteen serial temperatures, in July, August, and September, 1878, in depths greater than twenty-five fathoms, show that the water was slightly colder below about forty-five fathoms at the mouth of Massachusetts Bay, and off Cape Ann, than in 1913, and less uniform vertically; with bottom temperatures of 38.5° to 41.2°, instead of about 40.3° as in 1912; 41° or more as in 1913. And the bottom water of the western basin was 38.5°–39°, as late as August 31 in 1878. But in August the surface layers were decidedly warmer in 1878 than in either 1912 or 1913, as illustrated by the following serial temperatures in Massachusetts Bay.

	1878	1912 Station 10045	1913 Station 10106
	Aug. 29	Aug. 31	Aug. 20
Depth	T°	T°	T°
0	64.2°	61°	61°
5	60	57	56
10	57	53	51.5
15	52.5	50	48.5
25	50.5	45	46
30	45	44.9	45
35	44	43.6	44
40	42.5	43.1	
45	41.5		

In 1879 the water was colder in the southern part of Massachusetts Bay than we found it in 1912, except on the immediate surface, as illustrated by the following pair of stations some eight miles northwest of Race Point: —

	1879	1912
Depth	Aug. 25	Aug. 31
0	61.2°	58.0°
5	49	55
10	44.5	52.7
15	43.5	47
20	43.5	45.9
25	43.5	44.6
30	43.5	44.3

and the difference can not be explained by differences in vertical circulation, the mean temperature being 46.7° in 1879, 49.9° in 1912. But by the end of September, 1878, the SPEEDWELL found the temperatures in this region very close to the GRAMPUS records of a month earlier, *e. g.*, 58°–59° at the surface, 44°–45° at thirty fathoms. There was even a greater difference between the two years in the deep water east of Cape Cod, especially in the mid-depths, as illustrated by a pair of stations within five miles of each other.

	1879	1912
Depth	Sept. 1	Aug. 29
0	60°	60°
10	52	55
20	47	50.9
30	43	48.5
40	41	44.3
50	40.8	44
60	40.7	42
70	40.6	41.7
80	40.6	41.3

The 1879 temperatures are not directly comparable with those of 1913, there being no pairs of stations at the same locality and date; but this side of the Gulf was even warmer in 1913 than in 1912 (p. 250).

The FISH HAWK records for August, 1882, are especially important, because in that year the subsurface temperatures were very low south of Cape Cod. They yielded the following results. Off Race Point, near Provincetown, the thirty-four fathom temperature was 39°–39.5°. A few miles further south, *i. e.*, along the shore off Cape Cod and Nauset light-houses, the bottom readings were:—

Fathoms	Temperature	Fathoms	Temperature
28	40°	61	37°
33	39°	83	38°
44	39°	90	38°
55	37°	110	38.5°

These records, taken with reversing thermometers (Tanner, 1884c), show that the deeper waters of the Gulf were considerably colder in the summer of 1882 than in any other year of which there is record; and, that in that year, as in 1913, the coldest water was not the deepest but in an intermediate zone at 50–70 fathoms. But the surface temperature of the Gulf in 1882 was apparently normal, just as it was south of Cape Cod, so far as the readings taken at various light-houses along the coast show (Rathbun, 1887).

In 1904 Dawson took a few subsurface temperatures at the mouth of the Bay of Fundy, finding water of 44.6°–48.4° in July, at fifteen fathoms; 48° to 52.1° in the middle of August, which agrees very well with our results. And Dawson seems the first to notice how the shoals and banks lower the surface temperature of the Gulf by causing vertical circulation (Dawson, 1905, p. 15).

Observations on salinity previous to 1913 are very scanty and many of them unreliable. Libbey (1891) took a large number of specific gravities in 1889, in the waters south of Marthas Vineyard, with the ordinary floating hydrometer. And although this instrument, as now universally recognized, is not sufficiently accurate to satisfy the demands of modern oceanography, his surface records agree fairly well with those of 1913, when reduced to salinity by Knudsen's (1901) tables. Thus on August 19, 1889, the surface salinity south of Block Island rose from 33.5‰, over the thirty fathom curve to 34‰ at the 100 fathom curve; in 1913 it was 34‰ near by, over the sixty fathom curve. Apparently, then, his instruments do not require the correction which Clark (1912) found necessary to apply to those used on the ALBATROSS. But his subsurface readings yield salinities as high as 38.5‰ at 100 fathoms, 39‰ or more at 500 fathoms. Such values as these are, of course, out of the question in the North Atlantic, where the 500 fathom salinity is known to be about 34.9‰ (Murray and Hjort, 1912) being equalled only in the eastern half of the Mediterranean and in the Red Sea, and a similar error runs through Libbey's whole series of subsurface densities. As just pointed out it can not be charged to the instruments, and in absence of information as to how soon the observations were made after the samples were collected, there is no means of judging whether it can be laid to evaporation of the samples. But whatever its origin, it is useless to attempt any reconstruction of the density curves along his profiles. Had this been possible, it would have thrown light on the origin of the cold tongue which Libbey suspected was a "mechanical intrusion of cold water from the surface of the continental platform, reinforced by the specific gravity of the water" (1891, p. 407), as was certainly the case in 1913.

In the neighborhood of Woods Hole, Sumner, Osburn, and Cole (1913) took a considerable series of hydrometer readings, checking them from time to time by titration. And though from their very nature they can not claim the accuracy of the latter method, yet their averages must be very close to the truth. They found the mean salinity of Vineyard Sound in July and August about 32.2‰ which agrees very well with our record of 32.29‰ off the entrance to Vineyard Sound (Station 10084). Dickson's (1901) charts show the water immediately south of Marthas Vineyard as 32‰ in July, 1897, with the salinity 33‰ and higher over the 100 fathom contour. In August of the same year, the coast water between Delaware Bay and Nantucket Shoals was below 32‰ bounded seaward by a zone of water with salinity between 32‰ and 33‰ over the outer part of the continental shelf. These charts, taken at their face value, suggest that the salinity was considerably lower in 1897 than in 1913, for in July of the latter year water fresher than 32‰ was confined to a small area off the mouth of the Hudson River, and along the south shore of Long Island. But the records on which they are based are so few that it is a question whether there actually was any such difference between the two years. And Schott represents the salinity of the water over the continental shelf between Cape Cod and Chesapeake Bay as 32–33‰ (1902, taf. 33). Further information as to the salinity of our coastal zone is contained in the Bulletins of the International Conseil for the exploration of the sea. In August, 1907, nd February, 1908 (1909), the water along the coast of Nova Scotia was 32‰ or less; the curve for 32‰ touching Cape Cod in the latter month. And the curves for May of that year afford the interesting nformation that 32‰ water spread seaward in an obtuse wedge, breast of the Gulf of Maine, and that water of that same salinity athed the coast as far as New York. Unfortunately there were no data from the continental shelf south of New York in that year, but in May, 1909 (1910), when there were no records for the northern part of the shelf, 34‰ water was found over the shelf opposite Cape May, just as was the case in May, 1913 (p. 188). And in August, 1909 (1911), 34‰ water lay close to land south of Cape Cod, agreeing with the Grampus station in this region in August, 1913. In November, 1909, the curve of 34‰ salinity followed the southern edge of George's Bank: but the Bulletins contain no more recent records for the continental shelf.

So far as the rather meagre data show, salinity, like temperature, was normal in 1913.

OCEANOGRAPHY OF THE GULF OF MAINE IN THE SUMMERS OF 1912 AND 1913.

The surface water next the coast between Cape Ann and Penobscot Bay was 1°–4° warmer in 1913 than the year before. But from Penobscot Bay to Mt. Desert and again off the Grand Manan Channel the readings were about 2°–3° below those of the preceding year. And this was also the case on German Bank (48° in 1913, 50° in 1912).

The readings at corresponding stations, tabulated below, show how closely the surface temperature agreed in the two summers, in the central and southwestern parts of the Gulf:—

10024	61°	10027	59°
10089	61.5°	10092	60°
10002	63°	10045	61°
10087	62°	10106	61.2°
10028	59°	10012b	65°
10093	60°	10105	64°

The area which was warmest in 1913 (Fig. 1) was not visited in 1912. Conversely less attention was devoted to Massachusetts Bay and to the coastal zone in general in 1913 than in 1912. But so far as the observations in the Bay go, the surface temperature, month for month, was about the same there in the two years.

The subsurface temperatures of 1913 did not differ anywhere in the Gulf from those of 1912 by more than 5°. August stations in Massachusetts Bay in the two years, at nearly the same locality

(Stations 10044, 10045, 10106) agree very closely with each other, the curves being practically parallel, and it is probable that the same was also true of the waters immediately off the mouth of the Bay, for while the temperature as a whole was higher there in 1913 (Station 10087) than at the same locality in 1912, the greatest difference was only about 1° in the intermediate depths, while the two were alike below forty fathoms.

The water immediately north of Cape Ann (Stations 10104, 10105) was 2°–5° warmer in 1913 than in 1912 (Stations 10011, 10012b) down to 50–60 fathoms; below fifty fathoms the two sets of observations hardly differ at all. Here again we are confronted with the difficulty that the 1913 stations were occupied a month later than those of 1912, hence the higher temperature of the former might be explained as due to seasonal warming during the last part of July and August. However, the waters off Cape Elizabeth were also slightly warmer (.5°–3.°) in 1913 than in 1912, though studied only fourteen days later in the season, which suggests that the upper layer of the coast water from Cape Ann to Cape Elizabeth was actually warmer in 1913 than in 1912.

Near Monhegan Island the temperature was about the same below fifteen fathoms in 1913 (Station 10102) as it was a week earlier in 1912 (Station 10021), though over 5° warmer on the surface.

The mean temperature on Jeffrey's Bank was about 1° higher in 1913 than in 1912 (50° as against 48.7°); and the fact that the vertical range of temperature was much greater there in 1913 than in 1912 shows that vertical circulation was less active. A few miles further east, however, the 1913 temperatures (Station 10101) are 1.5°–3° lower than those of 1912 (Station 10038) at all depths.

The 1913 temperatures are likewise consistently lower than those of 1912 off the northeast coast of Maine (Station 10098) and over the coastal bank off Nova Scotia, the observations having been taken at about the same date. For example, the Station of 1913, off Lurcher Shoal (10096) was 2° colder on the surface; 2.5° colder in the mid-depths; 3° colder at sixty-five fathoms than the water a few miles further south in 1912 (Station 10031). And German Bank was 1.5°–2.5° colder in 1913 than in 1912.

Our discovery that in 1913 the basins were coldest in the mid-depths, with warmer water below, was totally unexpected, because in 1912 they were coldest on the bottom; or the temperature was at least vertically uniform below about fifty fathoms. In the western basin the water was 2° warmer at the surface, 1° warmer at fifty fathoms, 3° warmer at 100 fathoms in 1913 than in 1912 (Stations 10088, 10007). The higher temperature in the upper layers in 1913 was probably due to the fact that the observations were made a month later than in 1912. But this will not account for the difference at fifty fathoms and below.

Off Cape Cod the 1912 temperatures were 3.5° lower on the surface, 3°–7° higher in the mid-depths, than those of 1913. But this is the type of difference which might be expected from the advance of the season (the 1912 Station, 10043, was three weeks later than that of 1913), being the first step in the equalization of temperature which is complete, down to forty fathoms, by November (1914b). And I doubt whether there was any more temperature difference between the Cape Cod waters of 1912 and 1913 than can be explained on this ground.

Off Platt's Bank the stations for the two years were made at so nearly the same season (August 7, 1912 and August 10, 1913) that no seasonal difference need be allowed for. The upper thirty-five fathoms proved to be almost exactly the same in 1913 as in 1912, except for the immediate surface, which was 2° colder, a difference which may be due to the fact that in 1912 (Station 10023) the temperature was taken in the afternoon of a very warm and calm day; in 1913, at daybreak. But below thirty-five fathoms, the water was about 1° warmer in 1913.

Our stations of 1913 in the eastern basin were made at almost the same localities, and within a few days of the dates of those of the year before. On its western side the water was warmer down to ten fathoms in 1913 than in 1912; but the difference was so slight that it is a question whether it is anything more than evidence of diurnal warming, one station having been occupied in the daytime, the other at night. And the two were almost precisely alike below eighty fathoms. But the temperatures of 1913 are 2–3° colder in the mid-layers. The east side of the basin was warmer in 1913 than in 1912, down to thirty-five fathoms, the greatest difference being almost 4° at twenty fathoms. But below that level it was 3° colder all the way down to the bottom. And this is also true of its northern end (Stations 10097, 10026), the extreme variation being 2°, at 100 fathoms.

The range of salinity on the surface was smaller in 1913 (31.8‰–32.8‰) than in 1912 (31.06‰–32.84‰); but this is probably chiefly due to the fact that in 1913 most of our work was carried on in August, by which time the salinity of the coast water may be expected to be higher than a month earlier. But seasonal difference does not explain the higher salinity of 1913 off Penobscot Bay, for there our observations were made at practically the same season in the two years. Comparison of the charts for the two years (Plate **2**, and 1914a, Plate **2**) shows how much further northwestward toward Penobscot Bay the salt tongue of off shore water extended, and, conversely, how much less evident was the outrush of comparatively fresh water from the bay, in 1913. But east of Mt. Desert the surface water next the coast was fresher in 1913 than in 1912.

Over the Nova Scotia coast bank, near Lurcher Shoal, likewise, the surface salinity was higher in 1912 (32.84‰ at Station 10031) than in 1913 (32.75‰ at Station 10096); but on German Bank the reverse was the case (32.70‰ at Station 10029, 32.79‰ at Station 10095). Over the eastern basin the surface salinity was slightly higher in 1912 than in 1913, the readings at three pairs of stations being: —

Station	10027	1912	32.66‰
	10092	1913	32.59
	10028	1912	32.75
	10093	1913	32.61
	10036	1912	32.75
	10097	1913	32.75

And in 1913 the surface salinity was nowhere so high in the Gulf as it was off Lurcher Shoal in 1912 (32.84‰).

The subsurface salinity for the two years was about the same in Massachusetts Bay, in August, for, though there was much less difference between surface and bottom in 1913 (Station 10106) than at the same locality in 1912 (Station 10045), the mean for the entire column is almost precisely the same (32.4‰).

The observations off the mouth of the Bay were taken a month later in 1913 than in 1912. And while the salinity was considerably higher above forty fathoms, lower below that depth, in 1913 than in 1912, the mean salinities for the two years differs by only about .1‰ (Station 10002, July, 1912, 32.54‰; Station 10087, August, 1913, 32.63‰), no more than can be charged to the general rise of salinity which takes place after the spring freshets from the rivers have passed (1914b). In the western basin the observations for 1913 (Station 10088) were intermediate in date, as well as in geographic location, between the two stations of 1912 (10007, 10043); and they were likewise intermediate in salinity all the way from surface to bottom, *i. e.*, it was about the same in this general region in the two years. The same is also true of the deep water off Platt's Bank, where the stations were occupied within six days of the same date.

In the eastern basin, the water was considerably less salt in 1913 than in 1912, although the two sets of observations were taken within a few days of the same dates. On its western side (Station 10027, 1912; Station 10092, 1913) the difference was greatest in the mid-depths (.35‰ at fifty fathoms), very slight at surface and bottom; but further east (Station 10028, 1912; 10093, 1913), it was uniform (.3‰–4‰) all the way from twenty fathoms down to the bottom. And the 120 fathom salinity at Station 10028 in 1912 (34.54‰) is almost .3‰ higher than any salinity in 1913. In the northern end of the basin, on the coastal bank near Lurcher Shoal, and off the northeastern coast of Maine the water was also slightly salter at all depths in 1912 (Station 10036) than in 1913 (Station 10097), though the two sets of observations were taken at nearly the same season, and the geographic locations were almost identical. But on German Bank the reverse is true, the water being about .05‰–.1‰ salter at all depths in 1913 than in 1912. The salinity of the coast water between Cape Ann and Cape Elizabeth was about the same in August, 1913, as it was two to three weeks later in 1912, correspondingly salter than the July salinities of that year (1914a). Off Monhegan, where the observations for the two years were taken at practically the same date, the water was slightly fresher on the surface, slightly salter at sixty fathoms, in 1913 (Station 10102) than in 1912 (Station 10021).

Thus, in brief, the Gulf was colder and fresher in its eastern, warmer, but of about the same salinity, in its western half, in 1913 than in 1912.

In the preceding lines the differences between the two years have been emphasized. But the most important general conclusion is that these differences are really very slight; and that the general distribution of salinity, highest in the east, lowest in the west, was the same in 1913 as in 1912

ORIGIN OF THE COAST WATER.

In few parts of the world is the coast water so sharply defined by salinity, temperature, and color, from oceanic water, as it is over the coastal shelf between Nova Scotia and Cape Hatteras. And not only are the physical differences great, but the transition from one type to the other is often surprisingly sudden.

The general characteristics of the coast water, as they impress the voyager, have been so well described by Schott (1912), and are a matter of such common knowledge, that it suffices to state here that water with a mean annual surface temperature below 59°, and mean salinity below 34‰ may be so classed, as distinguished from the warm and saline ocean waters of the Gulf Stream. This cold, comparatively fresh water, which bathes the whole breadth of the continental shelf between Nova Scotia and Chesapeake Bay, out to about the 100 fathom curve, except when temporarily obscured or dispossessed by Gulf Stream water, and which fills the Gulf of Maine, has usually been explained as coming from the north, or from the abyss of the Atlantic. According to the first of these theories, the coast water is a branch of a current flowing from the north and northeast. Almost all the ocean atlases show something of this sort; and it has been accepted in one form or another in almost all the textbooks on physical geography and oceanography (for example, Maury, 1855; Reclus, 1873; Attlmayer, 1883; Thoulet, 1904, Krummel, 1911; Schott, 1912; the German marine observatory, Deutsche Seewarte, 1882; the current chart of the U. S. Navy by Soley, 1911; and the British Admiralty current chart). The mere coldness of the coast water suggests a northern origin, as does its comparatively low salinity; while the fact, long ago emphasized by Verrill and others, that it supports a boreal littoral fauna, contrasting sharply with the warm water fauna carried northward in the sweep of the Gulf Stream is evidence in the same direction. The continuity, too, of the cold zone all along the coast as far north as Newfoundland, with gradually decreasing mean temperature from south to north; and its sharp limitation seaward by the Gulf Stream, argue for a northern origin. And when we add to this the southwesterly drift which has been noted at many points along the coast between Nova Scotia and Cape Hatteras, it would require very strong evidence to prove that northern currents do not enter, in greater or less degree, into the composition of our coast water.

Up to 1897 the Labrador Current, a polar stream which has borne an unsavory reputation among mariners ever since its discovery in 1497 by John Cabot, was generally accepted as the source of this northern water, being so represented in practically all of the early atlases and textbooks; while Libbey (1891, 1895) expressly describes the cold water on the continental shelf south of Nantucket as one of its branches. And this view is still widely held, for example, the U. S. Navy Department states that the Labrador Current flows from the Grand Banks past Nova Scotia, southward in a narrowing belt as far even as the coast of Florida (Sumner, Osburn, and Cole, 1913,

p. 35); and Engelhardt (1913, p. 9, chart B), thinks it certain that the Labrador Current bathes our coast at least as far as New England.

But in 1897 a new light was thrown on the subject by Schott, whose analysis of the currents on the Grand Banks led him to conclude that the chief source of our cold coast water was not the Labrador Current, but water flowing out of the Gulf of St. Lawrence via Cabot Straits. And his work was founded on so large a body of temperatures, and current records taken by vessels at anchor on the Banks, that it may well serve as the starting point of our modern knowledge of the relationship of the Labrador Current to the Gulf Stream in that region. The most important feature of Schott's work, from the present standpoint, is his failure to find any evidence that the Labrador Current, as such, flows southwest across the Grand Banks, although it follows their eastern edge southward to the southern extremity. It is true, he says, that a small amount of polar water turns westward, and flows along the southern coast of Newfoundland; but it enters the Gulf of St. Lawrence. And though movements of polar water toward the southwest across the banks have been observed, he maintains that they are too small in amount, and too irregular in occurrence, to be anything more than local surface currents caused by the frequent strong northeast winds.

This is perhaps an extreme view, for as Krümmel (1911) points out part of the polar water which flows around the south coast of Newfoundland, joins the outflow from the Gulf of St. Lawrence. And Krümmel furthermore maintains that there must be a general tendency for the polar water to flow southwestward across the Grand Banks, and thus to reach the coast of Nova Scotia directly, instancing the fact that icebergs, coming south with the Labrador Current, have occasionally been known to drift southwest from the Grand Banks. But Capt. C. E. Johnston (1913), whose experience as commander of the U. S. Revenue Cutter on ice patrol duty on the Banks in 1913 and 1914 has given him unusual opportunities to study the currents in that region, states that the "currents on the Grand Bank. . . .are almost wholly tidal. In a general way they flood to the northward and ebb to the southward. Winds drive them to the eastward or westward, sometimes overcoming the strength of the tidal current"; and we can hardly suppose that there is any constant movement of polar water southwestward around the southern edge of the Grand Banks, for although bergs have occasionally been known to drift for long distances in that direction (Krümmel, 1911), the general movement of the ice, after reaching the southern point of the Bank, is just the reverse, *i. e.*, toward the east and northeast, as graphically described by Captain Johnston (1913).

At present it seems safe to say that although there may be sporadic movements of Labrador Current water from the Grand Banks toward Nova Scotia, there is no constant current in that direction; and that the increment of polar water which reaches our coasts in that way, plus the polar water which joins the Cabot Current at Cabot Strait is too small in amount to have much effect on temperatures and salinities off New England. And it certainly has very little influence on the plankton west of Nova Scotia, where true polar organisms, such as characterize the plankton of the Labrador Current, are seldom recorded.

The existence of an outflow from the Gulf of St. Lawrence via Cabot Straits has been recognized by oceanographers for many years (Maury, 1855); but Schott (1897) seems to have been the first to emphasize its importance. Fortunately we now have considerable data as to its volume and physical characters, thanks to the tidal and current observations, temperatures and densities, taken by the Tidal Survey of Canada under the direction of Dr. W. B. Dawson (1896–1913). These establish a constant outflow along the south side of Cabot Straits, with velocities as high as 1–2 knots per hour between Cape North and St. Paul Id., termed the "Cape Breton current" by Dawson, but for which the earlier name, "Cabot Current" is appropriate; and an inflow along the north side of the Strait. The Cabot Current has sometimes been explained as polar water, entering the Gulf via the Straits of Belle Isle, and flowing southerly along the west coast of Newfoundland. But Dawson's (1907) survey of the Straits of Belle Isle proved that no great volume of water enters the Gulf from that quarter, there being very little balance of inflow over outflow, if any, in summer, though with a possibility of rather greater influx in early spring. The distribution of temperature in the Gulf likewise shows little or no effect of polar water, for in summer polar temperatures are not found within the Straits of Belle Isle (Krümmel, 1907, Dawson, 1907). And there is no evidence that such water as does enter via the latter flows southerly along the Newfoundland coast, but just the reverse, because the current along this coast is from south to north caused by the water which enters the Gulf along the north side of Cabot Straits. To enter further into Dawson's very interesting results is not necessary since the Gulf of St. Lawrence concerns us here only in its relation to the coastal water further south. What is important is that his work demonstrates beyond a doubt that the water which flows out through Cabot Straits is not polar, but true coast water. True, the Cabot Current contains small amounts of polar water, both from the Straits of Belle Isle, and from the Labrador Current via the south coast of Newfoundland, but this is modified past recognition in the general circulation of the Gulf. (For an excellent summary of Dawson's results, and of the general circulation of the Gulf of St. Lawrence, see Nature, April 18, 1901, p. 601).

The amount of outflow through Cabot Straits must be considerable for the Cabot Current is at least thirty miles broad abreast of Cape North, with a velocity of from .5 knot to 2 knots per hour on the surface (Dawson, 1913, p. 12). Its temperature is particularly characteristic in summer when the water is coldest (31°–33°) at about fifty fathoms, with warmer water (37°–40°) below at 100 fathoms, 39°–40° at 150 fathoms, while the surface warms to 58°–60° (Dawson, 1913, p. 37). And the discovery, by the ALBATROSS in July, 1885 (Townsend, 1901) of a corresponding layer of minimum temperature, at about the same depth, off the east coast of Nova Scotia, ranging from about 32° opposite Cape Breton to 35° off Halifax, and 39° off Cape Sable, with warmer water at greater depths, shows its influence along that part of the Coast. Surface temperature likewise indicates that the Cabot Current flows toward the southwest over the continental shelf (Schott, 1897); and so does salinity, for as Dickson (1901) has shown, water with a salinity of 32‰ or less, is continuous along the coast from the Gulf of St. Lawrence to the Gulf of Maine in spring and summer, though often separated from the equally fresh water over the Newfoundland banks by a salter wedge. And this salt wedge is normal for the whole year, according to Schott (1902, plate 33), though it may be temporarily obscured, as, for example in August 1897 (Dickson, 1901); and, finally, a southwesterly current has often been observed by mariners off the Nova Scotian coast. But although a southwesterly long-shore movement of St. Lawrence water is incontestable, it is by no means clear how far it can be traced as a recognizable current. According to Schott (1897) it makes its effect felt in the form of low temperatures to the neighborhood of New York. But according to the statement in the Nova Scotia and Bay of Fundy Pilot (British Admiralty, 1903), based on many years data of greater or less value, obtained by mariners, no true southwesterly current can be distinguished beyond Cape Sable, the movements of the surface water over George's Bank being wholly governed by tide and wind. And the work of our own coast survey, mentioned above (p. 231) has failed to reveal any dominant movement of water from northeast to southwest over George's Bank. According to the British

Admiralty (1903) there is a northerly drift into the east side of the Gulf of Maine; and our own records of salinity show that an indraught of comparatively saline water does take place more or less constantly into the eastern side of the Gulf. But it must be slow, or intermittent, for Dawson's (1905) measurements of currents failed to show any dominant drift along the west coast of Nova Scotia. And the organisms which it carries with it are good evidence that Gulf Stream as well as St. Lawrence water enters into its makeup. In short, it is extremely doubtful whether the Cabot Current can be traced, as an observable or measurable drift beyond Nova Scotia. Consequently the southwesterly currents noted south of New York (p. 230) require some other explanation.

In 1907, Pettersson offered a totally different explanation for our cold coast water, namely, that it was not northern water flowing southward, but water welling up from the Atlantic abyss. And although few, if any oceanographers have adopted this view in its entirety, both Schott (1912) and Krümmel (1911) believe that there is more or less upwelling along our coast, particularly in winter. And Clark (1914) maintains that the cold water off Nova Scotia must be abyssal in part, to account for the distribution of crinoids.

Upwelling, whether on a large or a small scale, must obviously largely depend on the prevailing direction of the wind; consequently along our coast, where off shore winds prevail in winter, winds parallel to the coast in summer, it might be expected to be seasonal. And for this reason our data for 1913 can only be expected to show its presence or absence in summer. But they are worth analyzing, because the occurrence of upwelling in this region has so far been deduced from theoretical grounds, rather than from actual observation, previous knowledge of subsurface salinity on the continental shelf being practically *nil*. If abyssal water had been flowing up the continental slope in any considerable amount at the time of our voyage, salinity and temperature would necessarily reveal its presence, just as they do in parts of the oceans where there is a well-marked updraught of bottom water, next the coast. Perhaps as useful an index as any in the warm months, in temperate zones, is surface temperature, for in regions of active upwelling, the constant access of cold water from below retards seasonal warming, and consequently causes the surface to be abnormally cold. And unless the updraught should extend along the whole coast line, a most improbable supposition, the cold region would be surrounded by warmer surface water, north and south as well as off shore, just as it is off the coast of California (McEwen, 1912), and off the southwest coast of Africa (Schott, 1902, taf. 8). Subsurface temperatures would reveal upwelling by continuity between the cold water near the surface and in the abyss; and surface salinity in regions of active upwelling, is about the same as the salinity of the layer from which the updraught comes, as is very clearly illustrated by the salinity curves off the coast of Morocco (Schott, 1912, pl. 33).

I have already pointed out (1914a) that the salinities and temperatures of the Gulf of Maine in 1912 do not suggest upwelling, except locally on a small scale; and the records for the winter of 1912–1913 and for the summer of 1913 all support this view. If abyssal water enters at all into the complex of the Gulf of Maine it must be in such insignificant amount that it has no appreciable effect on its temperature or salinity. However, this semi-enclosed basin may well differ hydrographically from the waters over the shelf south and west of Cape Cod.

In weighing the evidence of temperature, we must first consider whether the surface over the continental shelf is abnormally cold, as it has usually been characterized, most recently by Clark (1914). So firmly grounded is this idea, that the waters of the Gulf of Maine have often been called "Arctic." But, as I have already pointed out (1914a, 1914b) the observations in the Gulf of Maine during the summers of 1912 and 1913 and the winter of 1912 and 1913, corroborate Verrill's early contention that its temperature is nearly normal for its geographic location. It is, of course, much colder than the Gulf Stream; its surface temperature 7°–9° lower than the average for its latitude (Krümmel, 1907). But the waters of its deeps are no colder than the mean annual air temperature over the part of its watershed from which blow the chilling winds of winter, with their accompanying snowfall (1914a, p. 97). And the bottom temperature of its eastern basin in 1913, was almost precisely the same as the mean annual temperature of the air at Yarmouth, on the neighboring Nova Scotian coast (43.3° as given by the Nova Scotian Coast Pilot, British Admiralty 1903, p. 11), and about a degree warmer than the mean for the year at St. John, New Brunswick, on the Bay of Fundy. And as Tizard (1907) has pointed out, the coast water is warmer off New York in summer than off England, and even in November its surface temperature is no lower than west of Ireland, though the latter is commonly described as warmed by the Atlantic Current. In short, as Schott (1897) and others have insisted, it is more because of its contrast with the Gulf Stream than because of its absolute temperature that the coolness of our coast water has so impressed itself on students and laity alike. It is true that the surface temperature falls very low in winter near the coast, cooling to about 39° over the zone between Marthas Vineyard and New York (Sumner, Osburn, and Cole, 1913), with even lower winter temperatures in enclosed sounds and bays, for instance, 31.2° in February at the Woods Hole Station of the Bureau of Fisheries (Sumner, Osburn, and Cole, 1913, p. 48, average of three years). But this only happens where surrounding islands give the waters more or less the hydrographic character of lakes. And the zone over which the surface temperature falls below 40° in the coldest month (February) is nowhere more than thirty-five miles broad, south and west of Cape Cod, with a steady rise of surface temperature from the land seaward. The cold water is also correspondingly shallow, bottom water colder than 40° being probably limited seaward by the fifty fathom contour in this region. In short, the water is coldest just where it might be expected to be influenced most by the icy northwest winds of winter. And so far as the scanty winter data show, this is true all along the coast as far as Chesapeake Bay.

Air temperatures 10°–15° F. below freezing, such as are common in winter in southern New England, are surely enough to account for considerable cooling of the adjacent water. How closely the winter temperature of our coast water depends on the influence of the land is illustrated by the fact that Gloucester Harbor, which opens freely to the deeps off Massachusetts Bay, is 1°–2° warmer than the more enclosed waters of Woods Hole in winter, although a degree of latitude further north, and bordering a colder ocean area. Gloucester Harbor in turn, is colder than Massachusetts Bay; for example, its surface temperature fell to about 34° during the winter of 1912–1913, the lowest reading a few miles outside being 37°. And Boothbay Harbor, seventy-five miles north of Gloucester, which bears something the same relation to the land as Woods Hole, being shut in by numerous islands, is colder than either Gloucester or Woods Hole (about 30° F. in February), reflecting the very cold winter climate of northern New England; and likewise colder than the water off shore. (The mean temperature for December and March, at Mt. Desert Rock, is about 38° and 36°; at Boothbay, 37° and 32.2°). These comparisons of surface readings apply just as well to the whole of the upper 30–40 fathoms, for our winter work (1914b) has shown that the temperature of the Gulf of Maine is practically uniform, vertically, to at least that depth from December to March. The fact that in summer the water is coldest at the bottom of such partially enclosed sinks as the trough between Jeffrey's Ledge and the mainland, *i. e.*, just where outside influences of any kind must be least active, is further evidence that it is winter cooling by the air that is responsible in the main for the cold water. And this same process equally well explains the general persistence of low temperature in summer near shore below twenty fathoms or so, solar warming progressing but slowly below that depth, consequent on the progressive increase in the vertical stability of the water.

And how closely mean air and water temperatures agree, for bays and sounds, is illustrated by Long Island Sound, where the mean surface temperature for the year (52°–53°) is practically the same as the mean air temperature for the year at New York. The mean surface temperature in Massachusetts Bay is about 50°–52°; the mean air temperature at Boston about 4.9°. In short, the temperature of the coast water between Cape Sable and Chesapeake Bay is not abnormally low, considering its relation to the land mass to the west, and the winter climate of the latter. Hence it gives no direct support to the upwelling theory.

Neither is there anything in the surface temperature curves to suggest such upwellings as those off California, off Morocco, and off South Africa, for though the surface temperature is much lower over some of the coast banks, and in the northeast corner of the Gulf of Maine as a whole, than elsewhere, subsurface temperatures, salinities, and tidal currents prove that their cold surface is the result of violent vertical circulation, accompanied by correspondingly high bottom temperatures. Furthermore, the mean temperature is lowest where there seems to be the least possibility of abyssal upwelling, *i. e.*, in partially enclosed basins next the coast.

The rapid rise of surface temperature during July and August is in itself a strong argument against the view that upwelling can have been active at that time; and so is the great annual range of surface temperature (30° for the Gulf of Maine, nearly 40° off New York, with an even greater extreme range, Murray, 1898); for any considerable upwelling of cold abyssal water would necessarily check the former, and consequently lessen the latter. It would be hard to reconcile our subsurface temperatures with an upwelling over the upper part of the continental slope at the time of our visit, whatever may have been the case earlier in the season, because if such a process had been taking place, the cold water over the shelf would have been continuous with the cold water at greater depths further off shore, instead of separated from the latter by the warm bottom zone, which was found south of Cape Cod and Long Island; and which probably extended to Chesapeake Bay. And the considerable difference in temperature between the surface and the water a few fathoms down is almost as conclusive evidence in the same direction, because any constant accession of cold water from below would have made the temperature more uniform, vertically.

The evidence of salinity supports that of temperature, for although Schott (1912) believes that the low salinity of the coast water suggests upwelling, a more rational explanation of this phenomenon is that it results from the large amount of river water which enters the sea between Chesapeake Bay and Newfoundland, as maintained by Tizard (1897). I have already pointed out (1914a), that the river water which enters the Gulf of Maine would be sufficient to raise the level of the latter half a fathom per year, were it an enclosed basin, evaporation being more than offset by rainfall. And even larger amounts of fresh water come from the rivers west and south of Cape Cod; *e. g.*, the Connecticut, Hudson, Delaware, and the watershed draining into Chesapeake Bay. There is therefore no more need to call upon upwelling to account for the low salinity of our coast water, than for that of the Baltic, of the Gulf of St. Lawrence, or of the waters off the mouths of the Niger and Amazon rivers. Furthermore, while upwelling would lower the salinity of the surface water below that of the Gulf Stream, it could not possibly reduce it to the comparatively fresh state of the coast water (32‰ to 33‰), because the deeper layers of the Atlantic, from which any updraught must come, are far salter than this (34.9‰, Murray and Hjort, 1912). In short, low surface salinity does not indicate upwelling in this case, though it does not necessarily preclude the possibility that such a process might be taking place to a small extent. Unfortunately our salinity profiles across the continental shelf do not establish the upper limits of the water of the abyss as well as the temperature profiles, for they leave a bare possibility that the fresh coast water may have been connected with the abyssal water of 34.9‰ by a continuous zone of bottom water fresher than 35‰ (p. 344). But although the data are not absolutely conclusive, for want of bottom salinities at the crucial depth (75–100 fathoms), it is very much more probable that the bottom water at this depth was salter (above 35‰), just as it was warmer (p. 164), than the water below it. And this was certainly the case south of Nantucket in August, when the salinity of the bottom water, in sixty fathoms, was 35.17‰ (p. 193). If our salinity profiles are correct in this respect, it is impossible to reconcile them with active upwelling. Density, likewise, argues against the existence of an updraught of abyssal water over the continental shelf, in summer, because, as the profiles show (p. 233), the tendency must have been just the reverse. And the very considerable difference in density between surface and deep water off the coast must be a bar to upwelling, even though it may not absolutely prevent it, as it does in stratified waters where the layers of different densities are sharply defined (Sandstrom, 1908; Wedderburn, 1908).

It is not to be expected that our work could conclusively settle such a complex problem. But considering that the evidence of temperature, salinity, and density agree, and that it is hardly conceivable that one or other of them would not have revealed upwelling, it is safe to say that no widespread vertical movement of this sort was taking place over the continental shelf in July, 1913. And the fact that the cold water over the shelf south of Marthas Vineyard is usually separated from the cold water of the abyss by a zone of warmer bottom water in summer, suggests that this conclusion holds good for that season normally. It is true that during one summer, 1882, the whole shelf is known to have been bathed by cold water; but it is as likely that this resulted from an unusual accession of northern water or from abnormal winter cooling, as from upwelling.

Upwelling may be more important in winter, for, as Krümmel (1911) and Schott (1912) point out, the prevailing north and northwest winds, which often rise to storm strength, would have more tendency to produce this type of circulation, than the southwest, long-shore winds of summer. Furthermore, density is not so effective a barrier to upwelling in winter as in summer, because its vertical range is much smaller then. Nevertheless, it is probable that upwelling caused by off shore winds would be from a comparatively shallow depth, say 100 to 200 fathoms, both because the direction of the wind is not constant but often reversed, and because the abyss water must be considerably heavier than coast water even in winter. And gravity would similarly resist any upwelling which the effect of the rotation of the earth might tend to produce along the inner edge of a current moving parallel to the coast. Upwelling of this latter type may play a very important part in the movements of ocean waters, as pointed out by Ekman (1905a) and recently by McEwen (1912); but until the movements of the bottom water of the North Atlantic are better understood, discussion of this theoretic aspect of the case may well be postponed.

The real explanation of the low temperature of the coast waters is to be found neither in upwelling, nor in a northern current, but in the land climate of eastern North America. On this side of the North Atlantic the relation between land climate and ocean temperatures is exactly the reverse from what it is off the west coast of Europe, because the winds as a whole, and the great majority of cyclonic disturbances, drift from the land out over the sea, instead of from sea to land. Hence the coast water must necessarily borrow its temperature, in large degree, from the land climate, instead of tempering the extremes of the latter, as is the case in the favored continent of Europe. Granting this, and the principle is so important, and so obvious, that it is remarkable that it has not been emphasized more strongly in the past, the fact that the water is coldest next the coast, and in enclosed troughs, with a steady rise of temperature, depth for depth, passing off shore, is at once explained, for the cold winds of winter would necessarily be most effective as cooling agents near shore. And they would become progressively less so, further and further from land, being warmed by the absorption of heat from the sea water over which they blow. The change from our torrid summer to frigid winter, with its prevalent off shore winds, sufficiently explains the rapid cooling of the coast water in autumn and winter. Conversely, solar warming and the warm land winds of spring and summer are the only agencies which could produce the very rapid warming of the surface, which characterizes our coastal zone at that season; for if the change were due to flooding by Gulf Stream water, salinity would rise correspondingly, something which does not happen until the surface water has warmed by some 25°–30° F, if at all (p. 188). The change in land climate, with latitude, is an obvious explanation for the rise in surface and subsurface temperatures over the continental shelf from north to south. Still another continental influence, which must play a part in chilling the coast water is the low temperature of the river water, and the river ice which enters the sea in spring; but this can hardly have as much effect south of Cape Cod as supposed by Tizard (1907).

The Gulf of St. Lawrence affords an excellent example of the degree o which winter cooling takes place, and of the rapidity with which he temperature falls in autumn, in an enclosed basin under the in-uence of the rigorous climate of eastern North America, for its low emperature is certainly due to local causes (Krümmel, 1907). Were he Gulf of Maine as nearly enclosed as the Gulf of St. Lawrence, would reproduce the temperature of the latter even more closely han is now the case, the northern part of the former being separated om the southern part of the latter by only forty miles of latitude.

In short, the Gulf of Maine is warmed, not cooled, by the combination of northern and Gulf Stream water which enters it; and this is even more true of the coastal waters south and west of Cape Cod. This does not mean that more or less northern water does not enter into the composition of the coast water; on the contrary, such water enters into the Gulf of Maine in amounts varying from year to year. But by the time it has flowed so far south as this, it has been so warmed by mixing with warm off shore water, that it is no longer cold enough to chill the coast water below the temperature which would be given it by the land climate alone. And the northern water has even less effect on salinity than on temperature south of Nova Scotia, because the volume of fresh water which empties into the Gulf of Maine, and over the shelf beyond Cape Cod, is sufficient to lower the salinity of the coast water nearly to that of the water which flows out of Cabot Strait (p. 259).

The upper layers of the Gulf Stream can not be neglected in studying coast waters. It has long been known that Gulf Stream water drifts northward almost every summer, flooding the surface even to the southern shores of New England. And salinity profiles suggest that it was a shoreward movement of the surface waters of the Stream, dipping below the fresher coast water, which raised the salinity of the bottom water of the shelf southwest of Nantucket so considerably during July and August (p. 193). In the Gulf of Maine, too, Gulf Stream water is probably of more importance than is usually realized, its entrance being an annual phenomenon, signalized by the tropical organisms it bears with it (p. 336).

The evidence marshalled in the preceding pages shows that our coast water is not of any one origin; it does not even have any one predominant source, as has been so often assumed, but is really very complex and variable in its composition. The constituents which enter into it are northern water, chiefly from the Gulf of St. Lawrence, and hence itself coastal, not polar, plus a possible small component of polar Labrador water; river water from the land; water of high salinity from the upper layers of the Gulf Stream; water from the mid-layers off shore, and possibly Atlantic abyssal water, besides rain water. In just what proportions these components mix, is for more detailed studies to show. But temperature and salinity suggest that it is St. Lawrence water which is the most important off Nova Scotia. In the Gulf of Maine, St. Lawrence water, land water, and water from the upper 100 fathoms off shore play more equal rôles, now one, now another having the upper hand with the succession of the seasons;

and there is no actual hydrographic evidence that abyssal water enters at all into the Gulf. Between Cape Cod and New York, the chief components of the coast water are the surface and upper layers of the Gulf Stream, which is far more important here than in the Gulf of Maine, and river water, northern water being hardly appreciable, except perhaps in exceptional years (p. 266). Salinities and temperatures do not afford any actual indication of upwelling here in summer (p. 260). South of New York the problem of upwelling assumes more importance, because of the prevailing direction of the winter winds; though no evidence of it was found in summer. But the questions to what degree it is effective in winter and whether it floods the shelf, or is limited to the waters outside the slope can not yet be answered.

OCEANOGRAPHY OF THE GULF OF MAINE AND OF THE NORTH SEA.

A brief comparison between the Gulf of Maine and the North Sea is pertinent because the latter is now the best known water-area, both physically and for its plankton, on the globe. (For an excellent summary of the hydrography of the North Sea, see Knudsen, 1909). Both also support fisheries, which differ more in extent than in kind.

The salinity of the North Sea as a whole, 34‰ to 35‰, is considerably higher than that of our Gulf. At the west end of the English Channel, and off the north coast of Scotland, the two sources from which ocean water enter, it is above 35‰. On the other hand, there is a coast-belt fresher than 34‰, near Denmark; and of course the surface grows much fresher passing through the Skagerrak into the Baltic. The salinity of the North Sea further differs everywhere from that of our Gulf in being practically uniform from surface to bottom, the result of strong currents; and in changing very little from season to season.

The Gulf of Maine agrees very closely in mean surface temperature (about 48°) with the central parts of the North Sea (48.2°); and Massachusetts Bay (50°–52°) corresponds with its southern part (50°). This generalization can be extended also to the upper ten fathoms of the whole of the North Sea, and to the whole column of water (about twenty fathoms) in its southern half. The coldest winter temperature of the North Sea ranges from 37.4° near Denmark to 42° near Scotland — in the central part it is 39°–40°; which is slightly warmer than the Gulf of Maine, where the winter temperature as a whole is about 36°–37°. On the other hand the North

Sea is rather cooler as a whole than our Gulf in summer, its warmest water, off the coast of Belgium, being about 62.5°; with the greater part of its surface area 55°–60°. But nowhere in the North Sea are the surface temperatures of summer as low as they are in the northeast corner of the Gulf of Maine. At fifty fathoms the temperatures of the North Sea and of the Gulf are about the same, though the range is somewhat greater in the latter, the extreme limits being from 38°–48°. And they also agree closely in greater depths, which, in the North Sea, are limited to a small area at its northern entrance. Thus the 100 fathom temperature of the North Sea is between 41.9° and 44.6°; the temperature of the Gulf between 38° and 46° at that depth.

The surface density, at the temperature *in situ*, like the salinity, is considerably higher, as a whole, in the North Sea than in the Gulf of Maine. In summer the densities of the two overlap, that of the Gulf ranging, from about 1.0227 to about 1.0254; the North Sea from about 1.0247 to 1.0266. But during the rest of the year the density probably does not rise as high anywhere in the Gulf as in the North Sea. And in May the difference is great, for at that season, owing to the inrush of fresh river water, the surface density of the western side of the Gulf of Maine falls below 1.023, whereas in the North Sea it ranges from 1.0263–1.0273. Subsurface densities, likewise, are lower in the Gulf, for, while the temperature is not very different from that of the North Sea, the salinity is much lower.

In short, there is nothing in the temperatures to cause any faunal difference between the two bodies of water, but the difference in salinity is so great that it might well have some influence. And it would not be surprising to find that the density was an important factor in determining the fish fauna of our Gulf by governing the flotation of pelagic eggs.

The coast water as a biological environment.

The hydrographic facts outlined in the preceding pages have a twofold interest: first for their bearings on the general problems of oceanography; secondly for their relation to the animal population which the coast waters support. As a biological environment, the different parts of the continental shelf differ greatly, though all are characterized by relatively low temperature and salinity. The Gulf of Maine, except for its uppermost layers, is a region of great physical uniformity from season to season. Below say sixty fathoms the extreme range of temperature over the entire Gulf, throughout the year is probably not over 10° (38°–48°); at 100 fathoms the extreme range is about 8° (38°–46°). And the deep parts of the western half of the Gulf are still more uniform; the extreme temperature variation at all depths below sixty fathoms, being not more than 4° in the basins and troughs next the western shore. Salinity, too, is surprisingly uniform in the deeper parts of the Gulf. In short, the fauna which occupies these depths enjoys an environment whose physical factors are practically unchanging from year's end to year's end.

But quite the opposite is true of the surface layers of the Gulf, where there are violent seasonal fluctuations of both temperature and salinity. Along the western shore, and in Massachusetts Bay, the surface temperature rises from about 36° in winter to 63° or 64° in summer, *i. e.*, a range of almost 30°. And though the annual range is smaller along the eastern side, it is still considerable. The salinity, too, oscillates between wide limits, and the changes are very sudden in spring. For example, north of Cape Ann, the range is from about 32.8‰ in February to about 29‰ early in May.

In addition to these regular seasonal changes, the Gulf is subject to sporadic invasions, on the one hand by water from the Gulf Stream, with its characteristic fauna, on the other by St. Lawrence water. But these are not extensive enough to cause much change in the Gulf as an environment, though they do alter the *facies* of the plankton by the addition of either southern, or northern organisms, as the case may be.

South and west of Cape Cod there are no parts of the continental shelf where the water is as uniform, from season to season, as it is in the deeps of the Gulf of Maine. On the contrary, the entire water mass over the shelf is subject to violent fluctuations, both seasonal and sporadic. These are most violent, of course, near the surface and next the coast. For example, the surface temperature off New York ranges from about 38° to over 70° during the year; the salinity from about 31‰ to possibly 34‰. And even as deep as sixty fathoms the temperature may rise from below 45° to nearly 60° in a month (p. 349), the salinity from 33.5‰ to 35.1‰ in the same short period. And this general statement is true all along the coast, at least as far as Chesapeake Bay. Thus any bottom animal may be subjected to great and sudden changes. At the edge of the shelf, where the water is deeper (75–125 fathoms), conditions are more uniform. And this is a particularly interesting zone zoölogically, as Verrill (1880, 1884a) long ago pointed out, because it is the only place where the bottom is normally bathed by water varying only a few degrees, either way, from 50°. Deeper down the slope the bottom water is constantly colder; nearer the shore it is so for at least part of the year. Along this zone, too, salinity is much more constant than it is nearer the shore, as well as higher, and probably with but little seasonal change. Added to these hydrographic advantages, is the abundant food supply which usually characterizes the contact-zone between warm and cold waters, the importance of which was long ago realized by Verrill (1881). The result is that the bottom fauna of this zone is remarkably rich, both in species and in individuals, and largely of southern origin (Verrill, 1880, 1881, 1884b). But its biological advantages are partly compensated for by its dangers, for at least once within the memory of man its inhabitants have suffered widespread destruction, the surface, for some hundred of miles, being strewn with the dead bodies of the tile-fish (Lopholatilus), as so graphically described by Collins (1884) and Verrill (1882, 1884b) and often commented upon by subsequent writers (Murray, '98, Murray and Hjort, 1912, Sumner, Osburn, and Cole, 1913). And at the same time the invertebrate bottom fauna was practically obliterated (Verrill, 1884a, p. 656; 1884b). Verrill believed that this was due to an off shore movement of the cold bottom water on the shelf, under the influence of violent northerly storms which swept the coast during the late winter and early spring of 1882. And whether this was the true cause, or whether an unusual accession of northern, or of abyssal, water was to blame for the lowered temperature observed by Verrill in that year (p. 239), the occurrence serves to illustrate the fluctuations to be expected along the meeting zone of cold and warm waters. And it was evidently not a unique, though no doubt an unusual occurrence, for in July, 1884, the ALBATROSS encountered great numbers of dead cephalopods floating on the surface, over the 100 fathom curve, further south (Lat. 37° 47′, Tanner, 1886). Conversely the failure of various northern littoral animals to extend their ranges beyond Cape Cod, is probably due to the excessive summer warming, partly due to solar heat, but also to sporadic flooding by Gulf Stream water.

THE PLANKTON.

General account of the macroplankton.

The plankton work of the cruise had two main objects: — first, a qualitative survey of the various species, which must precede any quantitative study to make the latter valuable; and, secondly a faunistic examination of the plankton as a whole, at each station, to illustrate the geographic occurrence of associations of species.

When the work in Massachusetts Bay in May, 1913, was finished the vernal diatom swarm had largely disappeared, and copepods, which had been very scarce during the preceding month, had reappeared in the shape of swarms of nauplii and older larvae; while by June, hauls off Gloucester yielded an almost pure Calanus plankton. Much this same condition obtained early in July, surface hauls off Gloucester, on July 7th, yielding a rich harvest of *Calanus finmarchicus,* with great numbers of the large blue copepod *Anomalocera pattersoni,* together with young schizopods, and a few other boreal organisms; while the importance of this region as a spawning ground for food fish was attested by the presence of numerous gadoid fry in the nets.

The hauls off Cape Cod (Station 10057) revealed the same type of macroplankton that occupied the greater part of the Gulf during the summer of 1912, namely, swarms of *Calanus finmarchicus,* a few *Euchaeta norvegica,* many small schizopods (Thysanoessa), Euthemisto and Hyperoche among amphipods, the pteropod *Limacina balea* (p. 303); *Sagitta elegans* (p. 299); the Medusae *Staurophora mertensii* and *Melicertum campanula;* the siphonophore *Stephanomia cara* (p. 315); and the ctenophores *Beroe cucumis* and *Pleurobrachia pileus.* Although open nets alone were used, their contents clearly showed that the plankton was bathymetrically stratified. Thus it was the surface hauls alone that yielded any considerable number of copepod nauplii and eggs; and while the haul at 15–0 fathoms caught swarms of Calanus, and many schizopods, and hyperiids, but only a few Sagittae, the haul from thirty fathoms contained almost no schizopods, hyperiids, or pteropods, but on the other hand brought back great numbers of Sagittae; and Euchaeta was taken in the deep haul only; *i. e.,* Calanus, schizopods, hyperiids, and pteropods were mostly above fifteen fathoms, Euchaeta, and Sagittae below that depth, Beroe, Pleurobrachia, and Stephanomia more evenly distributed horizontally.

Over the southern part of the basin of the Gulf (Station 10058) the plankton was qualitatively much the same — but quantitatively very different, for Calanus was not nearly so abundant in the haul from forty fathoms; the net, however, yielded many *Euchaeta norvegica,* with few *Calanus hyperboreus;* and fully one half the catch consisted of Stephanomia bells and denuded stalks (p. 316); there were also more fish fry than were found nearer shore.

At the Station on the northwest side of George's Bank, a rather surprising discovery was made, namely that the surface water was full of campanularian hydroids (Obelia) broken from their attachments, and many of them entirely regenerated. A similar phenomenon was noted on George's Bank during the winter of 1912–1913 (1914b, p. 414). It is interesting faunistically as showing how the strong tides of the region, by keeping the detached hydroids afloat, mechanically introduce an exotic element into the plankton. So far as I can learn, nothing of the sort has been observed elsewhere, at least on so large a scale. The place of Calanus was taken by another copepod, *Temora longicornis,* while the bulk of the deep haul consisted of Sagittae (*S. elegans*). The net also yielded many young Cyanea, and several caprellids, no doubt shaken loose from the hydroids.

In the waters over Nantucket Shoals (Station 10059) Calanus was again the prevalent organism, with but few Sagittae; near the lightship, however, (Station 10060), Sagittae about equalled Calanus in bulk; and this Station was also notable for swarms of young Euthemisto (p. 281), of pteropods (*Limacina balea,* p. 304), and of the free medusae of Obelia.

We saw fragments of Gulf weed on the surface south of Nantucket light-ship, and at Station 10061, over the eighty fathom curve, the influence of the Gulf Stream was made evident by the presence of Salpae, Phronima, and the amphipod Vibilia, though the bulk of the plankton still consisted of *Calanus finmarchicus,* with such other boreal forms as *Euchaeta norvegica,* Euthemisto, *Sagitta elegans,* and *Limacina balea.* The plankton over the shelf south of Marthas Vineyard and Block Island (Stations 10062 and 10063) consisted chiefly of swarms of young and old Euthemisto (p. 281), with smaller numbers of copepods (Calanus and Centropages, p. 287), Sagittae and an occasional *Pleurobrachia pileus.* And here for the first time large numbers of fish fry, a striking feature of the tows further south, were encountered. When the deep water outside the shelf south of Long Island (Station 10064) was reached the boreal plankton was replaced by a warm water assemblage, for while the 175 fathom haul still yielded many Euthemisto, the rest of the catch consisted of such typical Gulf Stream species as small "black fishes" (Myctophidae), swarms of Salpae of several species (p. 275), Doliolum, Phronima, Vibilia, Saphirrina and other species of copepods not taken in the cold waters nearer shore (p. 296); and such typical warm water coelenterates as *Rhopalonema velatum, Physophora hydrostatica,* and *Agalma elegans* (p. 316). But the haul from twenty-five fathoms yielded little except hundreds of colonies of *Agalma elegans,* with only a few Salpae; and the surface water was practically barren. Along this part of the coast Gulf Stream fauna was confined to the waters outside the continental shelf, for as we ran shoreward once more a typical Calanus plankton in great abundance was encountered, together with other boreal organisms, over the forty fathom curve (Station 10065).

Cape Cod is often spoken of as the dividing line between warm and cold water faunae on our coast; but at the time of the cruise it was not until we neared New York that any decided change in the character of the plankton of the coast water was noted. East of this, and in the Gulf of Maine (p. 285), copepods, chiefly Calanus, everywhere played an important rôle, though occasionally overshadowed by the extraordinary abundance of some other organism, for example, the hydroids on George's Bank, and the swarms of Euthemisto south of Block Island. But they were a very insignificant part of the plankton south of New York and were occasionally entirely lacking in the hauls. Near New York (Stations 10067 and 10068) the water was filled with swarms of *Pleurobrachia pileus* to the exclusion of almost everything else, except on the immediate surface, where the no. 20 net brought back a considerable number of small copepods (*Centropages typicus*). A few miles further south (Station 10069) large numbers of Salpae (p. 277) were seen on the surface close to land. At this Station, too, swarms of the large warm water ctenophore, *Mnemiopsis leidyi,* which has never been known to enter the Gulf of Maine, but which is common along shore as far as Cape Cod later in the summer, were noted for the first time. Other interesting coelenterates, common near the surface at this Station and further south, are the well-marked southern variety of the large hydromedusa, *Aequorea groenlandica,* and the pale southern Cyanea (p. 315). But all these warm water forms seem to have been limited to a shallow surface zone, because the haul from fifteen fathoms yielded great numbers of *Pleurobrachia pileus,* but no Salpae or Mnemiopsis, and only a few Aequorea which were probably caught near the surface. Besides the Pleurobrachia there were about twenty *Aglantha digitale*

(p. 316) besides a few Sagittae (p. 298), Euthemisto, one large *Tomopteris helgolandica,* and many fish fry of several species. We fully expected to find Salpae more abundant on our line seaward opposite Barnegat; but this was not the case, for, though great numbers of Mnemiopsis and Salpae were noted on the surface for some thirty miles from the land, both then disappeared, and at Station 10070, over the forty fathom curve, the hauls yielded no Mnemiopsis, and only seventeen specimens of Salpa, though the latter represented no less than six species. And Salpae were nearly as scarce at about the same relative position on the shelf off Cape May (Station 10072), none being seen on the surface, and the total catch only about thirty (p. 275). But the water there was full of Mnemiopsis, which clogged the nets; and the haul from fifteen fathoms yielded swarms of Pleurobrachia, many fish fry and one unmistakable warm water species, the small hydromedusa Niobia (p. 317).

The Gulf Stream station off Cape May (Station 10071) yielded much the same plankton that was found in the edge of the Stream off New York (Station 10064), as might have been expected from the high temperature and salinity of the water (p. 163). Little was to be seen on the surface except a few bits of Sargassum; and the surface nets yielded practically nothing. But the hauls from 175 and 190 fathoms brought in masses of Salpae of four species, notably *S. cylindrica* (p. 277); and such other warm water organisms as Phronima, *Agalma elegans, Diphyes serrata,* young myctophids, Leptocephali, *Sagitta inflata,* Rhizophysa, several southern pteropods (p. 302), and the oceanic schizopod *Nematoscelis megalops.* The only members of the list from this Station which are regular inhabitants of the coast water north of New York are a few copepods (Calanus and Metridia), which shows how little the coast water influences the plankton outside the continental shelf.

The plankton of the coast water was composed of much the same constituents south of Delaware Bay as off Barnegat. At Station 10073 the surface water was very barren, the total yield of the surface nets being only a few small Doliolum, one Pleurobrachia, two Sagittae, seven or eight copepods, a few small appendicularians, and fish eggs. But at fifteen fathoms the net was clogged by Mnemiopsis, while Geryonia, Diphyes, Cuboides, Sapphirina, several species of warm water pteropods (p. 302), and two specimens of the Leptocephalus of the conger eel gave it a more southern aspect than that of the shallow water further north. The hauls over the forty fathom contour, some fifty miles further south (Station 10074) contained an even larger proportion of warm water animals, and loggerhead turtles, sharks, and pilot fish were seen on the surface. And the deep haul contained many oceanic species, *e. g.*, Criseis, Corolla, Firoloides, Liriope, Aglaura, Rhopalonema, *Agalma elegans*, and the tropical hydromedusa Niobia, which, owing to its asexual budding, comes into the oceanic category so far as its dispersal is concerned. But there were also many neritic forms, *e. g.* fish eggs and fry, stomatopod larvae, gammarids, young crabs, and the ctenophore Pleurobrachia. Five miles nearer land the water was crowded with copepod larvae and the ctenophore Mnemiopsis, though still with an occasional Agalma, Doliolum, and Liriope. The swarm of Mnemiopsis, which revealed its presence by its phosphorescence (for we ran through it at night) as well as by an occasional use of the dip net, was some twenty miles broad. But as land was approached it gave place to hosts of Salpae, which filled the surface waters at Station 10075. At this Station we noted an occasional Cyanea, and Aequorea, and many large specimens of *Beroe forskalii*, besides schools of menhaden (Brevoortia) and porpoises (Tursiops).

The final Gulf Stream Station (10076) lay abreast of Chesapeake Bay. And though the plankton consisted chiefly of the same oceanic forms which were encountered further north, the presence of stomatopod larvae, Aequorea, considerable numbers of small copepods, and eel grass (Zostera) instead of Sargassum floating on the surface, showed as clearly as did the salinity (p. 200) that the influence of the fresh water from the Bay was felt over the whole breadth of the continental shelf. And perhaps this also explains the fact that all the hauls at this Station were scanty, and contained a large proportion of debris.

As the mouth of the Bay (Station 10077) was approached the macroplankton grew even more scanty, though there was a decided increase of microplankton (p. 334); and Beroe was once more found in considerable numbers, together with the neritic hydromedusa Laodicea, while a new element of shore origin was added by swarms of larvae of the blue crab (Callinectes) on the surface. The few oceanic elements were now much in the minority; but even near the mouth of the Bay (Station 10078), the nets yielded a few Liriope and an occasional siphonophore (Diphyes).

The stations on the run northward to Cape Cod all lay close to land, hence yielded chiefly neritic plankton. The swarm of Callinectes larvae extended for about thirty-five miles along the coast, being no doubt recruited from the various bays and inland sounds, as well as from the Chesapeake itself; but it had disappeared by the time Station 10079 was reached, and it is interesting to note that its disappearance coincided with a decided rise in the salinity of the surface water (Plate **2**). On the other hand Mnemiopsis, together with a few Aequorea, Cyanea, and Pleurobrachia, was again numerous at this Station, and there was a great increase in the number of Salpae (p. 275), which were but sparsely represented at the stations off the mouth of Chesapeake Bay. The hauls at Station 10079 likewise yielded such oceanic genera as Doliolum, Criseis, and Firoloides. Immediately north of Delaware Bay (Station 10080) we once more found swarms of small Salpae (p. 275) and Mnemiopsis, the nets coming in full to the brim. But both of these genera must have been limited to a very shallow surface zone, because a net working about a fathom down caught very few of either. Deeper down, about ten fathoms, the water was occupied by a swarm of Pleurobrachia. Stations 10080 and 10081 illustrate how much more varied the plankton was near shore along this part of the coast than in the Gulf of Maine, for no Pleurobrachia, and very few Mnemiopsis were taken at the latter only about forty miles north of the former and about the same distance from land, with about the same temperature and salinity. But the deeper water layers must have swarmed with small Salpae, for the haul at ten fathoms yielded a perfect Salpa soup; and the surface hauls caught great numbers of Callinectes larvae, which were not represented at all at Station 10080.

By August 1, Salpae, which were first met in numbers off Barnegat, on the voyage south, had spread northward as far as the Hudson trough (Station 10082) where they formed the bulk of the surface tow. But the haul at twenty fathoms yielded very little except Pleurobrachia. When the shore of Long Island (Station 10083) was approached, the Salpae, and the Pleurobrachia swarm, were replaced by a rather scanty copepod plankton.

The remainder of the work was carried on in the Gulf of Maine. And no sooner had the Grampus rounded the southern angle of Cape Cod (Station 10085) than the boreal plankton, with which we are familiar from previous work in the Gulf, was encountered. Stations 10057 and 10086 were located at the same geographic position off Highland light, and the only apparent change which had taken place during the interval of four weeks which separated them was that the Staurophora, Stephanomia, and Beroe, which had been prominent in the tow early in July were no longer found. Off Massachusetts Bay we found a typical Calanus plankton, with *Euchaeta norvegica,* northern schizopods, *Sagitta elegans,* Euthemisto, *Limacina balea,* Pleurobrachia, Melicertum, *Tomopteris helgolandica,* Euchaeta, and hosts of

GULF OF MAINE PLANKTON.

SPECIES	STATIONS																			% of stations for each species
	10086	10087	10088	10089	10090	10091	10092	10093	10095	10096	10097	10098	10099	10100	10101	10102	10103	10104	10105	
Calanus finmarchicus	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	100
Pseudocalanus elongatus	?	×	×	×	×		×		×	×	×	×	×	×	×	×	×		×	80
Metridia lucens	×	×	×	×	×		×	×		×	×	×	×	×	×	×	×	×	×	80
Anomalocera pattersoni			×	×	×	×	×	×	×	×	×	×		×	×	×	×	×	×	80
Euchaeta norvegica		×	×	×	×	×	×	×		×	×			×	×	×		×		70
Meganyctiphanes norvegica			×				×	×			×			×	×		×			40
Thyanoessa inermis		×																		
Euthemisto compressa	×	×	×	×	×	×	×	×	×	×	×			×	×	×	×	×	×	90
" bispinosa				×	×	×	×	×	×	×	×					×				50
Hyperoche kroyeri	×	×	×								×	×		×				×		40
Limacina balea	×	×	×		×	×	×	×	×	×	×		×	×	×	×	×	×		80
Tomopteris helgolandica		×	×	×		×		×	×	×	×		×	×	×		×			60
Sagitta elegans	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	100
Phialidium languidum			×	×	×	×			×	×	×	×	×	×	×	×	×		×	80
Staurophora mertensii				×	×	×		×						×			×	×		40
Pleurobrachia pileus	×	×		×					×	×	×	×	×	×			×			50
Total species per stations	8	11	12	12	11	10	10	11	10	12	14	8	8	14	11	10	12	9	7	

larvae of the red fish (*Sebastes marinus*). And the assemblage over the western basin was the same, with the addition of the schizopod, *Meganyctiphanes norvegica.* Off Penobscot Bay (Stations 10091 and 10100) there were swarms of *Limacina balea,* a pteropod represented at most of the other Gulf Stations by small numbers only; at several stations the nets brought back numerous specimens of Staurophora (p. 273), and at Stations 10091 and 10092 the surface waters were swarming with young amphipods (Euthemisto), as well as with young stages of *Calanus finmarchicus,* in the proportion of about one of the former to four of the latter. The accompanying table showing the occurrence of fifteen of the more characteristic and faunistically important species, illustrates the extreme uniformity of the plankton of the Gulf. At fourteen of the nineteen stations in the Gulf ten or more of these fifteen species are represented; and at only three stations were less than eight found; the poorest even (Stations 10098, 10099, 10105) had half of the species. Two forms, *Calanus finmarchicus,* and *Sagitta elegans* were taken at every station; and a third, *Pseudocalanus elongatus* was probably also universal (p. 291). *Euthemisto compressa, Anomalocera pattersoni, Limacina balea* and *Phialidium languidum* occurred at 80–90% of the stations and *Euchaeta norvegica* at every station where the haul was deeper than forty fathoms. And no subdivision of the Gulf into faunal regions is possible for any of the species, except that in a general way neritic forms, *e. g., Tomopteris helgolandica,* Staurophora, and Phialidium, and the various metazoan larvae which are always more or less in evidence in the tows near shore, occurred less regularly at the stations in the centre of the Gulf.

The only region which showed a decided variation from the general plankton type just described was German Bank (Station 10095) where the copepods were largely replaced by a swarm of *Pleurobrachia pileus.* But this was an impoverishment, rather than a different plankton type, for Pleurobrachia is widely though irregularly distributed over the Gulf in summer; and when it swarms, seems to obliterate or devour almost everything else in the water.

In 1913, as in 1912, we found a few pelagic organisms of unmistakably oceanic and warm water origin in the Gulf, *e. g.,* Salpa, two copepods, *Euchirella rostrata,* and *Pleuromamma robusta,* and a chaetognath, *Sagitta serratodentata;* but the Gulf Stream component was smaller than in the previous year; while on the other hand, three cold water species, which, though not truly polar, are at least at home in low temperatures, *i. e., Calanus hyperboreus, Euchaeta norvegica* and *Eukrohnia hamata,* were more abundant than in 1912, and a fourth, the copepod *Metridia longa*, which is more typically arctic than any of the preceding, is recorded from the Gulf for the first time. Northern species, however, were not uniformly more abundant than in 1912, the reverse being true of *Clione limacina* (p. 305).

DISTRIBUTION OF SALPA AND DOLIOLUM.

Identified by W. F. Clapp.

Table of occurrence.

Station	Depth	Date	S. fusiformis v. echinata		S. tilesii		S. democratica		S. zonaria		S. cylindrica		S. confoederata		Doliolum	
			agg.	sol.	agg.	sol.	agg.	sol.	agg.	sol.	agg.	sol.	agg.	sol.	00z.	blast.
10061	30–0	7/10/13			Chain 9				2							
10064	175–0	7/11/13	m.	56					33	13					2	
10065	20–0	7/12/13							23	1						
10069	Surface	7/19/13					Swarm m.	m.								
10070	0												1			
10070	20–0	"	2	2	2	1	2	4		1			1		1	
10071	0		1	1				1					1			
10071	190–0	7/20/13	1	m.			1		f.		m.	m.				
10072	15–0	7/21/13					×	×	23							
10073	Surface	"											f. chains			
10073	15–0	"						f.								m.
10074	Surface	7/22/13			f.			3					chains m.			
10074	20–0	"						3	29				11		1	f.
10075	8–0	7/23/13					swarms m.	m.								
10 miles E. off Hog Id.	Surface	7/29/13					m.									
10076	20–0	7/24/13			1				14				23			
10076	120–0	"		f.	2	2	f.	f.	1	2						
10077	20–0	"			1		m.	m.							1	
10078	8–0	7/29/13					f.	f.								
10079	0						swarms m.	m.								
10079	10–0	7/30/13					swarms m.	m.								12:
10080	Surface	7/31/13					swarms m.	m.								
10080	12–0						m.	m.								
10081	10–0	"					m.	m.								
10082	0						m.	m.								
10082	15–0	8/1/13					m.	m.								
10096	30–0	8/12/13			6											
10064	25–0								f.							
10076	0												chains m.			

f. = few = 25 + m. = many = 100 +

Judging from the general distribution of the various species of Salpa in northern waters (Apstein, 1909) their occurrence in numbers was expected only where the surface temperature was high. And this proved to be the case. Salpae were more or less abundant at all the stations south of New York and over the outer edge of the continental shelf (Fig. 67). By the first of August they had extended their range to the waters off New York (Station 10082). And although they had

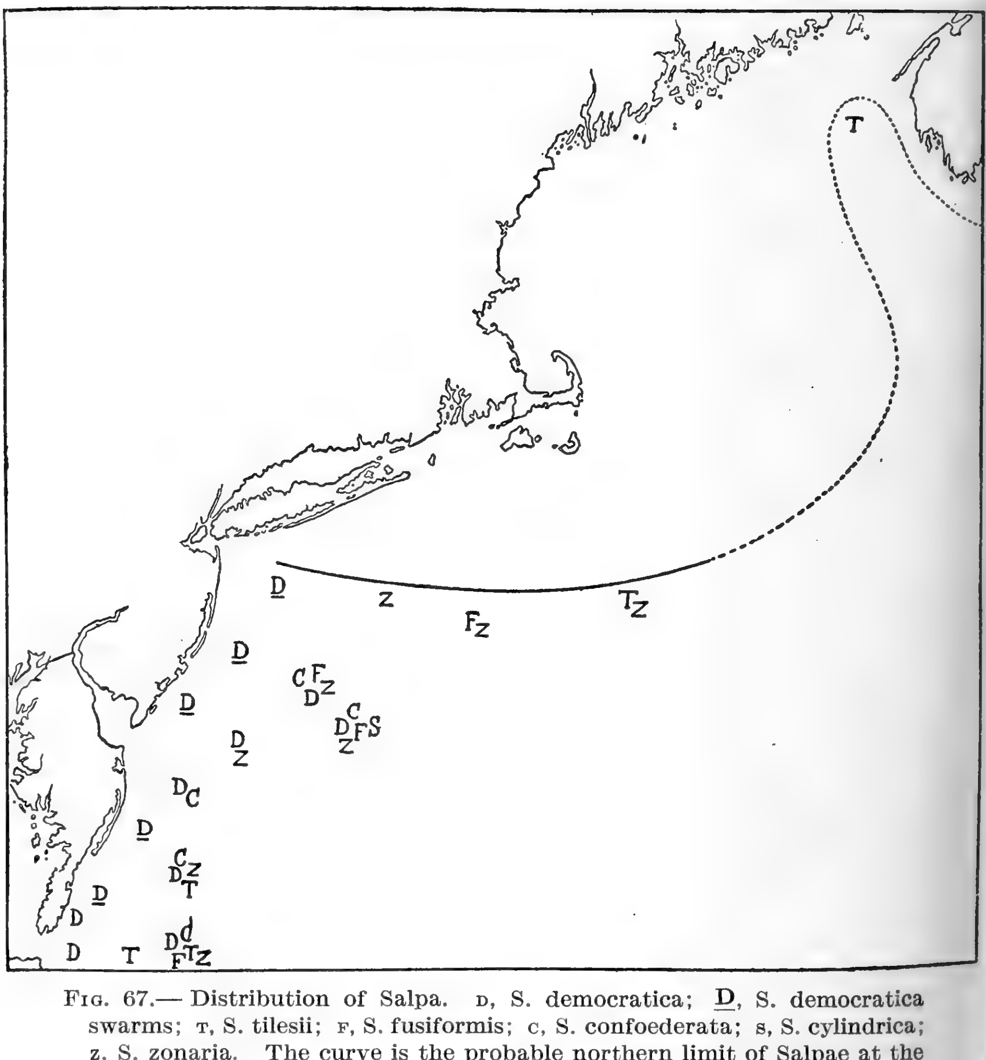

Fig. 67.— Distribution of Salpa. D, S. democratica; D, S. democratica swarms; T, S. tilesii; F, S. fusiformis; C, S. confoederata; S, S. cylindrica; Z, S. zonaria. The curve is the probable northern limit of Salpae at the time of our cruise.

not then reached the south shore of Long Island (Station 10083), they do so more or less regularly later in the season. The only Salpae encountered in the Gulf of Maine were a few specimens of *S. tilesii* which were taken on the eastern side (Station 10096). And I may note that great numbers of this species were taken by fishermen in Massachusetts Bay in the ensuing November and December. The commonest species was *S. democratica.* It was not taken over the edge of the shelf south of Nantucket and Long Island. But it swarmed on the surface off Barnegat (Station 10069); and was taken at all the stations further south, though it was far less abundant in the Gulf Stream than at certain localities near land, *e. g.*, Stations 10069, 10075, 10079, 10080, 10081, and 10082. But it was not universally common over this part of the shelf, there being regions of scarcity off Delaware Bay and off Chesapeake Bay (Stations 10070, 10072, 10074, 10078). All the captures were from temperatures higher than 65°. Salinity was about the same (32.1‰–32.4‰) at several of the poor Stations (10070, 10072) as at several rich ones (10069, 10079, 10080, 10081); and the total range of salinity occupied by the species was very great (32.27‰ to 35.25‰). The unequal quantitative distribution of *Salpa democratica* is, I believe, an index of the abundance of the food supply, not of the amount of Gulf Stream water. During the early summer the surface temperature rises sufficiently to make the coast water a favorable habitat for the Salpae which are dispersed over this part of the continental shelf by the constant mixture between land and Gulf Stream water, and wherever they find a plentiful food supply, they reproduce with marvelous rapidity. Examination of the intestinal contents of *S. democratica* supports this view, for the specimens taken at Stations 10069, 10077, 10081 contain large amounts of diatom and peridinian debris. *Salpa democratica* occasionally swarms in the Gulf of Maine, for example, off Chatham in September, 1912 (1914a), though not encountered there in 1913.

The five other species of Salpa do not agree in distribution with *S. democratica,* for they were all absent in the coastal belt south of New York, (Stations 10069, 10075, 10078 off Hog Island, 10079, 10080, 10081 and 10082), *i. e.*, just where *democratica* was most abundant (p. 275). *Salpa zonaria* was second to *democratica* in the number of stations at which it was observed, but unlike the latter, it was most abundant at the edge of the Gulf Stream and over the outer part of he shelf (Stations 10064, 10071, 10072, 10074); absent close to land. *Salpa fusiformis* was even more restricted to the edge of the Gulf Stream, being most abundant in the deep hauls at the Stations where Gulf Stream water was purest (10064, 10071), much less so off Chesapeake Bay Station (10076). It was not found anywhere over the ontinental shelf, except a few specimens at Station 10070.

Our only capture of *S. cylindrica* was at the most typical Gulf tream Station (10071), where it was numerous, far outnumbering all other Salpae put together. And the few chains of *S. confoederata* which were seen, or collected, it was nowhere abundant, were restricted to Gulf Stream Stations (10071, 10076) and to the outer part of the shelf (10070, 10073, 10074). *Salpa tilesii*, on the contrary, was not taken at all at Stations 10064 and 10071, but was found in adulterated Gulf Stream water at Station 10076, and was more or less common along the edge of the continental shelf (Stations 10061, 10070, 10077); and in the eastern part of the Gulf of Maine (Station 10096).

Salpae as a whole were far less numerous along the inner edge of the Gulf Stream in July, 1913, than they were in July, 1908 (1909, p. 198), when they were more abundant on the surface south of Nantucket than I have ever seen them.

The hyperiid amphipods.

Hyperiid amphipods often form a large part of the macroplankton in boreal waters and are of considerable importance as food for pelagic fishes. The species so far captured in the Grampus hauls, all of which are easily recognizable, are *Hyperia medusarum, Hyperia galba, Hyperoche kröyeri, Parathemisto oblivia, Euthemisto compressa, Euthemisto bispinosa, Phronima atlantica, Phronima sedentaria, Tyro atlantica,* and *Vibilia jeangerardi.* Their occurrence, in the summer of 1913, is shown in the following table (p. 279).

(The identifications follow Bovallius, 1887–1889, and Sars, 1895. For previous records off the New England coast, see Holmes, 1905, and Rathbun, 1905).

The most widely distributed hyperiids in the coast water, as well as the most abundant numerically, were the two species of Euthemisto, *compressa* and *bispinosa* (Fig. 68). This genus as a whole (the relationship of the two species to each other will be considered later) was generally distributed over the Gulf of Maine (Stations 10058, 10087 to 10105); it was present on George's Bank (Station 10059), in the waters over Nantucket Shoals (Station 10060), over the outer part of the continental shelf, south of Block Island and Long Island (Stations 10062, 10063, 10065, 10066); and in the mixed water at the inner edge of the Gulf Stream (Stations 10061, 10064, and 10076). But we did not find it in Gulf Stream water proper (Station 10071, 10073), in any of the tows in the comparatively fresh water off Chesapeake Bay (Stations 10077 and 10078), or at any of the stations near shore between New York and the Chesapeake (Stations 10067, 10068, 10079–10083), except in one instance (Station 10075).

TABLE OF HYPERIIDS.

STATIONS	Hyperia galba	Hyperia medusarum	Hyperoche kröyeri	Euthemisto compressa	Euthemisto bispinosa	Vibilia	Tyro	Phronima sedentaria	Phronima atlantica
10057	......	......	16	2					
10058	14	4	17	f.					
10059	5	2	......	f.					
10060	......	......	......	m.	m.				
10061	......	......	......	m.	m.	1		1	
10062	......	......	......	......	m.				
10063	......	......	......	f.	m.				
10064	......	......	......	m.	m.	10	......	5	7
10065	......	......	......	2	m.	3			
10066	......	......	......	1	13				
10069	......	......	......	3	1				
10071	1	......	......	......	......	14	1	7	4
10074	......	......	......	2	2				
10075	......	......	......	4					
10076	......	......	......	f.	f.	21			
10080	......	......	......	......	......	......	......	1	
10085	......	......	3	1					
10086	......	......	4	m.					
10087	1	......	1	f.					
10088	5	1	1	f.					
10089	......	......	......	f.	f.				
10090	......	......	......	m.	m.				
10091	......	......	......	f.[1]	f.				
10092	1	......	......	m.	m.				
10093	......	......	......	f.	f.				
10095	......	......	......	m.	f.				
10096	......	1	......	m.	f.				
10097	......	......	1	6	2				
10098	......	......	6						
10100	......	......	6	m.					
10101	......	......	......	f.					
10102	......	......	......	m.	2				
10103	......	......	......	f.					
10104	3	......	5	m.					
10105	......	......	4	f.					
10112	......	......	......	m.	m.				

m. = 50+. f. = 20+

---

[1] and a swarm of larvae, probably this species.

The distribution of the two species is not exactly the same, though roughly parallel, for while *compressa* was taken at practically every station where *bispinosa* occurred, it alone occurred off Cape Cod and on George's Bank, near the coast south of New York (Station 10075) off Massachusetts Bay (Stations 10087, 10088), and, in general, in the coast water north of Cape Ann (Stations 10100, 10101, 10103, 10104, 10105). Of course horizontal hauls can not afford an accurate idea of its abundance, but they do show that it swarmed on the surface

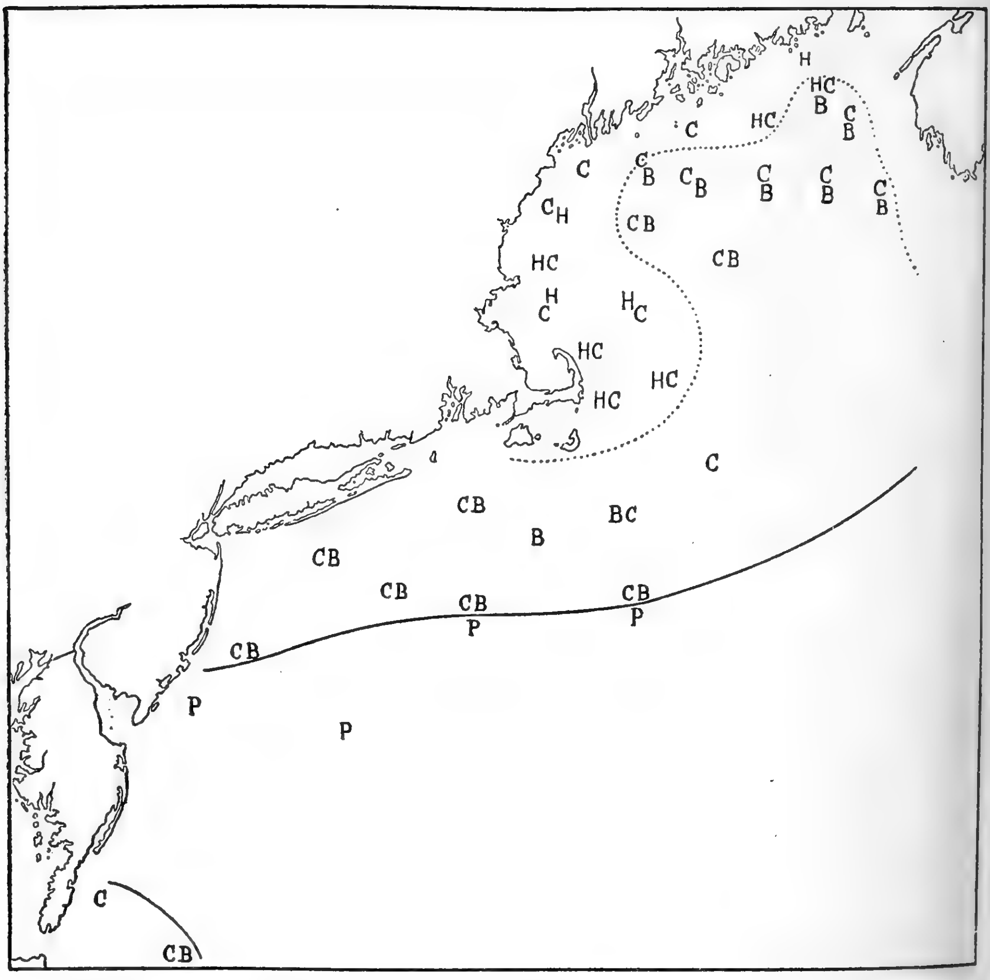

Fig. 68.— Distribution of hyperiid amphipods.
B = Euthemisto bispinosa; C, E. compressa; H, Hyperoche; P, Phronima. The curve —, is the probable southeastern limit to Euthemisto, the dotted curve, ... , the northern limit of E. bispinosa in the Gulf of Maine, at the time of the cruise.

over the eastern basin of the Gulf of Maine (Station 10092); and the swarms of larval Euthemisto which were taken on the surface off Penobscot Bay (Station 10091) probably belong to this species. Secondary centres of abundance for *compressa* in the Gulf were at Station 10102, and German Bank (Station 10095). The only place south of Cape Cod where it was taken in large numbers was on the south side of Nantucket Shoals (Station 10060). *Euthemisto bispinosa* was most abundant, in July, over the outer part of the continental shelf south of Nantucket and Long Island (Stations 10060, 10061, 10062, 10063, 10065); with a second centre of abundance in the eastern part of the Gulf of Maine (Stations 10092, 10093). Late in August young *bispinosa* swarmed in the water southwest of Nantucket (Station 10112) where the large specimens were about evenly divided between that species and *compressa.*

The hauls throw some light on the bathymetric occurrence of the two species. To begin with, it was seldom that the surface hauls contained more than a few representatives of either, though made by night as well as by day. But, as just pointed out, there were swarms on the surface at Stations 10062, 10091, 10092, and 10093. Judging from the stations where two or more intermediate hauls were made at different depths *E. compressa,* like *Calanus finmarchicus,* was most abundant above say forty fathoms in coastal waters, as illustrated by the counts of specimens at three representative stations in the Gulf of Maine and on Nantucket Shoals.

Stations	Fathoms	P. compressa specimens
10061	40–0	29
	70–0	3
10092	35–0	19
	85–0	6
10097	30–0	3
	80–0	0
10104	15–0	35
	50–0	8

And this difference is an actual one, not the accidental result of different nets, etc., because, as pointed out (p. 327) sometimes one net, sometimes another, was used for the deepest haul; and other things being equal, it is the net which worked the deepest, not the shallowest, which would be expected to yield the largest catch, because of the longer column of water through which it fished on its way down and up.

Off Chesapeake Bay (Station 10076) the numbers in the deep and shallow hauls were more nearly equal. In the edge of the Gulf Stream, south of Long Island (Station 10064) *compressa* was ten times as numerous in the haul from 175 fathoms, as in the twenty fathom haul.

Euthemisto bispinosa like *compressa* was more abundant in the deep than in the shallow haul at Station 10064. And it was likewise several times as numerous in the shallow as in the deep haul in the eastern part of the Gulf of Maine (Station 10092). But it was about equally numerous in the two hauls at Station 10061; and off Chesapeake Bay it was most numerous in the deep haul.

Station	Fathoms	Specimens of bispinosa	Station	Fathoms	Specimens of bispinosa
10061	40–0	56	10092	35–0	111
	70–0	67		85–0	29
10064	20–0	5	10097	30–0	1
	175–0	11		80–0	1
10076	20–0	0			
	120–0	17			

The quantitative relationship of the two species to each other is shown in the following table, which gives the relative number of each species in a sample at stations where both were taken.

STATIONS →	10060, 20–0 F.	10061, 40–0 F.	70–0 F.	10063, 25–0 F.	10064, 20–0 F.	175–0 F.	10065, 20–0 F.	10066, 0 F.	10069, 10–0 F.	10076, 20–0 F.	120–0 F.	10089, 25–0 F.	10090, 75–0 F.
Euthemisto compressa	58	29	3	10	4	42	10	1	3	10	6	28	39
Euthemisto bispinosa	52	56	67	200	5	11	75	13	1	0	17	18	40

STATIONS →	10091, 0 F.	10092, 0 F.	35–0 F.	85–0 F.	10093, 0 F.	85–0 F.	10095, 20–0 F.	10096, 0 F.	30–0 F.	10097, 30–0 F.	80–0 F.	10102, 20–0.	10112, 20–0.
Euthemisto compressa	1	30	19	6	25	1	30	10	22	3	0	75	10
Euthemisto bispinosa	1	2	111	29	50	8	9	0	6	1	1	2	100

Thus the two species were about equally abundant over Nantucket Shoals (Station 10060), in the centre of the Gulf of Maine (Stations 10090 and 10091), and in the upper layers near the edge of the Gulf Stream south of Long Island (Station 10064). But *compressa* preponderated off Barnegat (Station 10069) and at all the stations near shore in the Gulf of Maine where both were taken, (Stations 10089, 10095, 10096, 10097, 10102), as well as on the surface over the eastern basin (10092); *E. bispinosa* over the outer part of the continental shelf south of Nantucket and Long Island, in the deep haul off Chesapeake Bay, and in the deep hauls in the eastern basin of the Gulf of Maine. When *bispinosa* outnumbered *compressa*, its preponderance was usually greatest in the deep hauls.

Both species were living at a wide range of temperature, with a maximum of about 69° (Station 10066, surface). And swarms of *bispinosa* were taken in water as warm as 67° (Station 10062, surface); but *compressa* was not common in water warmer than 62° (Station 10092), and most of its captures must have been from considerably colder water. The lowest temperatures for both was about 42° (deep hauls in the Gulf of Maine); and *bispinosa* must have been living in numbers in this cold water, because plentifully represented in one of the deepest hauls in the Gulf as well as in the shallower ones (p. 282).

The range of salinity was likewise very wide for both species, with an upper limit of 35.2‰ (the deep haul at Station 10064) and a lower limit of about 31.5‰ (surface, Station 10066). But it was only once that either was taken in water fresher than 32‰, and the freshest water in which they were abundant was 32.8‰ for *bispinosa* (surface, Station 10062), 32.6‰ for *compressa* (surface, Station 10092).

The data outlined above suggest that both *compressa* and *bispinosa* belong to the coastal, not oceanic waters, of which *compressa*, at least, is almost as regular an inhabitant as *Limacina balea*, Calanus, or indeed any of the typical boreal plankton animals. Both species, it is true, were found in large numbers, and of unusually large size, in the deep water under the edge of the Gulf Stream; but the fact that this was only where the surface of the stream was considerably diluted with fresh water, and that both were absent in the Gulf Stream water proper (Station 10071, 10073) shows that neither of them is a regular inhabitant of the stream. They thrive below the inner edge of the stream, not because of temperature or salinity, but because of the abundant food supply.

Hyperoche kroyeri was taken only in the Gulf of Maine where it occurred at twelve stations, all near shore, as follows:—

Station	Fathoms	Specimens	Stations	Fathoms	Specimens
10057	15–0	10	10088	80–0	1
	30–0	6	10097	80–0	1
10058	40–0	17	10098	18–0	6
10085	20–0	3	10100	40–0	7
10086	20–0	4	10104	50–0	5
10087	15–0	5	10105	50–0	3
	30–0	1			

The numbers of specimens concerned are so small that they do not show anything about bathymetric distribution.

The few captures of *Hyperia medusarum* are likewise from the Gulf of Maine, and so are most of the *Hyperia galba,* which is consistent with the distribution of their medusan host Cyanea. But one specimen of *H. galba* was taken in the Gulf Stream (Station 10071, 190–0 fathoms).

The remaining hyperiids were all taken either in the Gulf Stream, or where Gulf Stream water was in evidence: they are all visitors from the south, or at least from the warmer parts of the Atlantic, and do not belong to the permanent plankton of the coast water.

Vibilia was taken at all the stations outside the continental shelf, and twice over the outer part of the shelf; curiously enough, however, it was not encountered in the Gulf Stream tongue south of Delaware Bay. The depths of the captures are:—

Station	Fathoms	Specimens	Station	Fathoms	Specimens
10061	70–0	1	10071	20–0	2
10064	175–0	10		190–0	12
10065	20–0	3	10076	20–0	2

Thus most of the specimens came from deep hauls, none from the surface.

Tyro was taken only once, in the Gulf Stream, one specimen, twenty fathoms, Station 10071.

The two species of Phronima were likewise restricted to the Gulf Stream, and to the outer edge of the shelf, except for a single specimen of *sedentaria* near Cape May (Station 10080). Though the two agree geographically *sedentaria* was living deeper than *atlantica* as shown in the following table of captures.

Station	Depth	Sedentaria	Atlantica
10061	40–0	1	
10064	20–0		7
	175–0	5	
10071	20–0		4
	190–0	7	
10080	12–0	1	

The only *sedentaria* taken in shallow water was dead and very fragmentary; those from the deep hauls were all alive, and most of them inside their "houses" (Doliolum shells). The *atlantica* were all free, and alive. Neither was taken on the surface, which agrees with the rarity of Salpae and Doliolum on the surface, in the Gulf Stream (p. 278) at the time of our visit. When Salpae swarm at the surface of the stream, as they occasionally do (1909b), Phronima appears there too.

COPEPODS.[1]

Copepods were by far the most important constituent of the plankton in the Gulf of Maine (p. 274), where they were extremely abundant; and the hauls revealed a rich copepod plankton over the shelf south of Cape Cod. But on the run west and south, these little crustaceans gave way to other organisms (p. 269), the copepods in the hauls south of New York being counted by individuals, instead of by hundreds of cubic centimeters. And in some of the southern hauls, *e. g.*, at Stations 10068, 10069, 10078, no copepods at all were detected, something never experienced in the Gulf of Maine. The geographic occurrence of the various copepods is listed in the following table.

[1] Identified by Dr. C. O. Esterly.

Table of the numbers of individuals of several species of copepods in the quantitative hauls (column of water .1 square meter) in the Gulf of Maine, from samples counted by Dr. Esterly.

STATIONS →	10087	10089	10090	10092	10095	10096	10097
Calanus finmarchicus	3750	1650	3750	8800	375	3000	2800
Calanus hyperboreus				80			
Pseudocalanus elongatus	360	1050	375	2600	2400	3000	5600
Euchaeta norvegica			15			20	30
Centropages typicus	90		75				
Temora longicornis				40	150	60	
Metridia lucens	900	225	60	160	105	240	280

STATIONS →	10098	10099	10100	10101	10102	10103	10105
Calanus finmarchicus	500	1200	5400	3000	2250	2000	1350
Calanus hyperboreus			270				
Pseudocalanus elongatus	3200	600	4500	3200	600	1200	975
Euchaeta norvegica							
Centropages typicus							150
Temora longicornis	80	300	1800	1200		160	
Metridia lucens	60	60	450	300	180	80	225

TABLE OF COPEPODS IN THE HORIZONTAL HAULS.[1]

STATIONS →	10057	10058	10059	10060	10061	10062	10063	10064	10065	10066	10067	10068
Calanus finmarchicus	s.	m.	1	m.	s.	....	m.	....	s.	3	....	....
Calanus hyperboreus	....	2	....	....	....	....	....	....	....	....	....	....
Pseudocalanus elongatus	....	....	×	....	....	....	....	....	....	....	....	....
Rhincalanus nasutus	....	....	....	....	....	....	....	30	....	....	....	....
Euchirella rostrata	....	....	....	....	....	....	....	70	....	....	....	....
Euchaeta norvegica	f.	f.	....	....	m.	....	....	....	....	....	....	....
Euchaeta media	....	....	....	....	....	....	....	....	....	....	....	....
Undeuchaeta minor	....	....	....	....	....	....	....	6	....	....	....	....
Undeuchaeta major	....	....	....	....	....	....	....	....	....	....	....	....
Centropages hamatus	....	....	....	1	....	....	....	....	....	....	....	....
Centropages typicus	....	....	....	....	....	s.	1	....	m.	s.	m.	....
Temora longicornis	....	....	m.	s.	....	....	....	....	....	f.	....	....
Metridia lucens	f.	f.	....	....	....	....	....	35	....	....	....	....
Metridia longa	f.	....	....	....	....	....	....	....	....	....	....	....
Pleuromamma robusta	....	....	....	....	....	....	....	400	....	....	....	....
Pleuromamma xiphias	....	....	....	....	....	....	....	....	....	....	....	....
Pleuromamma rotundum	....	....	....	....	....	....	....	....	....	....	....	....
Pleuromamma sp.?	....	....	....	....	....	....	....	....	....	....	....	....
Anomalocera pattersoni	....	....	....	....	....	....	....	....	....	....	....	....
Scolecithrix persecans	....	....	....	....	....	....	....	2	....	....	....	....
Candacia armata	....	....	....	....	....	....	....	....	....	....	....	....

STATIONS →	10069	10070	10071	10072	10073	10074	10075	10076	10077	10078	10079	10080
alanus finmarchicus	....	....	6	....	....	4	....	6	4	....	1	6
alanus hyperboreus	....	....	....	....	....	....	....	....	....	....	....	....
seudocalanus elongatus	....	....	....	....	....	....	....	....	....	....	....	....
hincalanus nasutus	....	....	12	....	....	....	....	7	....	....	....	....
uchirella rostrata	....	....	....	....	....	....	....	1	....	....	....	....
uchaeta norvegica	....	....	....	....	....	....	....	....	....	....	....	....
uchaeta media	....	....	....	1	....	....	....	....	....	....	....	....
ndeuchaeta minor	....	....	....	....	....	....	....	....	....	....	....	....
ndeuchaeta major	....	....	1	....	....	....	....	....	....	....	....	....
entropages hamatus	....	....	....	....	....	....	....	....	....	....	....	....
entropages typicus	....	m.	....	....	....	11	3	60	....	....	m.	7
mora longicornis	....	....	....	....	....	....	....	....	....	....	....	....
etridia lucens	....	....	10	....	....	....	....	10	....	....	....	....
etridia longa	....	....	....	....	....	....	....	....	....	....	....	....
uromamma robusta	....	....	2	....	....	....	....	....	....	....	....	....
uromamma xiphias	....	....	1	....	....	....	....	....	....	....	....	....
uromamma rotundum	....	....	....	....	....	....	....	15	....	....	....	....
uromamma sp.?	....	....	40	....	....	....	....	....	....	....	....	....
omalocera pattersoni	....	7	3	....	....	....	....	....	2	....	....	10
lecithrix persecans	....	....	....	....	....	....	....	....	....	....	....	....
ndacia armata	....	....	....	....	....	40	....	m.	6	....	....	....

The occurrences of Pseudocalanus are chiefly from the quantitative hauls, p. 291.

STATIONS →	10081	10082	10083	10085	10086	10087	10088	10089	10090	10091	10092	10093
Calanus finmarchicus	1	....	s.	s.	s.	s.	m.	s.	s.	s.	s.	s.
Calanus hyperboreus	....	....	....	....	....	....	....	....	....	....	....	....
Pseudocalanus elongatus	....	....	f.	....	....	m.	f.	s.	m.	....	×	....
Rhincalanus nasutus	....	....	....	....	....	....	....	....	....	....	....	....
Euchirella rostrata	....	....	....	....	....	....	....	....	....	....	....	....
Euchaeta norvegica	....	....	....	....	....	f.	f.	f.	m.	f.	m.	f.
Euchaeta media	....	....	....	....	....	....	....	....	....	....	....	....
Undeuchaeta minor	....	....	....	....	....	....	....	....	....	....	....	....
Undeuchaeta major	....	....	....	....	....	....	....	....	....	....	....	....
Centropages hamatus	....	....	1	....	....	....	....	....	....	....	....	....
Centropages typicus	....	15	m.	....	....	f.	m.	....	f.	1	6	....
Temora longicornis	....	....	4	....	....	....	....	....	....	....	f.	....
Metridia lucens	....	....	20	....	m.	×	5	×	1	....	m.	....
Metridia longa	....	....	....	....	....	....	5	....	2	....	2	....
Pleuromamma robusta	....	....	....	....	....	....	....	....	....	....	....	....
Pleuromamma xiphias	....	....	....	....	....	....	....	....	....	....	....	....
Pleuromamma rotundum	....	....	....	....	....	....	....	....	....	....	....	....
Pleuromamma sp.?	....	....	....	....	....	....	....	....	....	....	....	....
Anomalocera pattersoni	40	....	....	....	....	....	55	×	f.	×	m.	f.
Scolecithrix persecans	....	....	....	....	....	....	....	....	....	....	....	....
Candacia armata	....	....	....	....	....	....	....	....	....	....	....	....

STATIONS →	10095	10096	10097	10098	10099	10100	10101	10102	10103	10104	10105
Calanus finmarchicus	m.	s.	s.	s	s.	s.	s.	s.	s.	s.	s.
Calanus hyperboreus	....	....	....	....	....	m.	f.	....	f.	....	....
Pseudocalanus elongatus	s.	s.	s.	s.	m.	s.	s.	m.	s.	....	m.
Rhincalanus nasutus	....	....	....	....	....	....	....	....	....	....	....
Euchirella rostrata	....	6	....	....	....	....	....	....	....	1	....
Euchaeta norvegica	....	m.	m.	....	....	m.	×	×	....	f.	f.
Euchaeta media	....	....	....	....	....	....	....	....	....	....	....
Undeuchaeta minor	....	....	....	....	....	....	....	....	....	....	....
Undeuchaeta major	....	....	....	....	....	....	....	....	....	....	....
Centropages hamatus	....	....	....	....	....	....	....	....	....	....	....
Centropages typicus	....	f.	....	....	....	....	....	....	....	f.	m.
Temora longicornis	f.	f.	f.	f.	f.	f.	m.	f.	f.	....	....
Metridia lucens	f.	m.	m.	f.	f.	f.	m	m.	f.	f.	×
Metridia longa	....	....	....	....	....	....	....	....	....	....	....
Pleuromamma robusta	....	....	....	....	....	1	....	....	....	....	....
Pleuromamma xiphias	....	....	....	....	....	....	....	....	....	....	....
Pleuromamma rotundum	....	....	....	....	....	....	....	....	....	....	....
Pleuromamma sp.?	....	....	....	....	....	....	....	....	....	....	....
Anomalocera pattersoni	f.	f.	f.	×	....	1	1	f.	60	f.	f.
Scolecithrix persecans	....	....	....	....	....	....	....	....	....	....	....
Candacia armata	....	....	....	....	....	....	....	....	....	....	....

f. = few, 20 +
m. = many, 100 +
s. = swarm, 1000 +
× = the species occurred.

Calanus finmarchicus was, by far the most widespread and abundant species in 1913, as in 1912, very numerous in the Gulf of Maine in every haul from ten or more fathoms (Fig. 69). This was generally the case in the waters south of Nantucket also, as far as the edge of the continental shelf (Station 10061), except for Station 10062, where it was wholly lacking, its place being taken by swarms of *Centropages typicus,* and of the amphipod Euthemisto. But it was represented by occasional specimens only, in the hauls off New York (Stations 10066, 10067) and further south; and only one specimen was detected

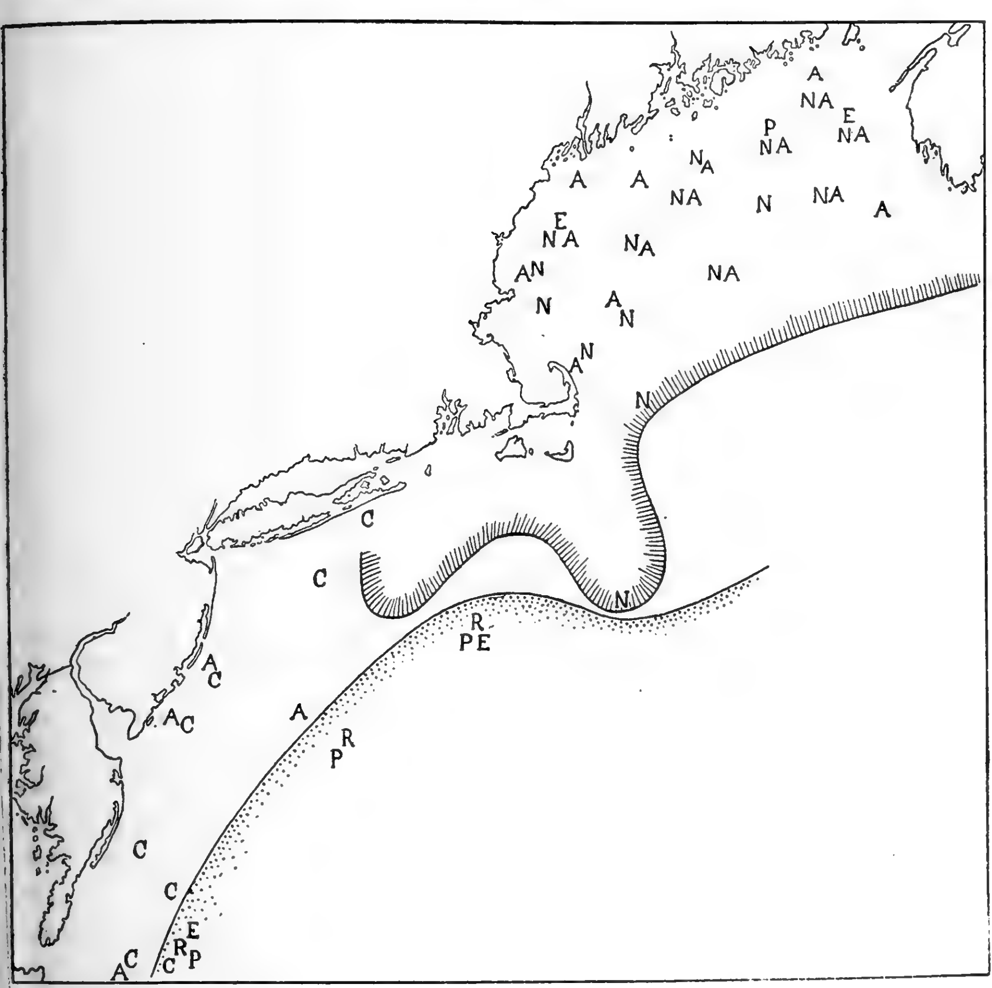

FIG. 69.— Distribution of copepods, July–August, 1913.
N, Euchaeta norvegica; A, Anomolocera pattersoni; R, Rhincalanus nasutus; P, Pleuromamma; E, Euchirella. |||||| Southern limit to abundant Calanus finmarchicus; C, occasional Calanus finmarchicus. ⁞⁞⁞ Northern limit to Rhincalanus, Pleuromamma, and Euchirella.

in the hauls on George's Bank (Station 10059). It was also notably lacking in the Gulf Stream water (Stations 10064, 10071), except for a few specimens at Station 10076 abreast of Chesapeake Bay. Calanus appears to be uniformly rare, or absent, in the bays and sounds of the southern coast of New England in summer: but it swarms in Narragansett Bay in winter (Williams, 1906). Calanus was rare on the surface, even in the Gulf of Maine, except at Stations 10085, 10093, 10096, 10097, 10100, 10101, and immediately off Gloucester, July 8, where it swarmed at that level. Four of these stations were occupied in daylight, three after dark; which shows that its absence on the surface, in the regions where it swarms in deeper water, does not depend altogether on sunlight, though the latter may be one of the factors which confine it to deeper levels. And Calanus certainly did not come to the surface off Cape Cod during the night of August 5, for surface hauls taken at 2 A.M., and at practically the same locality at 8 A.M. (Station 10086), yielded very few Calanus, although the deep haul caught thousands. Stations 10057, 10061, 10087, 10090, 10092, 10102, 10104 where hauls were taken at three levels, surface, intermediate, and deep, show that Calanus was not usually equally abundant at all depths, the yields of hauls at 15–20 fathoms being very much larger than those at 50–85 fathoms. The numbers of specimens per haul were far too large for counting; but the shallower catches were usually two to four times as large in bulk as the deep ones, a difference too great to be charged to the difference in mouth area between the four foot and the Helgoland nets. And this source of possible error was further checked by occasionally alternating the two nets. The only exceptions to this rule were Stations 10093, 10097, and 10100, all in the eastern half of the Gulf, where Calanus was about equally abundant in deep and shallow hauls, *i. e.*, just the stations where it was abundant on the surface.

Calanus finmarchicus was taken through a very wide range of temperature, from about 42° (the deep hauls in the Gulf of Maine) to 76° (surface, Stations 10079 and 10080). But it was not abundant in water warmer than 62° (surface hauls, eastern part of the Gulf of Maine), and the great majority of the species was living in much cooler water (42°–50°). The lowest salinity for Calanus was 31.8‰ (surface, Station 10103), the highest may have been as high as 35‰ (Station 10074, 20–0 fathoms haul). But it is by no means certain that the specimens taken at that Station came from such salt water, the net having passed through water as fresh as 33.2‰. The vast majority were living in water of 32.7‰ to 33.4‰, in the intermediate depths of the Gulf of Maine. Calanus was wholly absent in pure Gulf Stream water, as exemplified by Station 10071, and the deeper layers at Stations 10064 and 10076; and it was likewise lacking in the very fresh water at the mouth of Chesapeake Bay. The possibility that the density of the water may determine the bathymetric distribution of copepods, by its effect on flotation, just as is the case with fish eggs, must be taken into account in geographic studies. The Calanus swarms in the Gulf of Maine were living in water of about 1.024 to 1.027. The lowest density in which adults were found abundant was 1.0239 (Station 10093, surface) though larval stages swarmed in water of 1.0231 (Station 10085, surface); the highest, for swarms, was about 1.027 in the deeper parts of the Gulf. None of the physical factors just outlined offer an obvious explanation for the scarcity of Calanus in the waters south of New York in July, for the subsurface salinities, temperatures, and densities of many of those stations were well within the range occupied by the species in the Gulf of Maine. What the limiting factor is, is one of the numerous questions raised, but not answered, by our cruise. Most of the specimens were large adults, as was the case in the summer and autumn of 1912. But the catch off Cape Cod on July 9 (Station 10057) was larval stages; and young stages swarmed in Massachusetts Bay during the early spring of 1913. (For an account of the biology of *Calanus finmarchicus* in Norwegian waters, see Damas, 1905).

The results of the quantitative hauls give a rough idea of the absolute abundance of Calanus in our Gulf (p. 286). Taken at their face value, they show that the numbers of Calanus in a column of water of one square meter cross section varied from 3750 to 88000, being greatest, as the plankton as a whole was richest (p. 237), off Massachusetts Bay and over the eastern basin, least in the northeast corner of the Gulf (Station 10098) and German Bank. The average of the hauls for the Gulf as a whole is 28000 per square meter of surface area. But Calanus must have actually been more numerous than this, because the calculations take no account of the failure of the net to filter the water completely.

The only species which vied with *Calanus finmarchicus* in abundance in the Gulf of Maine was *Pseudocalanus elongatus;* though it was far ess important in the economy of the Gulf because of its small size. Pseudocalanus outnumbered Calanus on German Bank (Station 10095) and in the northeast corner of the Gulf (Stations 10097, 10098); and it was taken in large numbers in every haul of the quantitative net; hough Calanus was usually the more abundant of the two. But the four foot and Helgoland nets failed to capture it at seven out of these thirteen stations. Probably their larger mesh allowed this minute species to pass through. The coarse nets alone being used for the subsurface work in the water south and west of Cape Cod, the apparent absence of this species there may have been partly due to the apparatus. But it can hardly have been abundant there, or it would have appeared occasionally in the catches of the four foot net, just as it did in the Gulf of Maine. And this agrees with Williams's observation (1906) that it is only in winter that Pseudocalanus appears in Narragansett Bay. In July and August it is abundant off Nova Scotia (Wright, 1907).

Eucheata norvegica was taken at practically every deep haul in the Gulf; as well as in three hauls from twenty fathoms (Stations 10090, 10091, 10101), one from fifteen fathoms (Station 10104) and one surface haul (Station 10097). It was found only once south of Cape Cod (Station 10061, 70–0 fathoms). The largest numbers were yielded by the deeper hauls, *e. g.*, 90–0 fathoms at Station 10100; 80–0 fathoms at Stations 10088 and 10097; 75–0 fathoms at Station 10090; 70–0 fathoms at Station 10061. At Stations 10092 and 10097 it was as abundant in the hauls at thirty fathoms, as in the deep hauls, and this was an interesting phenomenon for it was at these same stations that Calanus was uniformly distributed from the surface downward instead of being localized in the mid layers (p. 290). Euchaeta is never abundant in the Gulf of Maine, in the sense that Calanus, or any of the other small copepods can be so described, the richest hauls yielding a couple of hundred specimens at most. It occurred in only three of the quantitative hauls, and then only in small numbers (p. 286); but since the other nets yielded considerable numbers where the quantitative nets missed it, it is probably sufficiently active to avoid the latter, just as the Sagittae are (p. 329). *Euchaeta* was living in water colder than 50°; and at a comparatively high salinity (33‰–34‰); and its quantitative occurrence indicates the lower temperature and higher salinity for its optimum. The exceptions afforded by the one surface capture, and by its abundance at thirty fathoms at Stations 10092 and 10097, where the salinity was about 32.9–33‰ are probably due to local causes.

Metridia longa was likewise restricted to the Gulf of Maine in marked contrast to its relative *M. lucens.* Its captures are too few to allow any general statement of its range in our waters; but the fact that it occurred at all is of interest because it is the "most typically Arctic copepod of whose distribution there is any accurate knowledge"

(Farran, 1910, p. 70). It was not found in the Gulf in 1912, nor has it been recorded before from American waters.

The only other species limited to the waters north of Cape Cod was *Calanus hypoboreus,* which was taken at four stations in the Gulf, both on the surface (Station 10103) and in deep hauls. The only haul which yielded any considerable number was at 90–0 fathoms (Station 10100); where the quantitative net contained 270 *C. hypoboreus* to 5400 *C. finmarchicus;* at Station 10092 the relative numbers were 80 to 88008.

All the other copepods found regularly in the Gulf of Maine likewise occurred over the continental shelf south and west of Cape Cod. *Centropages typicus* was taken irregularly in the Gulf (eight stations) (Fig. 70), but never in large numbers. It did not appear at all in the hauls on George's Bank or on Nantucket Shoals; but it was represented at the shallow Stations south of Long Island (10062, 10063); and at most of the stations on the shelf further south and west. It was not taken at Stations 10064 or 10071; but was well represented in the deep haul at Station 10076: and it swarmed south of Nantucket (Station 10062), off Long Island (Station 10066); and on the surface off Fire Island July 13. South of New York it was much less numerous, as was the case with copepods as a whole. And it never rivalled the Calanus swarm in abundance (p. 286), for which reason and because of its small size, it must be of comparatively little economic importance in our waters in summer. Centropages was most abundant ear the surface, for example, the surface haul at Station 10088 yielded en times as many specimens as the haul from eighty fathoms, though nade with a net of only $\frac{1}{6}$ the mouth area. And the discrepancy was ven greater at Station 10083, where the surface haul yielded several undred Centropages, the haul from twenty fathoms only one speciien. The swarms at Stations 10062 and 10066 were on the surface, nd between fifteen fathoms and the surface. The species was living t a rather high temperature (about 54° to 76°), and rather low saliny (31.5‰, surface, Station 10066 to 33.2‰, surface, Station 10074), ith an optimum, as suggested by its greatest abundance, of about °–69° and 31.5–33‰.

Temora longicornis was abundant only on Nantucket Shoals (Station 060), *i. e.,* just where *Centropages typicus* was wanting, and was casional in the surface tows on George's Bank, south of Long Island tation 10066) and in the Gulf of Maine. But it was not taken at all tside the continental shelf or over the shelf south of New York. was most numerous on the surface; for example, the surface haul at Station 10060 yielded thousands, while the haul from twenty fathoms only caught twenty-five specimens. And it was not taken at all in hauls from depths greater than thirty-five fathoms. Its range of temperature was from about 54° (surface, Station 10096) to about 69° (surface, Station 10066); salinity 31.5‰ (surface, Station 10066) to 33‰ (Station 10059); *i. e.*, it was living in rather

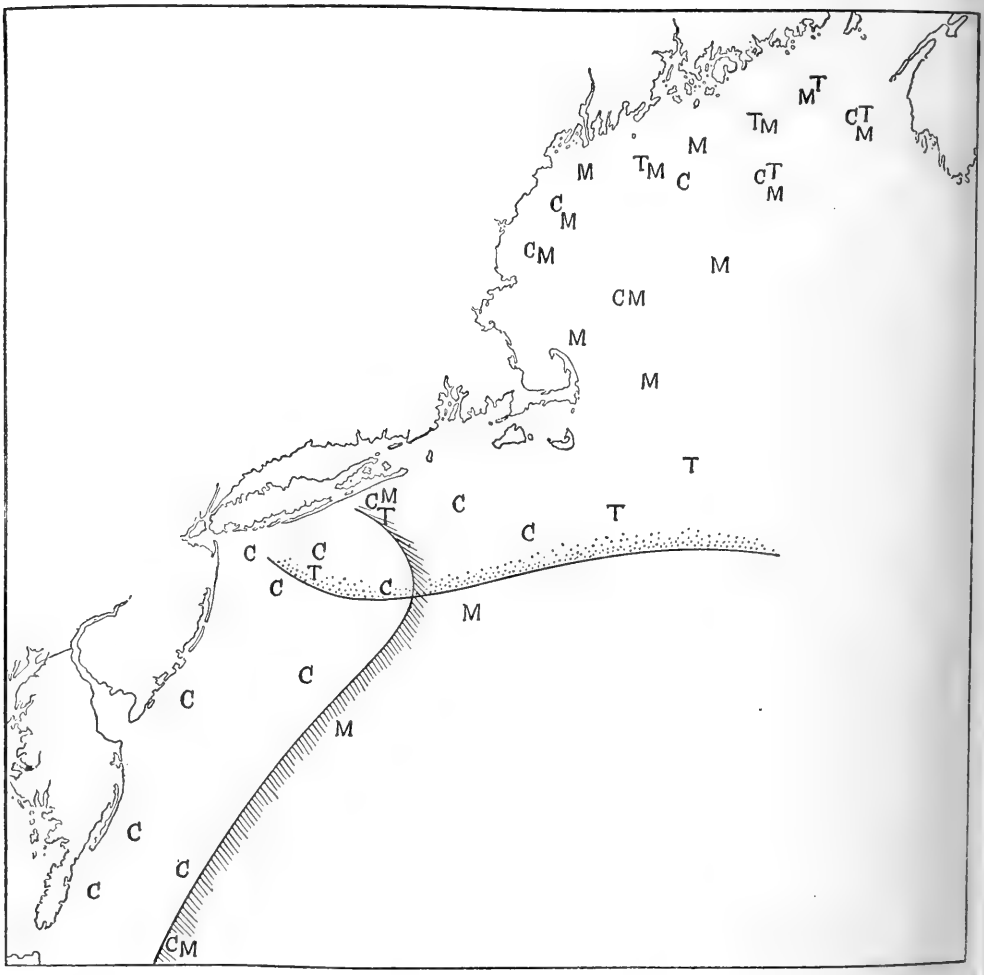

Fig. 70.— Distribution of copepods, July–August, 1913. c, Centropages typicus; m, Metridia lucens; t, Temora longicornis; ⋮⋮⋮ Probable southern limit to Temora longicornis in July. ||||| Western limit to Metridia lucens in July.

colder water than *Centropages typicus,* which corresponds with its abundance as far north as the Labrador Current (Herdman, Thompson, and Scott, 1898) and with its abundance in summer off Nova Scotia

(Wright, 1907). Its absence in the Gulf Stream water and in southern waters in general, agrees with its distribution in European waters (Farran, 1910) where it seems to be of northern origin, and with Wheeler's (1901) and Williams's (1906) statements that it is most abundant in winter at Woods Hole and in Narragansett Bay.

Metridia lucens, unlike *M. longa,* was taken regularly in the Gulf of Maine (eighteen out of twenty-one stations), and it likewise occurred at all three of the Stations outside the continental shelf (10064, 10071, 10076). But it was found at only one Station on the continental shelf, south or west of Cape Cod, (10083) where the haul yielded twenty specimens. And we did not find it on George's Bank or Nantucket Shoals. *Metridia lucens* was not abundant anywhere; in fact so far as known it never swarms in the Gulf of Maine as it does in European waters. It was not taken in any surface haul, the shallowest captures being 15–0 fathoms off Cape Ann (Station 10104), and 8–0 fathoms off Long Island (Station 10083). And its invariable absence from the surface in our waters is evidence that it was not at home in the high temperatures and low salinities of the surface, because it has a well-marked habit of coming to the surface at night in other regions (Farran, 1910). The lowest salinity in which its presence can be established was about 32.4‰ (Station 10104), with a maximum of at least 35.00‰ (Station 10071). In the Gulf of Maine most of the specimens were living in water of 32.6‰ to 33.7‰. The limits to the temperature range of our captures were about 42° to about 50°. *Metridia lucens* has usually been called a northern species (Cleve, 1900). But Farran's (1910) tabulations of the data of the International Committee seem to show that it really belongs to the oceanic waters of the North Atlantic; and that it is carried to the coasts of Iceland and to the northern part of the North Sea by the Atlantic Current; an explanation which agrees fairly well with its occurrence in our waters.

Anomalocera pattersoni was taken at most of the stations in the Gulf of Maine, which supports my suggestion (1914a) that it is more universal in the Gulf than the records of 1912 would indicate; at five ocalities on the shelf south of New York (Stations 10070, 10077, 10080, 10081 and off Hog Island) and at one of the off shore Stations 10071); while Wheeler (1900) records it as abundant in the Gulf tream south of Woods Hole. Most of the records are from the urface; only one from a haul as deep as forty fathoms; and of course hat one specimen may have been caught at or near the surface; and his may also be true of the few specimens yielded by hauls from wenty, twenty-five, and thirty fathoms in the Gulf of Maine. Its surface habitat makes it easy to establish the hydrographic conditions in which it was living, the temperature range being 54°–76°; the salinity 32.1‰ to 35.25‰.

In European waters, likewise, *Anomalocera pattersoni* is chiefly found on the surface (Scott, 1911) though it inhabits rather salter water there, and our catches support Scott's statement that it is a creature of the open seas, to the extent that it was not found in enclosed bays or harbors. But its regular occurrence in the Gulf of Maine shows that it is not typically oceanic in the sense in which Pleuromamma or Rhincalanus may be so described.

The copepods discussed so far are more or less regular inhabitants of the Gulf of Maine; but several species were found outside the continental shelf which enter the Gulf only sporadically if at all. Such are *Rhincalanus nasutus, Euchirella rostrata,* the several species of Pleuromamma, *Euchaeta major, E. minor,* and *Candacia armata.* The first of these was taken at all three off shore stations (Fig. 69), and nowhere else, the total number of specimens detected being only forty-nine. The salinity was about 35‰–35.25‰ which agrees very well with the high salinities of 34.9‰ to over 35.6‰ from which it is recorded by Cleve (1900) and Farran (1910). The temperatures can not be established exactly, the catches all being in open nets from considerable depths: but the absence of the species on the surface and in the hauls from twenty fathoms, and its occurrence in hauls from 175 fathoms (Station 10064), 190 fathoms (Station 10071) and 120 fathoms (Station 10076) leads to the conclusion that it was living at a temperature of about 48°–55°. According to Cleve (1900, p. 139) the mean temperature for the species is 59°. But, as Farran (1911) points out, its range of temperature is very great. Its occurrence in the deeper layers at the edge of the Gulf Stream, and its absence from our coastal waters, whence it has never been recorded, agree with its oceanic habitat, for it is only in the sweep of the Atlantic current that it is recorded by the International Committee.

Pleuromamma robusta was taken in some numbers (about 400 specimens) in the deep haul (175–0 fathoms) at Station 10064; two specimens were detected in the haul from twenty fathoms at Station 10071, and a single specimen in the Gulf of Maine (Station 10100, 90–0 fathoms). Thus it, like Rhincalanus, was living in water of high salinity, from about 33.8‰ in the deeps of the Gulf to upwards of 35.2% (Station 10071). And it, too, is rarely taken near the surface anywhere (Scott, 1911), though widely distributed in the North Atlantic. *Pleuromamma xiphias* and *P. rotundum,* likewise oceanic, were each taken at one station, outside the continental shelf, in hauls from 190 and 120 fathoms respectively (p. 287).

Euchirella rostrata, a member, according to Cleve (1900), of the oceanic plankton of the temperate North Atlantic, was taken at four Stations, two at the edge of the Gulf Stream outside the continental shelf (10064 and 10076) and two in the Gulf of Maine (10096 and 10104). And it was found twice in the Gulf in 1912 (1914a, p. 116); though Wheeler (1900) does not record it from the Woods Hole region.

Candacia armata was taken at three Stations, 10074, 10076, and 10077, all south of Delaware Bay, in hauls from twenty fathoms.

The remaining copepods were taken so seldom (one or two stations and only one or two specimens each) that the captures throw little light on their distribution in our waters.

The Sagittae.

The identifications and notes on the Sagittae are due to the kindness of Dr. A. Pringle Jameson, of the University of Sheffield, England.

Eight species of Sagittae were collected by the Grampus, the numbers of individuals in the various hauls being given in the following table:—

Stations, and depths, fathoms.	10057, 15–0	30–0	10058, 40–0	10059, 20–0	10060, 0	20–0	10061, 40–0	70–0	10062, 15–0	10063, 25–0	10064, 175–0	10066, 0
agitta elegans	1050	223	28	997	379	1158	633	144	112	129	....	5
agitta serratodentata	....	....	....	....	....	....	16	6	17	7	3	1
agitta enflata	....	....	....	....	....	....	....	....	....	....	....	....
agitta bipunctata	....	....	....	....	....	....	....	....	....	....	....	....
agitta hexaptera	....	....	....	....	....	....	....	....	....	....	....	....
agitta lyra	....	....	....	....	....	....	1	....	....	....	29	....
terosagitta draco	....	....	....	....	....	....	....	....	....	....	....	....
ukrohnia hamata	....	....	....	....	....	....	8	29	....	....	9	....

Stations, and depths, fathoms.	10068, 10–0	10069, 10–0	10070, 0	20–0	10071, 0	20–0	190–0	10072, 15–0	10073, 0	15–0	10074, 0	20–0
Sagitta elegans	2	....	....	....	....	....	....	....	....	....	....	....
Sagitta serratodentata	....	10	453	621	3	4	1	175	2	4	3	221
Sagitta enflata	....	....	4	11	12	59	5	....	....	....	12	55
Sagitta bipunctata	....	....	....	....	....	5	....	....	....	....	3	....
Sagitta hexaptera	....	....	....	....	....	....	2	....	....	....	....	....
Sagitta lyra	....	....	....	....	....	....	2	....	....	....	....	....
Pterosagitta draco	....	....	....	....	....	1	....	....	....	....	....	....
Eukrohnia hamata	....	....	....	....	....	....	....	....	....	....	....	....

Stations, and depths, fathoms.	10076, 20–0	120–0	10077, 20–0	10079, 5–0	10080, 12–0	10081, 10–0	10082, 15–0	10085, 20–0	10086, 20–0	10087, 30–0	10088, 80–0	10089, 15–0
Sagitta elegans	....	....	....	....	....	....	45	24	53	142	14	8
Sagitta serratodentata	162	....	....	8	15	5	4	....	....	....	....	....
Sagitta enflata	10	3	33	10	....	....	....	....	....	....	....	....
Sagitta bipunctata	....	....	....	....	....	....	....	....	....	....	....	....
Sagitta hexaptera	....	1	....	....	....	....	....	....	....	....	....	....
Sagitta lyra	....	1	....	....	....	....	....	....	....	....	....	....
Pterosagitta draco	1	....	....	....	....	....	....	....	....	....	....	....
Eukrohnia hamata	....	5	2	....	....	....	....	....	....	....	....	....

Stations, and depths, fathoms.	10090, 20–0	75–0	10091, 20–0	10092, 35–0	85–0	10093, 35–0	85–0	10095, 20–0	10096, 30–0	10097, 0	30–0	80–0
Sagitta elegans	10	22	9	37	13	24	15	14	11	14	73	16
Sagitta serratodentata	1	5	....	3	....	....	....	1	23	....	1	....
Sagitta enflata	....	....	....	....	....	....	....	....	....	....	....	....
Sagitta bipunctata	....	....	....	....	....	....	....	....	....	....	....	....
Sagitta hexaptera	....	....	....	....	....	....	....	....	....	....	....	....
Sagitta lyra	....	....	....	....	....	....	2	....	....	....	....	....
Pterosagitta draco	....	....	....	....	....	....	....	....	....	....	....	....
Eukrohnia hamata	....	4	....	2	35	25	63	2	2	....	10	18

Stations, and depths, fathoms.	10098, 18–0	10099, 20–0	10100, 40–0	90–0	10101, 25–0	10102, 20–0	10103, 30–0	10104, 15–0	50–0	10105, 40–0
Sagitta elegans	16	4	27	11	4	13	349	15	7	503
Sagitta serratodentata	....	....	16	....	....	2	....	....	....	....
Sagitta enflata	....	....	....	....	....	....	....	....	....	....
Sagitta bipunctata	....	....	....	....	....	....	....	....	....	....
Sagitta hexaptera	....	....	....	....	....	....	....	....	....	....
Sagitta lyra	....	....	....	....	....	....	....	....	....	....
Pterosagitta draco	....	....	....	....	....	....	....	....	....	....
Eukrohnia hamata	....	1	2	9	....	2	....	....	....	....

The most important feature of the collection, from the geographic standpoint, is the presence of a very characteristic tropical fauna, *i. e.*, *Sagitta enflata, S. hexaptera, S. bipunctata,* small *S. serratodentata,* and *Pterosagitta draco* in the coast water south of Delaware Bay and in the inner edge of the Gulf Stream. This is just what was to be expected from hydrography, and agrees with the tropical aspect of the plankton as a whole in those regions.

Elsewhere in the GRAMPUS collecting ground the chaetognath fauna is typically boreal, characterized by the presence of *Sagitta elegans* in abundance, and of large specimens of *S. serratodentata.* Though Sagittae were taken at nearly all our Stations, it was only at eight (10057, 10059, 10060, 10061, 10070, 10103, 10105) that they were an important constituent of the plankton, quantitatively speaking.

Sagitta elegans was the prevalent Sagitta in the Gulf of Maine, where it was found at all Stations, three times in swarms (10057, 10103 10105). It likewise swarmed on George's Bank early in July (Station 10059); and was the most abundant species over the continental shelf east of Long Island. But it was rare in the coast water further west and south, and lacking outside the continental slope, as well as over the shelf south of Delaware Bay. And this agrees with its boreal habitat on the other side of the Atlantic. It was usually most abundant at about twenty fathoms depth; being numerous on the surface on one occasion only.

Sagitta serratodentata was likewise taken in the Gulf of Maine; but at eight stations only, and always in small numbers. And it was less numerous than *elegans* over the shelf south of Marthas Vineyard. But it was the prevalent Sagitta in the shallow waters south of New

York. There is a decided difference in size between northern and southern specimens, those from the Gulf of Maine being much the larger. This seems to be the general rule with this wide ranging species. And probably it is separable into distinct races, a northern and a southern.

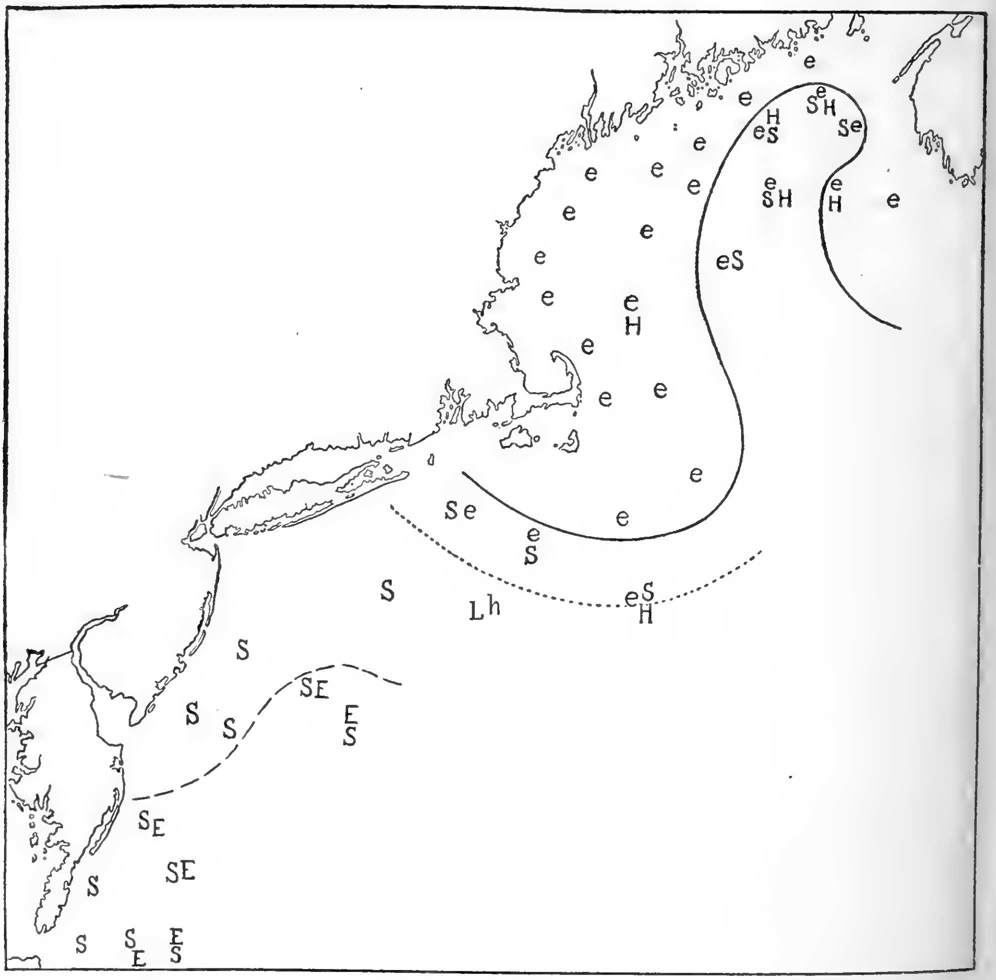

Fig. 71.— Distribution of Sagittae, July–August, 1913.
o, Sagitta elegans; E, S. enflata; H, S. hexaptera; L, S. lyra; s, S. serratodentata; H, Eukrohnia hamata.
Northern limit to S. serratodentata, - - - -, northern limit to S. enflata; . . . ., southern limit to S. elegans.

The occurrence of *Sagitta enflata, S. hexaptera,* and *Pterosagitta draco* has been noted; they were all confined to southern stations. And this was also true of *Sagitta bipunctata.* The captures of the latter deserve emphasis because it is only recently that this species has been clearly enough distinguished from allied species for its truly warm water habitat to become apparent (Ritter-Zahony, 1911). Finally, *Eukrohnia hamata* deserves brief mention. The GRAMPUS has never found it on the surface; and only rarely, and in small numbers in hauls as shallow as 20 fathoms. But it was fairly numerous in the deeps of the Gulf of Maine, (much more so than in 1912), and in the deep hauls under the inner edge of the Gulf Stream (Stations 10064, 10076). As previously noted (1914a) it was to be expected in the deeper layers, its range being from the surface in the arctic, to the mid depths in low latitudes.

TOMOPTERIS.

The specimens of Tomopteris all belong to *T. helgolandica* Graeffe. The records are from Stations 10057, 10058, 10068, 10069, 10082 10088, 10089, 10091, 10093, 10095, 10096, 10097, 10099, 10100, 10101, 10103; off Chatham, at Lat. 41° 48′, Long. 70° 5′ and at Lat. 41° 39′, Long. 69° 15′. Thus *T. helgolandica* was very generally distributed in the waters of the Gulf of Maine and off New York; but it was not found over the shelf south of New York, or in the Gulf Stream waters.

PTEROPODS AND HETEROPODS.

Identified by Mr. W. F. Clapp.

Besides the occurrences listed (p. 301) *Limacina balea* was taken by Capt. McFarland as follows:—

38° 45′ N; 73° 32′ W;	May 3, 1913	— 8–0 fath.	6 specimens
40° 45′ N; 70° W.	June 21, 1913	— 10–0 "	swarm
40° 42′ N; 69° 38′ W.	Aug. 8, 1913	— 10–0 "	13 specimens
15 miles S. E. of Chatham, Mass.,	Aug. 16, 1913	— 10–0 fath.	10 specimens
10–18 miles S. E. of Chatham, Mass.,	Aug. 21, 1913	— 20–0 fath.	5 specimens

Station	Depth	Clione limacina	Corolla calceola	Diacria trispinosa	Creseis acicula	Creseis conica	Creseis virgula	Limacina balea	Limacina inflata	Pterotrachea keraudrenii	Firoloida desmarestia	Atlanta peronii	Atlanta sp.?	Creseis sp.?
Off Gloucester	0			2									1	
10057	15–0							9						
10058	40–0							m.						
10059	20–0							5						
10060	20–0							m.						
10061	40–0							m.						
	70–0							f.						
10063	25–0							m.						
10064	175–0							4						
10065	20–0							m.						
10070	20–0		m.											
			juv.											
10071	190–0								27	1	1	1		
10073	30–0		13		3	1					1			
10074	30–0		9		12	5	11				3			
10075	8–0				2									
10076	150–0													2
off Hog I.	0				1									
10078	8–0					1								
10079	10–0		23			40	4				6			
10081	10–0					2								
10085	20–0							2						
10086	20–0							f.						
10088	80–0							7						
10090	20–0							m.						
	75–0							f.						
10091	20–0							s.						
10092	35–0							m.						
	85–0							f.						

f. = few — 25+ m. = many — 100+ s. = a swarm

Stations	Depth	Clione limacina	Corolla calceola	Diacria trispinosa	Creseis acicula	Creseis conica	Creseis virgula	Limacina balea	Limacina inflata	Pterotrachea keraudrenii	Firoloida desmarestia	Atlanta peronii	Atlanta sp.?	Creseis sp.?
10093	25–0	...	.....	...	...	...	...	m.						
	85–0	...	.....	...	...	...	...	f.						
10095	20–0	...	.....	...	...	...	...	m.						
10096	30–0	2	.....	...	...	...	...	m.						
10097	–0	...	.....	...	...	...	...	1						
	30–0	...	.....	...	...	...	...	m.						
	85–0	...	.....	...	...	...	...	f.						
10098	15–0	...	.....	...	...	...	...	f.						
10099	15–0	...	.....	...	...	...	...	f.						
10100	30–0	...	.....	...	...	...	...	m.						
	70–0	1	.....	...	...	...	...	f.						
10101	25–0	...	.....	...	...	...	...	35						
10102	20–0	...	.....	...	...	...	...	54						
	50–0	...	.....	...	...	...	...	f.						
10103	0	...	.....	...	...	...	...	31						
	30–0	...	.....	...	...	...	...	f.						
10104	15–0	...	.....	...	...	...	...	s.						
	50–0	...	.....	...	...	...	...	4						

The pteropods and heteropods of the cruise fall into two distinct groups, *Limacina balea* and *Clione limacina* in one; Corolla, *Creseis acicula, C. conica, C. virgula, Limacina inflata,* Pterotrachea, Firoloida, and *Atlanta peronii* in the other. *Limacina balea,* by far the commonest species, was universal from the neighborhood of Gloucester as far as Station 10065; and was taken again at nearly all our Gulf of Maine Stations. But it was wholly lacking in all the southern stations, and even in the cool water off New York (Stations 10066 to 10083, fig. 72). Its bathymetric range, likewise, must have been somewhat circumscribed, for, as the table shows, it was only once taken on the surface (Station 10103), although a surface haul was made at every station, usually with a net of the same mesh as the one in which Limacina was taken in the depths. On the other hand, most of the Limacinas did not come from any very great depth, because whenever two hauls were made, a deeper and a shallower, it was usually the latter which made the largest catch. This was the case both south of Cape Cod (Station 10061) and in the Gulf of Maine (Stations 10092, 10093, 10097, 10100, 10102) and the only exception (10064) yielded so few specimens (4) that no deductions can be drawn from it. The precise depths where Limacina was most abundant can hardly be determined by the open nets which were used, but the fact that the nets which

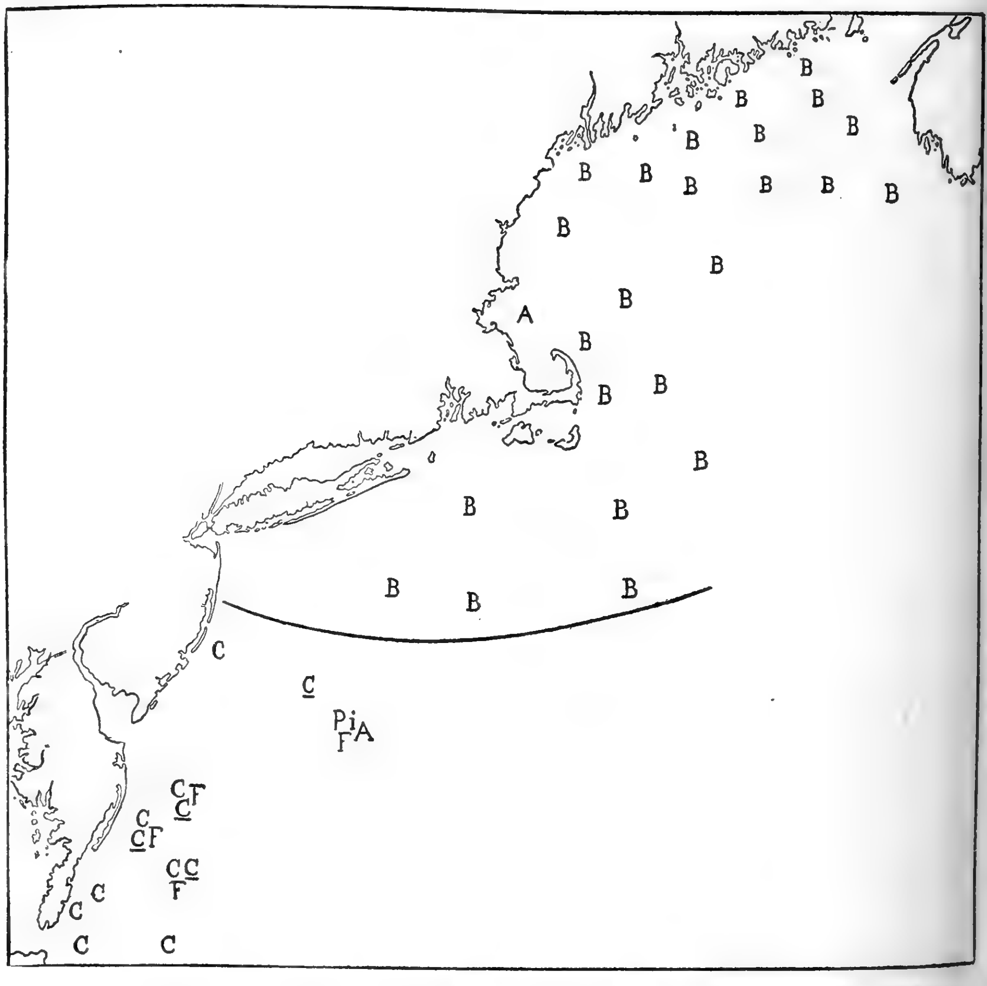

FIG. 72.— Distribution of pteropods and heteropods, July–August, 1913. A, Atlanta; B, Limacina balea; C, Criseis; C̲, Corolla; F, Firoloida; I, Limacina inflata; P, Pterotrachea.
The curve shows the probable southern limit to Limacina balea.

were sent to the greater depths did not capture many specimens in their passage upward through the water, is good evidence that the large catches were made at about the depth at which the nets were working horizontally. This was fifteen fathoms at Station 10104; twenty-five fathoms at Station 10093 and 30–35 fathoms at Stations 10092, 10097 and 10100. The largest catch of all was made at twenty fathoms (Station 10091); and the depths of the rich hauls south of Cape Cod (Stations 10060, 10061, 10065) were twenty to forty fathoms. *Limacina balea* covers a considerable range both of salinity and of temperature: but was never found in the warm salt Gulf Stream water, nor is it at home anywhere in tropical seas. According to Meisenheimer (1906), it is the only pteropod endemic in the northern boreal region; and is a good index of boreal waters. All the captures were from salinities of 31.8‰ or more, and the absolute maximum may have been higher than 35‰ (Station 10064). But the few specimens from that Station were probably only stragglers from the coast waters. The maximum salinity for the rich hauls was 32.5‰–33.2‰. At the two Stations (10091 and 10104) in the Gulf where swarms were encountered, the salinities were respectively 32.5–32.6‰ and 31.9–32.5‰. Thus in summer the optimum for *Limacina balea* is neither the freshest coast water, with salinities of 32‰ or less, nor the ocean water outside the continental slope with salinity above 33‰, but the transition water.

The temperature can be precisely stated for only four captures, *i. e.*, 55° (Station 10059), 55° (Station 10097, surface), about 48° (Station 10095); and 61° at Station 10103 (surface). But the fact that no specimens were taken at the surface at any of the stations south or west of Cape Cod indicates that none of the captures were from temperatures above 60° except possibly in one or two instances; and even then (Stations 10064, 10065) the specimens may have been living in much colder water. The rarity of Limacina on the surface in the Gulf of Maine further simplifies the problem, because, to assume that the specimens came from even as small a depth as five fathoms, lowers the upper limit of temperature for most of the captures to about 58°. On the other hand, most of the Gulf specimens were certainly from water warmer than 46° (Stations 10091, 10095–10104); and we have no proof that any of them were living in water colder than this, for though the deep water temperature was 43° at several stations, there is no reason to suppose that the specimens of Limacina came from the deepest layers (p. 304). The other northern pteropod, *Clione limacina*, was restricted to the Gulf of Maine, where it was decidedly rare. And we have never found it common in the Gulf, although specimens occasionally appear there both in summer (1914a) and in winter (1914b).

The demarcation between the ranges of *Limacina balea* and of the warm water pteropods and heteropods, *i. e.*, the various species of Creseis, Corolla, *Limacina inflata*, Pterotrachea, Firoloida, and Atlanta, was remarkably sharp, for the latter were only taken at the southern and Gulf Stream stations where *Limacina balea* was lacking (Fig. 72); and not a specimen of any of them was found at any of the northern stations where *Limacina balea* occurred, except for a single Atlanta off Gloucester. They are all oceanic, as pointed out by Meisenheimer (1905). None of them occurred regularly, only one (*Creseis conica*) at as many as five of the eighteen stations south of the limits of *Limacina balea;* and the total number of specimens of this species was only forty-nine. The other warm water forms were even more sporadic in their distribution:— *Corolla calceola*, Firoloida, and *Creseis acicula* occurring at four stations each; the others at only one or two. Under these circumstances it is impossible to say much about the influence of hydrographic conditions on their distribution further than to point out that all have a southern, or oceanic origin, and that it is doubtful whether any of them would have been found in the coast water in winter. Direct evidence to the effect that they are summer visitors only is afforded by the fact that none of them were taken by Capt. McFarland off Cape May in May, 1913, although several were encountered there in July.

The occurrence of two living specimens of *Diacria trispinosa*, and of an Atlanta, in a haul off Gloucester early in July is surprising, because it is certain that neither of these genera is a regular inhabitant of the Gulf of Maine; both belong to the warmer parts of the north Atlantic, not to boreal waters (Meisenheimer, 1905). It is difficult to account for their presence, because they were taken with an otherwise typical boreal assemblage of plankton organisms, *e. g.*, Calanus, Euthemisto.

PELAGIC HYDROIDS.

BY C. MCLEAN FRASER.

During the month of July, 1913, the GRAMPUS made a collection of floating hydroids off George's Bank, which, through the kindness of Dr. H. B. Bigelow, was sent to me for examination. Under ordinary circumstances the material would scarcely be worth a comment as none of the various species found are new to the Atlantic Coast or even rare, but when the location is taken into consideration and the effect of the conditions of such a location on at least two of the species, the collection proves to be of more than passing interest.

It is not unusual to find fragments of hydroid colonies torn from their support or from the rest of the colonies, living for a considerable time as they float on the surface. The majority of the species in this collection are represented by just such fragments, but the fact that there are so many of these species must indicate that in this region a vortex must be formed by currents whose influence reach to the shallow water some distance away. Furthermore, it would seem that some time not so very long previous to the time of collection, there must have been a rather violent storm, sufficient to make the effect of the waves felt at a greater depth than usual, as some of the species represented are not usually found at low tide or even in very shallow water. It is doubtful if any data have been obtained as to the length of time that fragments or even whole colonies of hydroids would live under such conditions. It is quite true that Sargassum torn away by storms, will carry hydroids in a perfectly fresh condition for weeks, during which time they may be carried hundreds of miles by the current, but the case is scarcely parallel as the Sargassum itself remains in good condition during this period unless it drifts ashore and dries out in the sun. In the present instance, no support was present in any case except portions of blades of eelgrass. Even here if the roots were attached, the eelgrass would remain fresh for some time, but there were no roots. There were only small fragments of leaves that may have been dead before they were carried away. In the majority of cases even this support was lacking, while one species, *Clytia cylindrica*, to which special attention is paid later, ordinarily making much use of a support, apparently regenerated and continued to grow without any support.

Doubtless if the spot where these were found is a vortex, there would be abundance of food material and the hydranths would not suffer in that regard. They might be better off even than in their own habitat. If light and specific gravity have any special directive influence on the growth of the colony, some power must have been exerted to overcome it, since the different position of the support or the lack of it places the colonies in entirely new positions. Many cases of adaptability to unusual circumstances have been cited among hydroids and this must be added to the list.

The thirteen species found make quite a varied collection, as only in two cases is a genus represented by more than one species, although but four families are included. *Clytia cylindrica* forms the great bulk of the material, although there is a good supply of *Obelia geniculata*; and *Diphasia rosacea, Sertularia cornicina,* and *Campanularia calceolifera* are represented by good specimens. The remainder of the list consists of larger or smaller fragments. In many cases gonangia are present.

List of Species.

EUDENDRIDAE

Eudendrium ramosum (Linné)

CAMPANULARIDAE

Campanularia calceolifera Hincks
Clytia cylindrica Agassiz
Obelia geniculata (Linné)

HALECIDAE

Halecium articulosum Clark
halecinum (Linné)

SERTULARIDAE

Diphasia rosacea (Linné)
Hydrallmania falcata (Linné)
Sertularella gayi (Lamoroux)
Sertularia cornicina (McCrady)
Thuiaria argentea (Linné)
cupressina (Linné)
thuja (Linné)

Clytia cylindrica Agassiz (Fig. 73, 74)

This species was first described from Massachusetts Bay by L. Agassiz,[1] and has since been collected at various points near Woods Hole. It has not been reported to the northward but the range extends far southward as I have found it in abundance at Beaufort, N. C.[2]

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[1] Cont. nat. hist. U. S., 1862, **4**, p. 306.

[2] Hydroids of Beaufort, N. C. Bull. U. S. bureau fisheries, 1912, **30** p. 358.

The stolon commonly runs along its support nearly in a straight line and it never forms a very complicated network. From the stolon the individual zooids arise, the pedicel being usually rather rigidly erect. In the Grampus material there are hundreds of colonies all of them entirely removed from their support. I say "removed" because one can scarcely conceive of a planula settling down to form a hydroid colony unless it had something on which to settle. As the stolons adhere quite closely to their means of support, they must have been torn away with some violence so that the stolons were broken in pieces s well. This separation and setting adrift produced complications, o the results of which reference must now be made.

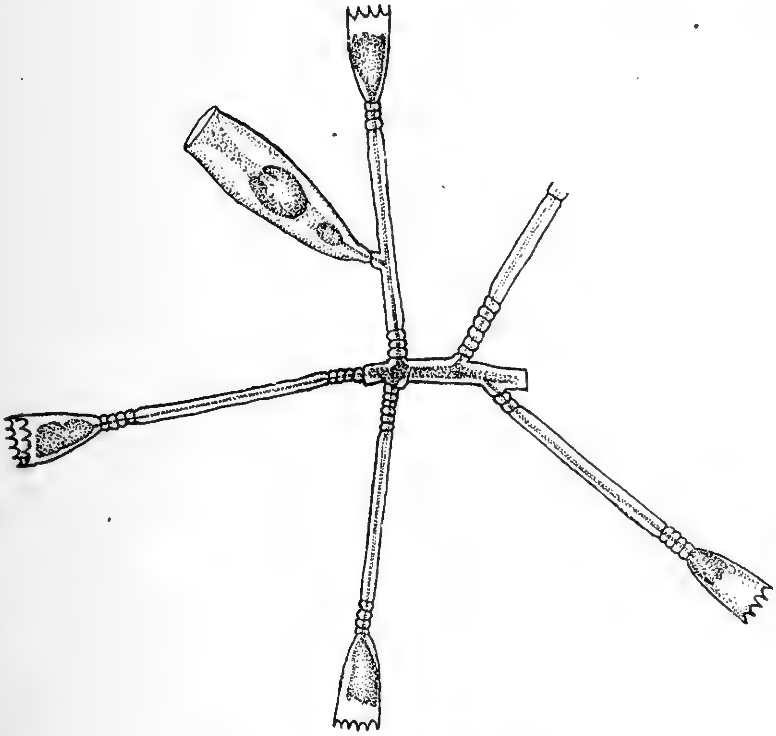

Fig. 73.— Clytia cylindrica.

With the first glance at a mass of this material one is immediately mpressed with the fact that there are very few free stolon ends. In olonies collected under ordinary conditions, we can usually see the rowing ends of the stolons. Here there seems to be nothing of the ind except in very rare instances. What has happened to them? gain one would suppose that when the colonies were torn away there would be one or two free broken ends for each piece, but one does not find it so. Occasionally a single free end may be found but scarcely ever two free ends on the one piece.

In the case of the growing end of the stolon it appears that since there is no longer any inducement to continue in the same general direction in which growth has previously taken place, on account of the lack of support, the growth is completed by producing a zooid which thus terminates the stolon and leaves no free growing end. The lack of free broken ends seems bewildering at first and it seems permissible to conclude that here is something new in hydroids, viz:—colonies developing from planulae at the surface of the high seas, for how could so many colonies, perfect ones at that, appear if they had been broken away from their regular support. Further examination brings out the fact that regeneration is responsible for the deception, but conditions must be very favorable for such regeneration since in almost every instance a zooid is growing out from the broken end and all are in good condition. In many cases the regenerated portion is so nearly equal in size to the original part, both in the perisarc and in the coenosarc, that it is difficult to detect the junction and hence the deception is complete. In other cases the regenerated part is sufficiently smaller to be readily noticed.

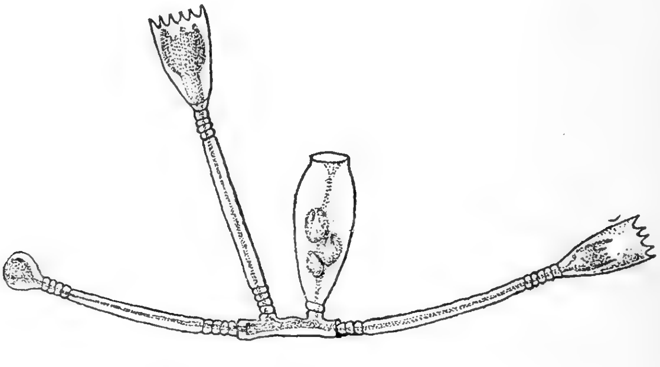

Fig. 74.— Clytia cylindrica.

Besides the zooids that grow out from the broken ends, others appear to have developed in the regular way after the separation from the support, as, instead of coming off regularly in the one direction, they may come off on any side of the stolon to make the colony decidedly irregular (Fig. 73). Commonly when a straight piece of stolon regenerates, a zooid grows out from each end in line with the stolon itself, while the zooids previously attached were at right angles to this (Fig. 74). The directive influence which causes the regular erect growth must be overcome in such a case since two of them grow in a diametrically opposite direction. There seems to be no hindrance to the growth of the hydranths, as they are found in various stages of development as well as in the adult condition, and when they were preserved several of them had undigested food in the enteric cavity. The development of the gonophore is not interfered with either, as medusae of different ages are found in the gonangia and some free medusae were found just liberated in the plankton. All the gonophores were found either on the stolon or on original pedicels, none on the regenerated portions.

Regeneration is no new thing in hydroids as it has been noticed by many observers, but I know of no case where anything on such a large scale as this and in such a location has been recorded. It is quite possible that some of the experimental work that has been done on such forms as *Tubularia crocea* and *Hydractinia echinata* would have given more satisfactory results if it had been done on *Clytia cylindrica.* It may be that the election of gymnoblastic forms for such experiments might have been improved upon by taking some of the simple calyptoblastic species. I am very doubtful if under artificial conditions in any case regeneration could be successfully brought about in over 99% of the cases as it must have been here if one is to judge from the generous sample that was collected.

Obelia geniculata (Linné). (Fig. 75–78).

As this is a cosmopolitan form and as it has been described and gured in so many instances, a description of a typical specimen from a ypical locality is quite unnecessary, but as many of the specimens in his material are not typical and as the location is unique, mention is specially made of the species here.

Two lots of specimens were present, both attached to eelgrass. In ne case the stolon ran irregularly along throughout the whole length the fragment of eelgrass, on both sides, making rather a dense mass. the other case a few colonies were distributed among several coloies of *Sertularia cornicina.* I do not know that *O. geniculata* is comonly found on eelgrass, as I do not remember having found it ere, or of having seen it recorded as so growing, but it does grow on tain Algae and hence the difference in the nature of the support is t sufficient to make this case remarkable. Other species, *e. g.*, *O. longissima*, are very often found on floating eelgrass, hence as long as the eelgrass fragments are of sufficient size to form a good basis of support for the stolon, it is not especially remarkable that *O. geniculata* should remain in good condition when floating. However, in hundreds of cases where *O. longissima* has been seen floating, there has been no great difference observed from the regular type (that may be because it very generally is found attached to floats, etc., where it is near the surface at all times), but in these specimens there are some unusual features, that may have been caused by a certain tendency towards orientation disturbed on account of a change in the position of the support. This change does not show itself in the hydranths themselves since they seem perfectly normal, possibly because the hydrotheca pedicels have sufficient adaptability to allow for sufficient change. In the stems, however, there is variation. Some of them are quite typical (Fig. 75) but a large number of them

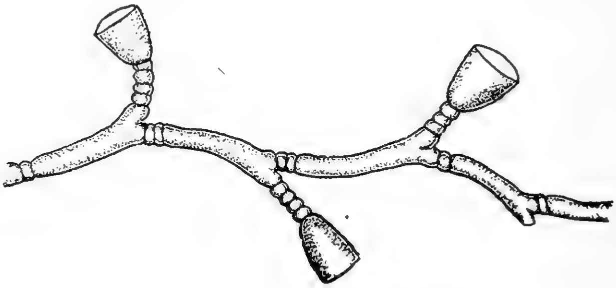

Fig. 75.— Obelia geniculata.

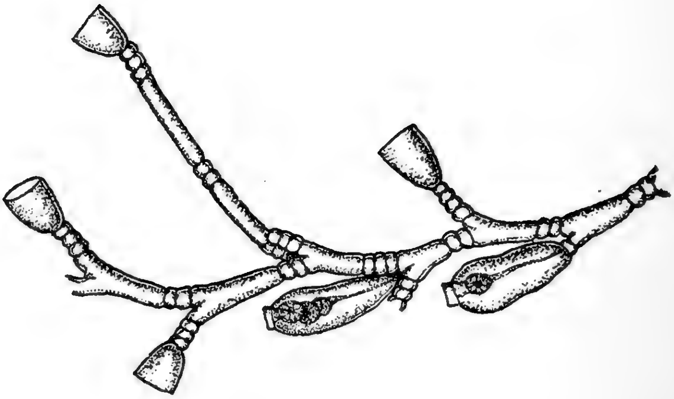

Fig. 76.— Obelia geniculata.

are more branched than usual, so much so, that if they were examined by themselves they would scarcely be recognized as belonging to the species. The branching sometimes is far from being regular, the position and the length of the branches vary so much. From a stem that is otherwise normal, there may be one or two hydrothecae borne on much elongated pedicels, arising either as ordinary hydrotheca pedicels, or in the axils of these. They are annulated slightly at both ends as well as towards the centre, with smooth places between (Fig. 76). The stem internodes, which typically are quite uniform in length, vary much in this respect in some specimens and the nature of the geniculation at each node also varies. The terminal internode may be much prolonged into a tendril-like process such as occurs late in the season in *Campanularia angulata*, *Obelia commissuralis*, and other similar species. These tendrils are noticeable chiefly on account of their breadth and the bluntness at the end (Fig. 77). Within the perisarc, at the end, the coenosarc has the appearance of a developing hydranth but no case was observed where such a hydranth had really leveloped.

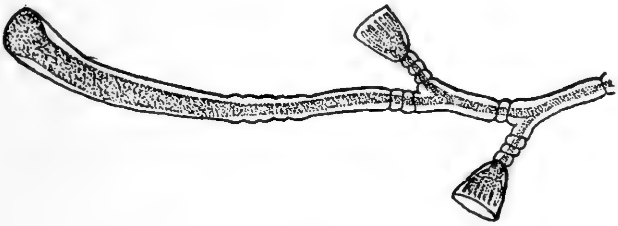

FIG. 77.— Obelia geniculata.

In a previous paper[1] I referred to a specimen of this species in which he gonophores were in an unusual position. In this material a still reater variation occurs. Some gonophores are placed typically, *i. e.*, n the axils of the hydrotheca pedicels. Others appear as those in he above reference, *i. e.*, in place of hydrothecae (Fig. 76). Besides hese there were several in a row growing directly from the stolon Fig. 78). They have similar short, annulated pedicels to those in he normal position and agree very well with them in other respects, lthough they are slightly larger than the others usually are. The evelopment has not been stopped at any rate, as the young medusae ere in as good condition as they were in any of the others. If the

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[1] Hydroids from Nova Scotia. Victoria Memorial Museum, Bull., 1913, no. 1, p. 167.

growth of the gonophores in this position is due to the change in position of the support of that particular part, the whole growth of these must have taken place after the colonies had been torn away.

Another instance is here exhibited of the ready interchange of the various parts of the colony and, here as well as in *Clytia cylindrica*, of considerable power of adaptability to varying conditions.

MEDUSAE, SIPHONOPHORES, CTENOPHORES.

The identifications in the table (p. 316–317) require explanation.

All with broad stomach, smooth subumbrella and considerable numbers of tentacles and canals are classed here as *Ae. aequorea.*

Aequorea groenlandica Péron et Lesueur. I follow Mayer (1910, p. 335) in identifying as a southern race of *Ae. groenlandica* the large aequorid, with stiff gelatinous substance, and numerous subumbral gelatinous papillae radially arranged, which is common off the coast of New Jersey in summer and autumn. The southern race has been recorded so seldom that a few counts of the radial organs are given:—

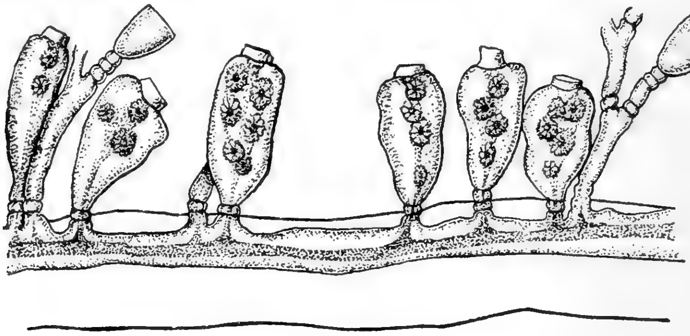

FIG. 78.— Obelia geniculata.

Station	Diam. mm.	Tentacles	Canals
10069	100	110	89, all with gonads
10075	75	71	96, 3 branched
"	75	68	88, 1 "
"	70	61	106, all simple
"	50	50	85, all simple

Aglantha digitale Fabricius. The status of the two forms of Aglantha, so often recorded from northern waters as "*rosea*" and "*digitale*," has been the subject of much discussion. The two have usually been separated according to the number of otocysts, specimens with eight being classed as *rosea,* those with four as *digitale.* But such a division is purely artificial, because specimens often have five, six, or seven otocysts. Mayer (1910) unites the two unequivocally. I have followed him in my discussion of Aglantha from Behring Sea (1913a) and Kramp (1914, p. 432) likewise concludes that the number of otocysts is not sufficiently constant to afford a specific character, though maintaining that *rosea* is recognizable as a variety of *digitale.* It is doubtful, however, whether even this last characterization of *rosea* will stand the test of time.

Every specimen of Aglantha in the present collection which was in good enough condition to show the otocysts at all had at least seven, and their spacing along the margin of the bell was such as to show that the number in life was eight. These specimens range from 7–11 mm. in height, with 39–94 tentacles; and are at various stages of maturity, from one with no gonads to one in which they are fully developed. The many specimens which I have studied from Labrador and Newfoundland likewise had eight otocysts (1909c, p. 312). These were recorded under the name *rosea,* following the custom usual at that time, for Aglantha with eight otocysts. And although Kramp (1913a, p. 527) has recently questioned whether these specimens were actually *rosea,* it was so simple a matter to count the otocysts that there can be no doubt that they belonged to the form with eight of these organs, no matter what may be its final nomenclatural resting place. And I may add that all the specimens of Aglantha from American waters, Atlantic or Pacific, on which I have been able to count the otocysts have more than four; usually eight.

Cyanea. The specimens from the Gulf of Maine and from George's Bank belong to the large, red northern race ("*arctica*"); but we found only the small yellowish form (*fulva* L. Agassiz) south of New York.

Stephanomia cara. The generic identity of the material is established by the fact that the few tentilla still intact have the involucre nd single terminal filament. And the bracts and nectophores, which vere taken in great numbers, agree perfectly with *S. cara* as described y A. Agassiz (1865) and by Fewkes (1888). But unfortunately the aterial was not in good enough condition to show whether or not he northern *cara* is actually separable from the southern *bijuga.*

Pleurobrachia pileus. Mayer (1912) has recently described a new leurobrachia, *P. brunnea,* from just the locality where Pleurobrachia as found in greatest numbers; which makes a review of the grounds which I class our specimens as *pileus* desirable.

	10057	10058	10059	10060	10061	10063	10064, 20–0 F.	10064, 175–0 F.	10066	10067	10069	10070	10071, 20–0F.
HYDROMEDUSAE													
Steenstrupia rubra													
Niobia dendrotentacula													
Calycopsis typa								1					
Obelia sp.?				m.									
Melicertum campanula	×												
[1] Staurophora mertensii													
Laodicea cruciata													
Tiaropsis diademata	2												
Mitrocoma cruciata	×												
[1] Phialidium languidum													
Aequorea aequorea											×		
" groenlandica											×		
Aglaura hemistoma													1
Aglantha digitale	2			12	2			1			22		
Rhopalonema velatum											1		
Liriope scutigera													
Geryonia proboscidalis													
Cunoctantha octonaria													1
SCYPHOMEDUSAE													
Cyanea capillata	×		×								×		
[2] Aurelia aurita													
SIPHONOPHORAE													
Abylopsis eschscholtzi													1
Galeolaria quadrivalvis													
Diphyes appendiculata												×	
Agalma okeni													3
Agalma elegans							m.						
Stephanomia cara	×	×	×										
Physophora hydrostatica							×						
Rhizophysa filiformis							1*						1
Physalia physalis							×*						
CTENOPHORAE													
[1] Pleurobrachia pileus				×		×			×	×	×	×	
Bolinopsis infundibulum	×												
[3] Mnemiopsis leidyi											×		
Beroe cucumis	×	×											
[4] Beroe forskalii													

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[1] For the occurrences of *Phialidium languidum; Staurophora mertensii* and *Pleurobrachia pileus* in the Gulf of Maine, see table, p. 273.

[2] Noted occasionally near land in the Gulf of Maine.

* On the surface.

[3] Also seen at other localities, p. 271.

[4] Also taken in Chesapeake Bay.

10072	10073	10074	10075	10076	10077	10078	10079	10080	10081	10082	10085	10086	10087	10088	10090	10095	10096	10097	10099	10100
1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
m.	...	m.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	×	×	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	×	×	...	...	×	×	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
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The characters by which he (1912, p. 14) separates his *brunnea* from *pileus* are that it is more oblong and egg-shaped, by the opaque yellow-brown color of the stomodaeum, and by the presence of terminal knobs on the tentacles. But the specimens from near New York and further south were quite as globular in life as any I have collected elsewhere, though now more or less contracted by preservation. The question whether or not the tentacles end in terminal knobs is easily settled in life; and in no case did I see anything which could be interpreted thus. And the tentacles are sufficiently extended in many of the preserved specimens to show that their calibre is uniform to the tip. In many, it is true, these organs are more or less thickened near the end; but this is obviously the result of contraction. Most of the specimens, as might be expected, are so violently contracted that it is impossible to determine anything about the tentacles. As to color, the stomodaeum in many of the southern specimens was of a pale reddish hue in life; but I have also found it so in northern specimens. Furthermore, the proportional lengths of apical canal and stomodaeum, and the relative level at which the adradial canals join the meridionals in the southern specimens are well within the range of variation of typical *P. pileus*.[1] In short there is nothing to separate southern from northern specimens except that the former were, as a whole, rather smaller.

P. brunnea may still be worthy of recognition; but it is not contained in the GRAMPUS collections, and until specimens agreeing with Mayer's account are reëxamined, its status will be dubious.

DISTRIBUTION OF PELAGIC COELENTERATES.

Pelagic coelenterates fall into two distinct categories according as they are, or are not bound to the coast line by a fixed stage, *i. e.*, they are either neritic or oceanic. And though some genera, for example Niobia, bridge the gap, they are not sufficiently abundant to invalidate the general classification. Among the neritic warm water species are *Steenstrupia rubra, Laodicea cruciata, Aequorea groenlandica* and the southern form of *Cyanea capillata*. Probably *Calycopsis typa* is also neritic if the term is used in its broad sense, for there is reason to believe that it passes through a hydroid stage on the continental slope (1909b). Omitting it for the moment, however, because

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[1] I have been able to compare the collection with a large series from northern waters.

of its deep-water habit, this southern neritic group was limited to a coastal·zone south of New York, some forty-five miles broad (Fig. 79, Stations 10069, 10072, 10073, 10074, 10075, 10076, 10077, 10078, 10079, 10080, 10082). We found none of these species north of New York; but most of them appear along the southern shores of New England later in the season. The most important of the group, faunistically, *Aequorea groenlandica*, was confined to the waters over the inner half of the continental shelf south of New York; spreading seaward to the slope off Chesapeake Bay, but absent in the edge of the Gulf Stream (Station 10071) and in the tongue of ocean water off Dela-

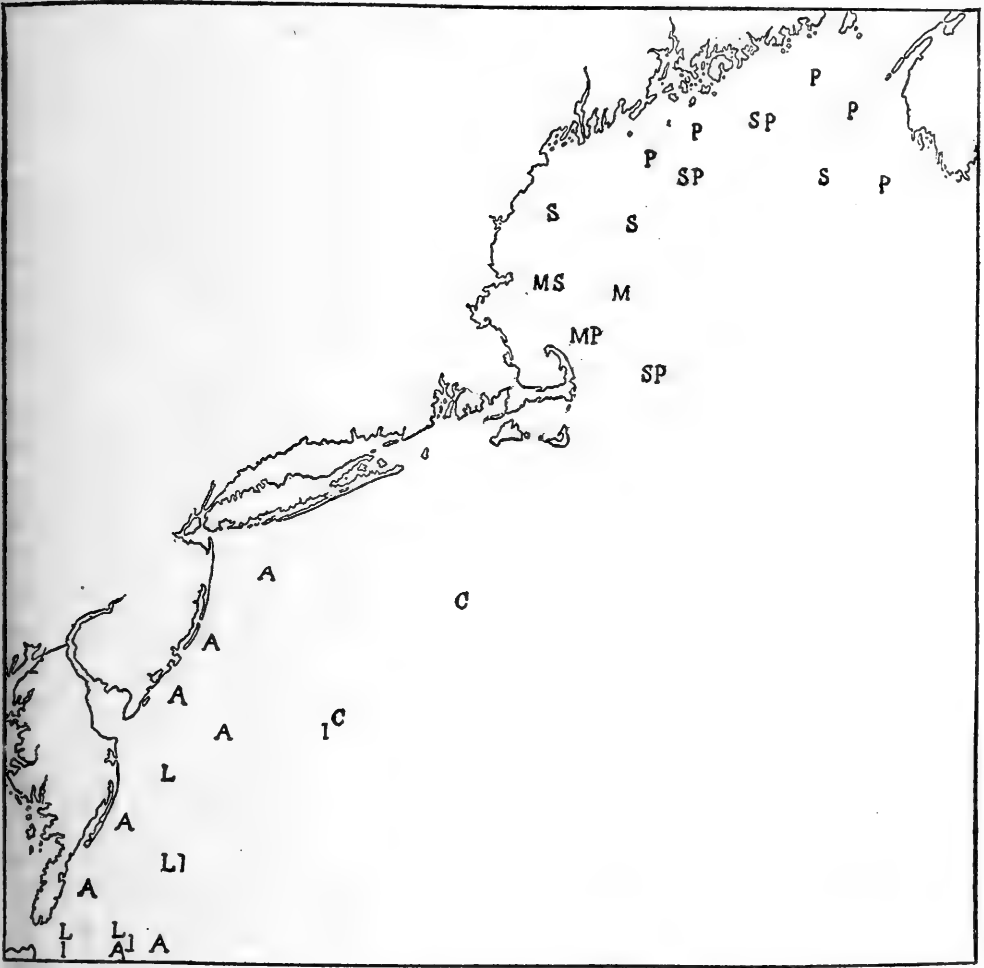

Fig. 79.— Occurrence of some neritic Medusae, July–August, 1913. A, Aequorea groenlandica, southern form. . l, Liriope scutigera; L, Laodicea cruciata; M, Melicertum campanula; P, Phialidium languidum; S, Staurophora mertensii.

ware Bay (Station 10073), its range being slightly more extensive than that of *Mnemiopsis leidyi* (p. 322). Probably it was the Chesapeake current which carried it to the outer edge of the shelf off Chesapeake Bay. *Aequorea groenlandica* like Mnemiopsis was living chiefly at the surface and for a fathom or so down, the deeper hauls yielding very few even where many were seen floating past the ship. The range of salinity was from about 31.3‰ (Station 10077) to about 34‰ (Station 10076), the temperature from about 65° to about 77°.

The boreal neritic species are *Melicertum campanula, Staurophora mertensii, Mitrocoma cruciata, Tiaropsis diademata, Phialidium languidum,* and the northern form of *Cyanea capillata.* In July and August these are all confined to the waters east and north of Cape Cod, (Fig. 79) though they appear in winter in the sounds and bays, as far west as Narragansett Bay. The occurrence of Phialidium, and Staurophora has been commented on (p. 274), and I need merely add that the rarity of the others in the central part of the Gulf agrees with our experience in 1912 (1914a).

Two important species, *Mnemiopsis leidyi* and *Pleurobrachia pileus* are intermediate between neritic and oceanic, for though neither has a fixed stage, and though Pleurobrachia occasionally occurs far from land, it is distinctly a creature of coast waters rather than of the open ocean (Kramp, 1913a, p. 532), while this is even more true of Mnemiopsis. The range of Pleurobrachia extends unbroken from Labrador (1909c) at least as far south as Pamlico Sound (1913a, p. 111) and perhaps farther. And we found it more generally distributed in the coast waters than any other coelenterate, swarming locally south as well as north of Cape Cod (Fig. 80).

From the distributional standpoint, localities where a species does not occur may be fully as significant as those where it does. And this is particularly true of Pleurobrachia, for it was absent in the inner edge of the Gulf Stream (Stations 10061, 10064, 10071, 10076, in the shoreward tongue of the Gulf Stream off Delaware Bay (Station 10073), on the one hand, and in the fresh water at the mouth of Chesapeake Bay (Station 10078) on the other. Otherwise there were only two Stations over the shelf where we failed to capture it (10081, 10083), at one of which (10083) the nets yielded very little of anything (p. 272). Pleurobrachia was taken at exactly half the stations in the Gulf of Maine, a rather larger proportion of occurrences than in 1912 (1914a, p. 126). But the species was rather more restricted in its range in the Gulf than in that year, occurring only once (Station 10103) in the coastal zone between Cape Ann and Penobscot Bay; and not at all in the central part of the Gulf (Stations 10090, 10092, 10093).

Although Pleurobrachia was widely distributed, it was by no means uniformly abundant. Its chief centre was from off New York (Stations 10067, 10068) nearly to Cape May (Stations 10069, 10080), where the deep water layers were filled with it, almost to the exclusion of other plankton (p. 269), extending for some twenty-five or thirty miles seaward (Stations 10072, 10070) beyond which their numbers rapidly decreased. It was still numerous when this region was passed again on August 1, on our way north (Station 10082). South of Cape May it was much less common, and very few were taken over the shelf east

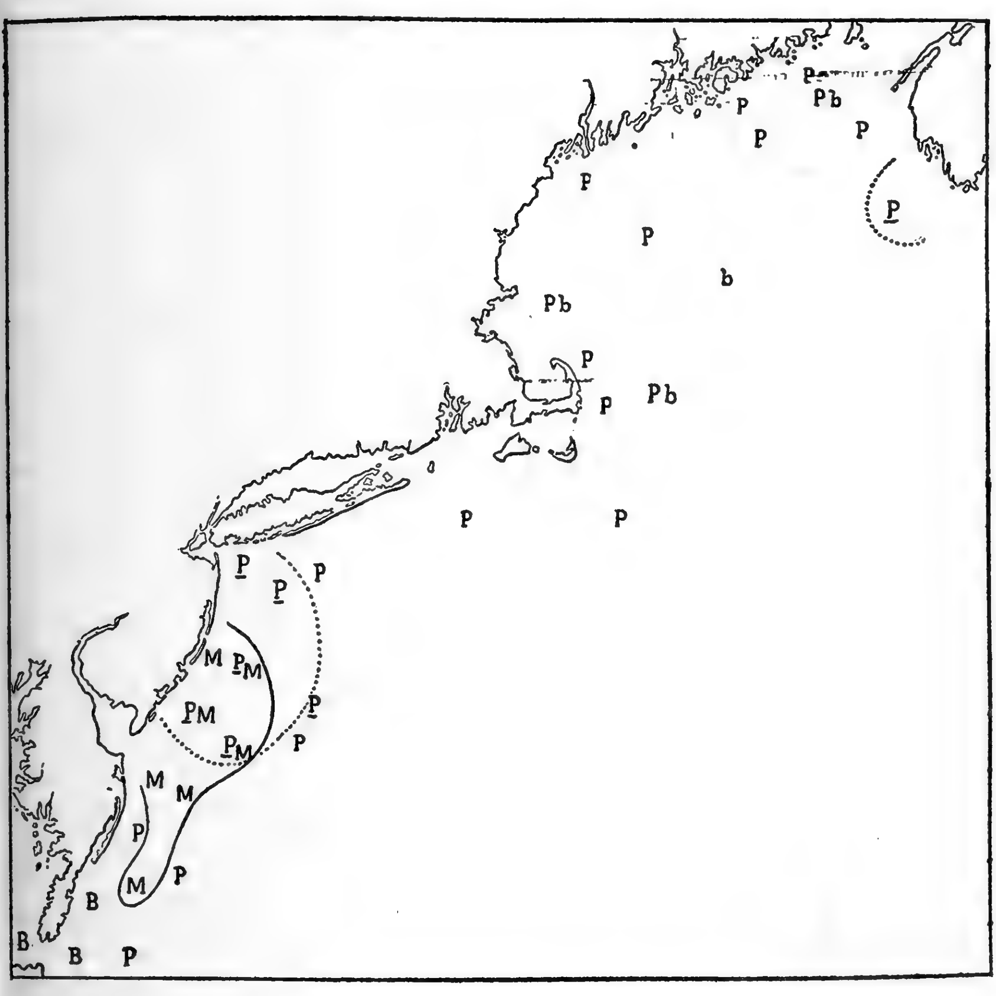

FIG. 80.— Distribution of ctenophores, July–August, 1913.
B, Beroe forskalii; *b*, B. cucumis; M, Mnemiopsis leidyi; P, Pleurobrachia pileus; P̲, P. pileus swarms. . . . . , probable limit to P. swarms. ———, probable limit to Mnemiopsis in July.

of New York (Stations 10060, 10063, 10066). The only place where Pleurobrachia was abundant in the Gulf of Maine in 1913 was German Bank (Station 10095), where small specimens swarmed. The southern swarm of Pleurobrachia only once reached the surface (off Scotland light-ship, July 12). Elsewhere it was limited to depths below about five fathoms; the water being from 15–30 fathoms deep over its area of abundance in this region. There were no Pleurobrachia in the immediate surface layers where Salpae and Mnemiopsis often swarmed (p. 269). And the absence of Pleurobrachia in the immediate surface layers and on the surface can not be credited to the effect of sunlight, because this was as true of night as of day time stations. Most of the Gulf of Maine captures were likewise in deep hauls; and there were none on the surface on German Bank, where a rich haul of Pleurobrachia was made at twenty fathoms.

The shallowness of the water in the region where Pleurobrachia was most abundant, and the general rarity of the genus on the surface, make it easy to establish the salinity and temperature in which it was living. The warmest water in which we can certainly establish its presence is 69° (Station 10066, surface), though some of the specimens from Stations 10074, 10077, and 10079, may have come from still warmer water. And south of New York in general the captures must have been in water warmer than 59°, that being the lowest temperature through which the nets fished. The swarm off New York was in temperatures of 50° (ten fathoms) to 65° (surface near Scotland light-ship). East of New York Pleurobrachia was usually living in water colder than 60°, with the minimum certainly as low as 48° (Station 10095), probably as cold as 43° (deep hauls in the Gulf). That is to say the genus covered practically the entire range of temperature encountered during the cruise, except the very warmest. It is not surprising to find Pleurobrachia at home in extremes as wide apart as this, because its range is known to be practically independent of temperature. Nevertheless, there is some evidence that specimens of Pleurobrachia grow much larger in cold than in warm water, as Esterly (1914) has pointed out for the Pleurobrachias of the west coast of the United States. And our captures strengthen this view, for although the genus swarmed in water warmer than 58° off New York and further south, the specimens taken there were all small (less than 10 mm. long). It was only in the cold water of the Gulf of Maine that we found large specimens; and work in previous years has shown that specimens upwards of 30 mm. long are common at the mouth of the Bay of Fundy, in summer, in temperatures of 50°–55°.

The extreme range of salinity for Pleurobrachia was from about 31.6‰ (surface, Station 10066) to about 35‰ (fifteen fathoms, (Station 10074). But most of the captures were from water of about 32‰–33.4‰. And there is only one Station where it is safe to assert that Pleurobrachia was living in water salter than 34‰, *i. e.*, at Station 10074, where the number taken in the horizontal haul at fifteen fathoms was so large that most of them must have been captured at about that depth, not in the short column of water through which the net fished on its way down and up (there were none on the surface). The major part of the haul at Station 10077 was likewise in water of about 34.5‰; but so few specimens were taken that they may have come from anywhere between the surface and the greatest depth reached by the net; *i. e.*, from a salinity anywhere between 31, .4‰ and 35‰. The southern swarm was living in water of about 32‰ to 33.2‰; the northern one (German Bank) in 32.8‰ to 32.9‰.

Rose (1913) has recently shown that the density of the water influences the vertical movements of Pleurobrachia; it is therefore worth while to correlate this physical constant with records for the genus. Near New York, where the captures can be located within a few fathoms because of the shallow water, they were from densities ranging from 1.022 (Station 10066, surface) to upwards of 1.0237. And the specimens taken at Stations 10082 and 10074 probably were living at a density of about 1.0252 to 1.0254. But the German Bank specimens were in much heavier water (nearly 1.026). Thus there does not seem to be any connection between the occurrence of Pleurobrachia, and density within a range of 1.022 to 1.026. But it is noteworthy that we found none in water lighter than 1.022, and seldom in densities less than 1.023, while it is doubtful whether any specimens were living in the densities of 1.027 and over, which characterize the bottom water of the deeper parts of the Gulf of Maine.

Mnemiopsis leidyi was generally distributed over the inner half of the continental shelf between Barnegat and Delaware Bay; and the mid-zone of the shelf south of the latter (Fig. 80). None were seen north of Barnegat though the species is abundant in the bays and sounds of the southern coast of New England later in the season, or off Chesapeake Bay. But the latter is not its southern limit, though it may interrupt the continuity of its range. It was most abundant near the coast, from Barnegat to Cape May, and again between Stations 10074 and 10075, swarming on the surface in myriads, and causing brilliant phosphorescence at night. And it seems to have been limited to a very shallow surface zone, the few taken in the deep hauls having probably been caught in the passage of the net down and up. The salinity in which it was living ranges from 32.1‰ (Station 10081) to 33.48‰ (Station 10073), the optimum, as shown by greatest abundance, being 32.2‰ to 33‰. The upper limit of temperature was 76° (Station 10080), its lower limit was probably about 60° (the five fathom reading at Station 10069). Thus it was living in warm water; but not in salt Gulf Stream water on the one hand, nor where the salinity is lowered below 32‰ by the influence of the Chesapeake, on the other. And this agrees with its known occurrence, for, according to Mayer (1912, p. 34) it is a creature of the pure sea water along the outer shores, its place being taken by another species, *M. gardeni,* in the brackish bays.

The swarms of Mnemiopsis and of Pleurobrachia were mutually exclusive, for though both were often taken at the same station, Mnemiopsis was invariably limited to the surface waters which it shared with the various Salpae (p. 269), Pleurobrachia to the deeper layers. Pleurobrachia and Mnemiopsis were not found side by side on the surface.

The oceanic, like the neritic coelenterates of our waters, fall into two more or less overlapping groups, according as they are at home in high or in low temperatures (Fig. 81). The most typical member of the former found in our coastal waters is *Aglantha digitale.* The captures are so scattered, and from waters of such different salinities and temperatures that they throw very little light on the conditions which are the optimum for the genus. But it is significant that although Aglantha was as abundant off Barnegat as on German Bank, only one fragmentary specimen was taken anywhere within the immediate influence of the Gulf Stream. And I may further point out that though it is a constant inhabitant of the Gulf of Maine, it never seems to attain the faunal prominence there, or anywhere further south, that it does off the coasts of Newfoundland and Labrador, or in Greenland waters. It is a creature of cold water, limited in its southern extension by the Gulf Stream.

The southern oceanic members of the list are *Niobia dendrotentacula* (put in this group by its asexual multiplication), *Aglaura hemistoma, Rhopalonema velatum,* Geryonia, *Cunoctantha octonaria* and the siphonophores Abylopsis, Diphyes, Galeolaria, *Agalma okeni,* Physophora, Rhizophysa, and Physalia. The largest catch of these species was in the edge of the Gulf Stream (Station 10071) where no less than eight of them were taken; and four were taken at Station 10074. One or other of them was likewise taken at Stations 10064, 10070, 10076.

That is to say, it was only in the waters of the Gulf Stream or over the outermost part of the continental shelf that they formed an important constituent of the pelagic fauna. The genus Liriope is also usually classed as among the typically oceanic Medusae. And this is cer- ainly true of *L. tetraphylla.* But the species found off Chesapeake ay, *L. scutigera* (p. 316), is so common in southern harbors and bays, hat it can hardly be considered as oceanic. *Agalma elegans,* too,

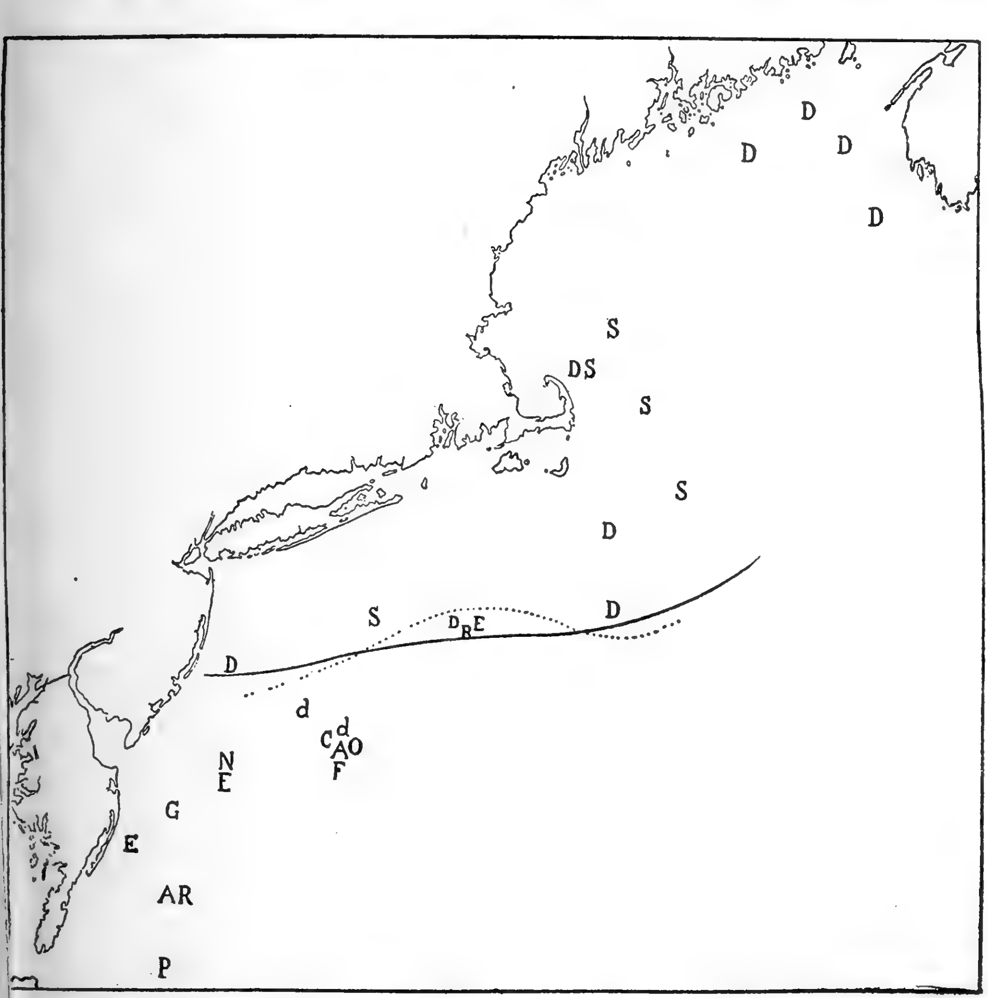

Fig. 81.— Distribution of oceanic Medusae and siphonophores, July–August. 1913.

A, Aglaura hemistoma; D, Aglantha digitale; d, Diphyes; E, Agalma elegans; F, Rhizophysa filiformis; G, Geryonia; N, Niobia dendrotentacula; O, Agalma okeni; P, Physophora; R, Rhopalonema velatum; S, Stephanomia cara.

. . . . , probable limit to tropical species in July. ———, S, probable limit to Aglantha digitale.

though certainly not neritic, is not oceanic in the true sense, because most of its records are from the neighborhood of land, not from the high seas, in marked contrast to *A. okeni.*

QUANTITATIVE HAULS IN THE GULF OF MAINE.

Quantitative hauls were made at fourteen of the Gulf of Maine stations; and they are directly comparable with one another because the interval of time between the first and last haul was so short (six days) that they can be considered as practically simultaneous. The volumes of plankton under each square meter of sea area, calculated from them were:—

Station	cc. in a column 1 sq. meter in cross section	Station	cc. in a column 1 sq. meter in cross section
10087	180	10099	30
10089	80	10100	220
10090	120	10101	100
10092	160	10102	90
10095	60	10103	70
10096	120	10104	90
10098	70	10105	55

These volumes are not the absolute amounts actually present, because they take no account of the coefficient of filtration of the nets. This, however, would be the same for all the hauls, and with the comparatively coarse silk of which they were composed would be small. It is obvious that the volumes do not give a direct measure of the density of the plankton, because the length of the column of water through which the net fished varied from 20 to 120 fathoms, according to the depth of water at the various stations. The volume of plankton per cubic meter of water (coefficient of filtration neglected) was as follows:—

Station	cc. per. cu. m.	Station	cc. per cu. m.
10087	1.4	10099	.8
10089	.44	10100	1.3
10090	.7	10101	1.4
10092	.7	10102	.7
10095	1.7	10103	.9
10096	1.3	10104	.6
10098	1.3	10105	.5

Were the macroplankton of the Gulf uniformly distributed at all depths from surface to bottom, this table would sufficiently establish the relative richness of different regions in plankton, and hence in food for the pelagic fishes. But unfortunately such is not the case (p. 290); hence to get a fair idea of the regional density of the plankton the less exact evidence of the ordinary tow nets must be used to check the results of the quantitative hauls.

VOLUMES OF HORIZONTAL HAULS.

Station	Fathoms	cc.	Station	Fathoms	cc.
10087	15	560	10097	25	750
	40	125		85	500
10088	80	375	10098	20	30
10089	25		10099	20	130
10090	20	1500	10100	25	500
	90	250		70	100
10091	20	875	10101	25	100
10092	35	300	10102	20	125
	85	100		50	100
10093	25	500	10103	30	175
	85	200	10104	15	675
10095	20	175		50	200
10096	20	375	10105	40	150

The depth is the level at which the major part of the haul was nade.

This table shows that at every station where the hauls were made at wo intermediate depths, the deeper invariably yielded the smaller olume of plankton. At first sight this difference might be laid to the se of different nets, the mouth area of the Helgoland net, which was sually used for the deeper haul, being only about 50% of that of e four foot net (the same grade of silk was used in both). But at tation 10092, where the nets were reversed, the catch of the Helland net was three times as great as that of the four foot net. nd even allowing for the different sizes of the nets, the shallow haul still considerably the richest at six of the eight stations. Appartly the plankton was usually densest in the upper layers, and decidedly poverished below, say, forty fathoms. On the other hand the surce water was usually barren, except at Stations 10092, 10093, 10096, 097, 10100, and 10103, but the surface hauls are not directly comparable with the deep ones, because they were made with small nets.

Thus the volumes of plankton per cubic meter, as calculated from the quantitative hauls, would be more representative of the true conditions, if the depths below about 40–50 fathoms were left out of account, because it appears that the vertical net can have caught but little below that level. In other words, to assume that the volume of plankton taken at, say, Stations 10092 or 10093, was evenly distributed down to 100 fathoms or more, results in far too small a density per cubic meter for the upper layers of water. I have attempted to offset this error by another table in which the volume of plankton per cubic meter is calculated on the assumption that the whole catch was made in the upper fifty fathoms. But this, though a closer reflection of actual conditions, is unsatisfactory, because the plankton is not vertically uniform even above fifty fathoms. Volume is itself so rough a measure, that it has largely been abandoned by students of plankton. But no other classification so far proposed gives so satisfactory an index of the comparative density of the plankton as a whole, as distinguished from its various individual components.

Station	cc. vol. per cu. m.	Station	cc. vol. per cu. m.
10087	2.	10099	.8
10089	.8	10100	2.4
10090	1.3	10101	1.4
10092	1.6	10102	1.
10095	1.7	10103	.9
10096	1.3	10104	1.
10098	1.3	10105	.6

According to this table, the plankton was densest off Massachusetts Bay (Station 10087) and off Mt. Desert Rock (Station 10100); distinctly less so over the central parts of the Gulf and the off shore waters in general. It was scantiest near the coast off Mt. Desert, and northeast of Cape Ann (Station 10105). And the plankton was rather less dense all along the coast, north of Cape Ann, than further off shore.

The table of qualitative hauls (p. 326) might suggest a rather different distribution, with the plankton densest in the centre of the Gulf (Station 10090) and off the mouth of Penobscot Bay (Station 10091): but this is not a valid objection to accepting the results of the quantitative hauls as approximately correct, because, with the plankton stratified as it undoubtedly was (p. 290), it was a matter of chance whether a horizontal net hit or missed the richest zone.

Copepods formed the bulk of the quantitative hauls, the more active of the larger organisms, *e. g.*, Sagittae and schizopods, being so poorly represented even at localities where the qualitative nets yielded large hauls of them, that they must have avoided the slow moving quantitative net; and our experience in 1912 (1914a) was the same.

The following counts of copepods were obtained by diluting the entire catch to 150 cc.; mixing well, then taking 3 cc. in a pipette while the plankton was in suspension, and counting. Each of the catches was sampled two or three times, and the results averaged.

Station	Relative no copepods in 3 cc.	Total number of copepods in a column 1 m. in cross section
10087	101	50500
10089	62	31000
10090	87	43500
10092	193	96500
10095	63	31500
10096	140	70000
10097	174	87000
10098	80	40000
10099	54	27000
10100	247	123500
10101	150	75000
10102	61	30500
10103	76	38000
10104	54	27000
10105	56	28000
	Average,	53266

This table shows that the central part of the Gulf and the waters off Mt. Desert Rock were most prolific, numerically, in copepods (Stations 10092 and 10100); the Stations off Monhegan (10102) and northeast of Cape Ann (10104, 10105) the poorest. Thus there is a marked discrepancy between the numerical distribution of copepods, and the volumes of the quantitative hauls, as outlined above. This is due to the fact that besides the adult Calanus, the more prolific hauls contain hosts of a very much smaller copepod, *Pseudocalanus elongatus* (p. 291), which added very little to the volumes of the hauls. The Calanus component agrees more closely, numerically, with the plankton volumes (p. 286). The total counts of copepods are not a fair index to egional richness or poverty, as feeding grounds for pelagic fishes, because one adult Calanus is worth many Centropages or Pseudocalanus in food value, though the latter are an important food for fish fry. It is the Calanus swarms which form the chief copepod constituent of the food of mackerel, pollack, and probably of the shad which summer in the Gulf; and for Calanus as for the volume of plankton, the richest parts of the Gulf were off Massachusetts Bay and off Mt. Desert Rock (Stations 10092, 10100), with a third prolific area off Chatham detected by Captain McFarland.

Microplankton.

The microplankton of the cruise will be treated later in special reports. But it is worth while to give a brief account of the distribution of general plankton types here, because of their bearing on general oceanographic problems (Fig. 82). They fall into four general types, which may be called "Ceratium," "diatom," "mixed" (a mixture of the two), and a tropical type characterized by the presence of considerable amounts of Trichodesmium. Of course these are not actually distinct, grading into one another; but they group sufficiently well to be treated in this way. To take the rarer types first, tropical plankton (the "Desmo Plankton" of Cleve) was encountered only once, in the inner edge of the Gulf Stream (Station 10071) where the rather scanty catch consisted chiefly of *Ceratium macroceros,* and of Trichodesmium, with an occasional diatom (Rhizosolenia). Diatom plankton was encountered in three distinct regions; on George's Bank (Station 10059); off the mouth of Chesapeake Bay (Stations 10075, 10077, 10078) and in the northern part of the Gulf of Maine near Mt. Desert (Stations 10099, 10101).

The species composing these diatom swarms were quite different in these three regions. On George's Bank the mass, which was rather rich, consisted chiefly of a species Guinardia, besides such forms as *Eucampia zoodiacus, Rhizosolenia stolforthi,* and *R. styliformis,* practically a pure diatom haul, except for an occasional Peridinium and Ceratium. The diatom swarm off Chesapeake Bay consisted chiefly of various species of Chaetoceras (among them *C. decipiens* and *C. contortum*) with smaller numbers of Rhizosolenia, Leptocylindrus, and Thalassiothrix. And at the mouth of the Bay the haul was chiefly Rhizosolenia.

The diatom plankton found in the Gulf of Maine is difficult to place because it was chiefly debris, and evidently moribund. But fragments of Rhizosolenia and *Chaetoceras decipiens,* with other species of Chaetoceras can be distinguished. Mixed plankton (Fig. 82) partly diatom, partly peridinian, was found just north of George's Bank (no doubt the effect of the diatom swarm on the Bank); south of Nantucket Shoals (Station 10061), and at all the Stations close to land south of New York, except where the plankton was purely diatom (10069, 10072, 10079, 10080, 10081). The plankton along the outer part of the continental shelf, south of Delaware Bay (Stations 10073, 10074) was also of this type. In the Gulf of Maine mixed plankton was encountered on German Bank (Station 10095); near shore east of Mt. Desert Island; and again north of Cape Ann (Station 10105). There were

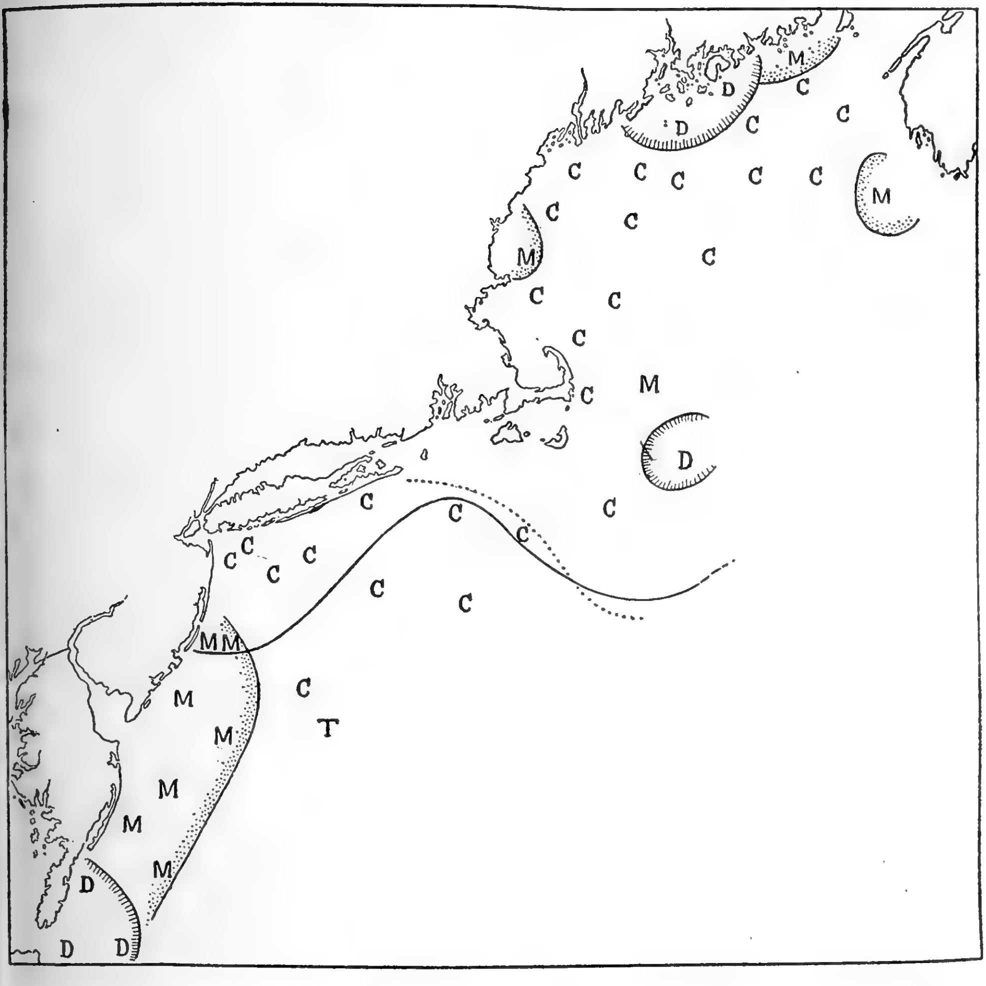

Fig. 82.— Distribution of different types of microplankton, July–August, 1913.
c, Ceratium plankton; M, mixed; d, Diatom; . . . ., northern limit to Ceratium macroceros ———; s. limit to c, longipes.

likewise more diatoms at our other stations near land than in the centre of the Gulf; but not enough to take the hauls out of the Ceratium class. The diatom constituents of the Gulf Stations were chiefly several small species of Chaetoceras, with occasional *C. decipiens*, *Rhizosolenia semispina* and *Nitschia serriata,* etc.

Peridinian plankton, in greater or less abundance, and composed of different species at different localities, occupied the waters of the Gulf of Maine (Stations 10057, 10086–10093, 10096, 10097, 10102, 10104) except at the few limited regions just mentioned; Nantucket Shoals (Staton 10060), the continental shelf from abreast of Nantucket to New York (Stations 10062, 10063, 10067, 10082, 10083, 10070) (Fig. 82). Unfortunately we have no data on the microplankton of the Gulf Stream water at Station 10076, the bottle being broken in transit. In the Gulf of Maine the prevalent organisms, of this plankton type, were two species of Ceratium, *tripos,* and the form classed by Paulsen (1904, 1908), as var. *oceanica* of *C. longipes.* (In my Report on the cruise of 1912, these two species were treated together). *Ceratium longipes* differs so noticeably from *tripos* in its curved apical horn and serrate shell, that it is easy to count the respective numbers of the two in plankton samples. And without delaying with the exact counts, the result of the comparison was as follows:—

Longipes outnumbers *tripos*	Roughly equal numbers *Tripos* and *longipes*	*Tripos* outnumbers *longipes*
Stations 10057	Stations 10058	Stations 10088
10059	10090	10089
10087	10092	
10091	10093	
10098	10095	
10102	10096	
10103	10099	
10104	10105	

On the whole, then, *longipes* was the more abundant of the two in the Gulf, where it was taken at practically every station, though notably absent at Station 10086, where it had been abundant a month earlier (Station 10057). The table likewise suggests that the preponderance of *longipes* was greater near shore than in the centre of the Gulf, the only stations where *tripos* predominated being far from land.

C. longipes occurred in the plankton on George's Bank, on Nantucket Shoals, and over the continental shelf as a whole as far as

Barnegat (Stations 10060 to 10068); but it was absent at the more southern stations, nor was it found over the outer part of the shelf south of Long Island (Stations 10063, 10065). And *tripos* invariably outnumbered it in the hauls south and west of Cape Cod. On our coasts, at least in summer, *longipes* evidently belongs to northern water. The salinity in which it was living (on the surface, where all the hauls with the # 20 silk net were made) ranged from 31.8‰ (Station 10104) to 33.4‰ (Station 10061); the temperature from 48° (Station 10095) to 69° (Station 10069). But it was far less abundant at temperatures above 62° or 63° than in the colder water of the Gulf:— for example at Station 10061, surface temperature 68°, only two specimens were detected; Station 10062, 67°, only an occasional specimen; Station 10069, 69°, only one specimen was found.

Ceratium tripos was taken at practically all our southern stations, as well as north and east of New York and in the Gulf of Maine, and at Stations 10063, 10065 over the outer part of the shelf where *longipes* was absent. At only three Stations have I failed to find it in the plankton, viz., 10075, 10076, 10078, all of them within the influence of Chesapeake Bay water (p. 200).

A third species of Ceratium, *C. macroceros,* easily distinguished by its very long, slender horns, occurred in the hauls at the southern stations. The most northerly records are Stations 10062, 10063, and 10083. East of Barnegat it was greatly outnumbered by *tripos* (Stations 10062, 10063, 10065, 10067, 10069, 10083). South of this, where *longipes* was not found, *macroceros* was always as numerous as *tripos,* the two species being, roughly, equal at Stations 10073, 10074, 10077, 10079, 10082. At Stations 10070, 10071, 10072, *macroceros* outnumbered *tripos. Ceratium macroceros* was living at a very wide range of salinity, as much so, even, as *tripos* (31.3‰ to 35.2‰); but its temperature range was considerably less, the records all being from water warmer than 63° (63° to 77°); it was only once found in water cooler than 67°, and then only an occasional specimen (Station 10067). And at only three Stations (10062, 10067, 10069) were both *longipes* and *macroceros* taken in the same haul. If the former belongs to boreal plankton, the latter is as certainly limited to warm water along our coasts.

A fourth species of Ceratium, *C. fusus,* plays a subordinate rôle. It has been found at twenty-seven stations, including the Gulf of Maine as a whole (Stations 10057, 10058, 10086–10090, 10092, 10093, 10096, 10097, 10099, 10102–10104), and the continental shelf south and west of Cape Cod (Stations 10061–10063; 10067–10070; 10073, 10074, 10077–10081). The only regions where it was notably absent were in the Gulf Stream water (Station 10071); and in localities where diatoms swarmed (*i. e.*, George's Bank, the mouth of Chesapeake Bay, and near Mt. Desert Island). And even then its absence from the plankton samples examined may be accidental, because there are a few other stations also where I failed to find it in the tow. It was outnumbered by the other species of the genus everywhere, except at one station in the centre of the Gulf of Maine (10090) where there were about equal numbers of *tripos, longipes,* and *fusus* in a sample.

Two other genera of peridinians may be mentioned briefly. Peridinium occurs in practically every sample in which Ceratium has been noted, being absent only in the Gulf Stream hauls (Stations 10071, 10073), off Chesapeake Bay (Stations 10075, 10076, 10077, 10078, 10079), and in the diatom plankton found off Mt. Desert. One species, provisionally identified from Paulsen's account (1908) as *P. crassipes* Kofoid occurs over the whole range of stations, except as above; but always in small numbers. Two other species, *oceanicum* at Station 10062 and 10070; *pallidum* at Stations 10063, 10067 and 10090, have likewise been detected so far. And additional records for these, and other species, may be expected when the microscopic examination of the microplankton is completed.

The genus Dinophysis is represented by two species, *ovum* (noted only twice) and *norvegica;* the latter being of considerable importance from the oceanographic standpoint, because it was found only in the Gulf of Maine (Stations 10090, 10096, 10097), and because of its northern distribution in general (Paulsen, 1908).

The hauls made in 1913 were not of a type calculated to reveal the exact quantitative amount of plankton in the water; for this purpose vertical hauls with a quantitative net must be resorted to. But as I have previously pointed out (1914a), the horizontal hauls do show in a rough way whether the water is barren, rich, or intermediate between these two extremes.

Off Cape Cod, in early July (Stations 10057 and 10058) the microplankton was rich: and this was likewise true south of Nantucket (Stations 10062, 10063); on George's Bank (Station 10059); off Chesapeake Bay (Stations 10075, 10078); and near Mt. Desert Island (Stations 10099, 10101). But nowhere, in 1913, was it found as dense as it was in several places in the Gulf in 1912 (1914a). And as a rule it was notably scanty, being so classed at Stations 10061, 10069–10073; 10079–10083; 10086–10090; 10092, 10093, 10096, 10098, 10102, 10104, 10105; perhaps most barren of all at Stations 10071, 10081, 10082 and 10083. It was intermediate, quantitatively, at Stations 10060, 10065, 10067, 10074, 10077, 10091, 10095, 10097, 10103.

GULF OF MAINE PLANKTON, 1912 AND 1913.

The summer plankton of the Gulf of Maine was of the same general type in 1913 as in 1912 (1914a). The lists of copepods, far the most important constituent of the macroplankton, are practically the same for the two years, the most numerous and most regularly occurring species was *Calanus finmarchicus*. But *Calanus hyperboreus*, taken only once in 1912 occurred at four stations in 1913, once in large numbers (p. 286); *Eucheata norvegica* was, likewise, taken more regularly in 1913, where it was practically universal in the deep waters of the Gulf (fourteen stations) than in 1912 (nine stations); and *Metridia longa* is recorded for the first time from our waters. Anomalocera was taken more regularly in 1913 than in 1912, but in this case the difference is probably apparent rather than real, due to different types of nets used on the surface, where Anomalocera is most abundant. *Euchirella rostrata*, singularly enough, was taken twice in each year, once on each side of the Gulf.

In the case of the hyperiids the difference between the hauls of the two years was much greater, because *Euthemisto bispinosa*, a species common in the centre of the Gulf in 1913 was not found at all during the preceding summer. Its history during the year in Massachusetts Bay is as follows: — absent there during the summer of 1912, it must have appeared in the early autumn, for it was about half as numerous as *compressa* in November (1914b). But later in the season it was proportionately rare in the hauls (six *compressa* to one *bispinosa* in April) and by August, 1913, the Euthemisto component of the plankton of Massachusetts Bay was once more exclusively *compressa*. This local series of changes suggests the possibility that there may be a parallel series for the Gulf as a whole, *bispinosa* appearing seasonally, in winter and spring, to disappear again in summer. If this be the case, the species must have persisted longer in 1913 than it did in 1912. But the appearance of *bispinosa* may have been the result of an invasion of the Gulf by this species during the autumn of 1912. In both summers *Euthemisto compressa* was very generally distributed over the Gulf. *Parathemisto oblivia*, taken at two Stations (10032 and 10036) in 1912, was not detected at all in the hauls of 1913. The rarity of this species is interesting because of its wide distribution and frequent occurrence on the other side of the Atlantic (p. 341). The remaining hyperiids, *Hyperia galba, H. medusarum* and Hyperoche were occasionally represented in both years.

The only pteropod which we have found in any great numbers in the

Gulf is *Limacina balea.* In 1912 the range of this species was limited to two circumscribed areas, *i. e.,* the northwest corner of the Gulf off Casco Bay, and German Bank. But in 1913 it was much more generally distributed over the Gulf. In 1912 it was most abundant off Cape Elizabeth (1914a), in 1913, off the mouth of Penobscot Bay. *Clione limacina,* on the other hand, was more frequently represented in our hauls in 1912 (nine stations) than in 1913 (two stations). But as the total number of specimens taken in the former year was only sixteen, it is doubtful whether the apparent difference has any special faunal significance. And this is likewise true of the one record of *Diacria trispinosa* off Gloucester in 1913. In neither year did we find any of the typical warm water pteropods in the Gulf.

Salpae are especially important because they give certain evidence of the entrance of Gulf Stream water into the Gulf. In both years Salpae were found on the eastern side of the Gulf; but while in 1912 they occurred on the surface over a considerable area (Station 10030 to Station 10031), in 1913 Salpa was taken in only one haul (Station 10096). In 1912 the species concerned was *fusiformis,* while *democratica* swarmed on the surface off Chatham in September (1914a). But in 1913 the single catch was *tilesii.*

The Sagitta fauna of the Gulf of 1913 was decidedly different from that of 1912, for while *S. elegans* was generally distributed over the whole area in both summers, *S. serratodentata* was far less numerous, and occurred at fewer localities in 1913. On the other hand *Eukrohenia hamata* was decidedly more abundant in 1913 (five stations) than 1912 (one station).

In 1912 at least one warm water siphonophore was taken in the Gulf, *Physophora hydrostatica* (one station), and probably a second, *Agalma elegans* (six stations) though the specimens of the latter were so fragmentary that identification was not so satisfactory as could be wished. In 1913 neither of these was found in the Gulf, though both were encountered south of Cape Cod, Agalma in abundance (p. 269). On the other hand *Stephanomia cara,* which appeared in numbers off Cape Ann during the winter (1914b) was occasionally represented in our tows in the Gulf in 1913 (three stations), though always in a very fragmentary condition (p. 315).

The neritic Medusa fauna of the Gulf was practically the same for the two years. But the only oceanic Medusa found there in either summer, *Aglantha digitale,* was much more generally distributed and locally more abundant in 1913 than in 1912.

These facts can be summed up as follows:—

The list is practically the same in 1913 as in 1912, hence it is evident that no great change, *i. e.*, no great ingress of water of either northern or Gulf Stream origin had taken place. In both years the plankton of the Gulf was typically boreal. But species which we can safely say are contributed to the fauna of the Gulf by the surface water of the Gulf Stream, *i. e.*, Salpae, and the warm water siphonophores, were distinctly less abundant, and less widespread in the Gulf, in 1913 than in 1912. On the other hand, several boreal and Arctic-boreal species, *i. e.*, *Limacina balea, Calanus hyperboreus, Metridia longa, Eucheata norvegica, Eukrohnia hamata,* and *Aglantha digitale,* were more prominent faunally in 1913 than in the preceding summer. And there is good reason to include *Euthemisto bispinosa* in the Arctic-boreal category, judging from its occurrence on the other side of the Atlantic and in the Arctic Ocean (Tesch, 1911). This suggests, of course, that St. Lawrence water was proportionally greater, Gulf Stream water less in amount in the summer of 1913; the plankton thus corroborating the evidence of salinity and temperature (p. 250).

The general quantitative distribution of the macroplankton was much the same for the two years; but the local differences were far greater in 1912 than in 1913; and nowhere, in the latter year, was the water as barren as the coastal zone east of Penobscot Bay in 1912. Whether or not the very rich plankton which was noted in Ipswich Bay in 1912, was reproduced there in 1913, is not known, because that exact locality was not revisited.

A question of importance is whether the Gulf as a whole was richer or poorer in macroplankton, *i. e.* in food for pelagic fish, in 1913 than in 1912, and here copepods play the chief rôle. The actual volumes, and relative number of copepods (p. 329) at corresponding stations for the two years are given in the table :—

Station 1912	Station 1913	Volume cc. 1912	Volume cc. 1913	Copepods 1912	Copepods 1913
10002	10087	25	18	239	101
10025	10089	8	8	125	62
10028	10092	3	16	25	193
10031	10096	3	12	20	140
10036	10097	3	?	50	174
10035	10099	Trace	3	10	54
10038	10101	2	10	24	150
10022	10103	3	7	97	76
10011	10104	2	9	30	54
Averages		5.5	10.3	69	111

Thus the only part of the Gulf where volume, or number of copepods, or both, was greatest in 1912 was off Massachusetts Bay, and near Cape Elizabeth and Platt's Bank; a difference which may be seasonal. Everywhere else both the volume of plankton and the number of copepods was greater in 1913 than in 1912. It is possible that locations close to shore might have proved an exception; but judging from what was found east of Mt. Desert and on German Bank, there is no reason to suppose that shore stations would have altered the case materially. On the average, the hauls for the whole Gulf were nearly twice as large in bulk, and 60% larger in number of copepods, in 1913; a difference so great that it can hardly be accidental, especially as the same net was used in both years. In short, there seems no escape from the conclusion that both the plankton as a whole, and its copepod constituent, were richer in August, 1913, than in the summer of 1912.

Very little can be said about the microplankton of the two years until the microscopic examination of the hauls is completed. But enough has been done to show that diatoms were far less numerous in August, 1913, than in the corresponding month of 1912. And the species which formed the bulk of the catch in that year, *Asterionella japonica,* has not been detected at all in the 1913 hauls. Furthermore the Ceratium plankton was nowhere so dense in 1913 as off Cape Elizabeth in 1912.

MACROPLANKTON OF THE GULF OF MAINE AND OF THE NORTHEASTERN ATLANTIC.

Our survey of the plankton of the Gulf of Maine in 1912 led to the conclusion that it was characteristically boreal, in the sense in which the term is used by Hjort (Murray and Hjort, 1912, p. 637), not Arctic, though with Arctic and Gulf Stream components (1914a, p. 106). And subsequent catches support this general thesis. The most important member of the plankton of the Gulf, *Calanus finmarchicus,* it is true, is practically eurythermal, but it is only in boreal, and in Arctic-boreal waters that it swarms (Farran, 1911) and it is not distinctive of polar water, although it is very numerous and very large in the Labrador Current (Herdman, Thompson, and Scott, 1898). On our coasts Calanus plankton apparently occupies an unbroken belt from the Labrador Current to Cape Cod. The only copepod which vies with it in abundance in the Gulf, *Pseudocalanus elongatus,* is likewise chiefly boreal, not polar, and far more plentiful in coastal than in oceanic water (Farran, 1910). And though *Temora longicornis* and *Euchaeta norvegica* are rather more northern, neither of them is distinctively polar. The only members of the copepod fauna which can be classed in that category, *Calanus hyperboreus,* and *Metridia longa,* are rare in the Gulf. The two oceanic copepods which are prominent in the Gulf belong, one, *Anomalocera pattersoni,* to the temperate Atlantic, the other, *Metridia lucens,* to rather more northern waters (Cleve, 1900); Pleuromamma and Euchirella alone are clearly of Gulf Stream origin, so far as the Gulf of Maine is concerned.

Only six species of euphausiid schizopods have yet been detected in the plankton of the Gulf (1914b, p. 410). One of these, *Meganyctiphanes norvegica,* is very widely distributed in the North Atlantic, but much more abundant in boreal water than in polar or warm waters; two, *Thysanoessa inernis,* and *raschii* are typical Arctic-boreal forms, one, *Thysanoessa longicaudata,* is rather more northern, but not polar, being found as far south as the southern part of the North Sea, and one, *Nematoscelis megalops* is oceanic, of very wide distribution in the North Atlantic. (For the general distribution of these species, see Kramp, 1913b). To one species only, *Thysanoessa gregaria* can a southern or Gulf Stream origin be assigned (Zimmer, 1909, p. 21), and this one has seldom been taken in the Gulf.

The only hyperiid amphipods which attain any faunal importance in the Gulf, *Euthemisto compressa* and *E. bispinosa,* are typical Arctic-boreal species, neither of them being found south of the English Channel in European waters. Of the two, *bispinosa* is decidedly the more northern (Tesch, 1911) which is suggestive in connection with the incursion of this species into the Gulf during the autumn of 1912 (p. 335).

The only pteropod which is common in the Gulf, *Limacina balea,* is one of the most typical of boreal organisms, at home neither in pure polar water, nor in the warmer parts of the Atlantic (Meisenheimer, 1906, Paulsen, 1910). *Clione limacina* is rather more northern, especially abundant on the Grand Banks of Newfoundland, though not an index of polar water (Murray and Hjort, 1912, p. 108).

The only chaetognath which is uniformly abundant over the Gulf as a whole, *Sagitta elegans,* has its centre of distribution in boreal coastal waters, though its extreme range includes the Mediterranean on the one hand, and the Arctic Ocean on the other (Apstein, 1911; Ritter-Zahony, 1911). The two other species which were taken in the Gulf in 1913 are of diametrically opposite origins: — *Sagitta serratodentata* is a southern species; *Eukrohnia hamata* is Arctic or from the mid depths off shore (Apstein, 1911). *Sagitta hexaptera,* taken in the Gulf in 1912 but not in 1913, is oceanic, very widely distributed.

The Salpae are, of course, all visitors from the Gulf Stream, as are such coelenterates as Physalia, *Agalma elegans,* and *Physophora hydrostatica.*

The ctenophores of the Gulf are either cosmopolitan forms (*Pleurobrachia pileus* and *Beroe cucumis*) or Arctic-boreal (*Bolinopsis infundibulum*); while a true Arctic species, *Mertensia ovum,* has been recorded rarely (A. Agassiz, 1865, Fewkes, 1888) and the only oceanic Medusa, *Aglantha digitale,* is widely distributed over the North Atlantic.

In short, the more important members of the Gulf plankton are of three types, 1, Arctic-boreal; 2, Gulf Stream; 3, Arctic; of which the first greatly outnumbers the other two in number of species and in number of individuals.

I have already pointed out (1914a, p. 107) that the summer plankton of the Gulf of Maine resembles that of the Norwegian Sea and the North Sea; a parallel which can be drawn even more closely with the collections made during the winter of 1912–1913 (1914b), and the summer of 1913.

And it is not only in its individual components that the plankton corresponds to the other side of the North Atlantic, but in their method of association; for example Dr. D. Damas informs me that the plankton assemblages found in the Gulf in 1912 (1914a) correspond almost exactly to many of the hauls taken by the MICHAEL SARS off the coast of Norway. And Dr. Otto Pettersen writes calling attention to the similarity of the GRAMPUS plankton to that of the Skagerrak. The parallel does not extend to the Norwegian Sea and North Sea as a whole, but only to the southern part of the former and northern part of the latter, where Arctic-boreal plankton, temperate neritic species, and warm water species carried around the northern end of Scotland by the sweep of the Atlantic Current, meet. There, as in the Gulf, *Calanus finmarchicus* is perhaps the most important member of the plankton being found locally in vast shoals (Farran, 1911, p. 38), and Pseudocalanus in great numbers. *Sagitta elegans* is taken in almost every haul; *Limacina balea* is locally abundant; *Anomalocera pattersoni* is taken more or less regularly on the surface, though seldom in great numbers; *Aglantha digitale* is frequently, Pleurobrachia irregularly recorded (Kramp, 1913a), *Euchaeta norvegica* is more or less regular in the deep hauls; *Eukrohnia hamata, Calanus hypoboreus,* and *Metridia longa* are both visitors from the north, as are the several northern species of Thysanoessa, and *Meganyctiphanes norvegica.* And all the hyperiid amphipods known from the Gulf of Maine are more or less regularly recorded (Tesch, 1911). In fact, all the species without exception which are listed as particularly characteristic of our Gulf (p. 273) meet one another in this region, most of them being regularly recorded in the plankton lists of the International Committee for the exploration of the sea. And the various Salpae, southern siphonophores and other warm water species make their appearance in summer (Damas, 1909, p. 107), just as they do in smaller numbers in the Gulf of Maine. But the relative importance of the various species is not quite alike, for example, *Euthemisto compressa,* one of the most constant members of the plankton of the Gulf of Maine, especially in summer, is usually rare (Tesch, 1911) in European waters. Its place is taken there by *Parathemisto oblivia,* which occurs in at least 50%, usually 75% of the hauls in the Norwegian Sea and the northern part of the North Sea; but *P. oblivia* is so rare in the Gulf that I have detected only two specimens among the thousands of Euthemisto which have passed under my notice (p. 335). *Euthemisto bispinosa,* on the other hand, is far more abundant on the western than the eastern side of the North Atlantic.

It is not yet possible to state the quantitative relationship which the plankton of the Gulf of Maine bears to that of the North and Norwegian Seas, because the quantitative nets used, speed of hauling, etc., have not been alike; and because the coefficient of filtration has not been determined for our nets. But this phase of plankton study is so important in its practical bearing on the food supply for fishes that it is worth while to compare our results briefly with Apstein's ist for the North Sea (Apstein, 1906; Johnstone, 1908). The bulk of plankton below each square meter of surface of the Gulf of Maine, n the summers of 1912 (1914a) and 1913, ranged from 10 cc. to 250 cc.; n 1913 the average for the whole Gulf was about 100 cc. Much reater amounts than this were found in the northeastern part of the North Sea by Apstein, who records volumes of 96–952 cc.; below each quare meter of surface in August, 1903; with an average of about 40 cc. for thirteen hauls. And even admitting all the objections which can be urged to volume as a measure of plankton (Steuer, 1910), o great a difference as this can only mean that there was a greater ulk of plankton in the North Sea in 1903 than in the Gulf of Maine in 912 and 1913. And the discrepancy between the two regions is even reater, if the comparison be extended to the amounts of plankton er cubic meter, for the largest amounts in the Gulf (p. 326) is only bout one tenth of Apstein's largest record (27.2 cc.) for the North

Sea, August, 1903. Most of the volumes per cubic meter given by Apstein are not for the whole column of water, but for parts of it only, as given by closing nets; to make them directly comparable with the GRAMPUS hauls, the entire depth at each station must be taken into account. When this is done, the average per cubic meter, for the North Sea, is about 9.1 cc.; the average for the Gulf of Maine 1 cc.–1.3 cc.

Copepods were much more numerous in the North Sea than in the Gulf, the average of fourteen hauls in the Gulf of Maine in August, 1913, being about 66000 under each square meter of surface; the average in the North Sea August, 1903, about 1,000,000 (Apstein, 1906; Johnstone, 1908). And although Calanus is present in large numbers in the Gulf, it was never found in such swarms as occur in the southern part of the Norwegian Sea, where a surface haul of five minutes duration with a meter net may yield more than a litre of Calanus (Damas, 1905, p. 15).

TABLE OF STATIONS, NETS USED, DEPTHS OF HAULS IN FATHOMS.

NETS.

A = Albatross 4 ft. net. B = 24 cm. net #20 silk. C = 36 cm. net #3 silk
F = Young fish trawl. H = Helgoland net. S = Michael Sars 1 meter net.
Q = Quantitative net. T = Otter Trawl. Italics indicate "no bottom."

Station	Lat.	Long.	Date 1913	Depth	Nets	Depth of hauls
10057	42° 6′	69° 56′	July 8	47	B. C. A. H.	0, 0, 15–0, 30–0.
10058	41° 47′	69° 10′	" 8	90	B. H.	0, 40–0.
10059	41° 06′	68° 42′	" 9	30	B. C. H.	0, 0, 25–0.
10060	40° 41′	69° 33′	" 9	27	B. C. S. Q.	0, 0, 20–0, 20–0.
10061	40°	69° 29′	" 10	80	B. C. S. H.	0, 0, 30–0, 50–0.
10062	40° 29′	70° 29′	" 10	41	B. C. A.	0, 0, 15–0.
10063	40° 45′	71° 16′	" 11	33	B. C. H.	0, 0, 25–0.
10064	39° 55′	71° 13′	" 11	370	B. C. H. A.	0, 0, 25–0, 175–0.
10065	40°	72° 06′	" 12	45	B. C. H. T.	0, 0, 20–0, 45.
10066	40° 20′	72° 55′	" 12	25	A.	0
10067	40° 29′	73° 46′	" 13	12	B. H.	0, 10–0.
10068	40° 22′	73° 50′	" 17	20	H. T.	10–0, 20.
10069	39° 35′	73° 47′	" 19	15	B. H. F.	0, 10–0, 15–0.
10070	39° 09′	72° 58′	" 19	44	B. C. H. T.	0, 0, 20–0, 44.
10071	38° 56′	72° 39′	" 20	*400*	B. C. A. F.	0, 0, 190–0, 175–0.

Station.	Lat.	Long.	Date 1913	Depth	Nets	Depth of hauls
10072	38° 50′	73° 51′	" 21	24	B. C. H. T.	0, 0, 15–0, 24.
10073	38° 26′	74° 30′	" 21	22	B. C. H. T.	0, 0, 15–0, 22.
10074	37° 41′	74° 27′	" 22	30	B. C. H. T.	0, 0, 20–0, 30.
10075	37° 29′	75° 21′	" 23	9	B. C. H. T.	0, 0, 8–0, 9.
10076	37° 03′	74° 33′	" 24	*150*	B. C. H. A.	0, 0, 20–0, 120–0.
10077	37° 03′	74° 56′	" 24	25	B. C. H. T.	0, 0, 20–0, 25.
10078	37°	75° 38′	" 29	12	B. C. H. T.	0, 0, 8–0, 12.
10079	38° 02′	74° 53′	" 30	15	B. C. H. T.	0, 0, 8–0, 15.
10080	39° 07′	74° 24′	" 31	13	B. C. H.	0, 0, 10–0.
10081	39° 45′	73° 58′	" 31	11	B. C. H.	0, 0, 8–0.
10082	40° 09′	73° 21′	Aug. 1	22	B. C. H.	0, 0, 18–0.
10083	40° 48′	72° 17′	" 1	16	B. C. H.	0, 0, 8–0.
10084	41° 10′	71° 13′	" 2	20		
0085	41° 39′	69° 42′	" 4	26	B. C. H.	0, 0, 18–0.
0086	42° 6′	70°	" 5	40	B. C. H.	0, 0, 20–0.
0087	42° 31′	70° 21′	" 9	71	B. C. A. H. Q.	0, 0, 15–0, 40–0, 70–0.
0088	42° 33′	69° 33′	" 9	149	B. C. A. H.	0, 0, 80–0, 80–0.
0089	43° 02′	69° 19′	" 10	108	B. C. H. Q.	0, 0, 30–0, 100–0.
0090	42° 51′	68° 25′	" 10	101	B. C. A. H. Q.	0, 0, 20–0, 75–0, 90–0.
0091	43° 24′	68° 49′	" 11	60	B. C. H.	0, 0, 20–0.
0092	43° 27′	67° 55′	" 11	131	B. C. H. A. Q.	0, 0, 35–0, 85–0, 120–0.
0093	43° 24′	67° 12′	" 12	120	B. C. A. H.	0, 0, 25–0, 85–0.
094	43° 25′	66° 43′	" 12	63		
095	43° 20′	66° 27′	" 12	31	B. C. H. Q.	0, 0, 20–0, 20–0.
096	43° 56′	66° 50′	" 12	61	B. C. H. Q.	0, 0, 25–0, 50–0.
097	44° 13′	67° 21′	" 13	115	B. C. A. H. Q.	0, 0, 25–0, 85–0, 100–0.
098	44° 24′	67° 29′	" 13	37	B. C. H. Q.	0, 0, 20–0, 30–0.
099	44° 08′	68° 10′	" 13	21	B. C. H. Q.	0, 0, 15–0, 20–0.
100	43° 52′	67° 58′	" 13	102	B. C. A. H. Q.	0, 0, 25–0, 70–0, 90–0.
101	43° 44′	68° 44′	" 14	54	B. C. H. Q.	0, 0, 25–0, 40–0.
102	43° 34′	69° 13′	" 14	75	B. C. A. H. Q.	0, 0, 20–0, 50–0, 70–0.
103	43° 32′	69° 55′	" 14	50	B. C. H. Q.	0, 0, 30–0, 40–0.
1 04	43° 08′	70° 06′	" 15	87	B. C. A. H. Q.	0, 0, 15–0, 50–0, 80–0.
1 05	42° 48′	70° 27′	" 15	63	B. C. H. Q.	0, 0, 40–0, 60–0.
1 06	42° 29′	70° 37′	" 20	38		
1 12	40° 17′	70° 57′	" 22	60	T.	60.

TABLE OF TEMPERATURES, SALINITIES, AND DENSITIES.

Temperatures are Fahrenheit; Salinity = grams of salts per kilogram of water. Density is at the temperature *in situ,* and = specific gravity at T°, compared to distilled water at 4°C. × 1000.

The density readings for depths greater than fifty fathoms are corrected for pressure by Ekman's (1910) tables IV and V. Readings at 50 fathoms or less, are corrected for pressure by table IV (Ekman, 1910) alone.

Station	Depth Fathoms	Temp.	Salinity	Density
10057	0	61.°	31.9	23.43
	10	50.6°	31.97	24.69
	20	42.6°	32.48	25.75
	30		32.7	
	40	41.2°	32.68	26.19
10058	0	63.°	32.4	25.53
	30	41.1°	33.1	26.44
	60	40.6°	33.35	26.91
	90	41.3°	33.36	27.17
10059	0	56.°	33.06	24.93
	15	54.7°	33.07	25.20
	30	54.7°	33.13	26.38
10060	0	61.°	32.63	23.94
	10	57.4°	32.68	24.42
	25	50.3°	33.04	25.67
10061	0	68.°	33.41	23.55
	25	47.9°	33.51	26.18
	50	47.3°	33.62	26.55
		51.°		
	75	51.5°	34.30	26.86
10062	0	67.°	32.86	23.42
	20	46.2°	33.04	25.93
	40	43.6°	33.44	26.57
10063	0	67.°	32.11	22.71
	15	53.2°	33.22	25.54
	30	44.3°	33.22	26.30
10064	0	70.°	33.16	23.15
	50	54.°	35.18	27.54
	150	48.5°	35.05	28.38

Station	Depth Fathoms	Temp.	Salinity	Density
10064	250	41.6°	34.96	29.80
10065	0	69.°	32.68	23.03
	15	54.9°		
	20		33.04	25.62
	30	44.6°		
	40	46.2°	33.89	26.75
	45	51.°		
10066	0	69.°	31.55	22.17
	15	51.5°	33.26	25.56
	25	45.8°	33.22	26.10
10067	0	63.°	31.22	22.64
	12	49.2°	32.82	25.57
10068	0	67.°	31.53	22.41
	20	47.3°	33.16	25.99
10069	0	69.°	32.27	22.76
	7	60.°	33.2	23.58
	15	48.°?	33.25	24.97?
10070	0	74.°	32.23	21.85
	10	70.4°		
	20	50.°	33.68	26.16
	40	48.4°	34.02	26.96
10071	0	76.°	35.25	23.87
	50	58.8°	35.55	27.46
	150	49.1°	35.25	28.52
	250	43.6°	35.03	29.65
10072	0	73.°	32.22	22.12
	10	66.2°	33.29	23.81
	24	47.8°	33.56	26.40
10073	0	75.°	33.48	22.50
	10	70.5°	34.04	23.89
	22	51.4°	33.93	26.16
10074	0	75.°	33.24	22.31
	15	64.6°	35.06	25.48
	30	50.8°	34.32	26.72
10075	0	75.°	31.88	21.27
	9	59.°	33.48	24.9
10076	0	76.°	33.57	22.57
	25	59.5°		
	50	54.5°	35.37	27.64
	100	51.3°	35.36	27.92

Station	Depth Fathoms	Temp.	Salinity	Density
10076	150	49.3°	35.15	28.37
10077	0	77.°	31.32	20.59
	10	68.5°	34.96	24.74
	25	51.5°	34.33	26.36
10078	0	80.°	29.25	18.46
	5	75.7°	31.91	21.34
	12	57.6°	33.5	25.13
10079	0	76.°	32.41	21.70
	5	74.5°	32.76	22.22
	10		33.86	
	15	52.5°	33.86	26.05
10080	0	76.°	32.23	21.56
	5	53.6°		
		52.6°		
	13	52.6°	33.14	25.47
10081	0	75.°	32.11	21.45
	5	74.2°	32.14	21.51
	7	53.°		
	11	52.6°	32.65	25.02
10082	0	74.°	31.85	21.61
	10	54.7°	33.01	25.09
	22	47.°	33.09	25.92
10083	0	68.°	31.29	21.97
	8	64.8°	31.49	22.72
	16	50.6°	32.75	25.34
10084	0	71.°	32.29	22.32
	10	62.3°	32.33	23.58
	20	50.1°	32.65	25.30
10085	0	63.5°	32.05	23.15
	10	43.6°	32.47	25.68
	26	42.5°	32.56	25.87
10086	0	62.8°	32.09	23.30
	10	53.1°	32.23	24.56
	20	43.8°	32.52	25.71
	30	43.3°	32.52	25.89
	40	43.2°	32.52	25.93
10087	0	62.°	32.09	23.41
	10	51.4°		
	20		32.68	
	25	42.9°		

Station	Depth Fathoms	Temp.	Salinity	Density
10087	50	41.3°	32.77	26.37
	70	41.3°	32.75	26.40
10088	0	66.5°	32.21	22.91
	25	45.9°		
	50	41.3°	33.17	26.68
	100	43.3°	33.87	27.47
	150	43.4°	34.27	28.21
10089	0	61.5°	32.52	23.88
	10	53.7°		
	25	44.°	32.95	26.11
	50	44.°?	33.26	
	100	41.2°	33.46	27.29
10090	0	61.°	32.56	23.91
	10	52.1°		
	25	44.2°	32.92	26.08
	50	43.5°	33.21	26.59
	100	43.9°	33.84	27.41
10091	0	61.°	32.47	23.84
	10	58.1°	32.57	24.34
	25	47.5°		
	50	44.1°		
	60		33.40	26.69
10092	0	62.°	32.59	24.05
	10	52.6°		
		48.6°		
	25	43.2°	33.1	26.22
	40-45	42.°		
	50	42.5°	33.28	26.66
	100	43.°	33.91	27.53
	130	42.9°	34.14	28.01
10093	0	60.5°	32.61	23.95
	10	58.1°		
	20	51.2°		
	30		32.95	25.87
	50	42.°		26.81?
	60		33.58	
	75	42.6°		
	120	42.6°	34.10	27.89
10094	0	48.°	32.75	25.46
	10	47.°		

Station	Depth Fathoms	Temp.	Salinity	Density
10094	20		33.01	25.86
	25	47.°		
	40		33.24	26.22
	50	46.7°		
	60		33.62	26.84
	62	44.9°		
10095	0	48.°	32.79	25.43
	5	47.8°		
	10	47.6°	32.92	25.69
	30	47.4°	32.94	25.88
10096	0	54.°	32.75	24.89
	10	51.7°		
	25	49.4°		
	30		33.42	26.14
	50	47.2°		
	60		33.39	
	65	43.°		26.86
10097	0	55.°	32.75	24.80
	10	53.°		
	25			
	30		32.77	
	50	46.4°		
	60			
	110	42.8°	34.09	27.74
10098	0	50.5°	32.47	25.01
	10	49.2°		
	15		32.59	25.33
	37	48.3°	32.70	25.62
10099	0	55.°	32.38	24.39
	20	48.8°	32.61	25.39
10100	0	55.°	32.72	24.67
	10	50.2°		
	20		32.95	
	25	47.3°		25.86
	50	46.°	33.28	26.46
	100	43.2°	33.87	27.49
10101	0	53.5°	32.68	24.83
	10	50.2°		
	20		32.92	
	25	48.7°		25.79?

Station	Depth Fathoms	Temp.	Salinity	Density
10101	50	47.3°	33.26	26.27
10102	0	61.°	32.23	23.65
	10	49.2°		
	20		32.66	
	25	47.7°		25.63?
	50	45.4°		26.20?
	70		33.17	26.76
	75	42.6°		
10103	0	61.°	31.83	23.35
	10	52.5°?		
	20		32.63	
	25	46.5°		25.66
	50	44.1°	32.83	26.23
10104	0	63.°	31.85	23.14
	10	49.3°		
	20		32.57	
	25	45.2°		25.76?
	50	41.9°	33.06	26.54
	80		33.1	26.94
	85	39.8°		
10105	0	64.°	32.09	23.18
	10	49.7°		
	25	44.4°		25.78?
	30		32.66	
	50	41.6°		26.28
	60	40.3°	32.74	26.45
10106	0	61.°	32.16	23.59
	15	48.5°	32.41	25.26
	38	44.10	32.57	25.90
10112	0	69.5°	34.	
	20	63.°		
	35	60.2°	34.83	
	60	59.8°	35.17	

TABLE OF SURFACE TEMPERATURES, TAKEN BY W. W. WELSH, BETWEEN CAPE COD AND CAPE MAY.

August 21–September 1, 1913.

Stations	Latitude	Longitude	Date	Surface Temperature
10107	40° 36′	69° 38′	Aug. 21	67.5°
10108	40° 21′	69° 39′	"	69.5°
10109	40° 07′	69° 46′	"	69.°
10110	40° 16′	70° 07′	"	68.°
10111	40° 23′	70° 38′	Aug. 22	67.°
10112	40° 17′	70° 57′	"	69.5°
10113	40° 22′	71° 15′	"	69.°
10114	40° 26′	71° 30′	"	70.5°
10115	40° 31′	71° 45′	"	71.25°
10116	40° 37′	72°	"	70.°
10117	41° 01′	71° 43′	Aug. 25	66.°
10118	40° 51′	71° 58′	"	69.5°
10119	40° 22′	71° 55′	"	71.5°
10120	40° 10′	71° 50′	"	72.°
10121	40° 04′	71° 54′	Aug. 26	72.°
10122	39° 58′	71° 52′	"	70.5°
10123	40° 08′	72° 03′	"	72.°
10124	40° 03′	72° 03′	"	72.°
10125	40° 03′	72° 22′	"	72.°
10126	40° 09′	72° 37′	"	71.5°
10127	40° 16′	72° 56′	"	71.°
10128	40° 27′	73° 38′	Aug. 27	71.°
10129	40° 22′	73° 28′	"	71.°
10130	40° 17′	73° 34′	Aug. 28	72.25°
10131	40° 10′	73° 21′	"	72.°
10132	40° 05′	73° 11′	"	71.5°
10133	40°	73° 27′	"	71.5°
10134	39° 53′	73° 17′	Aug. 29	71.°
10135	39° 47′	73° 09′	"	72.°
10136	39° 39′	73°	"	73.°
10137	39° 39′	73° 16′	"	73.°
10138	39° 41′	73° 19′	"	72.°
10139	39° 46′	73° 30′	"	72.°
10140	39° 48′	73° 42′	"	72.°
10141	39° 50′	73° 53′	"	72.°

Stations	Latitude	Longitude	Date	Surface temperature
10142	39° 39′	73° 49′	Aug. 30	72.°
10143	39° 43′	74°	"	71.°
10144	39° 34′	73° 53′	"	72.°
10145	39° 29′	73° 44′	"	72.5°
10146	39° 23′	73° 34′	"	73.°
10147	39° 16′	73° 26′	Aug. 31	74.°
10148	39° 09′	73° 23′	"	74.°
10149	39° 02′	73° 19′	"	75.°
10150	39° 02′	73° 34′	"	76.°
10151	39° 02′	73° 46′	"	75.5°
10152	38° 54′	73° 53′	"	75.°
10153	38° 45′	74° 01′	"	74.5°
10154	38° 40′	74° 09′	Sept. 1	72.5°
10155	38° 42′	74° 15′	"	74.5°
10156	38° 46′	74° 25′	"	74.5°

SALINITIES OF WATER SAMPLES COLLECTED BY CAPTAIN McFARLAND.

May–Aug., 1913.

Lat.	Long.	Date	Depth Fath.	Sal. ‰
38° 45′ N.	73° 52′ W.	May 3	0	34.18
38° 49′	73° 38′	" 9	"	34.18
"	"	" "	25	34.18
40° 46′	70° 32′	June 5	0	32.94
40° 48′	70° 05′	" 6	"	32.65
"	"	" "	15	32.75
40° 45′	70°	" 21	0	32.68
40° 42′	69° 38′	Aug. 8	20	32.77

Locality	Date	Depth Fath.	Sal. ‰
off Chatham, Mass.	Aug. 1	0	32.07
15 miles SE. of Chatham	Aug. 16	0	32.38
SE. of Chatham	Aug. 21	20	32.34

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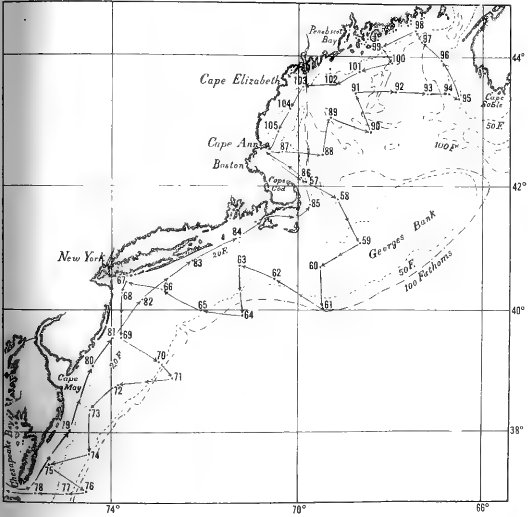
PLATE 1.

Chart of the route, showing the Stations, and the 20, 50, and 100 fathom curves.


Penobscot Bay
Cape Elizabeth
Cape Ann
Boston
Cape Cod
New York
Cape May
Chesapeake Bay
Cape Sable
Georges Bank
50 F.
100 F.
20 F.
100 Fathoms
57
58
59
60
61
62
63
64
65
66
67
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69
70
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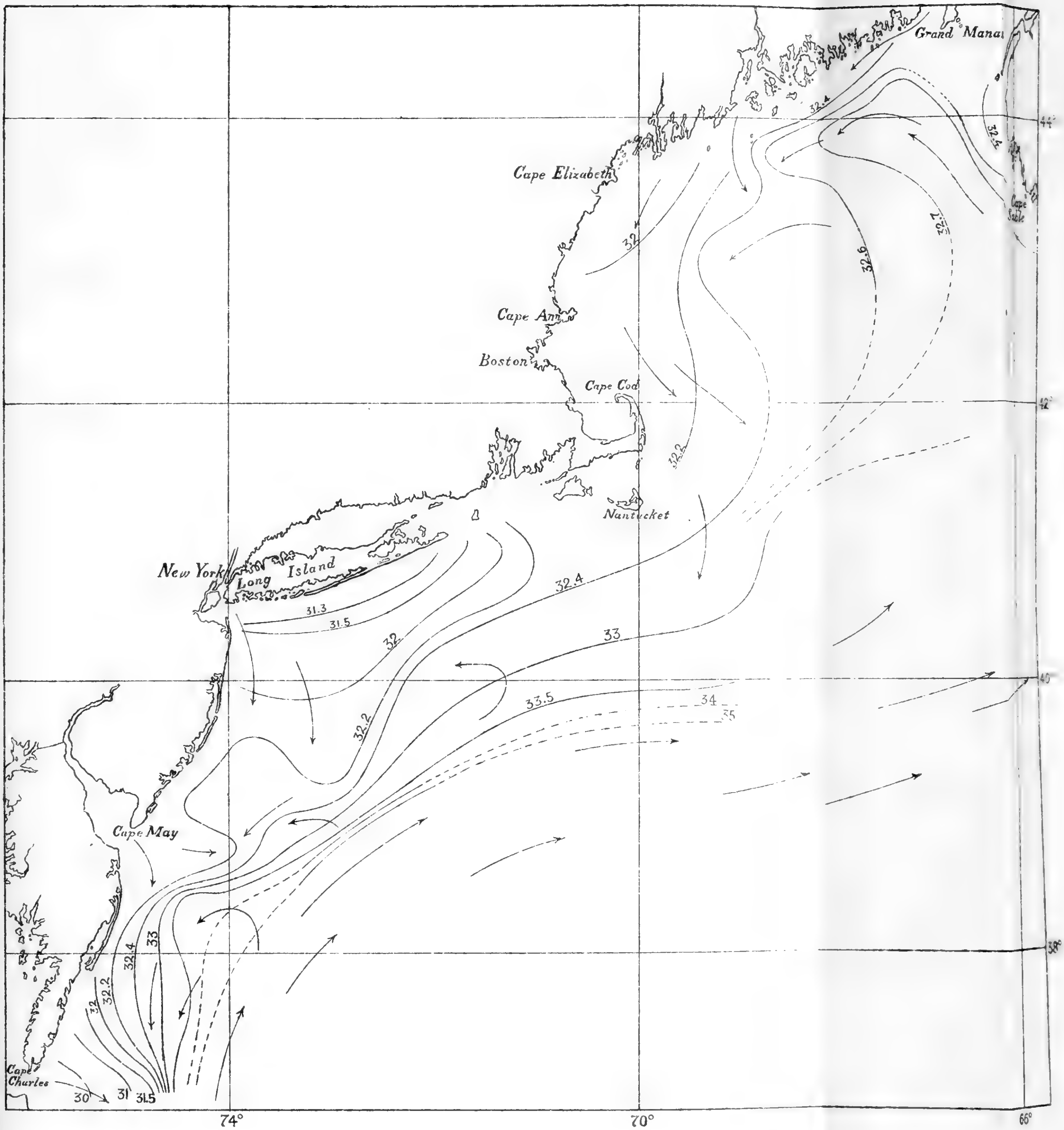
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100
101
102
103
104
105
44°
42°
40°
38°
74°
70°
66°

PLATE 2.

Chart of surface salinities and surface currents for the Gulf of Maine in August, and for the waters south and west of Cape Cod in July.


Grand Manan
32.4
32.4
44°
Cape Elizabeth
Cape Sable
32.7
32
32.6
Cape Ann
Boston
Cape Cod
42°
32.2
Nantucket
New York
Long Island
32.4
31.3
31.5
32
33
40°
34
33.5
35
32.2
Cape May
33
32.4
32.2
32
38°
Cape Charles
30
31
31.5
74°
70°
66°

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NOTES ON BIRDS FROM EAST SIBERIA AND ARCTIC ALASKA.

By W. Sprague Brooks.

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No. 5.— *Notes on Birds from East Siberia and Arctic Alaska.*

By W. Sprague Brooks.

Introduction.

In the spring of 1913, several graduates of Harvard University organized a hunting expedition in northern waters. Through the generous coöperation of Col. John E. Thayer and Prof. Theodore Lyman, Mr. Joseph Dixon and the writer had the pleasure of accompanying the expedition as zoölogical collectors. Our itinerary was as follows.

Leaving Seattle on the power schooner Polar Bear, Capt. L. L. Lane in command, we proceeded up the "inside" passage of southeastern Alaska, stopping for a few hours at Woewodsky and Kupreanof Islands on April 9 and 10, and at two points on Icy Straits April 11 and 12. Thence to the Semidi Islands on April 18 and 19, and from there to several points along the Alaskan peninsula where little time for work was at our disposal.

Obtaining a few supplies at Unalaska we proceeded to Copper Island arriving on May 6. Here the snow was too deep for travelling and in two days we left for Bering Island where winter conditions also caused much trouble.

May 10 found us at Petropavlovsk and from this date to May 27 we worked on the Kamchatkan coast from Petropavlovsk to Cape Africa. At the latter point ice conditions prevented further travel in a northerly direction and we crossed Bering Sea to St. Lawrence Island. This Island and the Chukchi Peninsula of Siberia were the centre of our activities during June, including a brief stop at Big Diomede Island in Bering Strait.

In July our work on the Siberian shore was extended to Cape Serdze from which point we crossed to Cape Lisburne, Alaska, and Point Barrow arriving at the latter Point on July 24. The favorable ice conditions east of Point Barrow soon ceased and we encountered every possible unfavorable condition of ice and weather during August, finally being forced to go into winter quarters at Humphrey Point, Alaska, after nearly losing the vessel. Humphrey Point lies about thirty-five miles west of the Alaskan-Canadian boundary. Though frozen in on September 3, we were not settled in our camp on the sand spit until October 5.

On March 2, 1914, Mr. Dixon and I went to Demarcation Point five miles west of the boundary where I remained until July 20; Mr. Dixon returned to Humphrey Point on May 1, to collect until the ice broke up.

Both localities are low slightly rolling wastes of tundra, the five hundred foot contour at the foot hills of the Endicott Mountains being twelve miles from the coast at Demarcation Point, and some fifteen miles farther at Humphrey Point.

At the former point there were many pools and ponds but contrary to expectations it proved to be a poor resort for breeding birds. Our notes on the arrival of water fowl are unimportant, for these birds first arrive in the open leads off shore before the snow is melted from the tundra. To go on the ice in spring is a hazardous undertaking, for it is obviously less strong than in winter, and a sudden off shore gale, so prevalent in this region, is very liable to break the ice between one and the beach, rendering the situation very dangerous.

The spring and early summer of 1914 were very cold and foggy, the ice remaining intact about the Point until July 19, when the whaling ship BELVEDERE broke loose from the floe ice in which she wintered and passed about eight miles off shore.

On July 26, I left on the trading schooner ANNA OLGA, that wintered at Clarence Bay, as ice conditions forced me to believe that being picked up by the POLAR BEAR was a matter of considerable doubt. Mr. Dixon remained with the POLAR BEAR reaching Nome shortly after my arrival on the revenue cutter BEAR which brought me from Point Barrow.

The extreme kindness of Dr. Rudolph M. Anderson, leader of the southern division of the Canadian Arctic Expedition, and of Captain Cottle of the whaling ship BELVEDERE added greatly to the pleasure and success of our sojourn on the Arctic coast of Alaska.

I am greatly indebted to Mr. Outram Bangs of the Museum of Comparative Zoölogy, and Mr. H. C. Oberholser of the U. S. National Museum for generous assistance in working on the collection.

The unfortunate loss of Mr. Dixon's excellent field notes detracts greatly from the value of the paper.

TETRAONIDAE.

LAGOPUS LAGOPUS ALBUS (Gmelin).

WILLOW PTARMIGAN.

During the first half of August, 1913, this species was abundant along the shores of Camden Bay, Alaska. At Humphrey Point during the same season they were often seen in small numbers late in September and early in October when they left for the mountains to spend the winter.

At Demarcation Point, a flock of about twenty, the first arrivals on the coast in the spring of 1914, were seen on April 6. These birds were in good condition and unusually wild. The day was hazy and for the first time that year there were evidences of thawing in sheltered spots with a southern exposure. During hazy weather when the whole landscape appears as a white mass with no shadows, ptarmigan in winter plumage are well protected for their feathers are not a pure white but seem to take on the same reflected colors as the snow. At a distance during flight the black tail feathers soon fail to attract the eye for there are many dark patches of exposed ground upon the wind swept tundra.

Willow Ptarmigan were found near the Point in considerable numbers until about the tenth of May when they began retiring to the foot hills. Very few were in pairs up to this time. During the day the flock about the Point could be found somewhere in the immediate vicinity scratching about in the snow for willow plants, on the twigs of which they seemed to feed exclusively. At night they would roost in the protected holes and angles of a pressure ridge close to the shore.

Only once did I note any signs of courting. On May 1, I saw a male running to and fro in front of a female, his breast puffed out and lowered close to the ground and tail elevated. The female appeared indifferent, but when her suitor finally flew out to the ice and with much cackling, had travelled about two hundred yards she followed

After the middle of May I could find no Willow Ptarmigan near the Point, and saw none except a pair June 4, about three miles back on the tundra. The nest was not found.

Males taken early in April were acquiring summer plumage on the neck and head, but none in full plumage were found until late in June.

No summer plumage was noted in females until early in May, but the change is more rapid than in the males, for a female in full summer plumage was taken on June 4.

During the last three days of September 1913, some males taken at Humphrey Point were entirely white except for a few brown feathers on the crown and sides of the head. Females taken at the same time were, with one exception, far less advanced towards full winter plumage.

LAGOPUS LAGOPUS ALEXANDRAE Grinnell.

ALEXANDER'S PTARMIGAN.

Quite common but exceedingly wild at Portage Bay, Alaska Peninsula, April 21, 1913. Seven were preserved.

LAGOPUS RUPESTRIS RUPESTRIS (Gmelin).

ROCK PTARMIGAN.

This is an abundant species on the coast from Camden Bay to the Mackenzie River delta during the spring and late summer after the breeding season which is spent in the foot hills of the Endicott Mountains.

At Demarcation Point the first of this species seen in the spring of 1914 was a pair on May 4. Their late arrival here was a matter of chance I believe, for at Humphrey Point, they were seen much earlier.

They seem to pair earlier than the Willow Ptarmigan, for while the latter were about in good-sized flocks the former were mostly paired or in groups of three to five. They were very tame in most cases, and this I do not understand for the Eskimo has as much opportunity to shoot this species as the other. Sometimes both species were seen together but very seldom.

The males are quite pugnacious, when in flocks, often pursuing each other and going through antics suggesting the young males of domestic fowls.

Rock Ptarmigan exhibit considerable curiosity at times, a trait I have not noticed in the Willow Ptarmigan. When one of its kind is dead or wounded the rest frequently show great concern and interest in the unfortunate one.

Many times while walking over the tundra I would be startled by the rattling call of a male Rock Ptarmigan, and turning about see him alight within a few yards of me with tail spread and eye-wattles erect.

After strutting about and "showing off" a moment he would busy himself searching for food as though no man were in the country. In the winter plumage the males are very beautiful.

The female begins to acquire summer plumage before the male, showing brown feathers on the crown and ear-coverts by May 6, though two observed with binooulars on May 20, revealed no summer plumage whatever. On May 8, I took two females, one in full winter plumage, the other in a state of transition not observed before. The head and neck were white but the right side of the rump and lower back had the summer plumage with its border down the middle of the back sharply defined. Females in full summer plumage were found early in June.

The earliest male showing any change was taken May 13, though one taken on the 20, showed no change. No opportunity was afforded for noting the plumage change in the males for the birds had gone back to the foot hills for nesting before acquiring full summer plumage.

During the latter part of May when most of the snow has gone the white males are very conspicuous. They do not roost on the snow patches that remain, and while on the tundra their form makes them very noticeable though the color might suggest a small bit of snow. For at least a month nature gives this bird little protection.

Beside a large series of birds from Camden Bay, Humphrey Point, Demarcation Point, and near Herschel Island, two males were taken at East Cape, Siberia, June 16, 1913, and a female at Portage Bay, Alaska Peninsula, April 21, 1913. The males from East Cape show summer plumage on the crown, nape, and sides of head.

LAGOPUS RUPESTRIS DIXONI Grinnell.

DIXON'S PTARMIGAN.

About three hundred were seen April 12, 1913, at Muir Inlet, Glacier Bay, Alaska. A series of five was preserved.

LAGOPUS RIDGWAYI Stejneger.

Several were seen on the mountain side at Copper Island, May 7, 1913. Dr. J. S. Kalinin who resides there and takes great interest in the local bird life stated that some years they were quite plentiful and during others absent. No doubt this is due to the blue foxes which are plentiful on the Island. Lying at anchor near one of the cliffs we could see a number of these foxes threading their way along the face of the precipice.

LAGOPUS LEUCURUS LEUCURUS (Swainson).

WHITE-TAILED PTARMIGAN.

A few were seen in company with about three hundred *L. rupestris dixoni* at Muir Inlet, Glacier Bay, Alaska, April 12, 1913. Two males and a female were preserved.

DENDRAGAPUS OBSCURUS FULIGINOSUS (Ridgway).

SOOTY GROUSE.

Several were seen about Point Gustavus, Glacier Bay, April 11, 1913. A pair was taken.

GAVIIDAE.

GAVIA STELLATA (Pontoppidan).

RED-THROATED LOON.

This species was noted in small numbers about a large marsh on the west side of Providence Bay, East Siberia, June 19 and 20, 1913.

During the last week in June they were found breeding on the southern side of St. Lawrence Island where two sets of eggs were taken on June 27, 1913. A number of nests were found that appeared to have been robbed by Glaucous Gulls.

At Cape Serdze, East Siberia, several were seen July 17, 18, 1913.

None were seen at Demarcation Point in 1914 until June 12, when a female was secured. Though I could find no nests, two pair at least remained in the vicinity of the Point during my stay.

This species is the tamest of the loons and instead of stealing quietly away when one is at their nest they fly immediately and circling about above one's head utter continually their harsh cry "kark-kark-kark." This cry can be heard almost any time through the day or night where this bird is breeding.

GAVIA PACIFICA (Lawrence).

PACIFIC LOON.

This is the most abundant of the loons at Demarcation Point where it was first noted on June 3; a pair in a pond, and five flying east.

As other writers have remarked this bird delights in making the most hideous noises imaginable while on the water. On still calm nights one often hears a heart rending wailing on the distant waste of tundra, as of a child in agony. Another sound which, though I heard it many times, never failed to startle me; a bird would often be concealed in the aquatic vegetation along the margin of a pond, and when within a few feet of the bird it would utter a piercing shriek, just as it was diving under water. These weird sounds had a great effect on the expedition's cook who occasionally took short excursions after ducks for the table. One day he returned in a state of considerable agitation with the report that far back on the tundra he had heard the groans of a dying man but could find no one. Thereafter his peregrinations from the kitchen seldom extended beyond the wood pile.

Many of the birds are mated on arriving at Demarcation Point and they soon select a pond suitable for nesting about which one or both of the birds can generally be found at any hour. The size of the pond seems to be immaterial provided there is sufficient space for taking wing. A Red-throated Loon requires less space than a Pacific Loon to leave the water.

The nest of the Pacific Loon is composed of a pile of roots and stems of aquatic vegetation placed in a patch of water weeds that grow in abundance about the margins of many of the ponds. The whole affair is very wet and soggy.

Until the surrounding vegetation has grown to a considerable height the black and white back of the brooding bird is very conspicuous, though on one's approach she lies very flat and extends the head and neck straight out over the water. When disturbed, the bird slides from the nest and disappearing under the water does not come to the surface until the cover of some grass has been reached some fifty yards distant, from which she quietly watches the intruder.

Fresh eggs were taken July 4, and eggs slightly incubated on July 6 and 7.

Specimens of this species were taken in Camden Bay, August, 1913, and Providence Bay, E. Siberia, June 18, 1913.

We saw no evidence of *G. arctica*.

GAVIA ADAMSI (Gray).

YELLOW-BILLED LOON.

This species was quite common at Humphrey Point during 1914, Mr. Dixon preserving nine males and five females. At Demarcation Point I took only two, for with the exception of three or four birds, those I saw were on large ponds far back on the tundra or high in air some distance from the coast. At Humphrey Point they were common by the shore.

We found no evidence of their breeding near the coast, and the Eskimo believe that they nest in large lakes on the other side of the mountains.

None were noted until early June, Mr. Dixon securing the first specimen, a female, on June 3.

PROCELLARIIDAE.

OCEANODROMA FURCATA (Gmelin).

FORKED-TAILED PETREL.

Fork-tailed Petrels were common in Bering Sea, May 27, 28, 29, 30, 31, 1913, from Cape Zhipanov, Kamchatka to St. Lawrence Island. A pair taken at Copper Island, May 24 was purchased.

PUFFINUS TENUIROSTRIS (Temminck).

SLENDER-BILLED SHEARWATER.

We did not observe this species but a male taken at Copper Island, May 29, was purchased.

FULMARUS GLACIALIS GLUPISCHA Stejneger.

PACIFIC FULMAR.

Pacific Fulmars were first observed and taken about seventy miles southeast of Seward, Alaska, on April 16, 1913. On April 18, they were common in Shelikof Strait, Alaska, sailing gracefully about in a tremendous gale that forced us to seek shelter at the Semidi Islands.

About the cliffs of Copper Island, on May 6, 1913, they were abundant and specimens were secured.

During the last week in May we noted quite a number on Bering Sea as we were crossing from Cape Zhipanov, Kamchatka to St. Lawrence Island, at about latitude 58° N.

Fulmarus rodgersi Cassin.

RODGER'S FULMAR.

Rodger's Fulmar was quite common May 27, 28, 1913, in Bering Sea in the vicinity of 174° E., 58° N. The species was abundant during June at the mouth of Providence Bay.

Three males taken at Copper Island, April 3, May 3, and July 27, were purchased.

Diomedeidae.

Diomedea albatrus Pallas.

SHORT-TAILED ALBATROSS.

One Short-tailed Albatross was seen a short distance northeast of Attu Island on May 2, 1913. On the following day four were seen when in sight of the same Island.

Diomedea nigripes Audubon.

BLACK-FOOTED ALBATROSS.

During the second week of September, 1914, while *en route* from Unalaska to Seattle a group of about a dozen Black-footed Albatrosses followed the vessel from Akitan Pass to the lower part of Vancouver Island.

Alcidae.

Uria lomvia arra (Pallas).

PALLAS'S MURRE.

Seen in great abundance about Bering Sea. On April 26, 1913, a great migration was arriving at Bogoslof Island, the birds flying high until close to the Island, and descending in the disorderly zigzag manner of the Old Squaw.

Specimens were taken at Copper Island, Petropavlovsk, East Cape, Siberia, and St. Lawrence Island.

A few were seen on July 19, 1913, about eighty miles south of Wrangel Island.

CEPPHUS MANDTI (Mandt).

MANDT'S GUILLEMOT.

The only one of this species observed was a male shot by Mr. Dixon on July 19, 1913, about eighty miles south of Wrangel Island.

CEPPHUS COLUMBA Pallas.

PIGEON GUILLEMOT.

Abundant about Bering Sea wherever cliffs were to be found.

Our collection contains specimens from Copper Island, Cape Shipunski, and East Cape.

CEPPHUS CARBO Pallas.

SOOTY GUILLEMOT.

A male of this species was taken at Cape Shipunski, May 21, 1913. We saw no others.

SYNTHLIBORHAMPHUS ANTIQUUS (Gmelin).

ANCIENT MURRELET.

We saw no Ancient Murrelets. Our collection contains a purchased pair taken at Copper Island, May 29 and June 30, —, and a juvenile male from Bering Island without data.

AETHIA CRISTATELLA (Pallas).

CRESTED AUKLET.

This species was common about St. Lawrence Island (Cape Chibukak), June 3, 1913, and about Providence Bay, Siberia, and Bering Strait, in June, 1913.

Specimens were taken at St. Lawrence Island and East Cape.

AETHIA PUSILLA (Pallas).

LEAST AUKLET.

This is the most abundant bird of northern Bering Sea. We found them in enormous numbers at St. Lawrence Island, Providence Bay, East Cape, and Big Diomede Island. At the latter place on June 15, 1913, there were literally swarms of Least Auklets; the air was full of them, the rocks covered with them, and judging from the noise every hole and crack in the rocks contained one or more. They go further inland from the cliffs here than either the Crested or Paroquet Auklets.

They make a considerable variety of noises, the least common of which is a note suggesting the call note of a Red-winged Blackbird. I have heard them utter it while on the wing on the breeding ground.

A large series of specimens was taken at St. Lawrence Island, East Cape, and Big Diomede Island. Specimens from Copper Island and Bering Island were purchased including a female taken July 19, 1910, at Bering Island.

PHALERIS PSITTACULA (Pallas).

PAROQUET AUKLET.

Observed wherever the two preceding species were noted but by far the least common of the three.

Specimens were taken at East Cape, Siberia. A male taken at Copper Island, July 24 was purchased.

This species is much tamer than the Crested Auklet.

LUNDA CIRRHATA (Pallas).

TUFTED PUFFIN.

The collection contains specimens from Cape Shipunski, East Cape, Copper Island, and Bering Island.

FRATERCULA CORNICULATA (Naumann).

HORNED PUFFIN.

We found this an abundant species at all the suitable localities visited in northern Bering Sea. Specimens were secured at East Cape.

LARIDAE.

STERNA PARADISAEA Brünnich.

ARCTIC TERN.

A colony of about twenty-five pairs was found breeding on a sand spit in the large lagoon on the south side of St. Lawrence Island in June 1913. Several sets of eggs taken June 25 showed that incubation had started.

One pair was seen at Cape Serdze, Siberia, July 17, 1913. A few were about the ice in Camden Bay, Alaska, during the last of July and early in August 1913.

The first noted at Demarcation Point in 1914 was a single bird seen May 31. With the exception of about twenty seen on June 8, during a heavy snow storm, there were never more than three or four about. They must have bred in the vicinity, but I could find no nests and came to the conclusion that they may have nested on Icy Reef across the mouth of Demarcation Bay.

No Common Terns were seen.

STERNA LONGIPENNIS Nordmann.

A small flock was seen at the edge of the ice near the mouth of a small river at Cape Zhipanov, Kamchatka, May 25, 1913. Two males were taken.

XEMA SABINI (J. Sabine).

SABINE'S GULL.

We did not see many of Sabine's Gull during the expedition.

A few were in Avatcha Bay, Kamchatka during the second week of May 1913, and a single male was taken at Plover Bay, June 18, 1913.

Early in August 1913, several were noted about the ice in the vicinity of Camden Bay, Alaska.

The first appearance of this beautiful species during the spring of 1914 at Demarcation Point was on May 28 when a single bird was seen flying east. One pair was observed flying about a pond on June 8. Several were seen on June 5 and 7, three on June 8, and the last, a flock of seven, were travelling east on June 19; these, no doubt, bred somewhere east of Demarcation Point.

Mr. Dixon took several specimens at Humphrey Point during the early part of June.

One immature bird was taken at East Cape, August 29, 1914.

Larus ridibundus Linné.

A few were seen at the head of Avatcha Bay, during the second week of May. The collection contains a male taken at Copper Island, May 22, —, purchased.

Larus schistisagus Stejneger.

SLATY-BACKED GULL.

A few were seen in Avatcha Bay during second week in May and about Cape Shipunski where a male was taken May 21, 1913.

Larus brachyrhynchus Richardson.

SHORT-BILLED GULL.

Several gulls were seen on Demarcation Bay, Alaska, July 18, 1914, that I referred to this species. No specimens were taken.

Larus glaucescens Naumann.

GLAUCOUS-WINGED GULL.

We found this species breeding at St. Lawrence Island, and Providence Bay, eggs taken June 20 at St. Lawrence Island being very advanced in incubation.

A female taken at Copper Island, May 22, is in the purchased collection.

Larus thayeri, sp. nov.

THAYER'S GULL.

I take great pleasure in dedicating this interesting species to Col. John E. Thayer whose enthusiasm and generosity have greatly enriched the collections of the Museum of Comparative Zoölogy.

Type.—Adult male, no. 40336, M. C. Z. Buchanan Bay, Ellesmere Land, collected June 10, 1901, by J. S. Warmbath.

Characters.— About the size of *L. kumlieni* Brewster, but differing in color of mantle, primaries, and having a larger and more heavy bill.

The color of the mantle is intermediate between *kumlieni* and *argentatus*, darker than the former, lighter than the latter.

The first primary is broadly tipped with white, the outer web blackish slate (Ridgway's Nomenclature of color), on the inner web this color extends rather less than one half across the web; second primary similar only with subterminal black band and blackish slate on inner web more narrow, on the outer web it does not extend as near the base of the feather as on the first; third primary with white tip, blackish slate on outer web less extensive, on inner web the black is limited to a subterminal patch about 35 mm. long extending across web; fourth primary with white tip, blackish slate on outer web extending about 45 mm., on inner web about 20 mm., fifth primary with white tip, then subterminal blackish slate band, then narrow poorly defined bar of white.

Measurements.— Type, adult male: wing, 406; tail 167; tarsus 65; bill 57.

Description of immature male taken by Joseph Dixon at Griffin Point, Arctic Alaska, June 25, 1914. Orig. no. 3752.

First primary fuscous hair-brown on outer web, lighter on inner web changing to a neutral gray, with narrow whitish tip; second primary similar but slightly darker on inner web, especially near tip where it is as dark as outer web, and extends to outer edge; third primary the same; fourth primary similar except that outer web has narrow lighter edge, and inner web for the most part neutral gray; fifth primary similar but no brown on inner web except a patch near the tip which extends across the web.

The tail feathers are white with subterminal patches of fuscous hair-brown varying in size, being smaller on the outer feathers.

The inner secondaries have light brown areas on outer webs about 30 mm. long, with pallid neutral gray edges.

Mr. Warmbath found this species breeding at Buchanan Bay, several sets of eggs being in Mr. Thayer's collection.

Besides the type there are three females in the M. C. Z. collection taken by Mr. Warmbath at the same locality, and Mr. Thayer's collection contains a small series.

Mr. Dixon took an adult female at Demarcation Point, Alaska, August 28, 1913.

Though there is no data to determine the range of this species it must be a very boreal form, and perhaps comparatively small in numbers. The Alaskan specimens may have wandered from Ellesmere Land, but it seems reasonable to believe that the bird may inhabit Prince Patrick, Melville or Bathurst Islands, nearly all this territory being north of 75°.

LARUS HYPERBOREUS Gunnerus.

GLAUCOUS GULL.

Glaucous Gulls were moderately common on the Arctic coast of Alaska, and young in the down were found at Camden Bay and on the mainland near Herschel Island.

None were seen at Demarcation Point in the spring of 1914 until May 14. After that two or three might be seen flying about over the tundra about every day, but no nest was found.

PAGOPHILA ALBA (Gunnerus).

IVORY GULL.

We did not see this bird alive and our collection contains only one specimen. It is an adult female found by an Eskimo in a trap he had set for white foxes about five miles out on the ice. It was taken November 25, 1913, five days after the sun had gone, but seemed fat and in good condition.

Murdoch rarely saw this species at Point Barrow.

RISSA TRIDACTYLA POLLICARIS Ridgway.

PACIFIC KITTIWAKE.

We found the Pacific Kittiwake common on the Commander Islands and east coast of Kamchatka during the first three weeks of May. It was very abundant about Bering Straits and extreme eastern Siberia.

We took specimens at Copper Island, Cape Shipunski, Indian Point, and East Cape.

STERCORARIIDAE.

STERCORARIUS POMARINUS (Temminck).

POMARINE JAEGER.

This species was only identified at Griffin Point, where Mr. Dixon took two males and a female during the last week of May 1914. The female was in the dark phase of plumage.

STERCORARIUS LONGICAUDUS Vieillot.

LONG-TAILED JAEGER.

The first jaegers arrived at Demarcation Point on May 24, a flock of seven flying east. They seemed to be of this species but often it is impossible to determine them in the field, their best diagnostic character being a matter of bill measurements.

Neither the Long-tailed or Parasitic Jaegers were common at Demarcation Point and no nests of either were found.

STERCORARIUS PARASITICUS (Linné).

PARASITIC JAEGER.

Not common at Demarcation Point. All dark phase birds seen were paired with birds in dark plumage. It seems strange that in so many cases dark plumaged birds should be mated if this coloration is merely a matter of chance or as some have stated a character of immaturity. Mr. Johan Koren found a nest of this species on Kodiak Island, Alaska, June 19, 1911, and both birds were in the dark color phase (Birds of the Arctic coast of East Siberia. By John E. Thayer and Outram Bangs. Proc. N. E. Zool. Club, 1914, **5**, p. 12).

CHARADRIIDAE.

MORINELLA INTERPRES MORINELLA (Linné).

RUDDY TURNSTONE.

We found this bird very rare on the Arctic coast of Alaska. The only ones seen in 1913 were four specimens taken in Camden Bay, July 31.

Mr. Dixon took two males and two females at Griffin Point, June 28, 1914.

I saw one flying east at Demarcation Point, June 5, 1914.

SQUATAROLA SQUATAROLA CYNOSURAE Thayer and Bangs.

AMERICAN BLACK-BELLIED PLOVER.

We found the American Black-bellied Plover quite rare on the north coast of Alaska.

Several, including a pair with a downy young, were observed at Collinson Point, August 3, 1913. A few were about on the seventh, but by the ninth all but two or three had left. On August 11 several were noted on the Hula-hula River.

At Griffin Point, Mr. Dixon took two males on June 3 and 7, 1914.

At Demarcation Point the species was noted but once, a single bird flying east on June 7, 1914.

PLUVIALIS DOMINICUS DOMINICUS (Müller).

GOLDEN PLOVER.

Although we found quite a number of Golden Plover about Collinson Point during the first week in August 1913, we did not find the bird common between Collinson Point and Herschel Island.

It was the first wader to reach Demarcation Point; a single female was taken on May 21, 1914, most of the other early arrivals were males. This female was very thin. Very few were seen during this season, possibly only two pair, one of which nested about two miles from camp.

I found this nest on June 25 with three eggs about one quarter incubated. The male was on the nest. It took several days to find the nest, for the bird would leave when I was a long way off and begin running about and feeding as though it had nothing else to do. By placing a lump of tundra each day where I first saw the bird I eventually found the nest, a mere depression in some greenish moss which with scattered bits of brown dead vegetation harmonized extraordinarily with the eggs.

When the bird saw that its nest was finally discovered it showed great distress and ran towards me until about twenty paces distant where it stood tottering as if about to fall, with one wing raised over its back. In a short time the bird with tail down and a wing dragging would walk slowly from me. As I never followed the bird would return and totter a while, repeating the same performance several times until secured for the proper identification of the eggs.

PLUVIALIS DOMINICUS FULVUS (Gmelin).

PACIFIC GOLDEN PLOVER.

A pair was taken at East Cape, Siberia, July 14, 1913, and a female at Cape Serdze July 17, 1913.

CHARADRIUS MONGOLUS (Pallas).

MONGOLIAN PLOVER.

We did not see this plover. Our collection contains five purchased specimens from Copper Island; a pair taken June 23, 1912, a pair taken June 20, —, and a female taken June 16, —.

CHARADRIUS HIATICULA HIATICULA (Linné).

RINGED PLOVER.

We saw very few of this species. Two were noted and a male taken at Providence Bay, June 4, 1913; two males shot on the north side of East Cape, July 15, 1913, and a male and female at Cape Serdze, July 17, 1913. The male was with a bird in down.

EUDROMIAS MORINELLUS (Linné).

DOTTEREL.

The only Dotterels seen were three specimens taken at the head of Providence Bay (Emma Harbor), June 14, 1913, by Mr. Dixon, and on June 17, 1913, farther up the Bay, a pair with two eggs. The eggs were fresh.

LIMOSA LAPPONICA BAUERI Naumann.

PACIFIC GODWIT.

A flock of about twenty was seen on a large marsh on the west side of Providence Bay, June 20 and 21, 1913. They were quite tame and we took eight, all being males.

MACRORHAMPHUS GRISEUS SCOLOPACEUS (Say).

LONG-BILLED DOWITCHER.

A pair taken by Mr. Dixon at Herschel Island, August 20, 1914. None were seen at Demarcation Point.

MICROPALAMA HIMANTOPUS (Bonaparte).

STILT SANDPIPER.

My observations at Demarcation Point lead me to believe that there is a possibility of the Stilt Sandpiper breeding west of the Mackenzie River delta.

It was first noted on May 23, a single very wild bird feeding about a small pool. On May 24 three were seen in a pool, and two more were associated with a flock of Pectoral Sandpipers. Ten were seen May 26; two pairs, five in one flock of Pectoral Sandpipers and a single bird in another flock. On the following day a pair was seen, the next day only one. From this date until June 8 when a pair was seen in the grass about a small pond, this species could not be found. I felt sure that this was a breeding pair it being so late in the season, but with the exception of one bird seen in the same place on June 10 I saw no more during my stay in the North.

Mr. Dixon secured two males and a female on August 2, 1914, at Herschel Island.

HELODROMAS SOLITARIUS SOLITARIUS (Wilson).

SOLITARY SANDPIPER.

A female was taken by Mr. Dixon at Griffin Point, June 1, 1914. Mr. Bangs and I after careful comparison refer this specimen to the eastern form of the Solitary Sandpiper.

HETERACTITIS INCANUS (Gmelin).

WANDERING TATLER.

We did not find this species and only brought back two purchased specimens, both females taken at Copper Island, on May 17 and 21, —.

ACTITIS HYPOLEUCUS (Linné).

COMMON SANDPIPER.

The collection contains the skin of a male taken at Copper Island, May 24, —. Purchased.

TRINGA GLAREOLA Linné.

WOOD SANDPIPER.

One pair was taken at Cape Zhipanov, Kamchatka, May 25, 1913. The purchased collection contains two males taken at Copper Island, May 19, —. These birds agree absolutely with western specimens.

EREUNETES PUSILLUS (Linné).

SEMIPALMATED SANDPIPER.

Between Collinson Point and Herschel Island this is a common bird. It was common at Collinson Point, on August 3 and 9, 1913. A few were seen at the delta of the Hula-hula River, August 11, 1913.

At Demarcation Point it is a common summer resident, the first arrivals coming May 22. On that date I saw three, and shot two which proved to be males. By May 27 they were common.

Most of these birds seemed to be paired on arrival, and could be found about pools or on the comparatively dry tundra.

Thirteen nests were found, the first, a set of three fresh eggs being taken on June 12. All the nests were essentially alike — mere cavities in damp tundra close to a pool, and lined with dry willow leaves. On seven nests the female was found, and the male on six. Although the male seems to take about an equal share in brooding on the eggs and taking care of the young I could not see that he did this at any particular time for I would find either sex on the nest at midnight or midday.

Neither sex showed any more concern than the other when an intruder was at the nest. In most cases the bird disturbed would flutter along a few yards and then remain walking quietly and watching. On one occasion, a female made a great disturbance, as does Baird's Sandpiper. Fresh eggs were found as late as June 27 and a very advanced set was taken on July 6.

Young in the down were found as early as June 25. Four broods were found, and in each case the male was caring for them.

Twice I carefully brought broods of downy young back to the cabin, only to have them die within half an hour, and yet on one occasion during a snowstorm I saw a parent bird trying to cover a brood of four with very poor success. No doubt they lived, for snow storms are a common occurrence during June and July.

Semipalmated Sandpipers on the breeding grounds are the most gentle and interesting birds in the North.

EREUNETES MAURI Cabanis.

WESTERN SANDPIPER.

The only Western Sandpipers seen on the expedition were three specimens taken in East Siberia — a male on the west side of East Cape, July 14, 1913, and two males at Cape Serdze, July 16, 1913.

I have not found a Siberian record for this species.

TRINGITES SUBRUFICOLLIS (Vieillot).

BUFF-BREASTED SANDPIPER.

We found no evidence of this species breeding at Demarcation Point or Humphrey Point.

They were first seen on May 26, at Demarcation Point, a flock of twenty or more on a low hill near the shore. They were very active, pursuing each other about and forming a confused mass of birds. The bird pursuing invariably held one or both wings extended straight over the body. Two taken from this flock were females. On May 27, 28 and 29, several pairs were observed about this hill; three were taken at Collinson Point, August 3.

The protective coloration of the Buff-breasted Sandpiper is remarkable; it is difficult to see one at a short distance even when moving slowly.

CALIDRIS LEUCOPHAEA (Pallas).

SANDERLING.

The only Sanderling seen was an adult female taken at Demarcation Point, August 30, 1913.

EURYNORHYNCHUS PYGMAEUS (Linné).

SPOON-BILL SANDPIPER.

This interesting species was observed both at Providence Bay and Cape Serdze.

Its status at Providence Bay we failed to ascertain for its coloring and actions agree so with *Pisobia minuta ruficollis* that we did not discover its presence until June 20, after which we only had part of a night to continue our work on this Bay.

The males of both species during the nesting season have a habit of rising to a height of forty or fifty feet and flying a short distance by a series of dips, then hovering a moment with rapidly beating wings, and slowly descending to the ground uttering a pretty, twittering song. The only difference between the actions of these species was that the Spoon-bill Sandpiper seemed to ascend to a greater height before singing the flight song.

A glint of light on the flat surface of the bill finally betrayed the bird and on the night of June 22, 1913, Mr. Dixon discovered on a large marsh on the west side of Providence Bay a nest containing two eggs. The male was on the nest. It seems improbable that more than three or four pairs were about this marsh.

At Cape Serdze, we also observed Spoon-bill Sandpipers near the entrance of a large lagoon. Here there were only seven or eight pairs in two small marshy areas on either side of the entrance. A brood of three downy young was taken on July 17, the male being with them at the time.

PISOBIA MINUTA RUFICOLLIS Seebohn.

EASTERN LEAST STINT.

The Eastern Least Stint was seen at Providence Bay and Cape Serdze.

At the head of Providence Bay a few pairs were breeding. Two sets of fresh eggs, numbering three and four respectively were taken on June 11, 1913; the male incubating one and the female the other. Both birds when disturbed fluttered off the nest like other sandpipers. The nests were cavities on small mounds of tundra lined with dry willow leaves.

A downy young with the male was taken at Cape Serdze, July 16, 1913. Its plumage agrees absolutely with that of *minuta* as described by Sharpe, in the Catalogue of birds of the British Museum, **24**, p. 541. The shorter interscapulars which are just showing through the down in this specimen, are black with rufous margins, the longer have white edges with a slight mixture of rufous.

PISOBIA MINUTILLA (Vieillot).

LEAST SANDPIPER.

At Demarcation Point, on June 5, 1914, I saw three small sandpipers flying east that I am convinced were this species.

PISOBIA DAMACENSIS (Horsfield).

LONG-TOED STINT.

This uncommon bird was observed by us at Capes Shipunski and Zhipanov, Kamchatka. At the former locality three were seen and a pair taken on May 21, 1913. Several were seen at Cape Zhipanov, on May 25, 1913, and a female taken. Two females from Copper Island taken May 25, —, were purchased.

PISOBIA TEMMINCKII (Leisler).

TEMMINCK'S STINT.

A few were seen at Cape Serdze, July 17 and 18, 1913, where a series of adults and downy young was secured.

PISOBIA PECTORALIS (Say).

PECTORAL SANDPIPER.

Although this is a common bird throughout Arctic Alaska in general, it bred very sparingly in the vicinity of Humphrey and Demarcation Points.

At the latter place they were first seen May 23, about twenty-five, in pairs and small groups. In the early spring they are about the pools and seldom on the more dry tundra as they are in late summer. All were paired by May 29.

Though I had read the excellent descriptions of the breeding habits of this bird by Murdoch and Nelson I was very much astonished at the volume and ventriloquial quality of the hooting of the male, and on first hearing the sound I did not believe it came from so small a bird as a sandpiper.

Several scattered pairs bred in the vicinity of Demarcation Point, three sets of four eggs each being found. Eggs about one quarter incubated were found on June 21 and 25. A set about to hatch was taken June 26.

I had considerable difficulty in finding the first nest for the bird incubating (the female in each case) acted quite differently from other waders with which I am familiar.

On approaching the vicinity of the nest the bird would leave it quietly and walk slowly about feeding and showing no excitement whatever. This happened several times until I decided to watch the bird and see if by any chance she might have a nest. In a short time she walked to a bunch of grass a few feet from me and settled on the nest. Even while I was packing away the eggs she showed no concern. I had precisely the same experience with the other two nests.

All the nests were cavities lined with dry willow leaves, and well concealed in comparatively long grass near pools.

This species was common about Collinson Point early in August, 1913, and three specimens were taken at Cape Serdze July 17, 1913. At Herschel Island Mr. Dixon found them abundant during the early part of August 1914.

PISOBIA BAIRDI (Coues).

BAIRD'S SANDPIPER.

Several pairs of Baird's Sandpipers bred in the vicinity of Demarcation Point, where they arrived in pairs on May 23. They were seen equally on dry and wet tundra.

Only once did I note any courtship activity. On this occasion (May 24), the male would fly a few feet above the female, while she rested on the ground, with quick erratic wing strokes suggesting a Nighthawk. Frequently he would alight and raise the wings high over the back as a gull does before folding them. Then with the forearms perpendicular, the primaries would be slowly raised and lowered like a pump handle, generally lowered to right angles with the forearms, sometimes lower. Not a sound was uttered.

Two nests were found, each containing four eggs and about one quarter incubated on June 12 and 14, 1914. Murdoch found them nesting rather later than other waders at Point Barrow, but my experience at Demarcation Point was quite the opposite, for here they were the first to breed. A female taken June 2, had a fully formed and colored egg about ready to lay. Both of the above nests were on dry, well-drained tundra near the bases of knolls. The nests were like the other sandpipers, and lined with dry willow leaves, but the cavities were less deep than those of the Semipalmated Sandpiper.

The female was on one nest and the male on the other. The former left the nest when I was some distance away and flying directly towards me alighted within a few feet. While I was at the nest she walked hurriedly about close by constantly uttering a plaintive "weet-weet-weet" always repeated three times. Occasionally she would take a short flight about me and utter a note very similar to the rattling call of the Pectoral Sandpiper.

The male when disturbed acted quite differently. He sat closer and on leaving the nest showed the greatest concern, dragging a "broken" wing in the most distressing manner.

In neither case was the mate about as frequently occurs with the Semipalmated Sandpiper.

Baird's Sandpipers were found common by Mr. Dixon during the first part of August 1914, at Herschel Island. A few were taken at Collinson Point, and at the mouth of the Hula-Hula River August 9 and 11, 1913. One adult male was taken at the head of Providence Bay, Siberia on June 11, 1913.

PISOBIA FUSCICOLLIS (Vieillot).

WHITE-RUMPED SANDPIPER.

Only two White-rumped Sandpipers were noted during the expedition. A female associating with a small flock of Semipalmated Sandpipers was taken June 5, 1914, at Demarcation Point. On June 7, a male was shot. It also was with several Semipalmated Sandpipers.

ARQUATELLA MARITIMA COUESI Ridgway.

ALEUTIAN SANDPIPER.

A few were noted at Providence Bay, Siberia and at the southeast end of St. Lawrence Island during June 1913, and at East Cape during the middle of July of the same year. Specimens were taken at these localities.

PELIDNA ALPINA PACIFICA Coues.

AMERICAN RED-BACKED SANDPIPER.

As stated by Thayer and Bangs, (Birds of the Arctic coast of East Siberia. Proc. N. E. Zoöl. Club, 1914, **5**, p. 17), there appears to be three distinct races of the Dunlin, the western European bird being the smallest; the North American form the largest; and the East Siberian bird intermediate.

Mr. Bangs and I carefully studied our series from Alaska and eastern Siberia comparing them with many Dunlin's taken from localities throughout its range. Our results confirmed the above statement. The size of the bill is a more constant character than coloration.

Red-backed Sandpipers though common at Point Barrow, where I saw them in abundance about the 20th of August, must be very rare east of Point Barrow, for we only noted one, a female taken at Collinson Point, August 3, 1913.

Several were taken on August 30, 1914, at Wainwright Inlet by Mr. Dixon.

PELIDNA ALPINA SAKHALINA (Vieillot).

EAST SIBERIAN DUNLIN.

We found this species rare at Providence Bay during June 1913, but quite common on low tundra near East Cape, and Cape Serdze during the middle of July 1913. Specimens were secured at these localities. Dunlins observed at St. Lawrence Island during the latter part of June 1913, were not taken.

Gallinago gallinago (Linné).

EUROPEAN SNIPE.

The collection contains two purchased specimens, a female and male, taken at Copper Island, on April 30, —, and May 8, —, respectively.

Phalaropus fulicarius (Linné).

RED PHALAROPE.

We first noted this species in the loose ice off Cape Zhipanov, Kamchatka, May 26, 1913. At St. Lawrence Island it was common east of Cape Chibukak, June 24, on the south side June 25, and at the southeast end June 27, 1913. Several were seen at East Cape, July 14, 1913, at Cape Serdze, July 17, and about the ice eighty miles south of Wrangel Island, July 19, 1913.

At Demarcation Point Red Phalaropes were first seen June 4, 1914, two single birds and a pair. At Humphrey Point Mr. Dixon took one on June 3.

Although this species is quite common about Demarcation Point only one nest was found. This was on July 4, and the young were just picking through the shells. The nest was better built and in a more dry location than those of Northern Phalaropes I have found.

These birds seem to be very erratic in their movements, one day being common, another day quite rare. At all times they appear to be tamer than *Lobipes lobatus.*

Specimens were taken at St. Lawrence Island, Indian Point, Siberia, Humphrey Point, Flaxman Island, Alaska.

Lobipes lobatus (Linné).

NORTHERN PHALAROPE.

During the summer of 1913 this species was observed once at Providence Bay, Mr. Dixon securing a female June 22. At the southeast end of St. Lawrence Island it was quite common on June 27.

At Collinson Point, Alaska, Northern Phalaropes were common on August 3 and 9, 1913.

These birds arrived paired at Demarcation Point, on May 23, 1914, quite a large migration arriving the night of May 28.

Murdoch found Northern Phalaropes very rare at Point Barrow only seeing two alive while the Red Phalarope was one of the commonest birds. McIlhenny took only six specimens in 1898 at Point Barrow; where a series of eighty-five Red Phalaropes was secured.

East of Point Barrow our experience would indicate that the Northern is nearly if not quite as common as the Red Phalarope. Like the latter its relative abundance varied greatly from day to day.

Fresh eggs (four to the set) were taken on June 17 and 21; eggs one fourth incubated on June 26, and a set about to hatch on July 9. In all cases the nests were very poor, mere hollows in tufts of grass lined with a few wisps of the same material, the eggs in two instances resting in a quarter of an inch of water.

Gruidae.

Grus canadensis (Linné).

LITTLE BROWN CRANE.

Two pairs of Little Brown Cranes were nesting on the west side of Providence Bay, in June 1913, and two pairs were seen on the southeast end of St. Lawrence Island where a pair and one juvenile about a week old were taken June 27, 1913.

Mr. Dixon saw a single bird at Humphrey Point, May 17, 1914.

Anatidae.

Olor columbianus (Ord).

WHISTLING SWAN.

Two pairs of swans were seen flying past the southeast point of St. Lawrence Island, June 28, 1913.

At Demarcation Point a single Whistling Swan flew west June 1, 1914. On the 28th of the same month an Eskimo killed one of these birds ten miles east of Demarcation Point, the unsexed skin of which he brought me. Mr. Dixon took a female at Humphrey Point, on June 15.

CHEN HYPERBOREUS HYPERBOREUS (Pallas).

LESSER SNOW GOOSE.

This does not seem to be a common species on the Arctic coast of Alaska though the spring of 1914 was so foggy that it was impossible to carry on observations of birds flying over the tundra back from the coast.

The only Snow Geese seen in 1913 consisted of a flock flying east on August 25, about twenty-five miles west of Demarcation Point.

At this locality the first birds were seen on June 11, 1914, a flock of about fifteen flying east. On June 20 about one hundred flew west in an evenly formed V. A single bird, a male, was taken June 30.

Mr. Dixon noted this species at Humphrey Point on June 1, and took two females on June 12 and 27, 1914.

A ship-wrecked sailor who was forced to spend the winter of 1913–14, at Point Barrow stated that in June he found the nest of a Snow Goose several miles inland from this Point. Mr. Charles Brower, an old trader at Point Barrow, and a man of integrity, vouched for this statement.

A pair of Snow Geese was shot at Herschel Island, on May 16, 1914.

ANSER ALBIFRONS GAMBELI Hartlaub.

WHITE-FRONTED GOOSE.

White-fronted Geese were seen by Mr. Dixon at Humphrey Point, June 1, 1914.

PHILACTE CANAGICA (Sevastianoff).

EMPEROR GOOSE.

We found this bird sparingly during June, 1913, at Providence Bay, and secured a male shot by an Eskimo at Indian Point on June 5.

On the south side of St. Lawrence Island during the latter part of June we found them abundant, where they were flying to and from a marsh by a large lagoon.

They were very tame, and possessed sufficient curiosity to be decoyed by the native method of lying on one's back and kicking the feet in the air.

We could find no nests.

BRANTA CANADENSIS HUTCHINSI (Richardson).

HUTCHIN'S GOOSE.

In the vicinity of Demarcation Point this species was not common. On May 20, 1914, a flock of about thirty was seen far back on the tundra flying west. After this date small flocks were occasionally seen flying west until June 7, when a small flock flew east. The last Hutchin's Geese seen were a flock of seven flying east on June 29.

I think one pair bred about five miles southeast of the Point, but I was not able to find the nest.

A female taken by Mr. Dixon at Herschel Island, August 9, 1914, has the fresh primaries and middle tail feathers two thirds grown. The new feathers on the under surface, back and rump are nearly complete in development.

BRANTA NIGRICANS (Lawrence).

BLACK BRANT.

During 1913 we saw a few Black Brant near Seymour Narrows, southern Alaska, on April 5. On the west side of Providence Bay, Siberia, we saw a flock of about twenty June 19. Several were seen at Demarcation Point, September 1.

During the spring of 1914, the first Brant were seen at Demarcation Point, on May 20, a flock of about fifteen flying west. Nearly every day until the first of June one or more flocks would be seen about two miles back from the shore flying west. From June 1 to 11 all those seen flew east as though they had been waiting west of me until conditions somewhere east were more favorable. After June 11 none were seen.

Specimens were taken at Providence Bay, Humphrey, and Demarcation Points.

ANAS PLATYRHYNCHOS Linné.

MALLARD.

Mallards were common near Wrangel Narrows, southern Alaska, April 9, 1913. On the 10th and 11th of the same month several were seen at Kupreanof Island and Glacier Bay respectively.

Mareca penelope (Linné).

EUROPEAN WIDGEON.

One purchased specimen is in the collection — a male taken at Bering Island, in April, 1910.

Nettion crecca (Linné).

EUROPEAN TEAL.

A male was shot on June 6, 1913, at Indian Point, Siberia, but unfortunately an Eskimo dog retrieved it.

Nettion carolinense (Gmelin).

GREEN-WINGED TEAL.

Two females and a male were seen at Demarcation Point, on May 23, 1914. I saw no others.

Mr. Dixon took a pair at Herschel Island, August 9, 1914.

Dafila acuta (Linné).

PINTAIL.

We did not find the Pintail a common bird on the Arctic coast of Alaska.

During the summer of 1913 small flocks were occasionally seen flying east, the last seen being a flock of four flying east at Demarcation Point, September 2.

During the spring of 1914 the species was first noted on May 24, —, a single pair in a pond. From this date until June 1 several pairs were to be seen in the vicinity every day. Then pairs and small flocks were seen for several days, the sexes in the flocks about evenly divided, though sometimes males predominated. After June 12 I seldom saw any Pintails, except an occasional pair flying about. No nests were found.

MARILA MARILA (Linné).

SCAUP DUCK.

A single male was seen on a small pond at Demarcation Point, on May 31, 1914.

Several scaups of some kind were seen near Wrangel Narrows, southern Alaska, April 9, 1913.

CHARITONETTA ALBEOLA (Linné).

BUFFLE-HEAD.

A single specimen was seen in Cross Sound, Alaska, on April 13, 1913.

HARELDA HYEMALIS (Linné).

OLD-SQUAW.

During the spring and summer of 1913 this species was seen in abundance about Bering Sea and the Arctic coast of Alaska.

At St. Lawrence Island, on June 2, 1913, they were very common in pairs and small flocks. When paired the female very often flies ahead of the male as does the female eider. A set of six fresh eggs was taken at St. Lawrence Island, June 25, 1913.

At Humphrey Point, Mr. Dixon first saw Old-squaw on May 20; I did not note them at Demarcation Point until May 24.

Although they were quite common during June I found no nests, but I am convinced that some must have bred near by. Mr. Dixon found them breeding at Humphrey Point.

Throughout June the males could be found in every stage of plumage change. Two males taken on June 22, showed one in full summer plumage, and the other with the winter dress but little changed.

From July 5 until I left Demarcation Point males were constantly arriving in small flocks from the east and collecting in Demarcation Bay where they were no doubt about to moult, for at Cross Island on July 27, 1913, we found many male Old-squaw unable to fly owing to moulted primaries.

Histrionicus histrionicus pacificus, subsp. nov.

WESTERN HARLEQUIN DUCK.

Type.— Adult male, no. 66786, M. C. Z. Cape Shipunski, Kamchatka, collected May 22, 1913, by Joseph Dixon. Orig. no. 3075.

Characters.— Male Harlequin Ducks from the Pacific differ from Atlantic birds in being larger, with heavier bills, and in the coloration of the crown. In the Pacific bird the chestnut stripes on each side of the crown do not extend so far forward, and the color is not nearly so rich, having a washed-out appearance. The transition from chestnut to white is also much more gradual.

Measurements.— Type, adult male: wing 208; tarsus 39 ; culmen 27.
“ female: “ 185; “ 37.5; “ 27.

All Pacific coast specimens appear to be constant in these characters. A male from the Big Horn Mountains, Montana, collection of William Brewster, no. 5666, shows intergradation of color on the crown but is clearly referable to the Pacific form.

We noted a few of these birds at the following localities:— Semidi Islands, Alaska, April 19, 1913, King Cove, Alaskan Peninsula, April 22, 1913, Avatcha Bay, Kamchatka, May 10, 1913, Cape Shipunski, Kamchatka, May 21, 1913, Cape Zhipanov, Kamchatka, May 25, 1913, and Providence Bay, Siberia during the first three weeks of June 1913.

Oedemia americana Swainson.

SCOTER.

This species was only noted on one occasion, a few being seen at Cape Shipunski, May 22, 1913.

Oedemia deglandi dixoni, subsp. nov.

DIXON'S WHITE-WINGED SCOTER.

Type.— Adult male, no. 66787 M. C. Z. Humphrey Point, Arctic Alaska, collected June 13, 1914, by Joseph Dixon. Orig. no. 3697.

Characters.— Similar to *deglandi,* with the exception of the size and shape of bill, which in *dixoni* is shorter and broader in proportion to its length and more blunt at the tip, with the angles from its greatest width to the tip more abrupt.

The female averages a more blunt bill, but this character is not so marked as in the male.

On examining a large series of White-winged Scoters from both sides of the continent there is no difficulty in separating Atlantic and Pacific birds by means of this character of the bill.

This subspecies I dedicate to Mr. Joseph Dixon of Escondido, California, an untiring worker in the field, and a loyal companion in the wilderness where the best laid plans at times miscarry.

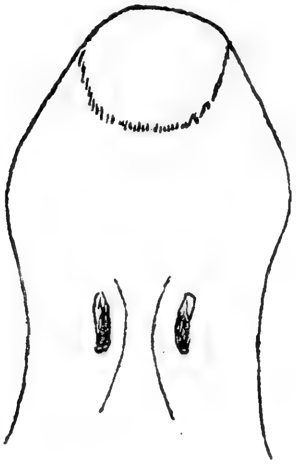

Fig. 1.

Fig. 2.

Fig. 1. — Bill of Oedemia deglandi dixoni Brooks. — Arctic Alaska.
Fig. 2. — Bill of Oedemia deglandi deglandi Bonaparte. — Massachusetts.

This is an uncommon species on the north coast of Alaska. At Demarcation Point none were seen until June 25, 1914, a single bird on the Bay. An Eskimo brought me the unsexed skin of a specimen shot by him on June 28 about ten miles east of the Point. On July 12 about fifteen were in the Bay associated with approximately the same number of *perspicillata*. A male was taken from this flock.

OEDEMIA PERSPICILLATA (Linné).

SURF SCOTER.

On July 12, 1914, two flocks each containing about thirty individuals were flying over Demarcation Bay, and in the Bay were some fifteen with about the same number of White-winged Scoter.

At Humphrey Point a male was taken by Mr. Dixon June 22, 1914.

POLYSTICTA STELLERI (Pallas).

STELLAR'S EIDER.

A few Stellar's Eiders were seen at Cape Shipunski, May 23, 1913, At Providence Bay they were quite common in flocks during the first three weeks of June 1913, and at East Cape, on June 7. On the south side of St. Lawrence Island a number of large flocks were about on June 25, 1913. These flocks consisted mostly of males, and the birds keeping in shallow water close to the beach were so massed that no space of water could be seen between them. We found no nests, but had little time at our disposal to devote to this branch of field work.

At Humphrey Point Mr. Dixon found a number of these birds, and secured a good series between June 12 and July 7. At Demarcation Point I saw on June 8, 1915, only one bird, a female sitting on the bank of a small pond in company with a pair of Old-squaw.

ARCTONETTA FISCHERI (Brandt).

SPECTACLED EIDER.

This species was only observed at St. Lawrence Island, and Humphrey Point. On the south side at the former locality three specimens were taken from a small flock on June 25, 1913.

At Humphrey Point, Mr. Dixon secured five on June 12 and 26, 1914.

SOMATERIA SPECTABILIS (Linné).

KING EIDER.

King Eiders were common about Cape Chibukak, St. Lawrence Island, in pairs and small flocks, on June 2, 1913. They were quite common at Providence Bay early in June, and a few were seen at East Cape, on June 7, 1913.

At Cape Serdze enormous flocks were flying east, on July 16, 1913.

Mr. Dixon found this species breeding sparingly at Humphrey Point where it arrived on May 15, 1914.

I found no nests at Demarcation Point nor did I see a bird until June 7. From this date I saw King Eiders about every other day but very sparingly and never paired; generally a male with three or four females or *vice versa*.

Once I found this species courting. On June 14 when approaching a small lagoon but still unable to see it owing to a slight elevation of the tundra before me, I heard a strange sound on the other side of the elevation. This peculiar noise came in series of three "*Urrr*-URRR-URRR," the last being the loudest, a sort of drumming call as when one expels air forcibly through the mouth with the tongue lightly pressed against the palate. I had heard this noise once before during the winter made by an Eskimo and used with indifferent results for encouraging his dog team. I thought this call was an invention of his own at the time, but when in sight of the lagoon I found that the disturbance came from a small flock of King Eiders, three females and five males. They were on the beach and three males were squatted in a triangle about a female, each about a yard from her. They did much neck-stretching as many male ducks do in the spring, and frequently bowed the head forward. The males constantly uttered the above drumming note. During this time the female was very indifferent to the attentions of her suitors doing nothing more than occasionally extending her head towards one of them. After a brief period of these tactics, one or more of the males would enter the water and bathe vigorously with much bowing of heads and stretching of necks, to return to the beach in a few moments and repeat the foregoing performance. Finally they all took wing uttering the croaking sound similar to the Pacific Eider.

By the middle of July a few small flocks of males were seen flying west.

SOMATERIA V-NIGRA Gray.

PACIFIC EIDER.

Pacific Eiders were first noted at the Semidi Islands, Alaska, on April 18, 1913. At St. Lawrence Island early in June they were common in pairs. At Providence Bay we found a number of nests of this species containing fresh eggs on June 19 and 20. The birds were very tame, always flying low and often passing close to one, The male always flies a few feet behind the female, and as a rule is uttering its characteristic guttural note, the only sound I have heard them make.

At Demarcation Point on September 1, 1913, a juvenile in the down was taken, and another with the scapulars and sides of back feathered.

At this Point in the spring of 1914 the first Pacific Eider, a single male, arrived May 26. They were rare and only occasionally seen and then but two or three flying east. No doubt they all went along the off shore "leads" for they bred abundantly east of the Mackenzie River delta.

The first males began going west on July 2.

A male taken by Mr. Dixon on August 9, at Herschel Island has the eclipse plumage about one third developed on the head, neck, breast, and back.

Mergus serrator Linné.

RED-BREASTED MERGANSER.

A rare bird on the Arctic coast of Alaska. At Humphrey Point Mr. Dixon took two males, on June 24 and July 1, 1914.

At Demarcation Point an Eskimo brought me a male killed on June 10, ten miles east of the Point. A male was seen at the Point on June 18, a pair June 21, and a male on June 28. Four males and two females were observed in Demarcation Bay, July 12.

Three juveniles in the down were taken by Mr. Dixon on August 3, 1914, on the mainland opposite Herschel Island.

Phalacrocoracidae.

Phalacrocorax pelagicus pelagicus Pallas.

PELAGIC CORMORANT.

Pelagic Cormorants were abundant at Copper Island, May 6, 1913, and quite common at the mouth of Providence Bay, in June.

At St. Lawrence Island they were beginning to lay by June 2, 1913, and eggs in an advanced state of incubation were taken at this Island, on June 28.

Phalacrocorax urile (Gmelin).

RED-FACED CORMORANT.

This species was positively identified only at Avatcha Bay, May 10, 1913, and at Cape Shipunski where a male was taken May 25, 1913. Only a few were seen.

FALCONIDAE.

ARCHIBUTEO LAGOPUS SANCTI-JOHANNIS (Gmelin).

ROUGH-LEGGED HAWK.

I have a female shot at Herschel Island, May 21, 1914, by Mr. J. Heard, Jr. It contained an ovary measuring seven eighths of an inch. Mr. Heard found these birds very common at Herschel Island when he took this specimen.

Mr. Dixon noted this species at Humphrey Point, on May 13, and I saw a single specimen at Demarcation Point, on May 24.

HALIAEETUS ALBICILLA BROOKSI (Hume).

EASTERN GRAY SEA EAGLE.

At Cape Shipunski, on May 22, 1913, three eagles were seen, two with white tails, and one in brown plumage.

HALIAEETUS LEUCOCEPHALUS ALASCANUS C. H. Townsend.

ALASKAN BALD EAGLE.

Bald Eagles were common in southeastern Alaska in April, 1913. Nests were found on Woewodsky Island and on the North Semidi Island.

THALASSAËTUS PELAGICUS (Pallas).

KAMCHATKAN SEA EAGLE.

Two very large eagles were seen near the mouth of Avatcha Bay, May 10, 1913. No doubt they were this form.

The collection contains an adult male acquired by purchase.

FALCO PEREGRINUS PEALEI Ridgway.

PEALE'S FALCON.

We did not see this bird, but secured a pair taken at Copper Island by Dr. I. S. Kalinin, April 10 and 12, 1913, and a female from Bering Island.

A duck hawk seen flying across the tundra at Demarcation Point, June 10, 1914, was probably *F. peregrinus anatum* Bonaparte.

FALCO COLUMBARIUS COLUMBARIUS Linné.

PIGEON HAWK.

One was seen at Demarcation Point, May 31, 1914.

STRIGIDAE.

ASIO FLAMMEUS FLAMMEUS (Pontoppidan).

SHORT-EARED OWL.

Short-eared Owls were quite common in the vicinity of Demarcation and Humphrey Points arriving at the former Point, on May 12. We could find no nests.

NYCTEA NYCTEA (Linné).

SNOWY OWL.

Snowy Owls were seen at Cape Serdze, July 17, 1913, and Big Diomede Island, June 25, 1913.

On the north coast of Alaska these birds are quite common in summer but scattered, each pair apparently having its own hunting ground.

A single bird was seen at Humphrey Point, December 5, 1913, flying low over the tundra in the noon twilight.

None were noted in the spring of 1914 at Demarcation Point until a single bird appeared on May 2. From that time until I left two or three birds would be seen every day but I could find no nest.

Snowy Owls are very shy and were best taken by means of traps set on poles. Their natural shyness is no doubt augmented by being constantly pursued by Eskimos who think their flesh a great delicacy. I attempted to eat a Snowy Owl that I captured but found it the most loathsome meat I have ever tasted, infinitely worse than fox.

Practically all the Short-eared Owls I trapped were eaten immediately by Snowy Owls so keen is their sight.

HIRUNDINIDAE.

IRIDOPROCNE BICOLOR (Vieillot).

TREE SWALLOW.

An Eskimo brought me a male Tree Swallow that he killed on the roof of his igloo ten miles east of Demarcation Point, June 7, 1914.

TROGLODYTIDAE.

NANNUS HIEMALIS PALLESCENS (Ridgway).

COMMANDER ISLAND WREN.

A specimen taken at Copper Island by Dr. I. S. Kalinin, August 25, 1912, is in the collection.

NANNUS HIEMALIS PACIFICUS (Baird).

WESTERN WINTER WREN.

A single specimen was seen and taken at Woewodsky Island, southeast Alaska, April 9, 1913.

NANNUS HIEMALIS SEMIDIENSIS, subsp. nov.

SEMIDI WINTER WREN.

Type.— Adult male, no. 66711 M. C. Z. Choyiet Island, Semidi Islands, Alaska, collected April 18, 1913, by W. S. Brooks.

Characters.— Similar to *N. alascensis,* but less rufescent, especially above; bill longer.

Measurements.— Type, adult male: wing, 52; tail, 34; tarsus, 18; bill, 16.

Adult male, North Semidi Island, April 19, 1913, J. Dixon: wing, 51.5; tail, 32.5; tarsus, 19; bill, 16.

TURDIDAE.

PLANESTICUS MIGRATORIUS CAURINUS Grinnell.

Several were seen about Glacier Bay, Alaska, April 11, 1913, and two on Inian Island, Cross Sound, Alaska, April 13.

IXOREUS NAEVIUS NAEVIUS (Gmelin).

VARIED THRUSH.

Two Varied Thrushes were seen at Point Gustavus, Glacier Bay, Alaska, on April 11, 1913, and one on Inian Island, Cross Sound, Alaska, April 13.

TURDUS OBSCURUS (Gmelin).

In the collection are two purchased specimens, a male taken at Copper Island, May 26, —, and a female from the same locality taken May 20, —.

CALLIOPE CALLIOPE CAMTSCHATKENSIS (Gmelin).

Two males taken at Copper Island, May 17 and 18, —. Purchased.

OENANTHE OENANTHE OENANTHE (Linné).

WHEATEAR.

Specimens were taken at the head of Providence Bay and East Cape during the first half of June, 1913. They were not common and exceedingly wild.

PARIDAE.

PENTHESTES RUFESCENS RUFESCENS (J. K. Townsend).

CHESTNUT-BACKED CHICKADEE.

A few Chestnut-backed Chickadees were seen at Woewodsky, and Kupreanof Islands, Alaska, April 9 and 10, 1913, and about Glacier Bay, April 11.

SYLVIIDAE.

REGULUS SATRAPA OLIVACEUS Baird.

WESTERN GOLDEN-CROWNED KINGLET.

This species was common about Kupreanof Island and Glacier Bay, Alaska, April 10 and 11, 1913.

CERTHIIDAE.

CERTHIA FAMILIARIS MONTANA Ridgway.

ROCKY MOUNTAIN CREEPER.

A female was taken at Point Gustavus, Glacier Bay, Alaska, April 11, 1913.

MNIOTILTIDAE.

DENDROICA MAGNOLIA (Wilson).

MAGNOLIA WARBLER.

A female? Magnolia Warbler was found dead on the sand spit at Humphrey Point, Alaska, October 1, 1913.

SEIURUS NOVEBORACENSIS NOTABILIS Ridgway.

GRINNELL'S WATER THRUSH.

A male taken at Demarcation Point, May 17, 1914.

MOTACILLIDAE.

MOTACILLA OCULARIS Swinhoe.

SWINHOE'S WAGTAIL.

Several Swinhoe's Wagtails were seen at Providence Bay, on June 5, 1913, and two males secured.

MOTACILLA LUGENS Kittlitz.

BLACK-BACKED KAMCHATKAN WAGTAIL.

At Cape Shipunski, on April 21 and 22, 1913, we saw a number of this Wagtail about the cliffs and stony beaches and four males and a female were taken. Deep snow covered the land making these frail little birds appear singularly out of place.

MOTACILLA BOARULA MELANOPE Pallas.

A male taken at Copper Island, May 20, —, was purchased.

BUDYTES FLAVUS SIMILLIMUS Hartert.

KAMCHATKAN YELLOW WAGTAIL.

A single Yellow Wagtail was seen at Cape Shipunski, May 21, 1913. On June 14 and 19, 1913, three males and two females were taken at Providence Bay. Two of the males are typical *simillimus,* but the rest show intermediate characters with *B. f. alascensis,* but are still of a sufficiently bright yellow on the underparts to refer them to *simillimus.*

Clark in his paper on The birds collected and observed during the cruise of the United States fisheries steamer ALBATROSS in the North Pacific Ocean, and in the Bering, Okhotsk, Japan, and Eastern Seas, from April to December, 1906, (Proc. U. S. Nat. Mus., 1910, **38**, p. 71), states that two examples from Plover Bay, which is a small bay near the mouth of Providence Bay, appeared to be intermediate; one being nearer *alascensis,* the other nearer *simillimus.*

ANTHUS CERVINUS (Pallas).

RED-THROATED PIPIT.

A few Red-throated Pipits were observed and taken at Providence Bay, June 20 and 21, 1913, and at Indian Point, June 4 and 7, 1913.

ANTHUS RUBESCENS (Tunstall).

PIPIT.

Mr. Dixon took three males at Herschel Island, August 9 and 11, 1914.

ANTHUS GUSTAVI Swinhoe.

SCHLEGEL'S TITLARK.

A pair taken at Copper Island, on May 26, —, was purchased.

ALAUDIDAE.

OTOCORIS ALPESTRIS ARCTICOLA Oberholser.

PALLID HORNED LARK.

The first arrival at Demarcation Point was a single male on May 6, 1914. Two females were taken on May 13 and 14. After this date none were seen until June 7, when a pair was noted. They could not be found again.

Mr. Dixon observed a Pallid Horned Lark, on May 7, at Humphrey Point, and took a male at Herschel Island, August 11, 1914.

FRINGILLIDAE.

FRINGILLA MONTIFRINGILLA Linné.

A male taken at Copper Island, May 4, —, was purchased.

SPINUS PINUS PINUS (Wilson).

PINE SISKIN.

Two males were taken April 10, 1913, at Kupreanof Island, Alaska.

ACANTHIS HOLBOELLI (Brehm).

HOLBÖLL'S REDPOLL.

Several Holböll's Redpoll's were seen near Petropavlovsk, May 19, 1913, and specimens taken. Specimens were also taken at East Cape and Big Diomede Island, June 14 and 15, 1913, and at St. Lawrence Island, June 27, 1913. At the latter place a breeding female was secured.

ACANTHIS HORNEMANNI EXILIPES (Coues).

HOARY REDPOLL.

The first Hoary Redpoll seen at Demarcation Point was a male, on May 24, 1914. During the rest of the month a few pairs were noted. On June 1, a flock of about twenty was about some ruined igloos on the sand spit. From this date to June 25, an occasional Hoary Redpoll was to be seen but no nest was found.

At Humphrey Point Mr. Dixon noted them May 13. He also took a male at Herschel Island, on August 16, 1914.

We also have a purchased male taken at Copper Island, April 23,—.

LEUCOSTICTE GRISEONUCHA GRISEONUCHA (Brandt).

ALEUTIAN ROSY FINCH.

A few were seen on the Semidi Islands, April 18 and 19, 1913, and a series of specimens taken.

LEUCOSTICTE GRISEONUCHA MAXIMA, subsp. nov.

COMMANDER ROSY FINCH.

Type.—Adult male no. 66,725 M. C. Z. Copper Island, Commander Islands, collected May 7, 1913, by Joseph Dixon. Orig. no. 3057.

Characters.— Similar to *L. griseonucha griseonucha* but larger, and darker on breast, lower throat, and interscapulars, especially on the breast and lower throat.

Measurements.— Type, adult male:—wing, 123; tail, 79; tarsus, 24; bill, 14.5.

Another male taken May 3, affords the following measurements:—wing, 122; tail, 81; tarsus, 24; bill, 14.

Ridgway in the Birds of North and Middle America, **1**, p. 73, gives measurements of rosy finches from the Commander, Aleutian, and Pribilof Islands. The Commander Islands specimens average larger. *Leucosticte griseonucha maxima* is an insular form constantly larger than *L. griseonucha griseonucha* from other localities justifying at least subspecific separation.

LEUCOSTICTE BRUNNEINUCHA (Brandt).

Several were seen about Petropavlovsk, on May 19, 1913, and a male taken.

CARPODACUS ERYTHRINA ROSEATA (Hodgson).

Five specimens of this species, three red males and two females, Copper Island, May 18 to June 5,— were purchased.

Carpodacus erythrina grebnitskii Stejn. was described from two very brightly colored males. The three males from Copper Island are not unusually bright red; indeed a majority of the specimens (Coll. M. C. Z.) from India and western Szechwan taken in the spring and early summer are more intense red than these Copper Island males. Hartert (Vogel der Palaarktischen fauna) doubted the validity of *grebnitskii* and from a study of our material I think his doubt well founded.

LOXIA CURVIROSTRA SITKENSIS Grinnell.

SITKA CROSSBILL.

Two males and three females were taken at Woewodsky Island, Alaska, on April 9, 1913, and a female at Kupreanof Island, April 10, 1913.

Examination of this series and other specimens in the M. C. Z. from the same general locality leads me to believe that *sitkensis* of Grinnell is a tenable subspecies, and I refer our series to this form.

Though I have no red specimens, those in "immature" plumage are rather more yellow than birds from the east, and all average noticeably smaller.

LOXIA LEUCOPTERA Gmelin.

WHITE-WINGED CROSSBILL.

A male, the only one seen, was taken at Point Gustavus, Glacier Bay, Alaska, April 11, 1913.

PYRRHULA PYRRHULA KAMTSCHATICA (Taczanowski).

KAMCHATKAN BULLFINCH.

Our collection contains a male and female of this species taken at Copper Island, May 21 and 25, —.

EMBERIZA PALLASI (Cabanis).

A single female taken at Copper Island, May 21, —, is in the collection.

EMBERIZA RUSTICA Pallas.

A few were seen and two females taken at Cape Zhipanov, May 25, 1913. They were exceedingly shy and the deep snow rendered their capture most difficult.

PLECTROPHENAX NIVALIS NIVALIS (Linné).

SNOW BUNTING.

Snow Buntings though never so abundant as Longspurs were seen at nearly all the places visited by the expedition.

A few were noted on the Semidi Islands, April 19, 1913, and at King Cove on the Alaskan Peninsula, April 22. At East Cape and Providence Bay they were quite common and breeding in June of the same year. At the latter place a set of six eggs beginning to incubate was taken on June 19. The nest was under a pile of loose rocks averaging the size of one's head, and before securing the nest we were forced to remove perhaps two hundred pounds of stone. On June 15 two nests, one containing five eggs, the other six, were found on Big Diomede Island. One nest was situated as far as one could reach under a shelving boulder, and the other in a deep crevice between two rocks. Both were well made of grass lined with feathers.

At St. Lawrence Island this was a common bird in June, and at Cape Serdze a few were noted July 17 and 18, 1913, where we found young birds able to fly.

They were common at Collinson Point on August 3, 1913, but returning on the ninth we found them greatly diminished in numbers.

Our latest record for the Arctic coast of Alaska is that of a female taken at Humphrey Point, on September 27, 1913.

At Humphrey Point Mr. Dixon found Snow Buntings breeding sparingly the first arrivals being noted May 1, 1914.

The first arrivals reached Demarcation Point, May 4, a flock of nine apparently all males, and two that were taken proved to be very fat. Two or three were seen nearly every day until the fifteenth when fourteen were noted. On May 16 about twenty were near the camp and on May 17 a flock of about one hundred and fifty containing both sexes; these were very shy.

After this date only a few remained in the vicinity, not more than seven or eight pairs breeding within a radius of four or five miles of the Point.

Up to May 20, quite a few still retained winter plumage, but none in this plumage were seen after May 25.

On the north coast of Alaska these birds nest equally in hollow driftwood logs on the beach or in ruined igloos, and in dark sheltered pockets under the overhanging sod of the cutbanks near the shore. Two conditions they seem to require, a dark sheltered nook for the nest and the site must be close to the shore of a bay or the ocean.

No eggs were found until June 28. This proved to be a set of seven, the largest I have seen and incubation was well started. This nest was in a hollow log on a sand spit and was composed largely of white fox hair with a lining of white ptarmigan feathers. On tearing the log to pieces to reach this nest I found a last year's one also composed of the same material. The female that I disturbed from the nest, was like other Snow Buntings very fearless and loath to leave her eggs uncovered, for she would return to them when I was beside the log.

On July 3 two sets of five eggs were found, one about to hatch and the other perhaps one third incubated. Both nests were in pockets under overhanging sod on the bank by the beach and were well made of fine grass lined with caribou hairs, presumably taken from a near by abandoned Eskimo camp site.

Four eggs too advanced to save were found in a driftwood log on July 8, and on July 14 a nest was found containing young about ten days old.

Mr. Dixon took young birds at Humphrey Point, July 12, 1914, and at Herschel Island, July 30.

PLECTROPHENAX NIVALIS TOWNSENDI Ridgway.

PRIBILOF SNOW BUNTING.

We did not see any Pribilof Snow Buntings, and have only a purchased specimen, a male taken at Copper Island, on June 5, —.

CALCARIUS LAPPONICUS ALASCENSIS Ridgway.

ALASKA LONGSPUR.

Were it not for this gentle, sweet-singing little bird the tremendous wastes of Arctic tundra would be far more desolate than now. Tramping day after day over the soft mosses where everything looks alike and one never seems to get anywhere, the other sounds that are most conspicuous are the wild cries of loons and the dreary wailing of white foxes, both of which add to the monotony and desolation of a country already dreary enough. The Alaska Longspur with its simple liquid melody heard on every side in June adds a cheer to one's existence and forms a link between the northern barrens and more favored climes where pleasing bird songs are the rule and not the exception.

The first Alaska Longspur seen was a single female taken at the Semidi Islands, April 19, 1913. They were quite common during June 1913, at Providence Bay, East Cape, and St. Lawrence Island, though we failed to find any nests. A few were noted at Cape Serdze, July 17 and 18, and on July 23, several young birds were flying about at Cape Lisburne, Alaska. They were common at Collinson Point, August 3 and 9, 1913. The last bird noted was a female shot at Demarcation Point, on September 2, 1913.

The first Alaska Longspur seen at Demarcation Point in the spring of 1914 was a single male on May 14. No more were seen until May 21, when about twenty males and two females were found sporadically. On May 23 Alaska Longspurs were abundant and a few pairs were noted, though males were greatly in the majority. They were also abundant on the following day and for the first time singing everywhere. By May 27 all the Alaska Longspurs seen were paired and immediately nest-building commenced, a task apparently falling exclusively to the female. The nests were made of dried grass and varied considerably in size and neatness of construction, but invariably were lined with the discarded winter plumage of ptarmigan. On the tundra about Demarcation Point there are many furrows, due I imagine to the action of frost. Along the sides of these furrows where the overhanging grass offers concealment one finds most of the nests though they are occasionally found in grass tufts on the more level ground.

Full complements of fresh eggs were found by June 7 and from this date until June 19. Young just hatched were found on June 27 and young able to fly July 3. This illustrates well the extraordinary rapidity with which birds breed in the far north, young able to fly being found forty-three days after the first females arrived.

Alaska Longspurs seem more prone to inactivity at night than other Arctic birds. Every night when the sun had dipped closer to the northern horizon and the temperature had fallen, a dozen or more of these birds were accustomed to squat behind various bits of wood, and the posts of a cache in front of my camp. Here they would remain from about eleven in the evening until two or three o'clock in the morning. If the constant crying of loons were any criterion one would infer that these birds were constantly on the alert throughout the eight weeks of continual sunlight.

Mr. Dixon found Alaska Longspurs abundant at Herschel Island early in August.

CALCARIUS LAPPONICUS COLORATUS Ridgway.

COMMANDER ISLAND LONGSPUR.

One male was taken at Copper Island, May 7, 1913. We saw no others.

PASSERCULUS SANDWICHENSIS ALAUDINUS Bonaparte.

WESTERN SAVANNAH SPARROW.

A female, the only Savannah Sparrow seen, alighted on the roof of my camp on the night of June 5, 1914, and was secured.

JUNCO HYEMALIS HYEMALIS (Linné).

SLATE-COLORED JUNCO.

On October 1, 1913, a single female was secured at Humphrey Point.

JUNCO HYEMALIS OREGONUS (J. K. Townsend).

OREGON JUNCO.

We secured a female on April 10, 1913, at Kupreanof Island, Alaska.

SPIZELLA MONTICOLA OCHRACEA Brewster.

WESTERN TREE SPARROW.

Mr. Dixon took a juvenile Western Tree Sparrow at the mouth of the Firth River opposite Herschel Island, August 1, 1914.

ZONOTRICHIA LEUCOPHRYS GAMBELII (Nuttall).

GAMBEL'S SPARROW.

At 1.30 A.M. on the morning of May 17, 1914, two males, the only Gambel's Sparrows seen, were taken at the door of the camp. On this night the midnight sun was first seen.

MELOSPIZA MELODIA RUFINA (Bonaparte).

SOOTY SONG SPARROW.

A male was taken at Woewodsky Island, Alaska, April 9, 1913.

MELOSPIZA MELODIA CAURINA Ridgway.

YAKUTAT SONG SPARROW.

Three males were shot at Woewodsky Island, April 9, 1913. This locality is south of the breeding range of this subspecies.

MELOSPIZA MELODIA SANAKA McGregor.

ALEUTIAN SONG SPARROW.

Several Aleutian Song Sparrows were taken on the Semidi Islands, Alaska, April 18 and 19, 1913.

PASSERELLA ILIACA TOWNSENDI (Audubon).

TOWNSEND'S FOX SPARROW.

A single female was taken at Woewodsky Island, April 9, 1913.

ICTERIDAE.

EUPHAGUS CAROLINUS (Müller).

RUSTY BLACKBIRD.

Mr. Dixon took a female Rusty Blackbird at Indian Point, Siberia, on June 7, 1913. Indian Point is the most barren spot we saw on the Chukchi Peninsula. This is undoubtedly the first Asiatic record for the species.

CORVIDAE.

CORVUS CORAX BEHRINGIANUS Dybowski.

COMMANDER ISLAND RAVEN.

After a careful study of Ravens from Copper Island and John Howland Bay, East Siberia, I am unable to detect the slightest difference between the birds and refer both to *behringianus.* The characters of *kamtschaticus* also appear unsatisfactory.

As Hartert suggests in Die Vogel der palaarktischen Fauna, that *Corvus corax sibiricus, ussurianus, kamtschaticus,* and *behringianus* may be the same, for the characters are variable and very unsatisfactory. If such is the case, the name *kamtschaticus* of Dybowski should be used. This form is intermediate in characters but not in range, between *corax* and *tibetanus* of Hodgson.

Corvus corax principalis from Alaska differs from our series of *behringianus* in having a slightly more slender and less deep bill, but the difference is slight; in fact it is often extremely difficult to separate American from European specimens.

The ravens seen but not taken by Koren on the Arctic coast of Siberia 1914, may have been *behringianus* instead of *sibiricus* as suggested by Thayer and Bangs (Proc. N. E. Zool. Club, 1914, **85**, p. 478).

CORVUS CORAX PRINCIPALIS Ridgway.

NORTHERN RAVEN.

The Northern Raven was seen sparingly during the spring of 1914, at Demarcation Point, their first arrival on the Arctic shore being April 28. After this date two or three were noted during our daily excursions until May 21, when they disappeared, no doubt to breed back in the mountains. On the north coast of Alaska they are exceedingly wild, and we were unable to secure any.

NUCIFRAGA CARYOCATACTES JAPONICUS Hartert.

Two specimens in worn plumage taken at Petropavlovsk, May 19, 1913. They are typical *japonicus,* and others noted about the town did not appear any darker in coloration.

Our observations lead me to infer that the dark form *kamchatkensis* of Barrett-Hamilton may have been described from an abnormally dark or melanistic *japonicus.*

Perisoreus canadensis fumifrons Ridgway.

ALASKA JAY.

A single Alaska Jay was seen at Demarcation Point, September 1, 1913.

Cyanocitta stelleri stelleri (Gmelin).

STELLER'S JAY.

Two Stellar's Jays were seen on Inian Island, Cross Sound, Alaska, April 13, 1913.

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A REVISION OF THE LIZARDS OF THE GENUS AMEIVA.

By Thomas Barbour and G. Kingsley Noble.

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No. 6.— *A Revision of the Lizards of the genus Ameiva.*

By Thomas Barbour and G. Kingsley Noble.

INTRODUCTION.

This paper is based almost wholly upon the collection in the Museum of Comparative Zoölogy; we have, however, had loaned for study some important specimens from other institutions and wish to thank Dr. Leonhard Stejneger and the U. S. National Museum, Henry W. Fowler Esq., and the Academy of Natural Sciences of Philadelphia, as well as Dr. A. G. Ruthven and the Zoölogical Museum of the University of Michigan, for valuable aid. From the two latter institutions we have received important specimens in loan or exchange; from Dr. Stejneger permission to study in Washington the types of *Ameiva polops* and *Ameiva tobagana,* as well as complete sets of photographs and notes of these important specimens for study in Cambridge.

Citations of original descriptions have been omitted, also synonyms, except where these have been changed or added to. Both have already been adequately given in Boulenger's Catalogue of Lizards in the British Museum, **2**, with later changes in Barbour's 'West Indian Herpetology,' Mem. M. C. Z., **44**, no. 2.

Some characters, such as the entry of granules between the gulars and the extent to which they may do so, have been found to be variable and hence have been omitted in drawing up the descriptions. So far as possible all characters which have been found to be really diagnostic have been included. Special attention is called to the fact that, making allowance for the variation connected with age or sex, color-pattern has been found to be of excellent taxonomic value. This statement is made upon the basis of the study of the very extensive series of some races such as *A. ameiva praesignis* and *A. ameiva ameiva.*

GENERAL CONSIDERATIONS.

The genus Ameiva, because it ranges widely through the West Indies, Central and South America, is an excellent subject for careful zoögeographic study. Almost every one of the Antilles, which has been carefully collected, has been found to support a peculiar species, while in Haiti, for example, three species occur in the very same localities. Since for a very long time there has been and is, especially just at present, considerable controversy regarding the origin of the Antillean fauna, we digress at some length regarding the light which a study of the species throws on the question.

Bland (Ann. Lyc. nat. hist. N. Y., 1862, **7**, p. 335) was among the first workers in the field of Antillean zoögeography, studying the relationships of the Mollusca of the different islands. His division of the region into faunal areas is interesting because his groupings agree well with those of other writers who have based their conclusions on other data. Bland proposed the following areas:—

1. Cuba and the Isla de Pinos, Bahamas, and Bermudas. 2. Jamaica. 3. Haiti. 4. Puerto Rico and Vieques, the Virgin Islands, Sombrero, Anguilla, St. Martins, St. Bartholomew, and St. Croix. 5. The southern Lesser Antilles, embracing those south of St. Bartholomew to and including Trinidad.

This grouping of the islands is by no means inconvenient, but it is quite incorrect to conceive that these areas really represent zoögeographic entities, or to say that they are anything more than expressions of the close similarity of some species in certain chosen groups. Our thesis is that the West Indian region taken as a whole has a singularly compact, homogeneous fauna, the same elements appearing on island after island. This fact is perhaps the most conclusive single argument against the theory of the origin of the fauna by flotation. Several recent writers, among whom may be mentioned Allen (Bull. M. C. Z., 1911, **54**, p. 175–263) and Barbour (Bull. M. C. Z., 1910, **52**, p. 273–301; and Mem. M. C. Z., 1914, **44**, p. 209–347) have been especially active in advocating the interpretation which required a presumed connection of the Antilles with the mainland and with each other to explain the present faunistic conditions. The most able of those who advocate the theory of haphazard population by flotsam and jetsam methods is W. D. Matthew, who has recently summarized his views in a scholarly review entitled Climate and evolution (Ann. N. Y. acad. sci., 1915, **24**, p. 171–318; p. 205, p. 290). In general, the majority of recent naturalists, among them Stejneger, Gadow, and Schaff, are opposed to Matthew's thesis.

This revision, which is a detailed study of a single genus of strictly terrestrial teid lizards, shows clearly the close relationship and origin from a common stock of many of the Antillean forms. The data derived from this study seem to argue strongly against the flotsam and jetsam theory. Stejneger (Rept. U. S. N. M. for 1902, 1904,

p. 562) and Barbour (Mem. M. C. Z., 1914, **54**, p. 326) have suggested that the Antillean Ameivas were derived from a centre of dispersal in northeastern South America, and that they have spread thence northward over a continuous land area to the Greater Antilles. Proceeding northward along the islands we find species which show a gradual transition in morphological characters, and there is no obvious break in the series, except where the evidence is wanting, as for example where the species on Dominica seems very different from that of St. Vincent, we must remember that the form which formerly inhabited Martinique is undescribed zoölogically and is probably now extirpated by the mongoose. This gradual transition, as we have said, points to a land migration and not to distribution by flotation. The latter means would not account for the presence of the genus upon so many islands, without presupposing an enormous amount of rafting. Such a constant flotation would have kept new immigrants coming to the islands already populated, as well as to those as yet without Ameivas, and would surely have tended to keep the whole Antillean group of individuals more homogeneous than they are. There is no real reason for supposing that there was more carriage in the past than at present. Then the derivation would probably have been from several stocks, whereas the Lesser Antillean Ameivas are all derived from the *Ameiva ameiva* stock, the Antillean and mainland races having probably had a common origin from an ancestral widespread stock which became differentiated as the stations occupied became separated. The comparatively fixed characters observed among the individuals of the island races stand at sharp contrast to the great variability of the same characters in the mainland races, and this points to a long complete isolation. Interchange of individuals between the islands is unthinkable on any basis, as their physical geographic characters make the setting free of rafts impossible. By the flotsam theory individuals must have reached all islands by rafts directly from mainland rivers.

Gadow (P. Z. S., 1906, p. 277–375) has shown that the closely related genus Cnemidophorus is composed of species having remarkably variable characters and that it is necessary to consider the sum of the distinguishing features when comparing two forms. Similarly in Ameiva too great stress cannot be laid upon a single character within a species, especially upon the mainland. This variability may make two species, probably but distantly related, appear closely similar. Some of these curiously close resemblances between widely separated forms may be mentioned, as they are interesting from an evolutionary point of view. *Ameiva vittipunctata* in size, in certain color-pattern features, and in many details of scutation, is similar to *A. erythrocephala;* a species with which it doubtless has but a rather distant relationship. *Ameiva exul* has its nostril between the two nasal plates, a character typical of the mainland and southern Lesser Antillean species, but otherwise it is not anomalous. The characters which in general we have found to be most constant in species of this genus are to be seen among the supraoculars, gulars, antebrachials, brachials, postbrachials, ventrals, and tibials.

In view of this variability noticeable in the island, and greatly exaggerated in the mainland, forms, we must either recognize a number of subspecies or merge all of the mainland races into five or six species. To do this, especially since we find that some variations have a definite relationship to their distribution, would be to obscure the true state of affairs, especially since we find that in some of these races speciation has far advanced and the appearance of any barrier to an interchange of individuals would doubtless result in the fixation of a valid species in a short time. We therefore recognize several subspecies of *Ameiva ameiva,* two of *A. undulata,* and one of *A. bifrontata.*

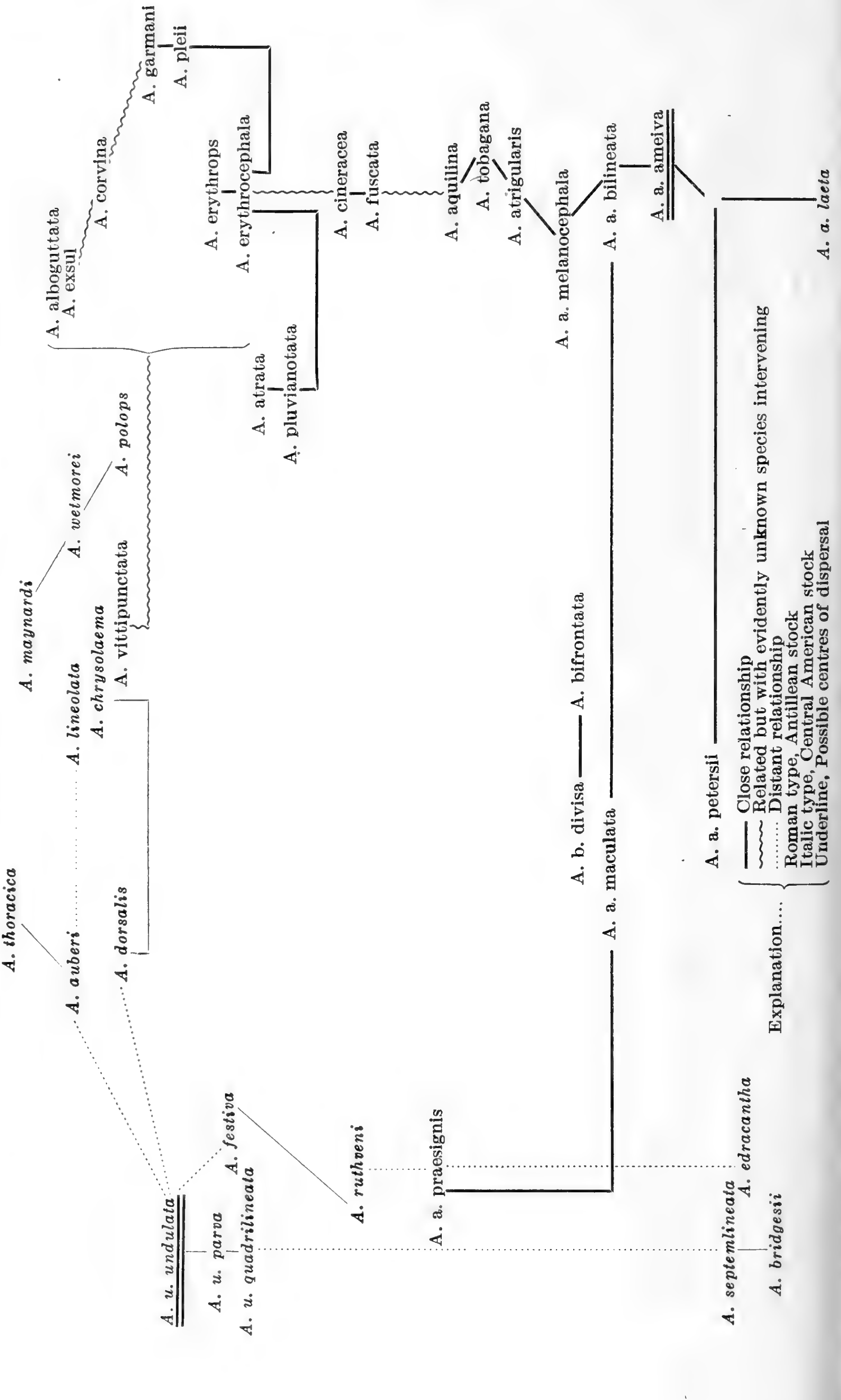
The whole question of explaining the origin of this genus and its dispersal is difficult and unsatisfactory. We may say, fairly that Ameiva and its possible offshoot Cnemidophorus represent the most generalized, perhaps the most primitive existing representatives of the characteristic American family Teiidae. Of the geologic history of this family we know really nothing; we can only postulate its origin by saying that along with the much more archaic Xantusiidae the Teiidae probably arose in America from early immigrants of the same stock which in the old world has given rise to the Varanidae. That this migration took place from eastern Asia to America by way of the Bering Strait land bridge is not improbable. Change of climate then probably forced the ancestral teiids southward and they flourished and are now wholly confined to the tropics, except *Cnemidophorus sexlineatus,* which has invaded secondarily the Austroriparian zone of North America, and a few which have pushed into temperate South America. Our study leads to the conclusion that the existing Ameivas have not all arisen in one region as Gadow shows was most probable for the Cnemidophori, but rather that they have probably spread from two centres. We submit then that probably some widespread ancestral Ameiva-like stock left two relict types, one of which gave rise to *A. undulata* and its allies, and the other *A. ameiva* and its relatives. The difficulty with this explanation is the fact that part of Central

America was under water probably while this ancestral stock was migrating, but a short period of emergence or the presence of an ancient land mass joining north Central and northwest South America, but lying to the westward of the present Middle America, would have made possible the migration. This land mass, the existence of which we have suggested, has been postulated by various other writers on other grounds. The sinking of this area would then have left the *A. undulata* allies free to distribute themselves in Central America as it assumed its present form and also to reach the Greater Antilles while they were in connection with Central America. The temporarily isolated South American stock then spread widely through the continent and passed into Antillea extending to Haiti. Finally with the completion of the appearance of lower Central America in its present form, we find it invaded by the *Ameiva ameiva* types in the form of *A. praesignis,* while western South America received some immigrant representatives of *A. undulata,* which on reaching this region so peculiarly favorable for speciation in reptiles became transformed into the curious and hardly recognizable *A. edracantha* and *A. bridgesii.* The latter of these reached Gorgona Island off the Colombian coast.

An alternative would have been to conclude that possibly the genus arose in Antillea and spread to Central and South America, but this seems hardly likely in view of the definite grouping of the species about the two prominent mainland types.

Two other stocks remain to be mentioned, which show a somewhat anomalous condition. The *maynardi-wetmorei-polops* group does not seem to show any very close relationship with the other species, and we can only conclude that these three very distinct species all represent chance survivors from some stock which once had a wider distribution, but which has completely disappeared. The other anomaly is afforded by *Ameiva bifrontata* and its subspecies *divisa.* These are not very dissimilar to *Ameiva ameiva,* but yet occur side by side with other races which are probably more closely related to *Ameiva ameiva* than either of them are. Whether these represent the survivors of a primary unsuccessful elaboration of *Ameiva ameiva* itself or are the remnants of some other stock, which in the same environment has come to look much like *Ameiva ameiva,* it is impossible to say. One gropes in the dark in treating all of this problem. It is even far from easy to surmise which are the more primitive types, while, of course, we know but little of skeletal variation within the group and there is no particular object to seek it out when it cannot be applied to palaeontology. How sadly different are the opportunities for the mammalogist and the herpetologist in essaying studies of this sort.

DIAGRAM OF THE PRESENT DISTRIBUTION OF THE GENUS AMEIVA.



Although no very satisfactory conclusions, perhaps, can be reached regarding the main question of the origin of the species of this genus, nevertheless one feature stands out strongly and clearly, and this is that the distribution of the Antillean species show by their relationship to one another and to the mainland types that they arose from an orderly progressive migration, such as would only be possible over a continuous area of land, and in no wise display the haphazard character which would be the only possible character of a flotsam and jetsam fauna. When we remember that the Ameivas of twenty-six different islands are already known, this conclusion will in no wise surprise those naturalists who know these creatures in their native haunts. Quick and active, absolutely terrestrial, they are farthest removed in habits from the lizards which we now know are at times moved about fortuitously, probably most often by human agency. The gekkos which hide in or under the bark of trees, enter and abide in human habitations, were from the nature of their secretive ways probably a frequent companion of primitive man while upon his journeyings. The skinks seem also, probably largely on account of their very small size, to have been spread far and wide, especially in the Pacific Island area, by human agency, and with these resistent creatures dispersal by fortuitous flotation probably occurs, but we cannot believe that it ever takes place except under the rarest and most exceptional cases with even these skinks. With other types, so many of which could never be imagined, starting on, surviving, or landing from an ocean voyage taken upon a sodden, water-soaked natural raft, it is quite useless to argue that the enormous length of geologic time makes it possible to say that such flotation may *occasionally* occur even using occasionally in a geologic time sense. That so many, many types would die invariably were they started forth annually or monthly upon a rafting voyage, makes but the more

Explanation of the Diagram.

The diagram, page 422, shows the relationship of the different species in the genus, the name of each race standing with relation to the others in geographic position. Each name occupies a position as near as possible identical with the area its habitat would occupy if the whole diagram were superposed upon a map of the Antillean region, Central America, and South America, the latter somewhat contracted.

improbable the fact that they should arrive at, land upon, survive, and reproduce their kind, upon some distant land, were they permitted to essay this journey but once in a thousand years or even less often. The enormous sum-total of species which make up the fauna of the Antilles, and the many zoölogical groups which are represented upon so many of the islands alone refute the flotation theory. If they did not we could lie-to in the mid-Caribbean and watch the rafts go by, speculating as a pleasant game as to which bore Onychophora and earthworms and which cyprinodonts or Amphibia, wondering how the little ponds in the rafts in which the fresh water fishes, molluscs, and crustaceans would have to be carried, are kept from becoming a bit, only a bit to be fatally, brackish. So much for the message of Ameiva with regard to the problem of the origin of the Antillean fauna.

KEY TO THE SPECIES.

- a¹ Caudal scales of adult oblique dorsally.
  - b¹ Nostril anterior to nasal suture.
    - c¹ Three supraoculars, the first not in contact with the loreal. . .*lineolata.*
    - c² Four supraoculars, the first in contact with the loreal. . . . . .*maynardi.*
  - b² Nostril between the nasal plates.
    - d¹ Caudal scales smooth or feebly keeled, whorls not raised posteriorly.
      - e¹ Eight longitudinal rows of ventrals. . . . .*wetmorei.*
      - e² Ten longitudinal rows of ventrals. . . . .*polops.*
    - d² Caudal scales strongly keeled, the keels not parallel to the sides of the scale, whorls raised posteriorly.
      - e¹ A single row of large postbrachials, two rows of tibial shields. *festiva.*
      - e² Postbrachials small and irregular, three rows of tibial shields. *ruthveni.*
- a² Caudal scales of adult straight dorsally.
  - b¹ Nostril anterior to nasal suture.
    - c¹ Fourteen longitudinal rows of ventrals. . . . .*pluvianotata.*
    - c² Less than fourteen longitudinal rows of ventrals.
      - d¹ Twelve longitudinal rows of ventrals.
        - e¹ Gular scales minutely granular, a broad band of enlarged granules extending across the throat.
          - f¹ Tibial shields with largest scale of outer row broader than high; pale spots on body not confluent. . . . .*pleii.*
          - f² Tibial shields with largest scale of outer row about as broad as high; pale spots of body confluent. . . . .*garmani*

e^2 Gular scales uniformly minute, or tending to form a central group of slightly larger ones.

f^1 Uniform dark brown in coloration, gulars not differentiated from each other.

g^1 Frontal and frontoparietals in contact with the third supraocular.. *atrata.*

g^2 Frontal and frontoparietals separated from the third supraoculars by granules................................ *corvina.*

f^2 Not uniformly colored, gulars differentiated into a median group or band.

g^1 Brachial shields small, scarcely differentiated from the granules of the arm........................ *vittipunctata.*

g^2 Brachials in two or three rows of moderate sized plates. *chrysolaema.*

d^2 Ten longitudinal rows of ventrals.

e^1 Antebrachials continuous with the brachials............ *dorsalis.*

e^2 Antebrachials not continuous with the brachials.

f^1 Tibial shields with the second scale of the outer row wider than long; adult with two broad lateral stripes of black.... *thoracica.*

f^2 Tibial shields with second scale of the outer row not wider than long, adult with dark spots on the sides.............. *auberi.*

b^2 Nostril between the nasal plates.

c^1 More than twelve rows of ventral shields.

d^1 Eighteen longitudinal rows of ventral plates............ *cineracea.*

d^2 Fourteen longitudinal rows of ventral plates.

e^1 Chin and throat bright flesh color in sharp contrast to the coloration of the neck region.

f^1 Gulars forming a band of enlarged granules extending across the throat.................................... *erythrops.*

f^2 Gulars not forming a band, but three groups of enlarged granules. *erythrocephala.*

e^2 Chin and throat bluish or smoky.

f^1 Nine irregular occipitals............................. *fuscata.*

f^2 Five regular occipitals.............................. *aquilina.*

c^2 Less than or just twelve rows of ventral shields.

d^1 More than eight rows of ventrals.

e^1 Twelve rows of ventrals.

f^1 Dorsal granules small.

g^1 Preanal plates minute, and undifferentiated; brachial shields uniform in five or six rows of swollen scales.. *ameiva maculata.*

g^2 Preanal plates differentiated into a group of larger ones; brachial shields in two or three rows, outer row wider than others.

h^1 Dorsal surface spotted with white or yellow.

i^1 A black band on each side, the edges of which are undulating and have no white margin........... *tobagana.*

i^2 No lateral black band except in the young and these bands not margined with white...... *ameiva praesignis.*

h^2 Dorsal surface greenish or olive, often spotted with black.

i^1 Dorsal surface with heavy confluent spots of black.

j^1 Throat sprinkled with a few black spots..*ameiva ameiva.*

j^2 Throat smoky.

k^1 Brachials in three rows of subequal scales. *atrigularis.*

k^2 Brachials in one row of very large scales and three rows of smaller ones........*ameiva melanocephala.*

i^2 Dorsal surface with a few black spots not confluent.

j^1 A broad lateral band of brown on each side of the adult. *ameiva bilineata.*

j^2 Lateral stripe indistinct or wanting..*ameiva petersii.*

f^2 Dorsal granules large........................*ameiva laeta.*

e^2 Ten rows of ventral plates.

f^1 A single, part double, row of very large brachials continuous with the antebrachials.

g^1 Three posterior supraoculars surrounded with granules. *bifrontata.*

g^2 Three posterior supraoculars not entirely surrounded with granules...............................*bifrontata divisa.*

f^2 A series of small brachials not continuous with antebrachials.

g^1 Flanks and sides of thighs spotted with pale green, the spots arranged mostly in transverse rows...............*exsul.*

g^2 Spots much more numerous and covering the back as well as the flanks...............................*alboguttata.*

d^2 Eight or six rows of ventrals.

e^1 Eight rows of ventral plates.

f^1 A distinct median group of enlarged gular scales.

g^1 A single row of large postbrachials.......*undulata undulata.*

g^2 More than one row of postbrachials irregularly arranged.

h^1 Two irregular rows of postbrachials of moderate size. *undulata quadrilineata.*

h^2 Three irregular rows of postbrachials, the median row much larger than the others............*undulata parva.*

f^2 No distinct median group of enlarged gulars.

g^1 Second supraoculars divided longitudinally into several parts. *septemlineata.*

g^2 Second supraocular entire....................*edracantha.*

e^2 Six rows of ventral plates........................*bridgesii.*

DESCRIPTION OF THE SPECIES.

AMEIVA AUBERI Cocteau.

Description:— Adult male; M. C. Z. 7277. Camaguëy, (Puerto Principe), Cuba; 1908; T. Barbour.

Rostral forming a little more than a right angle behind; nostril on the posterior edge of the anterior nasal; anterior pair of nasals broadly in contact behind the rostral; frontonasal as long as wide in contact with the loreal; prefrontals broadly in contact; frontal in contact with the first and second supraocular; a pair of frontoparietals in contact with the third supraocular for nearly their entire length; five occipitals in a transverse row, the two in contact with the median, largest; seven supraciliaries; three supraoculars, the first separated from the loreal; two posterior supraoculars separated from the supraciliaries by a double row of granules; last supraocular separated from the outer occipitals by three rows of small scales; seven large supralabials; five large infralabials; between the infralabials and chin-shields a wedge of one to three rows of granules extending anteriorly to the first chin-shield; chin and throat covered with granules, an indistinct band of very slightly larger ones extending across the middle, the median ones forming an ill-defined central group of scarcely enlarged scales; on the area between the two throat folds several rows of large hexagonal scales; under side of the body with ten longitudinal and thirty-five transverse rows of plates; preanal plates, two anterior median, and three posterior marginal ones; on the lower arm a double row of antebrachials, one much wider than the other, both decreasing in width towards the elbow joint; on the upper arm a similar but narrower single row of brachials continuous with the antebrachials; on the posterior side near the elbow a small group of enlarged postbrachials; under side of the thighs covered with six or seven series of hexagonal plates of which the outer series is considerably larger than the others; thirteen and fourteen femoral pores; on the under side of the tibia two rows of plates those of the outer row enormously enlarged; upper side of the wrist with a regular series of transverse plates corresponding to the inner and outer metatarsals; outer toe extending approximately as far as the inner; tail covered with straight scales with keels; about thirty-five scales in the fifteenth ring from the base.

Coloration: — Ground color of dorsal surface olivaceous brown, slightly reddish anteriorly, grayer on the tail; three poorly defined narrow stripes of a lighter color on the back; the two lateral stripes bordered on their outer side by a series of broad, dark brown spots which tend to become confluent; the same two outer pale stripes are bordered on their inner side by a poorly defined and much lighter series of similar dark spots; flanks, sides of head, sides and upper surfaces of the tail and appendages covered with a network of irregular brown patches; ventral surface straw-color; traces of the same color on the head-shields.

Variation: — Females differ but little from the males. A specimen (M. C. Z. 7277) for example is slightly more bluish in tonality than the male described. On each side there is another pale stripe, more bluish in color, added to the three dorsal ones, and extending along the sides of the tail. The under surfaces of the body are light blue-green except for the appendages which are suffused with straw-color.

Young specimens often vary considerably from the adult. A specimen (M. C. Z. 6920) has on each flank two black bands edged with white while a narrow white line runs the length of the back in the median region. These lines are all very clear cut. The under side of the chin and throat varies from smoky to blackish, while traces of the same color extend down over the abdomen.

Remarks:— The description was made of a full grown male that measured seventy-seven millimeters from snout to vent.

Habitat:— Widely distributed throughout the whole of Cuba and the adjacent Isla de Pinos, but not very abundantly.

List of specimens examined.

M.C.Z. No.	No. of specimens	Ages	Sexes	Locality	Date	Collector	Remarks
6920	3	all	♂	Santiago, Cuba	1904	W. Robinson	Descrip. of im.
7277	2	ad.	both	Camaguëy, Puerto Principe, Cuba	1908	T. Barbour	Descrip. of ♂ & ♀
4388	1	"	♀	Bahia Honda, Cuba	1879	S. Garman	
7937	1	im.	♀	Cojimar, Havana, Cuba	1912	T. Barbour	
7938	1	"	♀	San Diego de los Baños, Cuba	1912	T. Barbour	
10823	1	ad.	♀	Guane, Cuba	1915	T. Barbour and W. S. Brooks	
10919–10923	5	all	both	Nueva Gerona, Isla de Pinos		T. Barbour and W. S. Brooks	
10868	1	ad.	♂	Cabo San Antonio, Cuba		C. de la Torre	

AMEIVA DORSALIS Gray.

Description:— Adult male; M. C. Z. 7334. Kingston, Jamaica; 1908; T. Barbour.

Rostral forming an acute angle behind; nostril on the posterior border of the anterior nasal; anterior pair of nasals just in contact behind rostral; frontonasal as long as wide, in contact with the loreal; prefrontals just in contact; frontal in contact with the first and second supraoculars; a pair of frontoparietals in contact with the third supraocular anteriorly; five occipitals in a transverse row, the two in contact with the median largest; seven and eight supraciliaries; three supraoculars, the first separated from the loreal; last two supraoculars separated from the supraciliaries by one or two rows of granules; posterior supraocular separated from the outer occipitals by two rows of large granules and a group of smaller ones; six large supralabials; five or six large infralabials; between infralabials and chin-shields a wedge of one to three granules extending anteriorly to the postmental; chin and throat covered with minute granules, an indistinct band of a trifle larger ones extending across the middle, on the area between the two throat folds several rows of large hexagonal scales; under side of the body with ten longitudinal and thirty-five transverse rows of plates; preanal plates three, the median forming a triangle, two smaller ones at the basal angles; on the lower arm a double row of antebrachials, one very wide, both breaking up into granules near the elbow joint; on the upper arm a single row of narrower, more spherical brachials not continuous with the antebrachials, on the posterior side near the elbow a row of enlarged postbrachials; under side of the thigh covered with four or five series of hexagonal plates of which the outer series is considerably larger than the others; twenty-one and twenty-two femoral pores; on the under side of the tibia two rows of plates, the outer ones being twice as large as the inner; upper side of the wrist with a regular series of transverse plates corresponding to the inner and outer metatarsals; outer toe extending a trifle further than the inner; tail covered with straight keeled scales; about forty scales in the fifteenth ring from the base.

Coloration: — Ground color of dorsal surface olive varying to blue posteriorly; a pale light blue stripe in the middorsal region beginning just behind the occiput and gradually widening to the tail; on the sides a double row of light spots somewhat confluent into two longitudinal stripes; a series of black confluent blotches among the lateral stripes; ventral aspect light yellow-blue anteriorly, varying posteriorly into a checker pattern of dark ultramarine and light yellow-blue spots especially distinct laterally.

Variation: — The female and the young are very similar to the male in coloration; but, although the pattern is the same, the colors are much richer. In the female the dark blotches of the sides are more numerous and confluent than those of the male, while in the young these dark areas are so much increased that they often surround the light spots and make a dark background for them as for example in the specimen M. C. Z. 7334 (same data as above). Ventrally, the young have a wash of turquoise-blue varying to yellow instead of the checker pattern.

Remarks:— The description was taken from a full grown adult male that measures eighty-nine millimeters from snout to vent.

Habitat:— Confined to Jamaica where it has become rare, because of the introduced mongoose.

List of specimens examined.

M.C.Z. No.	No. of specimens	Ages	Sexes	Locality	Date	Collector	Remarks
7334	10	all	both	Kingston, Jamaica	1908	T. Barbour	Descrip. ♂
5440	8	all	both	Kingston, Jamaica	1879	S. Garman	

AMEIVA THORACICA Cope.

Description:— Adult male; M. C. Z. 6965. New Providence Island, Bahamas; 1904; T. Barbour.

Rostral forming approximately a right angle behind; nostril on posterior part of the anterior nasal; anterior pair of nasals broadly in contact; frontonasal as long as wide, in contact with the loreal; prefrontals in contact broadly; frontal in contact with the first and second supraoculars; a pair of frontoparietals in contact with the third supraocular for nearly its entire length; five occipitals in a transverse row, the two in contact with the median slightly larger; seven supraciliaries; three supraoculars, the first separated from the loreal; two posterior supraoculars separated from the supraciliaries by a single row of granules, last supraocular partly by a double row; last supraocular separated from the outer occipitals by a double row of small scales; five and six large supralabials; six and seven large infralabials; between the infralabials and chin-shields a wedge of one to three rows of granules extending anteriorly to the postmental; chin and throat covered with minute granules, an indistinct band of very slightly larger ones extending across the middle; on the portion between the two throat folds several rows of large hexagonal scales; under side of the body with ten longitudinal and thirty-five transverse rows of plates; preanal plates in a subtriangular group of large scales irregularly arranged, but having four scales on the base and being three scales in height; on the lower arm a double row of small antebrachials and a single row of large ones, all gradually diminishing in size toward the elbow joint; on the upper arm a single row of brachials almost continuous with the antebrachials; on the posterior side near the elbow a single row of enlarged postbrachials; under side of thigh covered with six or seven series of hexagonal plates of which the outer series is considerably larger than the others; fourteen femoral pores; on the under side of the tibia two rows of plates, those of the outer being enormously enlarged; upper side of the wrist with a regular series of transverse plates corresponding to the inner and outer metatarsals; fifth toe extending approximately as far as the inner; tail covered with straight scales with keels; about thirty-five scales in the fifteenth ring from the base.

Coloration: — Ground color of dorsal surface olive-brown with traces of blue-gray posteriorly; on each side a rather wide black stripe becoming narrow anteriorly, extending posteriorly half the length of the tail; the black stripe on each side set off by two marginal stripes of pale blue; lower flanks and ventral surface turquoise-blue of low intensity; most of the throat, chest, and abdomen washed with black, darkest in the gular fold region; chin-shields, palms, lower surfaces of feet, lower side of tail washed with yellow.

Variation: — The female and young are very similar to the adult males except that the colors are brighter and the pattern more distinct. The pale margin of the lateral black bands become whitish anteriorly. There is often added a median stripe of pale blue-gray running the length of the back. Young specimens sometimes have no black throat, then the whole ventral surface is pale blue.

Remarks:— The description was made of an adult male that measured one hundred and eleven millimeters from snout to vent.

Habitat:— Common throughout its limited range which includes the Bahaman Islands of New Providence, Eleuthera, and Andros. It has been reported from Great Abaco but was not found there by the Harvard Bahama Expedition of 1904.

List of specimens examined.

M.C.Z. No.	No. of specimens	Ages	Sexes	Locality	Date	Collector	Remarks
6965	14	all	both	New Providence Island, Bahamas	1904	T. Barbour & G. M. Allen	Descrip.
7096	9	all	both	New Providence Island, Bahamas	1904	A. E. Wight	
6948	6	all	both	Mangrove Cay, Andros Island, Bahamas	1904	O. Bryant	
5823	3	ad.	♂	Bahamas	1886	C. J. Maynard	
6243	2	ad.	♂	New Providence Island, Bahamas	1888	C. S. Dolley	
6912	1	ad.	♂	New Providence Island, Bahamas	1900	T. Barbour	

AMEIVA CHRYSOLAEMA Cope.

Description:— Adult male; M. C. Z. 8622. Manneville, Haiti; 1913; W. M. Mann.

Rostral forming an acute angle behind; nostril on the posterior part of the anterior nasal; anterior pair of nasals broadly in contact behind rostral; frontonasal as long as wide, in contact with the loreal; prefrontals broadly in contact; frontal in contact with the first and second supraocular; a pair of frontoparietals separated from the third supraocular by a row of granules; five occipitals in a transverse row the three median ones about the same size and very much larger than the outer ones; three large supraciliaries and four or five smaller ones; four supraoculars, the first separated from the loreal; three posterior supraoculars separated from the supraciliaries by a double row of granules; five and six large supralabials; six and seven large infralabials; between infralabials and chin-shields a wedge of one to three rows of granules extending anteriorly to the postmental; chin and throat covered with minute granules; a scarcely differentiated band of large scales extending across the mid-region of which the median granules are largest; on the area between the two throat folds there are a few rows of large hexagonal scales; under side of the body with ten longitudinal and thirty-six transverse rows of plates; preanal plates in a triangular group four scales wide at the base and three scales in height, the larger scales in the middle; on the lower arm a double row of antebrachials, one very much wider than the other, both breaking up in the mid-region into six or seven series of small scales; on the upper arm two rows, proximally three rows of brachials; on the posterior side near the elbow a small group of enlarged postbrachials; under side of thighs covered with six or seven series of hexagonal plates of which the outer series is somewhat larger than the others; seventeen and eighteen femoral pores; on the under side of the tibia three rows of plates, distally four rows, the third and fourth plate of the outer row considerably enlarged; upper side of the wrist with a regular series of transverse plates covering only the outer region; outer toe extending a little further than the inner; tail covered with straight scales with keels; about forty-five scales in the fifteenth ring from the base.

Coloration: — Ground color of dorsal surface blue-gray; pattern of coloration like *A. vittipunctata* but the seven dorsal white lines running the length of the back broken up into a series of indistinct more or less confluent spots; on each side a rather indistinct black band sharply bordered by the broken white lines; ventral surface somewhat like *A. erythrocephala* in having a pale throat in distinct contrast to a dark chest and abdomen, but the throat is bluish instead of flesh-color, and the gular folds and chest are dark blue-gray suffused laterally by a brighter tone of blue; ventral surface washed posteriorly with straw-color.

Variation: — Another specimen, a female (M. C. Z. 8631) differs from the male in having the dark lateral bands more distinct and the longitudinal series of spots more nearly fused into lines as in *A. vittipunctata.* A young specimen (M. C. Z. 8629) is similar to the adult male except that the under parts are uniform blue-gray.

Remarks:— The description was made of an adult male that measured one hundred and one millimeters from snout to vent.

Habitat:— Confined to Haiti where it is still common.

List of specimens examined.

M.C.Z. No	No. of specimens	Ages	Sexes	Locality	Date	Collector	Remarks
8621–33	13	all	both	Manneville, Haiti	1913	W. M. Mann	Descrip.
6292	1	ad.	♀	Haiti			
8649–59	11	all	both	Diquini, Haiti	1913	W. M. Mann	

AMEIVA LINEOLATA Dumeril et Bibron.

Ameiva taeniura Cope, Proc. Acad. nat. sci. Phila., 1862, p. 63. Boulenger, Cat. lizards Brit. mus., 1885, **2**, p. 350.

Description:— Adult male; M. C. Z. 8691. Diquini, Haiti; 1913; W. M. Mann.

Rostral forming a trifle more than a right angle behind; nostril on posterior part of anterior nasal; anterior pair of nasals broadly in contact behind rostral; frontonasal longer than wide in contact with the loreal; prefrontals broadly in contact; frontal in contact with the first and second supraoculars; a pair of frontoparietals in contact with the third supraocular for their entire length; five occipitals in a transverse row, the two in contact with the median largest, seven supraciliaries; three supraoculars, the first separated from the loreal; two posterior supraoculars separated from the supraciliaries by a single, part double row of granules, last supraocular separated from the outer occipitals by two rows of granules and a small scale; five large supralabials; five large infralabials; between infralabial and chin-shields a wedge of one to three rows of granules extending anteriorly to the postmental; chin and throat covered with minute granules, a band of somewhat larger ones extending across the middle; on the area between the two throat folds a few rows of large hexagonal scales; under side of body with eight longitudinal rows (ten including the small scales), and thirty-four transverse rows of scales; preanal plates in a triangular group of three large plates, anteriorly two smaller plates in a transverse line; on the lower arm a double row, one very wide, of antebrachials decreasing in width toward the elbow joint; on the upper arm a similar but narrower single row of plates continuous with the antebrachials; on the posterior side near the elbow a small group of slightly enlarged postbrachials; under side of the thighs covered with four or five rows of hexagonal plates of which the outer series is considerably larger than the others; fifteen femoral pores; on the under side of the tibia two rows of plates, those of the outer much the larger; upper side of the wrist with a regular series of transverse plates corresponding to the inner and outer metatarsals; outer toe extending about as far as the inner; tail covered with keeled, oblique scales dorsally, with smooth straight scales laterally and ventrally; about twenty-eight scales in the fifteenth ring from the base.

Coloration: — Ground color of dorsal surface very dark olive-gray, head slightly darker; flanks black; two rather widely separated, narrow white bands on each side, the superior starting from the supraciliaries and the inferior from the ear, both extending half way down the tail; a row of indistinct white spots between these white stripes; lower flanks profusely spotted with white or bluish, the spots arranged more or less in vertical rows; ventral surface pale straw-color suffused with dull blue-gray, edges of the shield lightest; chin-shields and under sides of legs more straw-color.

Variation: — A female (M. C. Z. 8693, same data as above) is similar to the male except that there are no white spots on the lower flanks. A young specimen (M. C. Z. 8742, Manneville, Haiti, 1913,

W. M. Mann) shows the extreme of variation in the juvenile stages. The whole dorsal and lateral surfaces are jet black. Eleven, narrow whitish or milky stripes run longitudinally on the back and sides, the median one starting just behind the shoulders, the two adjacent ones coming to an apex about mid-way between the shoulders. The remaining eight stripes are nearly parallel, four arising on each side from the supraoculars, the supraciliaries, the upper and lower corners of the eye, respectively. The ventral surface is pale straw-color, suffused with deep blue on the tail. A slight wash of smoky covers the abdomen. The dorsal surface of the legs are spotted with white.

Remarks:— The specimen from which the description was taken was an adult male that measured eighty-six millimeters from snout to vent.

A careful examination of a series of twelve specimens of this species makes it clear that *A. taeniura* is the adult of *A. lineolata.* The specimens have a wide range of variation both in color and scutation. According to Cope (Proc. Acad. nat. sci. Phila., 1862, p. 64) the distinguishing characters of *A. taeniura* are mainly of color and tail scutation. One, however, of the specimens before us has the typical nine white bands, and keelless caudal plates of *A. lineolata.* Another specimen shows the extreme variation in this direction by having eleven dorsal bands and keelless caudal scales. Representing the other extreme are six specimens having the characteristic lateral bands and keeled scales of the tail of *A. taeniura.* The remaining individuals have the coloration of *A. lineolata* but the keeled caudal scales of *A. taeniura.* These characters grade into one another and all the intermediate steps are present. Garman (Bull. Essex. inst., 1887, **19**, p. 11) noticed the variation in the tail scutation, but pointed out the larger preanals, and the smaller mesotychium scales as characterizing *A. taeniura.* The larger series of specimens shows that these characters are not at all constant, and among the specimens there are many variations.

Dumeril et Bibron (Erpet gen., 1839, **5**, p. 119) in describing *A. lineolata* possessed but a single young specimen as shown by their measurements and by Bocourt's figures of the type (Miss. sci. Mex. Rept., pl. xxa, fig. 5). In our specimens, also, it is always the smaller individuals that have the typical *A. lineolata* characters.

Habitat:— Confined to Haiti where it is widely spread throughout both the republics.

List of specimens examined.

M. C. Z. No.	No. of specimens	Ages	Sexes	Locality	Date	Collector	Remarks
8691–95	5	all	both	Diquini, Haiti	1913	W. M. Mann	Descrip.
8742	1	yg.	♀	Manneville, Haiti	1913	W. M. Mann	Descrip. of young.
3614	3	ad.	both	Jeremie, Haiti	1859	D. F. Weinland	Type of *A. taeniura.*
5441	1	ad.	♂	Puerto Plata, San Domingo	1885	M. A. Frazar	
3608	5	all	both	Jeremie, Haiti		D. F. Weinland	
3609	1	ad.	♂	Jeremie, Haiti		D. F. Weinland	

AMEIVA VITTIPUNCTATA Cope.

Description:— Adult male; M. C. Z. 8618. Manneville, Haiti; 1913; W. M. Mann.

Rostral forming an acute angle behind; nostril on posterior part of anterior nasal; anterior pair of nasals in contact for but a fraction of their length behind rostral; frontonasal as long as wide in contact with the loreal; prefrontals narrowly in contact; frontal in contact with the first and second supraoculars; a pair of frontoparietals in contact with the third supraocular anteriorly; five occipitals in a transverse row, the median slightly larger than the others; seven and eight supraciliaries; three large supraoculars and a small scale posterior to them, the first supraocular separated from the loreal, two posterior supraoculars separated from the supraciliaries by a double row of granules; last supraocular separated from the outer occipitals by two rows of small scales and several rows of granules; five and six supralabials; five large infralabials; between the infralabials and the chin-shields a wedge of one to three rows on granules extending anteriorly to the postmental; chin and throat covered with granules, a band of slightly enlarged scutes extending across the middle, the median ones forming a distinct group of slightly larger ones; on the area between the two throat folds several rows of large hexagonal scales; under side of the body with twelve longitudinal and thirty-eight transverse rows of plates; preanal plates in a marginal row of eight scales, median smallest, and in a double median series of about four pairs; on the lower arm two narrow, one very wide, rows of antebrachials separated from the brachials by several rows of small scales;

on the upper arm three rows of brachials somewhat larger but grading into the granules of the arm; on the outer side near the elbow a group of postbrachials poorly differentiated from the granules of the arm; under side of the thighs covered with seven or eight series of plates in the mid-region, the outer series considerably larger than the others; nineteen femoral pores; on the under side of the tibia three rows of plates, the second and third scale of the outer row considerably enlarged; upper side of the wrist granular; outer toe extending a little further than the inner; tail covered with straight scales with keels; about forty-two scales in the fifteenth ring from the base.

Coloration: — General tonality dark olive-gray; six narrow whitish stripes and part of a seventh, running the length of the back; the space between the two innermost stripes the lightest, and that between the two outermost on each side the darkest — almost black; beneath the lowest stripe on the flanks a series of pale bluish spots arranged somewhat in longitudinal rows; ventral surface straw-color washed laterally with light blue-gray.

Variation: — The female and young are similar to the adult male except that their colors are brighter and the pattern is more distinct.

Remarks:— The description was made of an adult male that measured one hundred and eighteen millimeters from snout to vent.

Habitat:— Widely distributed throughout San Domingo and Haiti, but peculiar to the island.

List of specimens examined.

M. C. Z. No.	No. of specimens	Ages	Sexes	Locality	Date	Collector	Remarks
8614–19	6	all	both	Manneville, Haiti	1913	W. M. Mann	Descrip.
8634–44	11	all	both	Momance, Haiti	1913	W. M. Mann	

AMEIVA MAYNARDI Garman.

Description:— Adult male; TYPE M. C. Z. 6225. Great Inagua, Bahamas; 1888; C. J. Maynard.

Rostral forming about a right angle behind; nostril on posterior part of anterior nasal; anterior pair of nasals broadly in contact; frontonasal wider than long in contact with the loreal; prefrontals broadly in contact; frontal in contact with the first three supraoculars; a pair of frontoparietals in contact with the third and fourth supraoculars; five large occipitals in a transverse row, the median slightly the largest; seven supraciliaries; four supraoculars the first in contact with the loreal; three posterior supraoculars separated from the supraciliaries by a single row of granules; last supraocular separated from the outer occipitals by a double row of small scales; five large supralabials; five large infralabials; between infralabials and chinshields a wedge of three or four small scales extending only to the third infralabial; chin and throat covered with granules of slightly varying size, no distinct grouping of the larger granules; on the area between the two throat folds several rows of large hexagonal scales; under side of the body with eight longitudinal rows of scales (ten including the large granules terminal on each cross row) and thirty-five transverse rows; preanal plates, a pair of large marginal ones and a median pair of about the same size; on the lower arm a single, partly double row of antebrachials breaking up into granules just before reaching the elbow joint; on the upper arm a single row of much narrower brachials; on the posterior side near the elbow joint a double row of postbrachials scarcely differentiated from the granules of the arm; under side of the thigh covered with three rows (four proximally) of hexagonal plates of which the outer series is larger than the others; twelve femoral pores; on the under side of the tibia two rows of plates, the outer row greatly enlarged; upper side of the wrist with an irregular, part regular, series of transverse plates; outer toe extending a little further than the inner; tail covered with smooth, oblique scales; about thirty scales in the fifteenth ring from the base.

Coloration: — General tonality milky, slightly olive on the head, grayer on the tail; three dark brown or blackish bands running the length of the body but not extending on the tail; the median dark band arises in the occipital region and extends not so far as the thigh; the two lateral dark bands arise just before the eye and extend backward covering nearly all the flanks; ventral surface including the lower part of the flanks whitish tinged with blue; under surface of the tail, and the gulars tinged with greenish.

Variation: — The female and young differ from the adult males in being generally brighter, that is in being more black and white.

Remarks:— The description was made of an adult male that measured sixty-six millimeters from snout to vent.

Habitat:— Confined to Great Inagua in the southern Bahamas.

List of specimens examined.

M.C.Z. No.	No. of specimens	Ages	Sexes	Locality	Date	Collector	Remarks
6225	3	all	both	Great Inagua, Bahamas	1888	C. J. Maynard	Types Descrip.
10958 10959	2	ad.	both	Great Inagua, Bahamas		W. W. Worthington	

AMEIVA EXSUL Cope.

Description:— Adult male; M. C. Z. 2746. St. Thomas, D. W. I.; 1872; L. Agassiz.

Rostral forming an acute angle behind; nostril between the two nasals; anterior pair of nasals narrowly in contact behind rostral; frontonasal longer than wide in contact with the loreal; prefrontals broadly in contact; frontal in contact with the first and second supraoculars, just touching the third; a pair of frontoparietals in contact with the third supraocular anteriorly; five occipitals in a transverse row, the median largest; six or seven supraciliaries; four supraoculars, the first separated from the loreal; three posterior supraoculars separated from the supraciliaries by a double row of granules; last supraocular separated from the outer occipitals by three rows of granules; six large supralabials; five large infralabials; between the infralabials and chin-shields a wedge of from one to three granules extending anteriorly nearly to the postmental; chin and throat covered with minute granules, a faintly indicated band of slightly larger ones extending across the middle in which again the median ones form an ill-defined central group of somewhat enlarged scales; on the area between the two throat folds several rows of larger hexagonal scales; under side of the body covered with ten longitudinal and thirty-five transverse rows of plates; three large preanal shields forming a triangle; on the lower arm a series of very wide plates decreasing in width toward the elbow joint to form several rows of smaller hexagonal scales; on the upper arm a similar but narrower series of brachials not continuous with the antebrachials; on the posterior side near the elbow a small group of enlarged scales; under side of thighs covered with six or seven series of hexagonal plates of which three rows are considerably larger than the others; fourteen to fifteen femoral plates; on the under side of this tibia two rows of plates, two plates of the outer row enormously enlarged; upper side of the wrist with a regular series of transverse plates corresponding to the inner and outer metatarsals; outer toe extending about as far as the inner; tail covered with straight, keeled scales; about forty-three scales in the fifteenth ring from the base.

Coloration: — Ground tone of dorsal surface dull olive-green becoming more olive on the head and grayer on the tail; posterior part of the back with slight traces of black penciling; flanks, sides and upper surfaces of legs, and sides of tail spotted with pale blue-green, the spots arranged mostly in a series of transverse rows; on each flank a series of large irregular black spots; ventral surface straw-color, grayer on gulars, suffused along the sides with turquoise-blue.

Variation: — The females and young differ in general from the adult males by the presence of a pale line margined with blackish on each side of the body. In several specimens the pale line is indistinct and only the broad dark bands are present. Females are generally browner than the males and have a series of narrow blackish cross-bars on the back and flanks the interspaces of which are filled with roundish spots of isabella, more numerous posteriorly. The tail and the upper surfaces of the legs are similarly spotted. The young are generally more brightly colored than the females.

Remarks:— The description was made of a full grown adult male that measured one hundred and forty-five millimeters from snout to vent.

Habitat:— Common along the coast line of Porto Rico in the neighborhood of salt and fresh water preferably where the ground is sandy or gravelly; also found in the interior along the river courses but not reaching the high altitudes. Common in Saint Thomas, especially in the hills back of Charlotte Amalie, also in Vieques, St. John and Water Island, but probably extirpated in St. Croix where it was found before the introduction of the mongoose.

List of specimens examined.

M. C. Z. No.	No. of specimens	Ages	Sexes	Locality	Date	Collector	Remarks
2748	1	ad.	♂	St. Thomas, D. W. I.	1872	L. Agassiz	Descrip.
5432	1	ad.	♀	St. Thomas, D. W. I.	1879	S. Garman	
5433	4	all	both	St. Thomas, D. W. I.	1879	S. Garman	
6082–83	6	all	both	San Juan, Porto Rico	1879	S. Garman	

AMEIVA ALBOGUTTATA Boulenger.

Description:— Adult male; M. C. Z. 7898. Mona Island, W. I., 1908; B. S. Bowdish.

Similar to *A. exsul* in scutation except for the following: — five occipitals in a transverse row, the two adjacent to the median largest; last two supraoculars separated from the outer occipitals by four or five rows of small scales; four large infralabials and a fifth small one at the anterior extremity; preanal plates consisting of three large ones forming a triangle and two slightly smaller marginal ones on either side; on the upper arm a series of brachials more spherical than those of *A. exsul;* thirteen and fourteen femoral pores; about thirty-five scales in the fifteenth ring from the base.

Coloration: — Similar to *A. exsul* in ground color but tonality bluer and lighter; no black pencilings on the back; flanks blue-gray much lighter than those of *A. exsul,* and surmounted by a dark brown band which is somewhat broken into confluent spots; pale dapplings more numerous than in *A. exsul,* and covering the back, tail, and legs.

Remarks:— This form is so similar to *Ameiva exsul* that the distinguishing characters only are indicated in the description which was made of an adult male that measured ninety-six millimeters from snout to vent. As Stejneger (Rept. U. S. nat. mus. for 1902, 1904, p. 618) has pointed out this form as more readily distinguished from *A. exsul* by its numerous pale mottlings, than by any scutation characters. Only the specimen described was examined.

Habitat:— Confined to the small island of Mona.

AMEIVA WETMOREI Stejneger.

Stej., Proc. Biol. soc. Wash., 1913, **26**, p. 69.

Description: — TYPE U. S. N. M. 49731. Guanica, Porto Rico; May 20, 1912; A. Wetmore.

"Nostril between the two nasals; anterior nasals broadly in contact behind rostral; frontonasal broader than long, in contact with the loreal; prefrontals broadly in contact; frontal pentagonal, in contact with the first and second supraoculars, not touching third; a single hexagonal frontoparietal broadly in contact with the third, very narrowly with the second supraocular; three occipitals; five supraciliaries; three supraoculars, the first in contact with the first supraciliary, the others separated from the supraciliaries by a single row of fine granules; last supraocular in contact with outer occipitals; seven supralabials; six large infralabials; between infralabials and chin-shields posteriorly a single line of flat scales, the anterior ones not reaching the first pair of chin-shields; chin and throat covered with small scales or granules diminishing in size posteriorly; mesopthychium with a median patch of enlarged scales, the larger ones about four times the size of the chin granules; under side of the body with eight longitudinal and thirty-five transverse rows of rectangular plates; one large preanal plate, preceded by one much smaller, and this one by two still smaller ones placed transversely; on the lower arms two rows of large antebrachials, separated from the much smaller single row of brachials by small scales; on the lower edge of the upper arm a single series of enlarged postbrachials; under side of the thighs covered with two series of large scales or plates and three smaller ones; thirteen or fourteen femoral pores; under side of the tibia covered entirely across by three plates, of which the upper is larger than the other two together; upper side of the wrist with three series of enlarged plates; outer toe extending far beyond the inner (first) toe almost to the claw of the second; tail covered with smooth scales, the scales being oblique with parallel sides, except for the median row which is wedge shaped; about twenty-two scales in the fifteenth ring from the base.

Coloration: — Above dark brownish olive with seven distinct greenish white longitudinal lines, the median one somewhat wider than the others and starting from the tip of the tip of the snout, while the others originate in front of the eye, and continue some distance on the tail except for the outer row which terminate in the groin; upper side of limbs also dark olive-brown with very distinct round greenish white spots; under side greenish white darkening on tail. Mr. Wetmore describes the tail of the living animal as varying from brilliant emerald-green to grayish blue according to light, and the under side as dull clay-red."

Remarks:— The description was taken from the type and only known specimen; it measured forty-seven millimeters from snout to vent. It is probable that the specimen was about half grown.

Habitat:— An extremely rare and local form known only from Guanica, Porto Rico.

Ameiva polops Cope.

Description:— Type U. S. N. M. 30,695. St. Croix Island, D. W. I.; A. H. Riise. Type examined; photographs M. C. Z.

Rostral forming a right angle behind; nostril between the two nasals; anterior pair of nasals just in contact behind rostral; frontonasal slightly wider than long (in photograph), in contact with loreal; prefrontals broadly in contact; frontal in contact with the second, third, and fourth supraoculars; a pair of frontoparietals in contact with the fourth supraocular for almost its entire length (the two scales are separated posteriorly by a very few small granules); five occipitals, the two bordering the median the largest; eight supraciliaries; four supraoculars; last supraocular separated from the outer occipitals by a few small granules; seven supralabials five infralabials; between infralabials and chin-shields a wedge of a single row of granules extending anteriorly almost to the first chin-shield; chin and throat with small granular scales, median gulars very slightly enlarged; on the area between the two throat folds several rows of scales considerably enlarged; under side of body with ten longitudinal and thirty-two transverse rows of plates; preanal plates irregular, in pairs, the posterior pair largest and with a small median scale wedged between; a row of large brachials hardly continuous with a row of large antebrachials; a few large postbrachials; four series of femoral plates; two series of tibials inner small; (details of plates on arms and legs *fide* Boulenger, as the photographs do not show these characters distinctly); eighteen femoral pores; upper scales of tail oblique, scales of sides smooth, others indistinctly keeled.

Coloration: — Dorsal region olive-gray; on each side three longitudinal white lines, the upper faint; the interspace between the two upper white lines brown-black; between the two lower lines dusky; limbs gray flecked and lined with darker; lower surfaces greenish white; according to Boulenger, a white black-edged line along the hinder side of the femur and tibia and the anterior side of the latter.

Remarks:— The type is in good preservation; it measures $2\frac{3}{16}''$ from snout to vent and the tail is $5\frac{1}{16}''$ long.

The species is confined to the Isle of St. Croix (Santa Cruz), where it is either extremely rare or perhaps quite extinct. Recent collectors have been unable to secure specimens.

AMEIVA CORVINA Cope.

Description:— Adult male; TYPE M. C. Z. 3616. Labeled Jeremie, Haiti, but undoubtedly one of the types from Sombrero.

Rostral forming an acute angle behind; nostril on posterior border of anterior nasal; anterior pair of nasals just in contact behind rostral; frontonasal longer than wide in contact with the loreal; prefrontals broadly in contact; frontal in contact posteriorly with the first supraocular, for nearly its entire length with the second; a pair of frontoparietals separated from the third supraocular by a single row of granules; eight occipitals in a transverse row of three pairs plus a single terminal scale on each side; seven supraciliaries; four supraoculars, the first separated from the loreal; three posterior supraoculars separated from the supraciliaries by a single, partly double row of granules; last supraocular separated from the outer occipitals by three rows of small scales; seven large supralabials; five or six infralabials; between infralabials and chin-shields a wedge of a single row of granules extending anteriorly to the first chin-shield; chin and throat covered with minute granules, an indistinct band of very slightly larger ones extending across the middle, the median ones forming an ill-defined central group of scarcely larger ones; on the area between the two throat folds several rows of large hexagonal scales; under side of body with twelve longitudinal and thirty-six transverse rows of plates; preanal plates irregular and of varying size, the two median ones in a line with the axis of the body, and the two adjacent ones largest; on the lower arm one row of very wide, and two of very narrow antebrachials breaking up into small scales proximately; on the upper arm two or three rows of brachials, very slightly larger and grading into the granules of the arm; on the posterior side near the elbow a small group of slightly enlarged postbrachials; under side of the thighs covered distally with four rows of plates, outer row much the largest, breaking up proximally into ten or twelve smaller rows; thirty-four and thirty-six femoral pores; on the under side of the tibia four rows of plates those of the outer being about double the others; upper side of the wrist covered with granules; outer toe extending a little further than the inner; tail covered with straight, keeled scales; about thirty-three scales in the fifteenth ring from the base.

Coloration: — Upper and lateral surfaces dark brown tinged with olive or with blue, no pattern but nearly uniform dirt-color; head and tail more olive; ventral surface dark green, tinged with olive or with blue.

Variation: — There is apparently no variation in the female. We have been able to examine no young individuals, but it is probable that they also do not vary.

Remarks:— The description was made of an adult male that measured one hundred and eleven millimeters from snout to vent.

There is every reason to suppose that this specimen was one of the types. Cope when he described *Ameiva corvina* in 1861 stated that the types were in the Academy of natural sciences of Philadelphia (collected by Mr. Hanson) and in the Smithsonian institution (collected by Mr. Riise). Dr. Stejneger writes me that there are *no* specimens of this species in the U. S. N. M. and that there is no evidence that there ever were any. The types in the Philadelphia Academy collection are nos. 9115 to 9121. The additional specimens which Cope examined and which he credited to the Smithsonian collection are beyond doubt now in this Museum. One, M. C. Z. 5532, was received when the research collection of reptiles was sent to this Museum by the Peabody academy of science of Salem. It is marked as "a type of *A. corvina* Cope from Sombrero Island." It may have been given to the Museum in Salem by Cope, or received in exchange for the courtesy of permission to study and describe species in the Salem collection. The types of *Chamaeleo basiliscus* Cope and *Sepsina grammica* Cope were among those which Cope described from the

Salem collection and these are now in this Museum. The other specimens are four examples (M. C. Z. 3616) which are marked Jeremie, Haiti, collection of Dr. D. F. Weinland. Cope had the Weinland collection borrowed from the M. C. Z. for study at the time he described *Ameiva corvina* and when that Haitian material was returned these specimens were doubtless included. They are, we think, certainly the Riise specimens which were either destined for the Smithsonian or which had been borrowed from the collection by Cope before they had been entered in the Washington catalogue. These examples are those which Garman mentioned as types (Bull. Essex. inst., 1887, **19**, p. 10) but apparently without suspecting the erroneous locality, Jeremie, Haiti.

There is also the possibility that Cope really received these specimens from Cambridge, that the mixing with Haitian material took place there, and that he wrote the Smithsonian Institution by mistake for the Museum of Comparative Zoölogy. Such a lapsus would have been easy to make when he was constantly receiving specimens from both institutions. In any case two of these examples have been transferred to the U. S. National Museum. One of the other series of cotypes, from the Philadelphia Academy, has been received recently in exchange.

Habitat:— Apparently confined to the islands of Sombrero and Anguilla of the Lesser Antilles. It is unusual that a small island like Anguilla should have two species of Ameivas upon it, for *A. garmani* is peculiar to that island. It is quite probable that this locality record is incorrect.

List of specimens examined.

M.C.Z. No.	No. of specimens	Ages	Sexes	Locality	Collector	Remarks
3616	2	ad.	both	(?) Jeremie, Haiti	D. F. Weinland	Descrip. See Remarks
5532	1	ad.	♀	Sombrero Id., W. I.		Type
10535	1	ad.	♀	Sombrero Id., W. I.	Hanson	Cotype from Acad. nat. sci. Phila.

AMEIVA PLEII Dumeril et Bibron.

Ameiva scutata Gray, Cat. lizards Brit. mus., 1854, p. 19.
Ameiva analifera Cope, Proc. Amer. philos. soc., 1869, **11**, p. 158.

Description:— Adult male; M. C. Z. 6085. St. Bartholomew, F. W. I.; 1880; F. Lagois.

Rostral forming an acute angle behind; nostril on the posterior border of the anterior nasal; anterior pair of nasals narrowly in contact behind rostral; frontonasal longer than wide, in contact with the loreal; prefrontals broadly in contact; frontal in contact posteriorly with the first supraocular, for nearly its entire length with the second; a pair of frontoparietals separated for their entire length from the third supraocular by a double row of granules; eight occipitals in a transverse row consisting of a median pair and a group of three on either side; four supraoculars the first separated from the loreal; three posterior supraoculars separated from the supraciliaries by a single, partly double row of granules; last supraocular separated from the outer occipitals by three or four rows of small scales; seven large supralabials; five infralabials; between infralabials and chin-shields a wedge composed of a single row of granules and small scales extending anteriorly to the first chin-shield; chin and throat covered with minute granules, a distinct band of larger ones extending across the middle of which the median ones form an ill-defined central group of slightly larger ones; on the portion between the two throat folds several rows of large hexagonal scales; under side of the body with twelve longitudinal and thirty-four transverse rows of plates; preanal plates in a marginal row decreasing in size from the median pair, and in a median line one plate larger than the marginal ones, and another smaller one in advance of this; on the lower arm one row of very wide, and another narrow row of antebrachials breaking up into small scales proximally; on the upper arm three rows of brachials the median largest; on the posterior side near the elbow joint a group of slightly enlarged postbrachials; under side of thighs covered distally with four rows of plates, outer row considerably the largest; breaking up proximally into ten or twelve narrower rows; twenty-four and twenty-five femoral pores; on the under side of the tibia three rows of plates, those of the outer row greatly enlarged; upper side of the wrist covered with granules; outer toe not extending quite so far as the inner; tail covered with straight, keeled scales; about thirty-three scales in the fifteenth ring from the base.

Coloration:— Dorsal surface olivaceous gray, slightly yellowish especially on the head and tail; whole upper surface posterior to the shoulders spotted with pale whitish or yellowish blotches, those of the flanks being largest; ventral surface straw-color washed with blue on the belly.

Variation:— A female (same data as above) differs from the male in having fewer spots dorsally. A young specimen (same data) is very different from either of the adults. There are seven narrow white lines running the length of the upper surface of the body; the two outermost on each side border a wide brown band. In place of the pale spots of the adult male on the upper surface there are four series of black spots between the dorsal stripes. The ventral surface is paler and more green than that of the adult.

Remarks:— The description was made of an adult male that measured one hundred and twenty-two millimeters from snout to vent.

The confusion of the localities of Plee's specimens has already been discussed by Stejneger (Herpetology of Porto Rico. Rept. U. S. N. M. for 1902, 1904, p. 622–623) and by Barbour (Recent notes regarding West Indian reptiles and amphibians. Proc. Biol. soc. Wash., March 12, 1915, **23**, p. 73). *A. pleii,* like so many other of Plee's species, was described as coming from Martinique. Since, however, *A. analifera* and *A. pleii* are the same it is reasonable to assume that *A. pleii* originally came from St. Bartholomew where Plee probably touched on his way to Martinique. This leaves the Martinique Ameiva unknown, as indeed it will probably remain, because the introduced mongoose has for a long time been common there and every year does increasing harm to the fauna.

Habitat:— Confined to the closely associated islands of St. Martin and St. Bartholomew.

List of specimens examined.

M. C. Z. No.	No. of specimens	Ages	Sexes	Locality	Date	Collector	Remarks
6085	5	all	both	St. Bartholomew	1880	F. Lagois	Descrip.
4357	1	im.	♀	? ? Martinique [1]			
Phil. Acad.							
9143	1	ad.		? ? St. Eustatius			
9081	1	ad.		St. Bartholomew			
U.S.N.M.							
11176	1	ad.		St. Bartholomew			
11177	1	ad.		St. Martin			

AMEIVA GARMANI Barbour.

Description:— Adult male; TYPE M. C. Z. 6141; Anguilla Island; 1880; F. Lagois.

Similar to *A. pleii* in scutation from which it may be distinguished by the following characters:— median band of gular scales made up of larger and more irregularly arranged granules than those of *A. pleii;*

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[1] An old specimen, and not improbably one of the types of the species, doubtless received from the Paris museum. whence came all the early material in the M. C. Z. labeled "Martinique."

brachials slightly larger, postbrachials distinctly larger than those of this species; the largest of the outer tibials is larger than that of *A. pleii*, and also much wider; in *A. pleii* the width of this scale is about twice that of the adjacent scale proximally, while in *A. garmani* the two plates are about equal; upper side of the wrist covered with scales rather irregularly arranged; about thirty scales in the fifteenth ring from the base.

Coloration:— Lighter in color than *A. pleii*, with numerous pale, blue-gray or straw-color spots posteriorly, giving the legs the appearance of being gray reticulated with brown instead of brown with gray spots as in *A. pleii;* the heavy blotching extending down the tail, the spots being often bordered anteriorly with a zigzag rim of dark brown.

Remarks:— The relationship of this form to *A. pleii* is so close that a detailed description is not necessary. The description was made of an adult male that measured one hundred and twenty-six millimeters from snout to vent. Only one example seen.

AMEIVA ERYTHROCEPHALA (Daudin).

Ameiva punctata Gray, Ann. nat. hist., 1838, p. 277; Boulenger, Cat. lizards Brit. mus., 1885, **2**, p. 359. Zool. record. Reptiles, 1887, p. 11.

Description:— Adult male; M. C. Z. 10378. St. Christopher, W. I.; 1914; G. K. Noble.

Rostral forming an acute angle behind; nostril between the two nasals; anterior pair of nasals just in contact behind rostral; frontonasal longer than wide in contact with the loreal; prefrontals broadly in contact; frontal in contact with the first supraocular posteriorly, with the second supraocular anteriorly, the posterior half separated by a single row of granules; a pair of frontoparietals separated from the third supraocular by one to four rows of granules, five occipitals, the three median in a transverse row and slightly anterior to the outer two; nine supraciliaries, the posterior four small; four supraoculars, the posterior smallest and followed by a large granule, the first separated from the loreal; three posterior supraoculars separated from the supraciliaries by a double row of granules ending anteriorly in a large granule; last supraocular separated from the outer occipitals by four or five rows of granules; six and seven supralabials; six infralabials; between infralabials and chin-shields a wedge of one or two rows of granules extending anteriorly to the first chin-shield; chin and throat covered with minute granules, a band of slightly larger ones extending across the middle, the median ones and two groups slightly anterior and on either side of them largest; on the area between the two throat folds a small group of enlarged scales formed of five transverse rows of about six or seven scales each; under side of the body with fourteen longitudinal and thirty-six transverse rows of plates; preanal plates irregularly arranged, the three largest forming a triangular group crowded slightly out of the median line by two or three smaller ones; on the lower arm a single row of four or five wide plates breaking up into granules before reaching the elbow; on the upper arm three or four rows of brachials, median largest, others grading into the granules of the arm; on the posterior side near the elbow a small group of slightly enlarged postbrachials; under side of the thighs covered distally with five, proximally with ten or twelve rows of scales, outer row widest; thirty-eight and thirty-nine femoral pores; on the under side of the tibia two rows of large and three of small scales, outermost considerably larger than the other two; upper side of the wrist with a regular longitudinal series of plates covering the outer part of wrist and hand only; outer toe extending a little further than the inner; tail covered with straight keeled scales; about thirty-seven scales in the fifteenth ring from the base.

Coloration:— Dorsal surface dark olive-green slightly tinged in life with russet, head lighter and more reddish olive, the sides of which are almost rosy in life; numerous black pencilings on the back and sides arranged in a very wide median band, and two narrower more distinct lateral bands running the length of the body but fading off on the tail; chin and throat pale flesh-color in sharp contrast to the rest of the under parts which are blue-gray; the pale throat almost brilliant in life serving to distinguish this form from all others except perhaps the closely related *A. erythrops*.

Variation:— The females are similar to the males except that the dark pencilings on the back are more numerous and distinct, forming almost a network of black lines having a generally transverse direction. There is a suggestion of a pale line anteriorly on each side of the body. This becomes more distinct in the young and borders a dark lateral band on the upper side while a similar white line forms a lower margin to the stripe. Generally speaking the young are like the adult females. One specimen, however, (M. C. Z. 10376) has a pale throat which is not in sharp contrast to the pale blue-gray under parts, and there are no ultramarine blue spots on the outer ventral plates as found in the adults.

Remarks:— The description was made of an adult male that measured one hundred and twelve millimeters from snout to vent. Old males often grow much larger than this specimen.

Habitat:— Apparently confined to the island of St. Christopher where it is common about the town of Basse Terre especially on the low-lying uncultivated fields to the west of the settlement.

List of specimens examined.

M. C. Z. No.	No. of specimens	Ages	Sexes	Locality	Date	Collector	Remarks
10375–8	4	all	both	Basse Terre, Saint Christopher	1914	G. K. Noble	Descrip.
6091	7	all	both		1881	F. Lagois	
6092	15	all	both		1879	S. Garman	

AMEIVA ERYTHROPS Cope.

Careful search at the Philadelphia Academy has failed to reveal the types of this species and they are beyond doubt lost. A new description of this form so closely related to, yet seemingly distinct from *A. erythrocephala* would have been very desirable. The following is derived from the original description (Cope, Proc. Acad. nat. sci. Phila., 1871, p. 221).

Description:— Four supraorbitals; nine supraciliaries; five infralabials separated by a few intermedials from posterior labials; seven rows of larger gular scales extending entirely across the throat; three larger series on gular fold which has several rows of granules near margin; abdominal plates 12–14 series; brachials small in four rows; postbrachials small; antebrachials large, two rows hexagonal, one transverse; preanal scales two large median with a single row of one or two in front; small scales occur in some specimens behind the posterior two; outer hind toe a little longer than inner.

Coloration:— Color brownish olive, with a broad greenish band extending on each side of the back beginning on the nape, above the ear. In young specimens these bands are bright. Another less distinct band extends along the side from above axilla to groin. Between these and the dorsals, and across the back are transverse black reticulations. Belly greenish, the color appearing as spots on the outer scales. Thorax and edge of sides of fold black; throat bright yellow; sides of head red; upper surface brown; limbs olive with black reticulations.

Remarks:— Cope's description was made in part from an adult that measured one hundred and twenty-six millimeters from snout to vent.

It has been pointed out by both Garman and Barbour that this form is closely related to *A. erythrocephala* but until fresh specimens are examined it will be impossible to state how close this relationship really is. There are apparently no specimens of this species in any museum. It was from St. Eustatius.

AMEIVA PLUVIANOTATA Garman.

Description:— Adult male; TYPE M. C. Z. 6086; Plymouth, Montserrat, B. W. I.; 1879; S. Garman.

Rostral forming about a right angle behind; nostril in the posterior border of anterior nasal; anterior pair of nasals just in contact behind rostral; frontonasal longer than wide in contact with the loreal; frontal in contact with the first, second, and third supraoculars; a pair of frontoparietals separated from the third and fourth supraoculars by one to four rows of granules; occipitals irregular, median largest, a group of five or six scales on each side of it, the outermost somewhat larger than the others; eight supraciliaries, last four small; four supraoculars, the first separated from the loreal; three posterior supraoculars separated from the supraciliaries by a single row of granules; last supraocular separated from the outer occipitals by four rows of granules; six and seven supralabials; six infralabials; between infralabials and chin-shields a wedge of one or two rows of granules extending anteriorly to the first chin-shields; chin and throat covered with minute granules, an indistinct band of larger ones extending across the middle, the median ones largest, two other groups on either side not quite as large as these; on the area between the two throat folds a transverse series of enlarged scales, the median row much larger than the others; under side of the body with fourteen longitudinal and thirty-six transverse rows of plates; preanal plates, consisting of three median scales, the posterior largest and followed by two granules, also a transverse series decreasing in size from the median pair; on the lower arm three rows of scales, the outer very broad and low; on the upper arm three or four rows of small brachials, medials largest, others grading into the granules of the arm; on the posterior side near the elbow joint a small group of slightly enlarged postbrachials; under side of thigh covered distally with five, proximally with ten or twelve rows of scales, outer row slightly larger than the others; thirty-one and thirty-three femoral pores; on the under side of the tibia five rows of scales, outermost much larger than the others; upper side of the wrist with a regular series of transverse plates covering the outer margin only; outer toe extending about as far as the inner; tail covered with straight keeled scales; about thirty-nine scales in the fifteenth ring from the base.

Coloration:— Ground tone of dorsal surface dirt-brown, grayer posteriorly; upper surface of thighs, sides of tail very slightly spotted with blue-gray; ventral surface straw-color, smoky on the throat, chest and upper abdomen; the straw-color carried up as a few odd spots on the sides of the head and thighs.

Variation:— The females and young males are very different from the adult males in being generally grayer and profusely dappled with light blue-gray. One specimen, an adult female (same data as above) is generally olivaceous gray above. Two indistinct brown bands run the length of the flanks. The sides and upper surface of the body, appendages and most of the tail is profusely spotted with light gray, while the under surface is bluish except for the gular folds which are suffused with black. A young specimen (same data as above) is identical with the female. Oddly enough the lateral bands are even less distinct than in the adult.

Remarks:— The description was made of an adult male that measured one hundred and thirty-five millimeters from snout to vent.

This species is a noteworthy exception to the general rule that the young tend more to be distinctly striped than the adults.

We have examined only the ten types of this species the data for which is given before the description. In this series of specimens there are young and adults of both sexes.

Habitat:— Apparently confined to the island of Montserrat. The Ameiva from the neighboring island of Antigua is unknown, if one still occurs there.

AMEIVA ATRATA Garman.

Description:— Adult female; TYPE M. C. Z. 6084. Redonda Island, B. W. I.; 1880; W. J. Branch.

Rostral forming about a right angle behind; nostril on posterior border of anterior nasal; anterior pair of nasals just in contact behind the rostral; frontonasal a trifle longer than wide, just touching the loreal; prefrontals broadly in contact and partly surrounding a small scale posteriorly, frontal in contact with the first three supraoculars; a pair of frontoparietals in contact, anteriorly, with the third supraocular; seven occipitals, rather small, irregular and in a transverse row, the two adjacent to the median smallest, the two outermost largest; eight supraciliaries; four supraoculars, the first separated from the loreal; three posterior supraoculars separated from the supraciliaries by a single, part double row of granules; six large supralabials; five infralabials; between infralabials and chin-shields a wedge of one or two rows of scales extending anteriorly to the first chin-shield; chin and throat covered with minute granules, an indistinct band of scarcely larger ones extending across the middle, the median ones slightly largest; on the area between the two throat folds several rows of large hexagonal scales; under side of the body with twelve longitudinal and thirty-five transverse rows of plates; preanal plates in a marginal row, the two median largest and in a pair of large median plates just anterior to these; on the lower arm one row of wide and two of very narrow antebrachials, grading into four or five rows of smaller scales near the elbow joint; on the upper arm two or three rows of brachials scarcely larger and grading into the granules of the arm; on the posterior side near the elbow a small group of slightly enlarged postbrachials; under side of the thighs covered distally with four rows of plates, outer row much the wider, breaking up proximally into ten or twelve smaller rows; femoral pores twenty-nine and thirty; on the under side of tibia four rows of plates those of the outer being very much enlarged; upper side of the wrist covered with granules; outer toe extending a little further than the inner, tail covered with straight, keeled scales; about thirty-nine scales in the fifteenth ring from the base.

Coloration:— Upper and lateral surfaces uniform dark brown tinged with olive-green anteriorly with bluish gray posteriorly; ventral surface dark blue-gray spotted laterally with turquoise-blue of low intensity.

Remarks:— The description was made of an adult female that measured one hundred and four millimeters from snout to vent. The type is the only recorded specimen of this species. It is interesting to note the almost melanotic coloration of the Ameivas from the small islands of Sombrero and Redonda, which parallels that of the wall lizards (Lacerta) of Filfola and other rocky islets of the Mediterranean.

Habitat:— Confined to the small island of Redonda.

AMEIVA CINERACEA, sp. nov.

Description:— Adult male; TYPE M. C. Z. 10577. Grand Isle off Petit Bourg on the coast of Guadeloupe, F. W. I.; August 24, 1914; G. K. Noble.

Rostral forming slightly more than a right angle behind; nostril between the two nasals; anterior pair of nasals just in contact behind rostral; frontonasal longer than wide in contact with the loreal; frontal in contact with part of the first two supraoculars; a pair of frontoparietals in contact with the second supraocular posteriorly, the third anteriorly, separated from the posterior part of the third supraocular by one to four rows of granules; five occipitals, the median partly divided, arranged with outer two slightly posterior but in the same transverse line as the other three; nine supraciliaries; four supraoculars, first separated from the loreal; three posterior supraoculars separated from the supraciliaries by two or three rows of granules becoming fused into a single row anteriorly; last supraocular separated from the outer occipitals by three or four rows of granules; six supralabials; six and seven infralabials; between the infralabials and chin-shields a wedge of one to three rows of granules and scales extending anteriorly to the first chin-shield; chin and throat covered with minute granules a scarcely differentiated band of larger ones extending across the throat of which the median group of scutes and two groups anterior to it and on either side of it are composed of the largest granules; on the area between the two throat folds a transverse series of scales, about a dozen of the median scales, in a group, somewhat enlarged; under side of the body with eighteen longitudinal and thirty-eight transverse rows of plates; preanal plates small, almost granular, in a transverse row of seven or eight scales and in a median row of two or three; on the lower arm three short rows of scales, the outer scales being much divided, all of the scales decrease rapidly in size from the mid-region to the elbow; on the upper arm a series of oblique rows each formed of four scales; on the posterior side near the elbow joint a small group of postbrachials scarcely differentiated in size from the granules of the arm; under side of thighs covered with seven or eight rows distally, with twenty-five or more proximately; thirty-one femoral pores; on the under side of the tibia five rows of scales, the two proximal ones of the outer row considerably larger than the others, the second the larger of the two; upper side of the wrist with a regular series of plates covering the outer edge only; outer toe extending about as far as the inner; tail covered with straight, keeled scales; about forty scales in the fifteenth ring from the base.

Coloration: — Dorsal surface ashy gray, more bluish on the flanks, slightly more olivaceous on the head and tail; a trace of three indistinct stripes of a slightly darker tone of gray running the length of the body along the back; a suggestion of another dark stripe on each side; in places all five of these bands are indistinguishable from the ground tone; ventral surface straw-color or milky encroached upon laterally by the blue of flanks and of the side of head.

Variation: — Neither of the two females before us show any variation of color from that of the adult male described. In this respect this species is rather peculiar.

Remarks:— The description was made of an adult that measured one hundred and fifty millimeters from snout to vent.

Three adult specimens, 1♂ and 2 ♀♀ of this species were examined. Their numbers are M. C. Z. 10575–10577.

Habitat:— Apparently confined to a small low island, known locally as Grand Isle, lying about half a mile off shore from Petit Bourg, Guadeloupe. This island, only some fifty yards in extent, consists of a low tangled mass of vegetation upon a "coral" foundation. In character it is similar to the Isle of Grande Terre (a part of Guadeloupe politically) and from which it has doubtless been separated in comparatively recent geologic times. Since any considerable uplift would raise the bench bank on which the islands of Grande Terre and Guadeloupe both stand and bring both into connection with Grand Isle. The entire area between Grand Isle and both the main islands is simply an enormous *cul-de-sac* which is extremely shallow. There certainly cannot be more than a dozen or two of these Ameiva in this place. Observations made by the Junior author in Guadeloupe seem to show that this is the last place where the Guadeloupe Ameiva occurs.

AMEIVA FUSCATA Garman.

Description:— Adult male; TYPE M. C. Z. 6087. Dominica, B. W. I.; 1879; S. Garman.

Rostral forming slightly more than a right angle behind; nostril between the two nasals broadly in contact behind rostral; frontonasal longer than wide in contact with the loreal; prefrontals in broad contact; frontal in contact with the first two supraoculars, separated from the third supraocular by one to three rows of granules; occipitals irregular, a median group of three small ones, on each side of this a very large scale, further to the side and posterior to these two scales, a group of two or three small ones; nine supraciliaries; three supraoculars, the first separated from the loreal; two posterior supraoculars separated from the supraciliaries by one or two rows of granules; last supraocular separated from the outer occipitals by four or five rows of granules; six supralabials; six and seven infralabials; between infralabials and chin-shields a wedge of one or two rows of granules and scales extending anteriorly to only the second chin-shield; chin and throat covered with minute granules of somewhat varying size, a band of distinctly larger ones extending across the middle, the median scutes enlarged to form an ill-defined group; on the area between the two throat folds three or four transverse rows of scales, the middle row widest, the scales of all the rows grading off sharply in size from the mid-region; under side of body with fourteen longitudinal and thirty-four transverse rows of scales; preanal plates in a longitudinal, median row of four large plates with several scales on each side, the posterior ones largest; on the lower arm three rows of antebrachials, outer row considerably larger than the others, all breaking up into small scales before the elbow joint; on the upper arm three rows of brachials, median largest; on the posterior side near the elbow joint a small group of small postbrachials; under side of the thighs covered with four rows distally, with fourteen proximally, outer row just above the knee formed of the widest scales; twenty-eight femoral pores; on the under side of the tibia five rows of scales, the two proximal ones of the outer row considerably larger than the others and both subequal; upper side of the wrist with a regular series of plates covering the outer edge only; outer toe extending a little further than the inner; tail covered with straight keeled scales; about forty-six scales in the fifteenth ring from the base.

Coloration: — Since the type specimen described is somewhat faded, another specimen (M. C. Z. 10571; adult male, collected 1914 on Dominica by A. G. Ruthven) is used for coloration. Dorsal surface very dark olive-blue; on each side, a row of irregular pale blue spots; upper surfaces of thighs spotted with the same color; ground tone of ventral surface straw-color; outer ventrals, lower part of flanks with two or three rows of pale bluish spots; whole throat, chest, and anterior part of the abdomen washed with very dark blue.

Variation: — The females are similar to the males but the colors are generally brighter. A young specimen (M. C. Z. 6087, same data as above) differs somewhat from the adults. Instead of the pale lateral spots, there is present a pale stripe on each side of the body. The flanks are blacker than the back and there are no series of light spots on its lower edge. The ventral surface is washed with blue-gray.

Remarks:— The description of the scutation was taken from an adult male that measured one hundred and fifty-four millimeters from snout to vent; the color notes from a slightly larger individual.

Habitat:— Confined to the island of Dominica where it is found commonly just outside of the town of Rouseau, "especially in the hills among the plantings of cocoa trees." (Ruthven, *in litt.*).

List of specimens examined.

M. C. Z. No.	No. of specimens	Ages	Sexes	Locality	Date	Collector	Remarks
6087	3	all	♂	Dominica, B. W. I.	1879	S. Garman	Types Descrip.
10571	1	ad.	♂	Dominica, B. W. I.	1914	A. G. Ruthven	Descrip.
U. of Mich. Mus.		ad.	♀	Dominica, B. W. I.	1914	A. G. Ruthven	

AMEIVA AQUILINA Garman.

Description:— Adult male; TYPE M. C. Z. 6088. Grenada, B. W. I.; 1879; S. Garman.

Rostral forming a trifle less than a right angle behind; nostril between the two nasals; anterior pair of nasals broadly in contact behind rostral; frontonasal longer than wide in broad contact with the loreal; prefrontals broadly in contact; frontal in contact with the first two supraoculars, with the second for its entire length; a pair of frontoparietals separated from the third supraocular by one or two rows of granules; five subequal occipitals, the three median ones in a transverse line, the other two beyond these and slightly posterior; seven supraciliaries; four supraoculars, the first separated from the loreal; the three posterior supraoculars separated from the supraciliaries by a single row of granules ending anteriorly in a large granule, last supraocular separated from the outer occipitals by two or three rows of granules; five large supralabials; six infralabials; between infralabial and chin-shields a wedge of one or two rows of granules and scales extending anteriorly half the length of the second chin-shield; chin and throat covered with minute granules, a band of distinctly larger ones extending across the middle, the median scales largest and forming an ill-defined group; on the area between the two throat folds three or four transverse rows of scales all about the same size; under side of the body with fourteen longitudinal and thirty-three transverse rows of plates, the outer very small; preanal plates irregular, placed more or less in a series of transverse rows, a median group of four scales largest; on the lower arm three rows of antebrachials, outer row considerably larger than the two inner which are somewhat irregular, the series extending to the brachials; on the upper arm three rows of brachials the median row slightly the largest; on the posterior side near the elbow joint a small group of postbrachials; under side of thighs covered with four rows distally, with fifteen proximally, outer row just above the knee formed of wider scales; eighteen and nineteen femoral pores; on the under side of the tibia five regular rows of plates, the second and third scale proximally of the outer row largest; upper side of the wrist with a regular series of transverse plates corresponding to the inner and outer metatarsals; outer toe extending a little further than the inner; tail covered with straight, keeled scales; about forty-one scales in the fifteenth ring from the base.

Coloration:— Dorsal surface olive-brown more bluish on the sides of the head and appendages; on either side of the body a broad rufous brown band, the edges of which are somewhat undulating, extending part way down the tail; sides of the body with four or five longitudinal rows of pale blue or milky spots; ventral surface straw-color, washed on the sides with bluish; outer ventrals, edges of the lateral spots often reticulated or marked with black.

Variation:— A female (same data as above) differs from the male in being more brightly colored. The dark lateral bands are almost black. On the back between these two bands there is a regular longitudinal series of two rows of dark spots. The dark bands on the sides are bordered by a series of pale spots. The flanks below the bands have each one or two more rows of similar spots. The outer ventrals are heavily marked with brown instead of black. A young male (same data as above) is similar to the adult female except that the region below the dark bands is considerably darker.

Remarks:— The description was taken from an adult male that measured one hundred and twenty-two millimeters from snout to vent.

Habitat:— Apparently confined to St. Vincent and Grenada, though it is probable that it also occurs in some of the Grenadines. In spite of the mongoose this species which was once almost exterminated seems now to be on the increase,— a peculiar fact due probably to the lizards' change of habits. Dr. Allen noticed this in Grenada and the same thing has been reported in Jamaica as happening with *Ameiva dorsalis*.

List of specimens examined.

M. C. Z. No.	No. of specimens	Ages	Sexes	Locality	Date	Collector	Remarks
6088	8	all	both	St. George, Grenada	1879	S. Garman	Descrip. Types
6089	25	all	both	Kingston, St. Vincent	1879	S. Garman	Types
8092–8	7	all	both	Sauteurs, Grenada	1910	G. M. Allen	
6090	2	ad.	both	St. George, Grenada	1886	W. B. Richardson	

AMEIVA TOBAGANA (Cope).

Dr. Stejneger has been kind enough to supplement photographs of the type of this species, with the following excellent description.

"Rostral forming an acute angle behind; nostril between two nasals; anterior pair of nasals broadly in contact behind rostral; frontonasal longer than wide, in contact with nasals, loreal, and prefrontals; prefrontals broadly in contact; frontal pentagonal, in contact with first and second supraoculars, well separated from third; a pair of frontoparietals in contact with second and third supraoculars anteriorly; five occipitals in a transverse row, much longer than wide, median not larger than adjoining pair; seven superciliaries; four supraoculars, the first in contact with two anterior superciliaries, and separated from the loreal by the first of the latter; three posterior supraoculars separated from the superciliaries by a single row of granules; the last two supraoculars separated from outer occipitals by two rows of small scales or granules; loreal undivided; seven large supralabials, third, fourth, and fifth longest, first in contact with posterior nasal, scarcely with anterior, second in contact with posterior nasal, third with posterior nasal and loreal; center of temples granular, the size of the granules increasing gradually downward and forward; a series of four distinctly enlarged scales from the postocular backwards; mental followed by an unpaired postmental; six large infralabials, third and fourth largest; first pair of chin-shields broadly in contact except at the extreme posterior end; between infralabials and chin-shields an interrupted single series of granules, extending from the second chin-shield backwards, third infralabial in contact with first and second chin-shields, and fourth infralabial in contact with fourth chin-shield; chin and throat covered with granules of varying sizes, the larger ones in the middle in four ill-defined groups, one anteriorly in the angle between the jaws, the second forming a band across the throat at the level of the ears, rather sharply defined posteriorly against the granules behind, the third a median group in front of the first transverse fold, and the fourth a transverse group of about three rows on the mesopthychium, the enlarged scales on the second and third being considerably larger than the others; back, sides, and upper sides of limbs covered with very fine uniform granules, slightly smaller on the sides, and larger on the limbs; under side of body anteriorly with ten, posteriorly with twelve longitudinal and thirty-two transverse rows of square plates; on the preanal region an ill-defined group of about ten somewhat enlarged scales of varying size and shape; on the lower arm a series of wide plates (antebrachials) decreasing rapidly in size, and replaced by large granules or small hexagonal scales before reaching elbow joint; on the upper arm two distinct rows of similar but narrower scales, surrounded by somewhat slightly smaller scales, gradually decreasing in size, widely separated from the antebrachial series; on the under side near the elbow a group of slightly enlarged hexagonal postbrachials; seventeen femoral pores on the right side, eighteen on the left; under side of thighs covered with about five series of somewhat enlarged hexagonal plates, only the outer series being regular and somewhat larger than the others; on the under side of tibia four rows of enlarged hexagonal plates, those of the outer series very much larger than the others; upper side of wrist with four regular series of transverse plates corresponding to the metatarsals; first (inner) toe extending very slightly beyond the fifth (outer), fourth toe extending beyond the third for a distance much longer than the third toe with claws;[1] tail covered with keeled scales in rings, scales being straight and the keels nearly parallel with the sides of the scales; about forty-three scales in the fifteenth ring from the base."

DIMENSIONS.

	mm.
Total length	288
Snout to vent	95
Tail	193
Snout to ear	23
Width of head	15
Fore leg from axilla	35
Hind leg from groin	76
Outer toe without claw	9
Inner toe without claw	5

Description:— TYPE U. S. N. M. 10113. Tobago, West Indies; F. A. Ober.

AMEIVA ATRIGULARIS Garman.

Description:— Adult male; TYPE M. C. Z. 6080. Trinidad, B. W. I.; 1879; C. S. Cazabon.

Rostral forming about a right angle behind; nostril between the two nasals; anterior pair of nasals in broad contact behind rostral; frontonasal longer than wide in broad contact with the loreal; prefrontals in broad contact; frontal in contact with the first two supraoculars, with the second for its entire length; a pair of frontoparietals separated posteriorly by one or two rows of granules from the third supraocular; five subequal occipitals, the two adjacent to the median slightly larger than the others; four supraoculars, the first separated from the loreal; three posterior supraoculars separated from the supraciliaries by a single row of granules ending anteriorly in a large granule; last supraocular separated from the outer occipitals by two or three rows of granules; five and six large supralabials; six infralabials; between infralabials and chin-shields a wedge of one or two rows of granules extending anteriorly half the length of the second chin-shield; chin and throat covered with small granules, a broad group in the median posterior region formed of large scales but varying gradually into the others; on the area between the two throat folds three or four rows

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[1] In *exul* fourth toe extends beyond third not more than length of third toe without claw.

of scales, median largest; under side of the body with twelve longitudinal and thirty-three transverse rows of plates, the scales of the outer row much smaller than the others; preanal plate in a triangle of three large scales, with a smaller scale at each of the basal angles, and another at the base of the median suture; on the lower arm three rows of antebrachials, the outer row widest, the two inner somewhat irregularly arranged, the series extending to the brachials; on the upper arm three rows of brachials all about the same size; on the posterior side near the elbow joint a group of small postbrachials; under side of the thighs covered distally with four, proximally with twelve rows of scales; sixteen and seventeen femoral pores; on the under side of the tibia three, or partly four rows of plates, outer widest; upper side of the wrist with regular series of plates, longitudinally arranged; outer toe extending not so far as the inner; tail covered with straight, keeled scales; about fifty scales in the fifteenth ring from the base.

Coloration: — Dorsal surface pale olive-brown, slightly more reddish on head; upper and lateral surface of the body, legs, and tail finely speckled with black, the spots confluent posteriorly into reticulations; flanks with six or seven longitudinal rows of white spots encircled often with black, the lower three rows on the outer ventrals; sides of the tail spotted irregularly with black and white; chin and gular region, part of the sides of head and arms black; ventral surface straw-color encroached upon by the spotting of the sides and the dark wash of the throat.

Variation: — An adult female (same data as above) differs from the male in that the dark confluent spots are much less numerous. The general tonality is pale, and the lateral spots are not sharply defined. A young male (same data as above) differs considerably from the adult. Although having the same general ground tone there are no black specklings. On each side there is a broad black stripe, stifled with a few white spots. The outer ventrals have two rows of black spots on either side. There is no black on the chin, throat, or sides of the head.

Remarks:— The description was made of an adult male that measured one hundred and fifty-five millimeters from snout to vent.

We have examined only the types of this species, M. C. Z. 6079 and 6080. There are fifteen specimens in this series, young and old of both sexes.

Habitat:— Apparently confined to the island of Trinidad.

AMEIVA AMEIVA AMEIVA (Linné).

Seps surinamensis Laurenti, Syn. Rept., 1768, p. 59.
Ameiva surinamensis Boulenger, Cat. lizards, Brit. mus., 1885, **2**, p. 352.

Description:— Adult male; M. C. Z. 6077. Paramaribo, Dutch Guiana, (Surinam); 1886; Wm. B. Richardson.

Rostral forming a trifle less than a right angle behind; nostril between the two nasals; anterior pair of nasals broadly in contact; frontonasal a trifle longer than wide, in contact with the loreal; prefrontals broadly in contact; frontal in contact with the first two supraoculars except for an abnormal granule lying on the suture; two pairs of frontoparietals, posterior smaller, both except for the anterior part of the first pair separated from the third and fourth supraocular by one to three rows of granules; five occipitals in a transverse row, the median one smaller and slightly anterior to the others; six supraciliaries; four supraoculars the first separated from the loreal; three posterior supraoculars separated from the supraciliaries by a single row of granules; last supraocular, part of the next to last separated from the outer occipitals by three or four rows of granules; seven large supralabials; five large infralabials; between infralabials and chin-shields a wedge of a single row of granules extending anteriorly to the middle of the second chin-shield; chin and throat covered with granules, an ill-defined band of larger ones extending across the throat of which a broad group in the median posterior region is composed of the largest granules; on the area between the two throat folds four or five irregular rows of scales, the median two rows widest; under side of the body with twelve longitudinal and thirty-three transverse rows of scales, the two outer scales on each side of the transverse rows much the smallest; preanal plates in a triangle of three large scales with another smaller scale at each of the basal angles; on the lower arm, two, or part three, rows of antebrachials, the outer widest; on the upper arm a single (partly double) row of very large brachials continuous with the antebrachials; on the posterior side near the elbow a group of small postbrachials; under side of thighs covered distally with four, proximally with twelve rows of scales; twenty-one femoral pores; on the under side of the tibia three, part four rows of plates, outer widest; upper side of the wrist covered with scales forming a regular series of longitudinal rows; inner and outer toe extending approximately the same; tail covered with straight, keeled scales; about forty-one scales in the fifteenth ring from the base.

Coloration: — Dorsal surface pale olive-brown tinged with green; head and neck, upper part of arms heavily spotted with black, the spots confluent and forming irregular bars and triangles; sides of body with a series of whitish spots arranged in vertical rows, each spot surrounded with black; these black areas somewhat confluent into vertical rows; on each flank the trace of a white stripe running from the thighs only part way the length of the abdomen; two blackish stripes on each side of the tail; ground color of ventral surface straw-color tinged with bluish; gular and chin region sprinkled with black, outer ventrals heavily spotted with the same color.

Variation: — This species and its several races vary considerably in both scutation and coloration. As mentioned (p. 462) the rows are not sharply defined; the characters blend one into another. The sexual differences are not very constant. In general a female is browner and has not as many confluent black spots on its upper surface. None of the variations of scutation seem to be sexual. A young female (same data as above) falls within the scutation variations but its coloration is rather distinctive. On each side of the body there is a wide black stripe margined with white, running from the eye half way down the tail. No black spots are to be seen on the upper surface of the body or head, but a few dark mottlings are found below the black stripes. The under surface is pale blue varying to straw-color; there are no black spots on the gulars.

Remarks:— The description was made of an adult male measuring one hundred and eighteen millimeters from snout to vent. Old males often grow much larger than this specimen.

Habitat:— Widely distributed over the northeastern part of South America from the Demerara River in British Guiana as far south as Bahia, Brazil, inland along the Amazon to as far west as the Madeira River.

List of specimens examined.

M.C.Z. No.	No. of specimens	Ages	Sexes	Locality	Date	Collector	Remarks
6077	2	ad.& yg.	both	Paramaribo, Dutch Guiana	1886	W. B. Richardson	Topotype Descrip.
1169	2	ad.& h. g.	both	Para, Brazil	1862	J. C. Fletcher	
5533	1	ad.	♀	Para, Brazil			Bought 1886
5536	1	yg.	♂	Para, Brazil			Bought 1886
5531	2	ad.	♂	Para, Brazil			Bought 1886
1014	2	h. g. & yg.	♂	Para, Brazil	1859	C. Cooke	
2174	1	ad.	♂	Mana, F. Guiana			Bought
2 ?	1	ad.	♂	Para, Brazil		Wm. Knight	

M.C.Z. No.	No. of specimens	Ages	Sexes	Locality	Date	Collector
3361	1	h. g.	♀	Santarem, Brazil	1865, 6	L. Agassiz
2608	4	ad.	both	San Gonçalla, Brazil	1865, 6	L. Agassiz
2781	1	ad.	♂	Santarem, Brazil	1865, 6	L. Agassiz
3395	1	ad.	♂	Brazil	1865, 6	L. Agassiz
1158	1	ad.	♂	Villa Bella, Brazil	1865, 6	L. Agassiz
2624	1	ad.	♂	Silva Lake, Brazil	1865, 6	L. Agassiz
2632	1	ad.	♂	Maués, Rio Madeira, Brazil	1865, 6	L. Agassiz
2907	2	ad.	♂	Rio Puty, Brazil	1865, 6	L. Agassiz
2888	1	ad.	♂	Para, Brazil	1865, 6	L. Agassiz
3308	1	ad.	♀	?	1865, 6	L. Agassiz
2813	1	ad.	♂	Santarem, Brazil	1865, 6	L. Agassiz
3314	1	ad.	♀	Santarem, Brazil	1865, 6	L. Agassiz
3311	2	ad.	both	Tajapurú, Brazil	1865, 6	L. Agassiz
U. of M.						
43961	1	ad.	♂	Tumatumari, British Guiana	1912	E. B. Williamson

AMEIVA AMEIVA BILINEATA, subsp. nov.

Description:— Adult male; TYPE Mus. of Zoöl., Univ. Mich. 46142. Dunoon, Demerara River, British Guiana; August 24, 1914; A. G. Ruthven.

Similar to *Ameiva a. ameiva* in scutation but between *A. a. petersii* and *A. a. melanocephala* in coloration; ground color of dorsal surface dark olive-blue; a few indistinct black blotches on the head forming on the body two parallel rows from the shoulders to the thighs; on each side of the body a broad stripe of dark brown, the lower margin of which is indistinct because of the dark flanks; a series of white spots more or less regularly arranged in ventral rows covering the sides of the body and the outer ventrals; similar but bluish spots covering the sides of the thighs; under surface pale blue of a low intensity; throat sprinkled with a few black spots extending partly over the sides of the head.

Variation:— Females, for example U. of M. 46150 (same data as above), are readily distinguishable from the males by their browner tonality, by a distinct lateral band of dark brown and by the absence of white spots on the lower flanks. Instead of the spots there is a series of indistinct milky bars somewhat confluent especially just below the broad lateral band where they form a white margin for a part of its length. About the anal region and on the femoral pores there is a delicate salmon blush, a distinctive character in two of the three females examined.

Remarks:— The description was made of an adult male that measured one hundred and six millimeters from snout to vent.

We have examined five specimens, adults, of both sexes, from the University of Michigan No. 46137, 46140, 46141, 46141, 46142 and 46150. These were all taken August, 1904, at Dunoon, Demerara River, by Dr. A. G. Ruthven and his assistant Mr. Frederick Gaige. Thanks to Dr. Ruthven's generosity the Museum of Comparative Zoölogy has been able to retain one of the paratypes mentioned above.

Habitat:— Apparently confined to the region between the Demerara and Orinoco Rivers.

AMEIVA AMEIVA MELANOCEPHALA, subsp. nov.

Description: — Adult female; TYPE M. C. Z. 9993. Cumanacoa, Venezuela; 1896; W. H. Phelps.

Similar to *Ameiva a. ameiva* in scutation except for the median gulars which are larger in this race and form a distinct group; unlike any of the other races of *Ameiva ameiva,* the throat, under side of neck and upper part of chest, of this form, are smoky; dorsal surface dark brown; numerous confluent black spots on the upper surface and extending down over the outer ventrals; an indistinct stripe on each flank margined by two light ones; ventral surface straw-color posteriorly, smoky anteriorly; legs and tail spotted with smoky blue.

Variation:— Three males from La Guayra, Venezuela, although having the characteristic smoky throat differ in other ways from this female in coloration. For example one specimen, U. S. N. M., 27788, is olive-gray above. There are no dark confluent spots nor any lateral stripes, but on each flank a series of pale blue spots, surrounded by dark circles. These spots are arranged somewhat irregularly in vertical rows. On the ventral side the smoky wash of the throat extends down over the abdomen. A young specimen M. C. Z. 9994 (same data as female described) has the broad lateral stripe of dark brown bordered with white. There is a faint smoky wash over the throat, and the lateral white spots are very faint. Only a few dark spots appear on the back.

Remarks:— The description was made of an adult female measuring one hundred and thirty-five millimeters from snout to vent.

We have examined three specimens from Cumanacoa, M. C. Z. 9993–5, adults and young. By the kindness of Dr. L. Stejneger we were able to compare with them three adult males, U. S. N. M., 22526, 27787 and 27788, from La Guayra, Venezuela, collected by

W. Robinson, and recorded by Dr. Stejneger in Proc. U. S. N. M., 1902, **24**, p. 183.

Habitat:— Probably widely distributed throughout Venezuela.

AMEIVA AMEIVA PETERSII (Cope).

Ameiva pleurotaenia Peters, Monats. Berl. acad., 1871, p. 398, 652.

Description:— Adult male; M. C. Z., 3023. Teffé, Brazil; 1865; L. Agassiz.

Similar to *Ameiva a. ameiva* from which it may be distinguished by the following characters:— Gulars forming a distinct group of considerably enlarged scales in the middle of a band of others slightly enlarged; three rows of brachials instead of two, the scales of which are larger than those of *Ameiva ameiva;* dorsal surface pale-olive tinged with bluish; upper and lateral surfaces of the body sprinkled with black, the spots unlike *Ameiva ameiva,* not being confluent; under part of neck and chin similarly spotted; on each flank a series of whitish spots in vertical rows, the spots more or less surrounded with black; below the series of white spots and on the outer ventrals numerous irregular black blotches; on each side of the body a trace of two broad lateral bands of brown.

Variation:— A female (same data as above) differs from the male in that the dark spots on the back and head are nearly absent. The lateral dark stripes are more distinct than those of the male. On the lower border of these stripes there is on each side a narrow white line bordered with black extending the length of the body. A young male M. C. Z. 3432 (same data as above) is indistinguishable from the young of *Ameiva ameiva* in color except that the general tonality is darker.

Remarks:— The description was made of an adult male that measured one hundred and sixty-two millimeters from snout to vent.

Habitat:— Found along the upper Amazon, probably from the Madeira River westward.

List of specimens examined.

M.C.Z. No.	No. of specimens	Ages	Sexes	Locality	Date	Collector	Remarks
3023	4	ad.	both	Teffé, Brazil	1865	L. Agassiz	Descrip.
3432	1	yg.	♂	Teffé, Brazil	1865	L. Agassiz	
3430	2	ad.	both	Teffé, Brazil	1865	L. Agassiz	
3434	1	ad.	♂	Teffé, Brazil	1865	L. Agassiz	
3348	1	ad.	♂	Teffé, Brazil	1865	L. Agassiz	
3306	3	ad.	both	Manaos, Brazil	1865	L. Agassiz	

AMEIVA AMEIVA MACULATA (Fischer).

Description:— Adult female; Mus. of Zoöl., Univ. Mich. 45299. La Tigrera, Santa Marta Mts., Colombia; August 4, 1913; A. G. Ruthven.

Closely related to *Ameiva a. ameiva* from which it may be readily distinguished by the following characters:— a single pair of frontoparietals larger than the occipitals which are regular; median occipital as large as the others; preanals granular and numerous, not arranged in a group of some sort as found in *Ameiva a. ameiva;* four rows of brachials covering the entire upper surface of the arm and gradually varying into the granules of the same; shields of the under side of the thighs smaller, more uniform in size than those of *Ameiva a. ameiva;* five rows of these tibial shields distally, fifteen proximally; shields of the under side of thighs also smaller and more uniform in size than those of *Ameiva a. ameiva;* these shields in four rows.

Coloration:— Dorsal surface olive-gray washed with blue-gray on the sides of body and outer ventrals; a series of white spots regularly arranged in vertical rows covering the flanks; these white spots indistinctly surrounded by black which is somewhat confluent forming vertical bars; in the median region running the length of the back, two rows of faintly indicated black spots; ventral surface whitish, sprinkled with blue-gray on the gulars; outer ventral shields spotted with white and dark blue-gray.

Variation:— A young male (Mus. of Zool., U. of M. 45303, from Aguadulce, Santa Marta Mts., collected July 11, 1913, by A. G. Ruthven) is similar to the adult in scutation except that the brachials are not so uniformly small. In coloration it differs from the adult by being generally darker. The white lateral spots are less numerous, the median row of lateral white spots is confluent to form a stripe on each side. The ground tone of the flanks is dark gray instead of light blue-gray. The throat, outer ventrals, and some of the median ones spotted with blue-gray of low intensity.

Remarks:— The description was made of an adult female that measured one hundred and fifteen millimeters from snout to vent.

Habitat:— We have only seen specimens from the Santa Marta Mts., Colombia, but this species may occur elsewhere and probably does.

AMEIVA AMEIVA LAETA Cope.

Description:— Adult female; TYPE M. C. Z. 10537. Rio Janeiro, Brazil; 1866; by L. Agassiz.

Related to *A. a. ameiva* but readily distinguished from it by its large dorsal granules, at least three or four times larger than those of *Ameiva a. ameiva;* the scales of the throat and neck also somewhat larger; instead of forming a median group of enlarged scales, the gulars are arranged in a distinct band across the throat, the scales of which, largest in the mid-region, rapidly diminish in size anteriorly.

Coloration: — Pattern more like *A. a. petersii* than *A. a. ameiva.* General tonality green; a sprinkling of a few dark spots dorsally; on each side a trace of a broad dark band, the upper and lower margins darkest; in the lower dark margin a very sharp and characteristic white line running the length of the body; in the upper margin of the dark band a faint white line; flanks and outer ventrals faintly spotted with dark brown, the latter edged with white.

Variation: — An adult male, M. C. Z. 4250 (Goyaz, Brazil, collected 1867 by Senor Honario) is similar to the female except that the upper white line is absent. On each flank there is a series of white spots somewhat irregularly arranged in vertical rows.

Remarks:— The description was made of an adult female that measured one hundred and twenty-five millimeters from snout to vent.

Habitat:— Southern Brazil as far north as Minas Geraes, and as far west at least as Goyaz.

List of specimens examined.

M. C. Z. No.	No. of specimens	Ages	Sexes	Locality	Date	Collector	Remarks
10536–7	2	ad.	♀	Rio Janeiro, Brazil	1866	L. Agassiz	Types. Descrip.
4250	3	ad.	both	Goyaz, Brazil	1867	S. Honario	Descrpi.
1367	1	ad.	♀	Rio Janeiro, Brazil	1866	L. Agassiz	
3028	2	ad.	both	Minas Geraes, Brazil	1865	L. Agassiz	

AMEIVA AMEIVA PRAESIGNIS (Baird and Girard).

Description:— Adult male; M. C. Z. 9926. Panama (near city); 1904; W. W. Brown, Jr.

Related to *Ameiva a. ameiva* from which it differs considerably in coloration and slightly in scutation. Unlike any of the other races of *Ameiva a. ameiva,* the ground tone of the dorsal surface is pale yellow-brown of a low intensity becoming darker posteriorly. On each flank there is a series of pale straw-color spots arranged in vertical rows. The characteristic feature of this coloration is that each granule is entirely of one color, the effect being a "pepper and salt" mixture.

A narrow stripe of dark straw-color runs the length of the back in the median line. The upper surfaces, sides of tail and appendages are profusely spotted with straw-color varying to bluish. The ventral surface is pale straw-color varying to bluish on the outer ventral. Part of the thighs is spotted with whitish or bluish. In regard to scutation the only real difference from *Ameiva a. ameiva* is in that the brachials are considerably larger and break up proximally into three or four rows of scales. In other specimens these brachial shields are partly fused to form a single series of very wide and short scales.

Variation: — Females may be readily distinguished from the males by their color. For example, M. C. Z. 9924 (same data as above) has no series of lateral spots but instead on each side of the body are two narrow pale straw colored lines bordered narrowly above and below with black. Except for a series of dark blotches on the back, tail, and legs, the dark brown of the posterior part of the body in the male is absent. A young female (M. C. Z. 9938) has not the "pepper and salt" coloration of the adults but instead is olive-brown blotched and dappled with dark brown. On each side is a broad dark brown band edged with white. The blotching on the back and sides form two parallel rows above and below these lateral stripes.

Remarks:— The description was made of an adult male that measured one hundred and eighty-four millimeters from snout to vent.

Habitat:— If the locality Acapulco is correct it is distributed from southern Mexico as far south as Panama where it is very common on the savannah near the city of Panama itself.

List of specimens examined.

M.C.Z. No.	No of specimens	Ages	Sexes	Locality	Date	Collector	Remarks
9924–41	18	all	both	Panama (near city of Panama)	1904	W.W.Brown, Jr.	Descrip.
9942–47	6	all	both	San Miguel Island Panama Bay	1904	W.W.Brown, Jr.	
2727	2	ad.	both	Panama	1872	L. Agassiz	
2728 & 30	2	h.gr.	both	Acapulco, Mex.	1872	L. Agassiz	
7290	1	yg.	♂	Panama	1908	T. Barbour	
3977	3	ad.	both	San Pablo, Panama	1866	A. Lesley.	

AMEIVA BIFRONTATA BIFRONTATA Cope.

Description:— Adult male; TYPE M. C. Z. 10770. Labeled St. Thomas, D. W. I., but doubtless from Venezuela.

Rostral forming an acute angle behind; nostril between the two nasals; anterior pair of nasals just in contact behind rostral; frontonasal a trifle longer than wide, in contact with the loreal; prefrontals broadly in contact; frontal divided transversally in the mid-region, entirely separated from the supraoculars by a single row of granules; a pair of frontoparietals separated from the third supraocular, and part of the fourth by a double row of granules; five occipitals in a transverse row, the outer two slightly posterior to the others, the median scale slightly smaller than the rest; six supraciliaries; four supraoculars, the posterior one very much smaller than the others, the first separated from the loreal; the three posterior supraoculars separated from the supraciliaries by a double row of granules; last two supraoculars separated from the outer occipitals by four or five rows of granules; five and six supralabials; five and six large infralabials; between infralabials and chin-shields a wedge of a single row of granules extending anteriorly to the first chin-shield; chin and throat, except near the folds covered with small scales, the median posterior ones largest but varying gradually into the others; on the area between the two throat folds four or five irregular rows of scales; under side of the body with ten longitudinal and thirty-four transverse rows of plates, the two outer longitudinal rows formed of narrower and rounded plates; preanal plates in a triangle of three large ones cut into in the middle of its base by a small scale, and completed at the basal angles by two larger scales; on the lower arm a double row of antebrachials, the outer widest; on the upper arm a single row partly double, of very large brachials which are continuous with the antebrachials; on the posterior side near the elbow a single row of postbrachials; under side of the thighs covered distally with three and proximately with nine or ten rows of scales; sixteen femoral pores; on the under side of the tibia three rows of plates, outer widest; upper side of the wrist covered with scales forming a regular series of longitudinal rows; inner and outer toe extending approximately the same distance; tail covered with straight, keeled scales; about forty-nine scales in the fifteenth ring from the base.

Coloration: — In the badly faded specimen before us, the upper surface is uniform blue-gray, the under surface milky, the outer ventrals spotted with pure white. But according to the original description (Cope, Proc. Acad. nat. sci. Phila., 1862, p. 67) the color was "above brownish pea-green, tail paler; in young specimen traces of two lateral and one median pale line, sometimes visibly posterior in adults. Occasionally a few brown spots on the rump. External belly plates varied with blue and white. Inferior surfaces yellow."

Remarks:— The description was made of an adult male that measured one hundred and twelve millimeters from snout to vent.

The specimen described is one of the types received in exchange from the Philadelphia Academy. Ruthven (Occ. papers, Mus. zoöl. University Mich., December 27, 1913, no. 2), has discussed the locality data of the types and concludes, "It is highly probable that *Ameiva bifrontata* does not occur on St. Thomas but is a Venezuelan form that is represented in Colombia by *Ameiva divisa* (Fischer)." We may emphasize what Ruthven has said viz., that this lizard certainly does not occur upon St. Thomas, this is proved by the recent carefully made collections. There is no reason to believe that it ever did. It is found in Venezuela, and is probably confined to that state.

Habitat:— Venezuela.

AMEIVA BIFRONTATA DIVISA (Fischer).

Description:— Adult male; M. C. Z. 10573; near La Tigrera, Santa Marta Mts., Colombia; 1913; A. G. Ruthven.

This race differs from typical *bifrontata* only slightly in scutation but decidedly in coloration. As Ruthven (Occ. papers, Mus. zoöl. University Mich., December 27, 1913, no. 2), has pointed out the Colombian race differs from the Venezuelan form in having the series of granules on the inner margin of the supraoculars ending on the posterior corner of the second instead of having the "three posterior supraoculars surrounded with granular scales." This seems to be the only real difference in their scutation.

Coloration: — Dorsal surface olive-gray tinged with bluish; on each side a broad stripe of dark olive-gray bordered above and below by narrow, pale bluish lines; several dark olive-gray spots on the back; head, thighs, and tail tinged with brown dorsally; the head varying to a fleshy color on the sides; dorsal surface of thighs and tail faintly reticulated with black, and spotted with pale olive-gray; ventral surface milky varying to pale blue on the sides; the outer ventrals spotted with pale turquoise-blue.

Remarks:— The description was made of an adult male that measured one hundred and twenty-eight millimeters from snout to vent.

Habitat:— Three adult males from the Santa Marta Mts. were examined, but this race is probable widely spread over the north of Colombia.

AMEIVA RUTHVENI, sp. nov.

Description:— Adult male; TYPE M. C. Z. 9931. Panama (near city); 1904; W. W. Brown, Jr.

Rostral forming a trifle more than a right angle behind; nostril between the two nasals; anterior pair of nasals moderately in contact behind rostral; frontonasal longer than wide in contact with the loreal; prefrontals also moderately in contact; frontal in contact with only the first two supraoculars; a pair of frontoparietals separated, except anteriorly, from the third supraocular by one or two rows of granules; three large occipitals in a transverse row, with a pair of intercalated scales between the outer pair and the frontoparietals; five and six supraciliaries, the third very long; three supraoculars the first in contact with the two anterior supraciliaries, separated from the loreal; two posterior supraoculars separated from the supraciliaries by a single, partly double row of granules; last supraoculars separated from the outer occipitals by two, partly three rows of granules; six and seven supralabials; five and six large infralabials; between infralabials and chin-shields a wedge of two rows of scales, extending anteriorly as far as the middle of the second chin-shield. Chin and throat covered with granules, a band of larger ones extending across the middle, a group of ten or a dozen very large ones in the mid-region of which no one scale is much larger than another; on the area between the two throat folds a single row of large scales; under side of the body with eight longitudinal and twenty-eight transverse rows of plates; preanal plates in a median longitudinally arranged pair and a marginal transverse pair, the former larger. On the lower arm one row of very large antebrachials becoming double proximally; on the upper arm one row of very large brachials continuous with the antebrachials; on the posterior side a group of small postbrachials; under side of the thighs covered distally with three rows of very large plates resolving proximally into six or eight rows; twenty-four and twenty-five femoral pores; on the under side of the tibia two, part three rows of very large shields; upper side of the wrist covered with three large scales and several smaller ones; inner and outer toe reaching approximately the same point; tail covered with keeled scales, the keels parallel with the longitudinal axis but the scales oblique; each whorl of caudal scales raised strongly on the sides, giving the tail a peculiar flattened appearance; about twenty-two scales in the fifteenth ring from the base.

Coloration: — Dorsal surface dark olive-brown, on each side, covering nearly the entire surface of the flanks a series of large vertical bars of black; these spots somewhat confluent, with the between spaces gray instead of brown like the back; indistinct mottlings of gray on the upper surfaces of the legs; ventral surface milky tinged with straw-color; outer ventrals, under surfaces of the legs reticulated with blue-gray.

Variation: — A half grown male M. C. Z. 9932 is not so distinctly marked as the adult, but the general pattern is the same.

Remarks: — The description was made of an adult male that measured one hundred and thirty-one millimeters from snout to vent.

Habitat:— Only known from near the city of Panama where it is found with *Ameiva a. praesignis* in the savannah of Panama.

AMEIVA FESTIVA (Lichtenstein).

Description:— Adult male; M. C. Z. 2723. Turbo, Isthmus of Darien; 1871; G. A. Maack.

Related to *Ameiva ruthveni* from which it may be distinguished by the following characters: — frontonasal separated from the loreal by the posterior nasal; last supraocular separated from the outer occipitals by four or five rows of granules; no distinct band of enlarged gulars extending across the throat but all diminishing in size from the centre where there is a group of six or eight very large scales, one being four or five times larger than any of the other scales; preanal plates in a triangular group of three large rotund plates, anterior largest; postbrachials in a single row of very large scales; nineteen and twenty femoral pores; tibial shields in only two rows of very large plates, those of the outer largest; upper side of the wrist covered with six or eight subequal scales; the whorls of caudal scales not raised laterally so strongly as those of *Ameiva ruthveni.*

Coloration: — Although somewhat faded, the coloration seems to be distinctly different from that of *A. ruthveni;* dorsal surface olive-brown, two irregular black bands running the length of the flanks, the lower border of these bands strongly notched; a narrow somewhat broken band of olive-gray running down the middle of each of these bands; ventral surface blue-gray tinged with yellowish; two or three longitudinal series of dark brown spots on the ventrals; the outer spots very irregular and attenuated; shields of the under side of thighs bordered partly or wholly with dark blue-gray.

Variation: — The series of eight adult males from several localities show a considerable degree of variation in coloration. One specimen, M. C. Z. 9581 (from Honduras, collected in 1907 by E. C. Post) has a very wide stripe of olive down the middle of the back, making the lateral bands proportionally narrower than those of the specimen described. In another specimen M. C. Z. 9568 from Nicaragua the same general pattern as the typical one is present but the tonality is much darker, the ground color being a very dark olive-blue. The dark lateral stripes are not at all olivaceous. There are two, instead of one, bright bluish gray stripes on each side.

Remarks:— The description was made of an adult male that measured one hundred and eight millimeters from snout to vent.

Habitat:— Widely distributed throughout Central America from the Isthmus of Darien to southern Mexico.

List of specimens examined.

M.C.Z. No.	No. of specimens	Ages	Sexes	Locality	Date	Collector	Remarks
2723	2	ad.	♂	Turbo, Isth. Darien	1871	G. A. Maack	Descrip.
9585	1	ad.	♂	Matagalpa, Nicaragua	1910	W. B. Richardson	
9568	1	ad.	♂	Matagalpa, Nicaragua	1910	W. B. Richardson	
10773	1	ad.	♂	Matagalpa, Nicaragua	1910	W. B. Richardson	
10774	1	ad.	♂	Matagalpa, Nicaragua	1910	W. B. Richardson	
9580	1	ad.	♂	Honduras	1907	E. C. Post	
9581	1	ad.	♂	Honduras	1907	E. C. Post	

AMEIVA UNDULATA UNDULATA (Wiegmann).

Description:— Adult male; M. C. Z. 7473. Colima, Mexico; Barbour collection.

Rostral forming a trifle more than a right angle behind; nostril between the two nasals; anterior pair of nasals in broad contact behind rostral; frontonasal longer than wide, separated from the loreal by the posterior nasal; prefrontals fairly in contact with the first two supraoculars; a pair of frontoparietals in contact with the first two supraoculars; a pair of frontoparietals in contact with the third supraocular for nearly its entire length; three subequal occipitals in a transverse row; five and six supraciliaries, the second from the anterior end very much larger than the others; three supraoculars, the first in contact with the two anterior supraciliaries and loreal; two posterior supraoculars separated from the supraciliaries by a single row of granules; last supraocular separated from the outer occipitals by two or three small scales; six and seven supralabials; five and six large infralabials; between infralabials and chin-shields a wedge of one or two rows of small scales extending anteriorly to the first chin-shield; chin and throat covered with large granules becoming larger towards the centre, a longitudinal row of four larger ones in the mid-region; on the area between the two throat folds two or three rows of scales, the median row largest, the scales differing in size from those in the middle; under side of the body with eight longitudinal and twenty-eight transverse rows of plates; preanal scales irregular, a marginal pair and two or three anterior scales the largest; on the lower arm a double row of wide antebrachials, outer row the widest; on the upper arm a single row of large brachials continuous with the antebrachials; on the posterior side a single row of large postbrachials; under side of the thighs covered distally with three, proximally with six or eight rows of scales; seventeen and nineteen femoral pores; on the under side of the tibia three rows of shields; upper side of the wrist covered with scales forming a series of longitudinal rows of two or three scales each; inner and outer toe extending to approximately the same distance; tail covered with keeled scales in rings, the scale and the keel being straight or slightly oblique on the sides; about twenty-two scales in the fifteenth ring from the base.

Coloration: — Dorsal surface dark olive-blue; on each side of the body a series of indistinct vertical stripes of black, somewhat confluent ventrally and spotted with indistinct blue blotches; ground tone of ventral surface steel-blue washed with straw-color about the anal region and on the under surfaces of legs.

Remarks:— The description was made of an adult male, the only specimen examined, that measured seventy-four millimeters from snout to vent.

Habitat:— Apparently confined to southern Mexico.

AMEIVA UNDULATA QUADRILINEATA (Hallowell).

Ameiva pulchra Hallowell, Proc. Acad. nat. sci. Phila., 1860, p. 483.
Ameiva gabbiana Cope, Journ. Acad. nat sci. Phila., 1876, ser. 2, **8**, p. 117, pl. 28, fig. 3.

Description:— Adult female; M. C. Z. 9546. Chinandega, Nicaragua; 1910; W. B. Richardson.

Similar to *Ameiva u. undulata* from which it may be distinguished by the following characters:— a pair of frontoparietals nearly separated from the third supraocular by one or two rows of granules; three subequal occipitals, the median divided longitudinally; last supraocular separated from the outer occipitals by two or three rows of granules; chin and throat covered with small granules, an indistinct band of large ones extending across the middle, in the mid-region a group of eight or ten large scales varying into the others; preanal plates irregular, a longitudinal series of three pairs; on the posterior side of the upper arm two irregular rows of postbrachials; on the under side of the tibia two rows of large plates and a few scales of a third row.

Coloration:— Dorsal surface olive-gray; two narrow white bands on each side, the uppermost very indistinct; the dorsal surface between the two upper lines marbled with black; a series of heavy black marblings on each side, the blotches very irregular in shape but evenly spaced; dorsal surface of tail and legs faintly mottled with black; ventral surface milkish or pale blue.

Variation:— A male M. C. Z. 9540 (same data as above) differs from the female slightly in coloration. The white lateral lines are absent and the dark mottlings of the flanks are very distinct because the spaces between them are bluish instead of olive-gray. The general tonality of the dorsal surface is brownish instead of blue-gray.

Remarks:— The description was made of an adult female that measured seventy-eight millimeters from snout to vent. Only two specimens were examined.

Habitat:— Our specimens come from Chinandega, Nicaragua, but this race probably has a wider distribution.

AMEIVA UNDULATA PARVA, nov. subsp.

This local race shows relationship to both *A. u. undulata* and *A. undulata quadrilineata* but may be distinguished from both in having a short stocky head, and in having the gular scales except for the median group very small.

Description:— Adult male; TYPE, M. C. Z. 5831. Guatemala.

Similar to *A. undulata quadrilineata* but differing in scutation as follows: — throat and neck covered with very fine uniform granules, a median group of a dozen or fifteen large scales varying into the others; postbrachials in three rows, median largest; tibial shields in three rows.

Coloration:— Much browner in tonality than *A. undulata quadrilineata,* having also more dark mottlings on the sides and on the back; the spaces between the black blotches brownish, not blue; ventral surface straw-color instead of blue.

Variation:— A female (same data as above) has the white lateral lines bordering a dark band on each side. A series of bluish spots arranged at regular intervals extends the length of this band. Several series of similar spots below these bands. A young specimen (same data as above) is similar to the female except that the entire flanks are blackish and that there are no spots present on the sides. The lower white line, however, is somewhat broken into spots.

Remarks:— The description was made of an adult male that measured seventy-four millimeters from snout to vent.

Habitat:— Apparently confined to Guatemala, and perhaps only found locally; the specimens before us are labeled simply Guatemala.

AMEIVA EDRACANTHA Bocourt.

Since it is impossible to examine a specimen of this species we are obliged to use this condensed form of the original description (Bocourt, Ann. sci. nat., 1874, ser. 9, **19**, art. 4).

Description:— Nostril between the two nasals; frontal proportionally large; frontoparietals united (perhaps abnormally); three occipitals; three supraoculars; six supraciliaries; supralabials and infralabials each five, the infralabials more attenuated and extending further behind; gular scales arranged like those of *A. ameiva,* but larger; on the portion between the two throat folds two or three rows of enlarged scales; under side of body with eight longitudinal rows of scales; a single oval preanal plate surrounded by small scales; on each side of this region six or seven spinose plates; on the upper arm a single row of brachials; under side of thighs covered with three rows of shields; twelve or thirteen femoral pores; on the under side of the tibia two rows of scales; caudal scales keeled.

Coloration:— Ground color olive-green, five yellowish longitudinal lines, the median beginning at the occiput and ending before the thighs, the second and third on each side running the length of the bodies, finally those of the flanks are a little less distinct and often broken; back and side with transverse dark brown lines; limbs and tail spotted with the same color; ventral surface yellowish.

AMEIVA SEPTEMLINEATA A. Dumeril.

Description:— Half grown male; M. C. Z. 8949. Rio Chan Chan, Ecuador; S. N. Rhoads.

Rostral forming about a right angle behind; nostril between the two nasals; anterior pair of nasals broadly in contact; frontonasal separated from the loreal; prefrontals separated by two intercalated scales; frontal formed by three or four scales continuous with the frontoparietals, which are formed of four or five scales in two longitudinal rows separated posteriorly from each other by a wedge of four scales, and separated from the supraoculars by one or two rows of granules; three large occipitals in a transverse row surrounded posteriorly by many small ones; four supraoculars, the second divided longitudinally into three parts, the last two considerably larger than the anterior ones; two posterior supraoculars separated from the supraciliaries by a single row of granules; six large supralabials; five infralabials; between infralabials and chin-shields a wedge of a single row of scales extending anteriorly to the second pair of infralabials; chin and throat covered with minute granules, a band of slightly larger ones extending across the middle; on the area between the two throat folds a single row of very large scales; under side of the body with eight longitudinal rows, outer row much narrower than the others and twenty-six transverse rows of plates; a pair of large preanal plates arranged one ahead of the other in the mid-region and surrounded by a series of small scales; on the lower arm a single row of large antebrachials becoming double proximally; on the upper arm a single row of large brachials continuous with the antebrachials; on the posterior side near the elbow joint a single row of large postbrachials; under side of the thighs covered with three rows of large plates breaking up proximally into six or eight rows; fourteen femoral pores; on the under side of the tibia two rows of scales, outer about twice as large as the inner; upper side of the wrist with one or two transverse series of large scales; outer toe extending about as far as the inner; tail covered with straight, keeled scales, dorsally strongly keeled; about seventeen scales in the fifteenth ring from the base.

Coloration:— Dorsal surface dark olive-brown; on each side a dark brown or blackish band, bordered above and below by a light stripe, the three stripes running the length of the body from the eye to the middle of the tail; ventral surface pale blue-gray suffused with straw-color.

Remarks:— The description was made of a half grown male, the only specimen examined, that measured eighty-six millimeters from snout to vent.

Ameiva bridgesii (Cope).

Description:— Adult male; M. C. Z. 6988. Gorgona Island, Colombia; 1905; W. W. Brown, Jr.

Rostral forming about a right angle behind; nostril between the two nasals; anterior pair of nasals broadly in contact behind rostral; frontonasal a trifle longer than wide separated from the loreal; prefrontals keeled, separated by six or seven intercalated, keeled scales forming part of a series which divides the frontal and frontoparietals; frontal formed of about ten irregularly arranged keeled scales; frontoparietal and occipitals formed of numerous irregularly arranged, small keeled scales, the two scales in the median occipital region largest;

two keeled supraoculars preceded by a group of five or six small keeled scales in the place of an anterior supraocular; the two large supraoculars separated from the supraciliaries by a double row of granules; last supraocular separated from the outer occipitals by four or five rows of granules; six or seven large supralabials; five infralabials; between infralabials and chin-shields a wedge of a single row of small scales together with several large scales extending anteriorly to the first chin-shield; chin and throat covered with granules of varying size, a broad band of slightly larger ones extending across the middle; on the area between the two throat folds three or four rows of small scales, the median ones about three times as large as the gulars, all irregularly arranged; under side of the body with six longitudinal and twenty-six transverse rows of scales; three somewhat rounded preanal plates arranged in a triangle, the anterior one much larger than the others; on the lower arm a single row of large antebrachials extending its entire length on the lower arm two or three rows of very small, irregular keeled scales; on the posterior side near the elbow joint two or three rows of postbrachials, median row formed of very large ones; under side of thighs covered with three rows of large scales ending abruptly in granules; twenty-four femoral pores; on the under side of the tibia two rows of scales, the outer about twice as large as the inner; on the upper side of the wrist between phalanges and joint two transverse rows of large scales; outer toe extending a little further than the inner; tail covered with straight keeled scales, dorsally strongly keeled; about nineteen scales in the fifteenth ring from the base.

Coloration: — Dorsal surface dark olive-green; on each side a dark brown band, bordered above and below by a light blue-gray stripe, running the length of the body; a pale median line not very distinct running from the occipitals to the tail; ventral surface dark blue-gray suffused with yellow on the abdomen.

Variation: — A female (same data as above) is similar to the male except that the pale median stripe is brighter and wider than the other pale lines, a condition which is reversed in the adult male.

Remarks:— The description was made of an adult male that measured one hundred and eighteen millimeters from snout to vent.

Cope's type of *Holcosus bridgesii* (Acad. nat. sci. Phila. No. 9651) which we have examined is in fair preservation. It is rather less than half grown. The locality slip which accompanied it bore simply the word "?Ecuador." In the original description (Proc. Acad. nat. sci. Phila., 1868, p. 306–307) curiously enough no mention whatever was made of habitat or locality. An examination of a series of this species and a comparison with *A. septemlineata* and *A. undulata* makes clear the relationship of this form. It does not seem at all advisable to recognize Cope's monotypic genus.

Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

Vol. LIX. No. 7.

TWO NEW GENERA OF MYRMICINE ANTS FROM BRAZIL.

By William Morton Wheeler.

CAMBRIDGE, MASS., U. S. A.:
PRINTED FOR THE MUSEUM.
November, 1915.

No. 7.— *Two New Genera of Myrmicine Ants from Brazil.*

CONTRIBUTIONS FROM THE ENTOMOLOGICAL LABORATORY OF THE BUSSEY INSTITUTION, HARVARD UNIVERSITY. NO. 103.

By William Morton Wheeler.

Mr. C. William Beebe, of the New York Zoölogical Park, recently sent me for identification nineteen vials of ants which he collected May 15, 1915, in a suburb of Pará, at the mouth of the Amazon. The specimens were all taken from four square feet of jungle mold at the foot of a single tree, whose bird fauna (76 species!) Mr. Beebe studied for a week. In addition to the ants he took from the same little patch of mold a number of beetles, termites, springtails, bugs, pseudoscorpions, ticks, mollusks, and worms. The collection of ants comprises seventeen species, two of which are of singular structure and evidently represent new genera. The fifteen other species are recorded in the following list:—

Pachycondyla harpax Fabr. One worker.

Euponera (*Trachymesopus*) *stigma* Fabr. Two workers.

Ponera opaciceps Mayr. Six workers.

Anochetus mayri Emery. One deälated female.

Solenopsis subtilis Emery. Fifteen workers, one male, and one deälated female.

Crematogaster victima F. Smith, var. One deälated female.

Pheidole flavens Roger subsp. *exigua* Emery. One soldier, three workers, three males, and one deälated female.

Pheidole subarmata Mayr. Two workers and one deälated female.

Trachymyrmex sp. One deälated female, without head.

Cyphomyrmex rimosus Spin. One deälated female.

Rhopalothrix (*Octostruma*) *balzani* Emery. Twelve workers and one deälated female.

Strumigenys subedentata Mayr. One deälated female.

Prenolepis steinheili Forel. Four workers and three males.

Rhizomyrma goeldii Forel. Nine workers.

Camponotus (*Myrmothrix*) *abdominalis* Fabr. var. One deälated female.

The solitary deälated females of the species of Anochetus, Crematogaster, Trachymyrmex, Cyphomyrmex, and Camponotus were evidently establishing colonies. At least eight of the species, viz. those belonging to the genera Euponera, Ponera, Solenopsis, Rhopalothrix, Strumigenys, Rhizomyrma and the two new genera Blepharidatta and Glamyromyrmex are hypogaeic (subterranean) ants, with small-eyed workers. With the exception of *Pachycondyla harpax* and *Camponotus abdominalis* all of the species are small or very small. I subjoin descriptions of the two peculiar species representing new genera.

BLEPHARIDATTA, gen. nov.

Worker. Small, monomorphic. Mandibles triangular, their apical margins with a few subequal teeth. Clypeus vertical, bicarinate. Frontal area large, frontal groove absent. Eyes moderately large and very convex. Ocelli lacking. Antennae 11-jointed, funiculus with a well-defined 2-jointed clava. Head rather large, with a deep scrobe on each side, extending its full length and bordered above by the frontal carinae which are large, expanded and horizontal, lobulate in front and extending to the posterior corners of the head. The inferior or lateral border of each scrobe is formed by a ridge as long as the frontal carina and running just above the eye. Thorax moderately long and slender, without promesonotal and mesoëpinotal sutures; humeri and inferior angles of pronotum dentiform; epinotum armed with a pair of long spines; metasternal angles large, compressed and sharply angular above. Petiole long and slender, pedunculate, with a low, rounded node. Postpetiole small, subglobular. Gaster small, spherical, first segment very large, without ridges, grooves or tubercles; remaining segments very small. Sting vestigial. Legs rather slender; middle and hind tibiae without spurs; claws simple.

Head, thorax, pedicel, and appendages opaque, sculptured; gaster smooth. Upper surface of body beset with long, paired, very sparse, stiff, and blunt hairs.

BLEPHARIDATTA BRASILIENSIS, sp. nov. (Fig. 1).

Worker. Length nearly 2 mm.

Head nearly $\frac{1}{3}$ longer than broad, narrower in front than behind, with strongly and broadly excised and marginate posterior border and nearly straight lateral borders, its dorsal and gular surfaces feebly convex, its posterior corners produced as prominent angular tubercles. Scrobes of nearly uniform transverse diameter throughout their length and sufficiently deep to accommodate the antennae. Frontal carinae expanded and lobular anteriorly, with translucent and slightly reflected borders throughout their length. Mandibles rather large, with moderately convex external borders, the apical borders rather oblique, with four subequal teeth. Clypeus with evenly rounded, entire anterior border, flattened in the middle between the two prominent longitudinal carinae and transversely impressed at the anterior border. Frontal area semicircular. Antennae slender, scapes reaching nearly to the posterior corners of the head, their apical halves distinctly thickened; first funicular joint large, fully twice as long as broad; joints 2–7 narrower, a little broader than long, joint 8 as long as broad; joint 9, the basal joint of the clava, longer than broad and twice as broad as the preceding joints; terminal joint large, pointed, nearly three times as long as broad. Thorax narrower than the head, more than twice as long as broad, broadest through the humeri, in profile more than twice as long as high, feebly and evenly convex above. Pronotum with acute, dentate anterior corners, from which there run a pair of distinct longitudinal ridges, gradually converging posteriorly to the epinotal spines. Each of these ridges bears two minute teeth. Epinotum sloping, concave in the middle, marginate on the sides below the spines, which are long, straight, acute, close together at their insertions and directed backward, outward and upward. Metasternal angles thin, translucent, broad and sharply angular above. Petiole fully three times as long as broad or high, with a short distinct peduncle in front and constricted behind the node, which is evenly and feebly convex above; seen from above the segment is broadest at its posterior margin. Postpetiole a little broader than the petiole but scarcely higher, from above rectangular, a little broader than long, in profile feebly convex above. Gaster subcircular from above, with straight basal margin.

Gaster smooth and shining; remainder of the body, including the appendages opaque, very finely and densely punctate-rugulose. Head above between the frontal carinae with six coarse, longitudinal rugae connected by sparse, indistinct transverse rugules or reticulations. Pronotum above with four feeble longitudinal rugae. Pleurae very indistinctly and irregularly rugose. Petiole and antennal scapes indistinctly longitudinally rugulose. Postpetiole and legs very finely and densely punctate. Gaster very finely and indistinctly shagreened, at the base above densely punctate and opaque.

Hairs yellowish; those on the upper surface of the body very long, slightly curved, of uniform thickness and blunt, arranged very regularly in pairs. On the head nearly all of them arise from the edges of the frontal carinae where the insertion of each hair is a minute tubercle; on the thorax the hairs are inserted along the ridges connecting the humeral angles with the epinotal spines. The petiole bears three, the postpetiole two pairs of these peculiar pairs. On the gaster there are four regular equidistant rows, with about six hairs in each row. Each fore coxa bears a single long hair and there is a pair of hairs on the gula. Legs, antennae, and terminal gastric segments with numerous, short, appressed pointed hairs and the dorsal surface of the gaster also with a few scattered reclinate hairs.

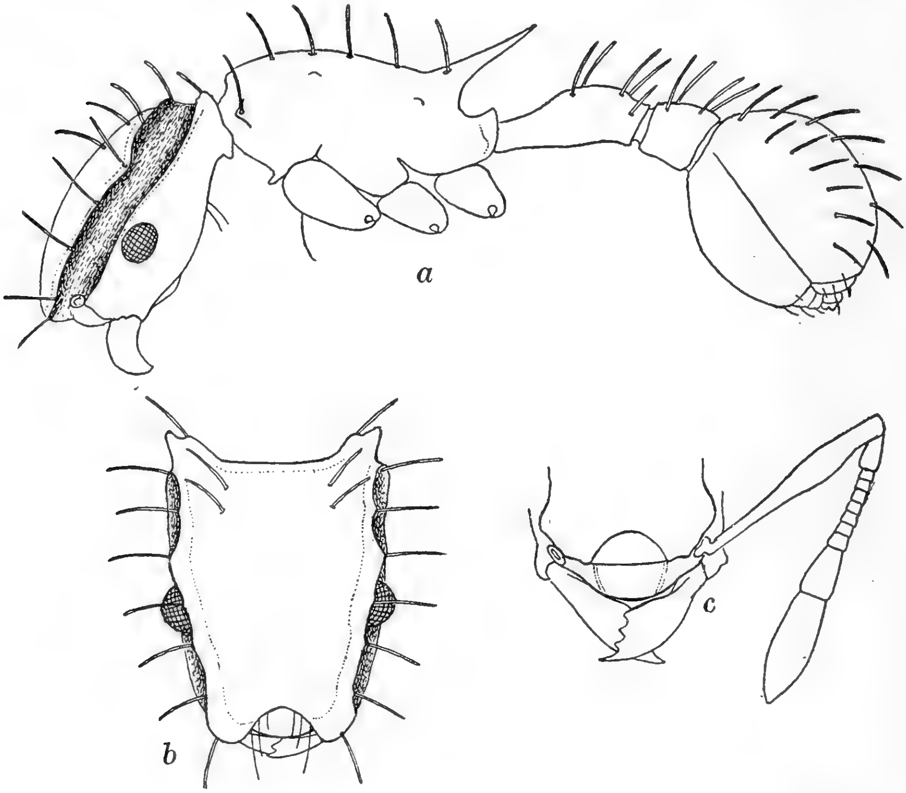

Fig. 1.— *Blepharidatta brasiliensis*, sp. nov. *a*, worker, lateral view; *b*, head of same from above; *c*, mandibles, clypeus and antenna of same from the front.

Color ferruginous; antennae, legs, tip and sides of gaster somewhat paler and more yellowish.

Described from ten specimens; Cotype M. C. Z. 9040.

This extraordinary ant is evidently to be placed in the tribe Attiini, but it differs so much from the other known genera in the structure of the head and especially in the 2-jointed club of the antennae, the 4-toothed mandibles and the regularly arranged, setiform hairs on the dorsal surface, that it seems necessary to establish a distinct genus for its accommodation. Apart from the head, the structure of the body is very simple and primitive for an Attiine ant, even simpler and more primitive than in the genus Proatta, recently established by Forel for a unique Sumatran species. It would be interesting to know whether *Blepharidatta brasiliensis* cultivates fungi like all the other known American Attiini.

GLAMYROMYRMEX, gen. nov.

Worker. Small, monomorphic; closely related to Strumigenys and Epitritus, but differing greatly from these genera in the structure of the head, which is suboblong, with deep scrobes on the sides above the eyes for the accommodation of the antennae. Lateral border of the head forming with the expanded frontal carina and external border of the clypeus a translucent plate overarching the scrobe on each side. Gular region rather narrow so that the eyes, which are small and in front of the middle of the head are approximated and seem to be on its lower surface. Upper surface of head rather flat, separated by a very indistinct suture from the transverse clypeus. Ocelli, frontal groove, and frontal area absent. Mandibles small, with distinct apical borders, armed with a regular row of rather slender acute teeth. Antennae 6-jointed, funiculus with a 2-jointed clava. Thorax, pedicel, and gaster much as in Strumigenys; petiole, postpetiole, and base of gaster bearing spongiform appendages. Epinotum armed with a pair of spines and with acute metasternal angles. Upper surface of head smooth and shining, sculpture of remainder of body much as in Strumigenys. Hairs slender and pointed, not clavate.

Female. Head decidedly shorter and broader than in the worker and narrowed in front, but otherwise of similar structure. Eyes larger, ocelli well-developed. Remainder of body much like that of Strumigenys, and the wings of similar but even more reduced venation, as the base of the cubital vein is largely obsolete, although the anal vein is present. Petiole, postpetiole, and base of gaster with fungiform appendages as in the worker.

Male. Closely resembling the male of Strumigenys. Mandibles very small, with only a single, apical tooth. Head of the usual structure, without dilated lateral margins or scrobes. Eyes very large and prominent, ocelli only moderately large and rather far apart. Antennae 13-jointed, with very short scapes. Thorax robust, broader than the head, mesonotum with deep Mayrian furrows, scutellum very convex. Petiole and gaster without fungiform appendages, those on the postpetiole minute and vestigial. Wings as in the female.

GLAMYROMYRMEX BEEBEI, sp. nov. (Fig. 2).

Worker. (Fig. 2*a* and *b*). Length 1.5–2 mm.

Head $1\frac{1}{2}$ times as long as broad, slightly broader behind than in front, with deeply excised posterior and more feebly excised lateral borders and broadly rounded anterior and posterior corners; behind feebly convex, flattened in the middle and with sloping clypeus. Mandibles convex, with about 8 slender and crowded teeth, which are longest at the apex. Clypeus much broader than long, flattened, with arcuately and deeply excised anterior and convex posterior border. Antennal scapes tenuous at the base, somewhat thickened and fusiform in the middle. First funicular joint fully twice as long as broad and much broader than the two succeeding joints; second joint longer than broad, third as broad as long; fourth longer than broad and less than $\frac{1}{3}$ as long as the rather tapering terminal joint. Thorax much narrower than the head, broadest through the pronotum, which is as broad as long and evenly convex above, with minute but distinct humeral angles. Pleurae rather flat. Mesonotum sloping to a feeble constriction in front of the epinotum, the latter a little longer than broad, its base marginate on the sides and passing into the subequal declivity through a blunt angle. Spines laterally compressed, straight and acute, as far apart at their bases as long, directed backward and upward. Petiole fully twice as long as broad, pedunculate in front, with a low rounded node behind and with three spongiform appendages, one forming a narrow longitudinal band on the median ventral surface, the others a triangular mass on each side of the node. Postpetiole transversely elliptical, distinctly broader than the petiole, with a large spongiform mass enveloping its sides and ventral surface. Gaster as large as the head, elliptical, with straight basal border and a small fungiform mass on the anteroventral surface. Legs rather slender.

Smooth and shining; mandibles and head covered with minute, sparse, piligerous punctures, the lateral borders of the head above longitudinally striate. Gula, pleurae, meso- and epinotum, and petiole opaque, densely and coarsely punctate-rugulose; gaster with a series of strong longitudinal rugae on the dorsal surface at the anterior margin.

Hairs and spongiform appendages sordid yellowish. Head with delicate hairs, which are short, sparse, and appressed on the dorsal

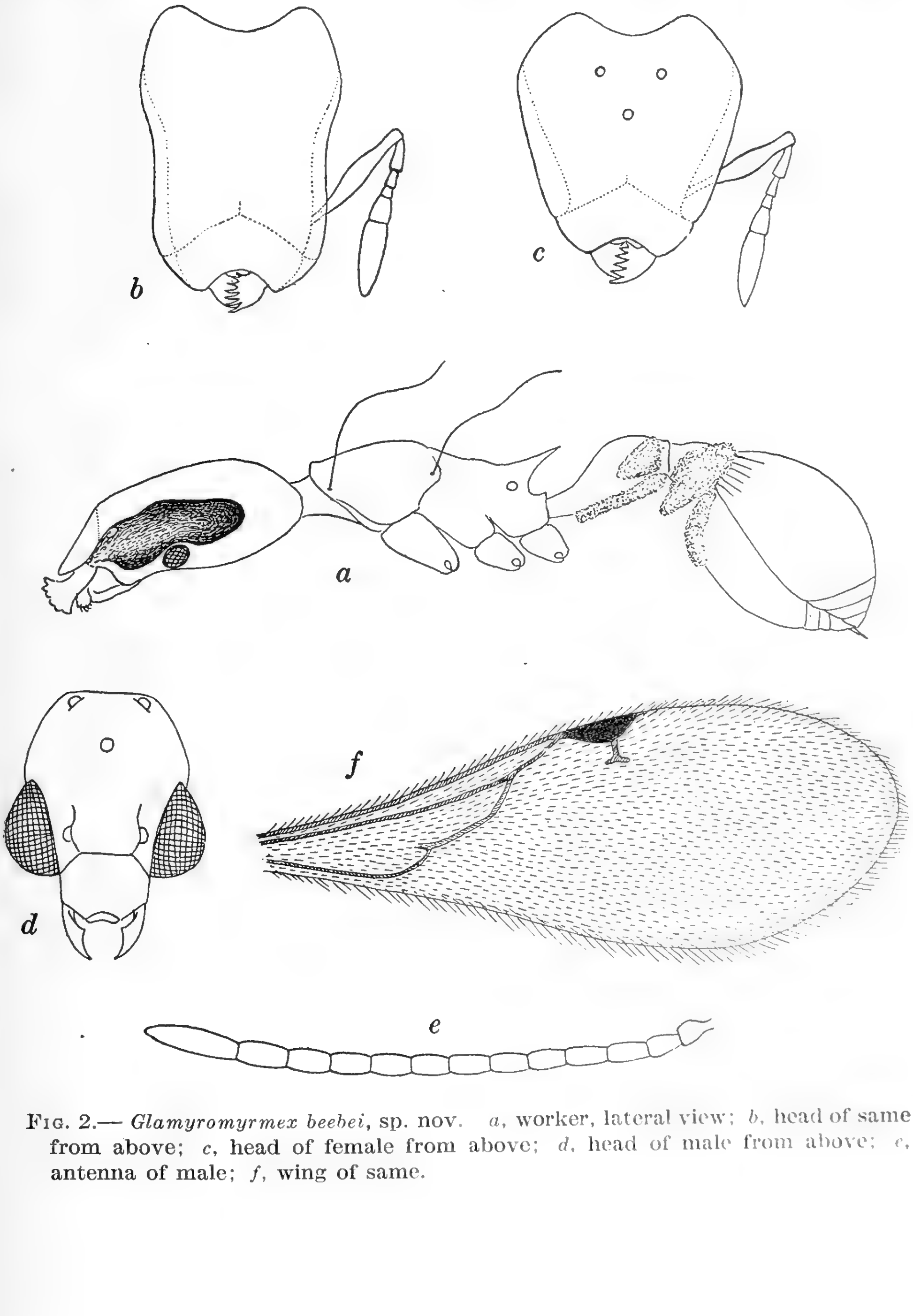

FIG. 2.— *Glamyromyrmex beebei*, sp. nov. *a*, worker, lateral view; *b*, head of same from above; *c*, head of female from above; *d*, head of male from above; *e*, antenna of male; *f*, wing of same.

surface but longer, denser and more oblique on the gula. Thorax with two pairs of very long, slender, flagelliform hairs, one on the humeral angles and one on the posterior corners of the pronotum. Petiole, postpetiole, and gaster with a few long, slender, erect hairs. Antennae and legs with short, subappressed hairs.

Castaneous; upper surface of head and gaster blackish; mandibles, translucent lateral borders of head and clypeus, antennae and legs paler and more reddish or even slightly yellowish.

Female. (Fig. 2*c*). Length 2.6 mm.

Head only slightly longer than broad, decidedly broader behind than in front, with straight sides, deeply concave posterior border and obliquely truncated posterior corners; in other respects, except for the larger eyes and the presence of ocelli, like the head of the worker. Thorax through the wing-insertions nearly as broad as the head, somewhat longer than high, narrowed in the pronotal region, with bluntly angular humeri. Mesonotum flattened above; scutellum convex, with acute, projecting posterior border. Epinotum abrupt and concave in profile, its spines and metasternal angles larger than in the worker, more translucent and compressed. Petiole, postpetiole, and gaster as in the worker.

Sculpture, pilosity, and color as in the worker, but the upper surface of the mesonotum and scutellum is opaque and coarsely longitudinally rugose, with reticulate-rugulose interrugal spaces, the mesopleurae are smooth and shining and the postpetiole is subopaque and finely punctate above. The flagelliform hairs on the humeral angles are shorter and there are numerous erect, slender hairs on the mesonotum. Wings with uniformly brownish membranes, dark brown stigma and resin-colored veins.

Male. (Fig. 2*d*, *e*, and *f*). Length 2 mm.

Head longer than broad, with very short cheeks, feebly rounded postocular borders and rather straight, marginate occipital border. Mandibles very small, triangular, with feebly convex external borders and acute tips. Clypeus a little broader than long, subhexagonal, with the anterior border arcuately excised in the middle. Frontal carinae subparallel, reaching to the middle of the head, rather far apart. Antennae long, their scapes scarcely twice as long as broad and scarcely longer than the first funicular joint; all the funicular joints subcylindrical, longer than broad, the terminal joint longest. Thorax shaped much as in the female but broader than the head. Epinotal spines and metasternal angles shorter and blunter, not compressed and translucent. Petiole with a slightly more angular node in profile, postpetiole more transverse and less elliptical.

Opaque; with only the gaster, mesopleurae, and legs smooth and shining. Head densely and uniformly punctate; thorax, petiole and postpetiole coarsely punctate-rugulose; sides of mesonotum above irregularly and longitudinally rugose. Gaster with short longitudinal rugae at the base.

Hairs pale yellowish, very sparse, slender and rather short and inconspicuous on the body. Flagelliform hairs on the thorax feebly developed. Hairs on the legs delicate, appressed.

Black; thorax and pedicel dark brown; mandibles, antennal scapes, first funicular joint and legs piceous, tibiae and femora darker in the middle. Wing membranes, stigma, and veins distinctly paler than in the female.

Described from three workers, three females and two males belonging to the same colony: Cotype M. C. Z. 9039.

This singular ant belongs to the tribe Dacetoniini and is evidently closely related to the species of Strumigenys, Epitritus, and Pentastruma but differs greatly from these and all the other known members of the tribe in the structure of the head, which recalls that of the Cryptoceriini, though the eyes in this tribe are behind and not beneath the deep antennal scrobes.

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NEW CHILOPODS FROM MEXICO AND THE WEST INDIES.

By Ralph V. Chamberlin.

With Five Plates.

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No. 8.— *New Chilopods from Mexico and the West Indies.*

By Ralph V. Chamberlin.

SCOLOPENDROMORPHA.

CRYPTOPIDAE.

TIDOPS, gen. nov.

Body composed of twenty-three leg-bearing segments. Eleven pairs of elliptic spiracles, one pair being present on the seventh segment.

Head overlapping the first dorsal plate.

Antennae short, flattened; consisting of thirteen articles.

Claws of prehensors dwarfed. None of joints of prehensors armed.

Prosternum bearing two long dentiform processes.

First dorsal plate with a transverse cervical sulcus. Other dorsal plates longitudinally bisulcate; most of them also with distinct lateral longitudinal sulci and, especially in the posterior region, with a median keel more or less set off by furrows. Last dorsal plate laterally margined.

Ventral plates with no distinct longitudinal furrows or sulci.

Coxopleura extended caudad in a long, acutely one-pointed process.

Tibiae unarmed or with only a subspinescent bristle at distal end. Tarsi, excepting of last two pairs of legs, undivided. Tarsus of fourteenth legs biarticulate.

Prefemur of anal legs armed ventrally; femur, also armed ventrally or mesally with spinules; tibia unarmed. Tarsus many jointed as in Newportia; clawless.

Genotype.— *T. simus*, sp. nov.

This interesting genus is manifestly very close to Newportia, to which its relationship is suggestive of that of Paracryptops to Cryptops. The agreement of Tidops with Newportia will be particularly noted in the possession of a many jointed tarsus on the anal legs, this feature separating these two genera from all other Cryptopidae. Tidops is at once to be distinguished from Newportia by its dwarfed prehensorial claws, the strongly developed prosternal dental processes, the thirteen-jointed antennae; and the characters of the ventral plates. Only the type species is known.

TIDOPS SIMUS, sp. nov.

General color ochraceous. Head and prosternum dark reddish brown or ferruginous. Legs yellow.

Head with median sulci showing as two short parallel lines across caudal border. Head differing slightly in width anteriorly and posteriorly; anterior margin widely semicircular; caudal margin subtruncate or but slightly excurved.

Antennae flattened, composed of thirteen articles of which the first two, three, or four are very sparsely hirsute, the others becoming gradually more and more densely and finely clothed with short straight hairs of the type usual in the family.

Claws of prehensors dwarfed. None of the articles of prehensors armed within.

Prosternum with two deep and continuous submedian longitudinal sulci. Anterior margin bearing two large, cylindrical, distally rounded teeth or dentiform processes.

Transverse sulcus of first dorsal plate strongly bent back in an angle at middle, the vertex lying in a rather deep depression or pit; sulcus wholly free from the cephalic plate. Longitudinal sulci subparallel or a little converging cephalad from the caudal margin to about two thirds the distance to the transverse sulcus where each bifurcates, sending its mesal branch to meet its mate at the angle of the transverse sulcus and its outer branch ectocephalad to meet the transverse sulcus farther laterad. Dorsal plates from the second one caudad longitudinally bisulcate. Lateral furrows distinct from the fifth plate caudad. Median keel low and flat, set off by furrows on the posterior plates, but becoming first indistinct and finally disappearing cephalad. Last dorsal plate with margin bowed out caudad as usual; the margin mesally truncate. With a median longitudinal sulcus.

Ventral plates long, longest cephalad, a little incurved near middle; more strongly narrowed caudad, the tongue-like, distally rounded caudal end lying well beneath the anterior portion of the succeeding plate. Widely but distinctly depressed transversely across middle of plate, but with no evident longitudinal furrows or sulci. Last ventral plate narrowed caudad. Caudal margin mesally indented or emarginate, the emargination very obtusely angular with the margin each side convex and the corners rounded. A pair of bristles on caudal portion.

Process of coxopleura rather short, acutely one-pointed. No spines proximad of tip of process or on caudal margin of coxopleura, but a stout bristle at base of each process. Pores of small size, numerous; the pore area not fully attaining the caudal margin, and removed from lateral margin caudally by a wide space but only by a narrow space anteriorly.

Spiracles obliquely and mostly narrowly elliptic.

Anterior tarsi undivided. Tibia with one distal spine, none being present on ventral side.

Antepenult legs with tarsus undivided; prefemur with two ventral spines and femur with one. The immediately preceding pairs of legs have one spine on femur and prefemur, these becoming bristle like cephalad.

Penult legs with prefemur bearing along ventral line two slender spines. Femur also bearing two ventral spines in a line, one of these being at distal end; in addition there are on mesal side toward distal end two additional similar spines. The biarticulate tarsus bearing a few long bristles ventrally, mesally, and dorsally, but ectally with numerous shorter and much finer hairs; the more proximal articles with but few bristles.

Tibia of anal legs unarmed; very much thicker than the tarsus, somewhat clavately widening distad and at ventroectal corner of distal end bearing a conspicuous cylindric process; sparsely clothed with bristles. First tarsal joint strongly clavately widening from base distad and compressed laterally; extended on ventromesal side at distal end into a conspicuous conical process; clothed with few long stiff bristles; clearly less than half as long as the tibia. Second division of tarsus abruptly much thinner than the first article is distally, its proximal article about half as long as the first division; articles of distal division, six to eight, clothed sparsely with long bristles like those of the preceding articles. Femur armed along ventromesal line with two small spines, one toward proximal end and one at or a little proximad of the middle; otherwise unarmed; clothed sparsely with bristles. Prefemur with a ventral row of three stout spines which are clearly shorter than the diameter of the article and are distally bent; along median line of mesal surface near middle of length with two spinules and along dorsomesal line with a series of five or six longer acute spinules; immediately ectad of ventral spines two short spinules and below middle of ectal surface about six longer spinules like those of the dorsomesal line; elsewhere bearing only hairs, which are sparse.

Length near 19 mm.

LOCALITY.— Grenada: Richmond Hill (C. T. Brues and G. M. Allen). TYPE, M. C. Z. 1746; one specimen.

NEWPORTIA CUBANA, sp. nov.

Dorsum olivaceous, excepting the first plate and the last two plates; a darker green to greenish black median longitudinal geminate band; lateral margins also darkened and caudal shorter mottled with dark green. Head with first and last two dorsal plates bright chestnut.

Antennae chestnut like the head, paler, yellowish, distad. Prosternum and prehensors and last ventral plate bright chestnut. Rest of venter light olivaceous, most plates showing a pair of circular dark spots on anterior border and an elongate one on anterior portion of episterna, each consisting of many fine dots. The pleural region also mottled with similar dark spots and streaks. Legs yellowish or ochraceous; the last pair darker, more or less chestnut; penult legs with prefemur, femur, and tibia ventrally whitish, the whitish area embracing an irregular mottling of fine dark dots.

Head densely finely punctate. Paired sulci represented merely by very short weak traces on the caudal border. Caudal margin widely convex.

Antennae short; consisting of the usual seventeen articles. Most articles densely clothed with the usual fine and very short hairs but these on proximal few articles becoming less and less dense and interspersed with longer, coarser hairs.

Prosternum with dental plates very wide but very short, their anterior margins forming a straight or nearly straight transverse line.

First dorsal plate with the cervical sulcus strictly semicircular and entirely free from the head. Paired sulci diverging cephalad and terminating at the cervical sulcus. Sulci of the second plate converging cephalad; those of the succeeding ones parallel. Most plates clearly longitudinally furrowed or depressed each side of the middle line and setting off a low keel-like elevation. Last dorsal plate mesally rather abruptly broadly produced caudad, the produced portion truncate; not sulcate.

Ventral plates, excepting the first and the last three, with a distinct median longitudinal sulcus which does not cross either the anterior or the posterior border. Last ventral plate with sides only very slightly convex, strongly converging caudad; caudal margin widely, subangularly incurved.

Coxopleural process long and slenderly conical, ending in a single spine; otherwise the process and coxopleura wholly unarmed.

Tarsi of all legs biarticulate. No tarsal spine present.

Tibia of anterior legs with a ventral spine at distal end but with no lateral one. No spinules on proximal joints of anterior legs.

Penult legs without spinules.

Anal legs with prefemur bearing ventrally a series of four long, distally curved spines which are shorter than the diameter of the joint; otherwise unarmed. Femur armed ventrally toward mesal side at proximal end with one shorter spine (and in one specimen on one leg with a second spine toward middle of length); otherwise unarmed. Tibia of uniform diameter throughout; more slender than, but equal in length to the femur; unarmed. First article of the tarsus more slender than the tibia though not greatly so; and a little more than half its length. Distal division of tarsus long, composed of from fifteen short to but seven longer distinct articles.[1]

Length 35–42 mm.

LOCALITY.— Cuba: Juan Guerra Sagira de Panamo; Guantanamo, Arroyo Hondo. (C. T. Ramsden). TYPE, M. C. Z. 1753; two specimens, Type and M. C. Z. 1754.

NEWPORTIA OREINA, sp. nov.

General color clear yellow to light brown. Head and prosternum light brown or testaceous. Legs mostly clear yellow, the caudal pairs darker, more orange. Antennae brownish yellow.

Body very slender; narrowed from near the caudal end cephalad to the second dorsal plate.

Head smooth and shining, not distinctly punctate. A short, chitinized median sulcus extending from the anterior margin. A pair of parallel sulci, one a little each side of median line, extending from caudal border only a short distance cephalad; no transverse sulcus. Median portion of caudal margin straight, the margin bending forward at sides about the well-rounded caudal corners.

Antennae short; articles seventeen. Articles distad of the fifth, densely clothed with very short fine, straight hairs, the hairs on the more proximal articles longer and more sparse but none of the articles glabrous.

Anterior margin of the prosternum with a slight acute emargination at middle. A very short, narrow chitinous plate each side of the indentation, the edge of which is straight and slants a little caudad of ectad. Two well-separated longitudinal sulci which extend cephalad to a little distance caudad of the anterior margin where they are united by a weaker transverse impression.

First dorsal plate with the cervical sulcus angular at middle, the vertex lying in a moderate depression; lateral portions of sulcus covered by the cephalic plate. The longitudinal sulci distinct, converging cephalad and bifurcating to form a w-shaped mark the ends of which terminate on the transverse sulcus in the usual way; commonly a fainter transverse sulcus connecting the caudal angles of the w-mark and extending slightly ectad on each side. Longitudinal sulci of second dorsal plate gently converging cephalad and near

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[1] The right leg of one specimen has the tarsus of the Scolopendrides type, the divisions being indistinct and irregular. The tibia of the same leg is of abnormal form, being somewhat bowed ventrad and distinctly constricted toward distal end. The leg is probably a regenerated one.

anterior border meeting a semicircular transverse sulcus the convexity of which is caudad. Sulci on the remaining plates parallel or very nearly so. On the third plate an oblique sulcus runs from the anterior end of each longitudinal sulcus obliquely ectocaudad. Some tergites of the posterior median region may show two longitudinal sulci close together and embracing between them a slight median ridge, but no true keel is present on any of the plates. The last dorsal plate with the caudal margin arcuate, the median portion protruding convexly with each lateral end becoming transverse or nearly so.

Ventral plates smooth and unfurrowed excepting for a transverse subsemicircular impression or furrow toward anterior end of each plate, this furrow usually more distinct in caudal region. Last ventral plate nearly equal in length and breadth. Sides convex, strongly converging caudad. Caudal margin mesally angularly emarginate.

Coxopleural processes moderately long, straight; the distal spine slender and acute. Process armed on ventral surface mostly with two spinules, but sometimes with only one. Caudal border of coxopleura also bearing usually two spinules.

Spiracles typically circular; the first very much larger than the succeeding ones, sometimes appearing more or less elongate.

Tarsi of all legs biarticulate. Second tarsal joint of anterior legs bearing a slender ventral spine near middle. Tibia with a small ventral but no lateral spine at distal end. Femora of all legs with ventral spinule at distal end. Prefemora with mostly two or three ventral spinules.

Penult legs with femur and prefemur bearing a considerable number of spinules chiefly on dorsal and mesal (caudal) surfaces.

Prefemur of anal legs bearing on ventral surface a longitudinal series of four long spines of which the most distal is farther ectad than the others and is at the very distal end of the article; these spines distinctly shorter than the diameter of the article. Femur with a similar ventral series of three spines nearly of same size as those of the prefemur; of these the most proximal is farther ectad than the others and the most distal one is about one fourth the length of the article from its distal end. Femur and prefemur in addition bearing numerous spinules on ectal and dorsal surfaces. Other joints unarmed. Tibia longer than the femur and longer than the first tarsal joint in about ratio 13:10. First tarsal joint much more slender than the tibia; somewhat angularly extended ventrad at distal end. Succeeding portion of tarsus abruptly very much more slender, proportionately short, commonly not much differing in length from the femur; composed of from five to eight distinct articles. Bristles sparse, moderate in length.

Length up to 22–23 mm.

LOCALITY.— Mexico: Hidalgo, Guerrero Mill (W. M. Mann). TYPE, M. C. Z. 1758; ten specimens, several of which are immature, Type and M. C. Z. 1719.

This species is closest to *N. spinipes* Pocock. It differs clearly in having all tarsi biarticulate; in having the anterior legs with but one tarsal spine additional to the ordinary dorsal one; in the number and disposition of spinules on the anterior legs; in the form and proportions of the first tarsal joint, and in the number of segments of the distal division of the anal legs (only 5–8 as against 13–14 in *spinipes*); in the very much smaller size.

CRYPTOPS MANNI, sp. nov.

Body yellow, with the head and caudal end a little darker.

Head subcordate; strongly narrowed cephalad from the middle; caudal margin between rounded corners straight. Clearly longer than wide (ratio about 39:35). Smooth. No sulci evident.

Prosternum with paired submedian longitudinal sulci which are not sharply defined. Not punctate. Anterior margin nearly straight except at ends where rounded caudad, also slightly indented at middle; on each side of middle bearing a pair of bristles directed cephalad and on each lateral curved portion another pair directed ectocephalad.

First dorsal plate with anterior border overlapped by the cephalic plate. A distinct transverse semicircular sulcus close to the margin of head, the sulcus not at all angulate at middle. Longitudinal sulci faint. Plates from the second caudad longitudinally bisulcate, the caudal ones especially showing in addition a curved sulcus on each side which is deepest on the cephalic part of plate. Plates not roughened or bearing cornicles. Hairs sparse. Last tergite with caudal margin mesally strongly convexly protruding; with a median longitudinal sulcus which is not distinct anteriorly; no pit-like depression caudad.

Last ventral plate with sides nearly straight, converging caudad. Caudal margin a little incurved or indented mesally.

Coxopleurae not at all produced caudally. Pores few.

First pairs of legs with tarsi entire but a division appearing and becoming more and more clearly detectable in proceeding caudad.

Prefemur of anal legs bearing numerous moderately stout spines ventro-laterally with longer bristles intermixed, a longitudinal ventral area free from spines but bearing bristles; dorsally at the distal end the joint is longitudinally furrowed and bears on the mesal side a stout short spine. Femur ventrally also with numerous long spines;

dorsally at distal end with two stouter short spines or teeth of which the ectal one is the larger. Tibia also somewhat flattened at distal end above and bearing two similar stout spines of which the ectal one is a little the larger; ventrally with a longitudinal series of five stout teeth. First tarsal joint bearing a ventral series of three, five stout teeth, followed by a small rounded process or lobe at distal end toward mesal side.

Length of type about 9.5 mm.

LOCALITY.— Haiti: Milot, January, 1913 (W. M. Mann). TYPE, M. C. Z. 1714; one specimen.

SCOLOPENDRIDAE.

SCOLOPENDRA POLYMORPHA PUEBLAE, var. nov.

Differs from typical *S. polymorpha* most clearly in having the distal process of the prefemur of the anal legs bearing uniformly only two stout spines (or in one specimen three on one side only). Spines of coxopleural processes three to five, of which one or two are stouter than the others, and one lateral one on the caudal edge of the coxopleura. Median sulcus of last dorsal plate fine, distinct. Dorsal plates sulcate from the tenth on. Tarsus of twentieth legs armed. Olive-brown with caudal borders of plates deeper green.

Length from 130 to 135 mm., much exceeding the average of the *forma typica* and the larger one exceeding the maximum length recorded for the species.

LOCALITY.— Mexico: Puebla (Mrs. L. C. Langton). TYPE, M. C. Z.1705; two specimens, Type and M. C. Z. 1748.

GEOPHILOMORPHA.

ORYIDAE.

TITANOPHILUS, gen. nov.

Head relatively small. No frontal suture present.

Antennae flattened, short, conspicuously pointed.

Labrum entire; widely concave; densely fringed with spinescent teeth.

Mandible with several pectinate lamellae.

First maxillae with lappets present, these more or less dorsal in position. Palpus biarticulate, the second article long. Inner branch set off by a suture. Coxae fused at middle. Claw of palpus of second maxillae simple, concave. Coxae fused at middle, the median portion bulging ventrad and broadly triangularly extended caudad. Salivary pore opening toward proximal end of coxal plate, the pore breaking through the mesal border.

Prehensors not large but considerably exposed from above. Claws, when closed, not surpassing front margin of head.

Prosternum with chitinous lines absent or vague. Anteriorly widely emarginate; unarmed. Basal plate very wide; short.

Dorsal plates with distinct paired submedian sulci.

Prescutellum large, distinctly separated from the spiraculiferous plate. In the anterior segments these sclerites touch the tergite, there being no suprascutella. Farther caudad first one and then more indistinctly two series of suprascutella appear between the two sclerites mentioned and the tergites.

Ventral pores occurring over most of plate excepting a median transverse area.

Last ventral plate wide.

Coxopleurae without pores.

Anal legs each consisting of five articles distad of the coxopleura; clawless.

GENOTYPE.— *T. maximus,* sp. nov.

Closely related to Notiphilides with which it agrees in having the anal legs only five jointed. From this genus it is most readily distinguishable through the presence of the paired submedian sulci and the absence of all suprascutella from a considerable number of the most anterior segments.

TITANOPHILUS MAXIMUS, sp. nov.

Dorsum anteriorly yellow of dilute ochraceous cast; in median region darker, testaceous, of dull olivaceous tinge; again lighter, yellowish, at caudal end. Head light testaceous. Antennae and legs yellow. Prosternum and prehensors like head. Venter anteriorly and caudally clear yellow, the median region testaceous of dull weak olivaceous cast.

Head with anterior margin wide, subtruncate or mesally widely angulate; caudal margin widely convex or somewhat arcuate; head depressed along caudal border each side of middle. Plate of nearly same width anteriorly as posteriorly, sides convexly bulging between. A short median longitudinal sulcus evident on caudal portion and a similar one on the anterior portion; 1.37+ times wider than long in type.

Basal plate very short, as wide as or slightly wider than the cephalic plate at its widest level; sides converging cephalad. Nine times as wide as median length.

Antennae moderate in length. First article broadest, the antenna being somewhat constricted at third article and then again widening to the fifth or sixth from where it narrows gradually to the distal end. Ultimate article shorter than the two preceding ones taken together (ratio 10:12 or 13).

Claws of prehensors when closed reaching anterior margin of head; slender. Other joints of prehensors very short.

Prosternum with a distinct median longitudinal sulcus over the caudal half of length; 2.4 times wider than the greatest length of the exposed portion. Margin between prehensors widely concave, smooth. Two, or a little more, times longer than the greatest length of femuroid.

First dorsal plate 1.5 times longer than the basal plate and considerably wider, its ends strongly depressed. Second plate longer but much narrower than the first. Dorsal plates of most of the body with two very sharply impressed longitudinal sulci close to middle of plate and a less sharply impressed median one between them, these sulci being faint or obscure on the most anterior plates and also faint on the last few. Plates otherwise unmarked; obscurely finely roughened.

Anal tergite broad, its caudal half strictly semicircular; 1.5 times wider than long.

Prescuta very short or quite concealed.

Most ventral plates a little concavely depressed from edges toward middle; some showing a vague longitudinal median sulcus. Under a lens the surface is seen to be very finely, somewhat obscurely, shagreened or tubercular. Last ventral plate short and very broad. Anterior and caudal margins straight; lateral margins straight, converging caudad; three times wider than long.

Anal legs in the male short, but longer than the penult and much stouter, being strongly crassate. Last four articles of about equal thickness and the ultimate and penult nearly of the same length. Hairs very short, rather sparse. Coxopleurae small, poreless.

Gonopods of male biarticulate, as a whole conical, the proximal article being very broad.

Pairs of legs 169 (♂).

Length between 190 and 200 mm. Greatest width of body 4 mm. Width of widest tergite, 3 mm.

Locality.— Haiti: Grand Riviere (W. M. Mann). Type, M. C. Z. 1732, one male.

TITANOPHILUS FRATRELLUS, sp. nov.

Dorsum anteriorly and at very caudal end of body ochraceous; in the middle of a distinctly olivaceous cast. The color of venter nearly the same as that of the dorsum. Head and prosternum with prehensors pale brown of a dilute olivaceous cast. Antennae and legs yellow.

Body robust; narrowed at very caudal end and less obviously in anterior region.

Head subcordate; widest caudally and conspicuously narrowed cephalad, as a whole somewhat convex, the caudal border apparently sharply depressed, the elevated edge arcuate. Only a little wider than long (37:34). A short, deep median longitudinal sulcus on middle portion of plate. Cephalic plate not wholly covering prehensors from above.

Basal plate very wide and very short; wider than the head; 6.5 times wider than its median length.

Antennae flattened as usual; very short; broad at base and uniformly narrowing distad. Ultimate article short, pointed, a very little shorter than the two preceding articles taken together.

Claws of prehensors slender; when closed not attaining front margin of head.

Exposed portion of prosternum a little more than twice wider than the greatest length; five times longer than the greatest length of femuroid. Margin between prehensors wide, weakly concave; a vague, dark nodular elevation each side of middle.

First dorsal plate wider than the basal plate and also than the second tergite. Not quite twice as long as the basal plate (ratio 11:6); shorter than the second in ratio 11:13; sides much converging caudad. Dorsal plates strongly bisulcate, with a much weaker or often obsolete median sulcus between the paired sulci; sulci becoming weaker or obscure on most anterior and most posterior plates. Anal tergite caudally semicircularly rounded or mesally somewhat obtusely angular; equal in length and breadth.

Prescuta in caudal region short but distinct, becoming very short cephalad. Prescutum of last pediferous segment longest at middle, running out to a point on each side, its caudal margin appearing convex and its anterior one straight.

Ventral plates not specially marked. Last ventral plate broad but relatively much longer than in *T. maximus,* being only twice as wide as long; sides straight, strongly converging; caudal margin weakly incurved from end to end.

Ventral pores small, not very dense, occurring over all of sternite excepting the usual median area.

Spiracles narrowly oblong, placed a little obliquely to the longitudinal line. Anterior ones large and conspicuous, decreasing moderately caudad.

Anal legs in male very strongly crassate; flattened dorsoventrally; femur thickest. Trochanter not quite half as long as prefemur which is longer than the femur. Greatly exceeding the penult legs in length. Densely clothed with very fine short hairs.

Number of pairs of legs 149 (♂).

Length about 115 mm. Greatest width 2.6 mm. Width of widest dorsal plate 2 mm.

LOCALITY.— Haiti: Petionville, November, 1912 (W. M. Mann). TYPE, M. C. Z. 1718; one specimen.

SOGONIDAE.

Key to Genera of Sogonidae.

A. Anal leg composed of but five articles distad of coxopleura. TIMPINA Chamberlin.

AA. Anal leg composed of six articles distad of the coxopleura.

  B. Anal leg clawless; first maxillae with long lappets. SOGONA Chamberlin.

  BB. Anal leg ending in a well-developed claw; first maxillae without lappets....................GARRINA, gen. nov.

GARRINA, gen. nov.

Head small; with no distinct frontal suture. (Prebasal plate exposed). Basal plate wide.

Antennae with proximal articles more or less flattened, attenuated and filiform distad.

Labrum mesally convex and laterally concave as usual.

First maxillae with palpus or outer process biarticulate; without lappets. Inner branch showing trace of a suture mesally but across most of branch to ectal side with no indication of separation. Coxae fused at middle. Coxae of second maxillae weakly narrowly united at middle. A deep narrow incision extending between them from anterior margin. Palpus of good size, triarticulate as usual, terminating in a well-developed, simple claw.

Prehensors small, wholly unarmed. Largely covered in dorsal view. Claws when closed not extending beyond front margin of head.

Prosternum with chitinous lines strongly developed.

Ventral pores small and few, arranged as usual in a narrow transverse band a little behind the middle of the sternite.

Last ventral plate wide.

Coxopleural glands opening into two large pits on each side.

Anal legs each consisting of six joints distad of the coxopleura; terminating in a well-developed claw.

GENOTYPE.— *G. ochrus,* sp. nov.

This genus is at once distinguishable from Timpina and Sogona, the other genera of the family, in having the anal leg armed with a distinct claw, and in lacking lappets on the first maxillae.

GARRINA OCHRUS, sp. nov.

Bright yellow, the color a little duller and somewhat dusky over middle. Head similar but color duller, darker caudad of suture antennae yellow of very faint brownish tinge. Prosternum yellow of dilute chestnut cast. Venter and legs clear yellow.

Body moderate, of nearly uniform width over much of length, but at very anterior portion strongly narrowed to the small head and over the caudal third of length gradually and considerably narrowing.

Head with no frontal suture; anterior border subtriangular; widest back of middle. Caudal margin wide; weakly excurved at middle and incurved toward each end. Equal in length and breadth. Basal plate with front margin concave, overlapped at sides by cephalic plate but mesally leaving prebasal plate exposed. Very wide, wider across base than the head (41:37).

Antennae approximate at base; first several articles broad and flattened, the antennae narrowing rapidly and becoming filiform distally. Short; slightly more than 2.5 times length of cephalic plate. Ultimate article nearly equalling the two preceding ones taken together.

Claws of prehensors moderately stout; when closed attaining front margin of head. Prehensors wholly unarmed.

Margin of prosternum between prehensors rather short; straight excepting for a weak median emargination. Sides straight and only slightly converging from anterior end back to the convex caudal portion. Wider than long in ratio 47:35; about 3.33 + times longer than greatest length of femuroid. Chitinous lines strongly developed, complete.

First dorsal plate anteriorly a little wider than the basal plate and much wider than the second tergite; sides convex, converging to the very strongly oblique caudal corners, the line of truncation of the corners being much more nearly horizontal than longitudinal. Dorsal plates bisulcate; on anterior tergites also a clearly impressed median longitudinal sulcus.

Prescuta mostly very short over entire length, a longer one occurring occasionally at irregular intervals.

Ventral plates with a median longitudinal sulcus extending from anterior margin to caudad of middle where it commonly ends in a weaker transverse furrow.

Last ventral plate broad; sides straight and strongly converging; caudal margin moderately angularly bent in from ends to middle.

Ventral pores small and rather sparse; arranged in a very narrow transverse band between middle and caudal margin.

Coxopleurae each with two large pits of which the inner portion is covered by the last ventral plate.

First spiracle subvertically obovate, the second and third less elongate and the fourth and succeeding ones circular. First spiracle clearly the largest, the others very gradually decreasing in size caudad, the anterior ones being large and the most caudal ones small or minute.

Anal legs very much longer than the penult. In the male crassate; the femur thickest with the tibia and first tarsal joint a little thinner and the second tarsal joint abruptly much thinner (Plate **3**, fig. 3). Armed with a distinct slender claw. Hairs mostly short, sparse.

Pairs of legs 59–63.

Length up to 26 mm.

LOCALITIES.— Mexico: Hidalgo, Guerrero Mill (W. M. Mann). TYPE, M. C. Z. 1723. Mexico: Pachuca (W. M. Mann); Distrito Federal, Esclava (O. W. Barrett); four specimens. Type and M. C. Z. 1721, 1722, 1724.

LINOTAENIIDAE.

PAGOTAENIA, gen. nov.

Head small; a true frontal suture not present. Basal plate wide. Prebasal plate not exposed. Dorsal plates not bisulcate.

Antennae filiform.

Labrum free; tripartite. Median piece very large, overlapping the small lateral pieces; conspicuously arcuate with the free caudal border fringed with close set spines across entire width much as in Azathothus.

First maxillae with coxae completely fused; coxal plate at each ectal end extended cephalad into a conspicuous process which resembles a large proximal joint to the palpus which it bears, giving the latter the appearance of being triarticulate. Palpus distinctly biarticulate, the second article large, bending about distal end of inner process; no lappets present. Inner process set off by a distinct suture. Second maxillae with coxae completely coalesced. Palpus not long; ending in a large simple claw.

Prehensors small; largely concealed by head in dorsal view; wholly unarmed. Claw slender but not constricted or excavated proximally; when closed extending a little distance beyond front margin of head.

Prosternum with chitinous lines strongly developed but incomplete cephalad.

Ventral pores in a transverse band in front of caudal margin, the band commonly divided at middle.

Last ventral plate wide.

Coxopleurae each with pores opening as two pits of moderate size at edge of sternite.

Anal pores not manifest.

Anal legs composed of six articles distad of coxopleurae; clawless.

GENOTYPE.— *P. lestes*, sp. nov.

Apparently most closely related to Agathothus, from which it differs in having the inner branch of the first maxillae separated off by a suture, the outer branch elevated on a distinct process of coxa, the prosternum provided with chitinous lines, coxopleural pores in form of two pits on each side, and the anal legs clawless.

PAGOTAENIA LESTES, sp. nov.

Dorsum light greenish brown; darker, clearer brown cephalad; lightest caudad. Head, antennae, prosternum, and prehensors dilute chestnut. Venter of greenish brown cast. Legs pale brownish.

Body of typical Linotaenia form being strongly narrowed from middle region both caudad and cephalad; entire body clothed with numerous straight short hairs.

Head small with true frontal suture not present, but a pale line in its place more or less traceable. Wider than long in ratio 12:11. Anterior or frontal portion semicircularly rounded, or the anterior margin mesally somewhat angulate. Sides convex. Head widest between frontal region and caudal end. Caudal border a very little overlapped by the basal plate. A median longitudinal sulcus evident on posterior portion. Hairs short, numerous. Basal plate wide;

as wide as head; nearly as wide across anterior as across posterior border; 2.6 times wider than long.

Antennae very short, filiform; only about 2.25 times longer than the head. Articles short; the ultimate a little shorter than the two preceding ones taken together. Hairs very short and rather dense; increasing in length on proximal articles.

Claws of prehensors very slender, narrow at base; unarmed; when closed surpassing the anterior margin of head and attaining the distal end of the first antennal article. None of the articles armed.

Margin of prosternum between the prehensors wide; forming a gently reëntrant angle. Sides convex; strongly converging caudad. Wider than long in ratio 7:4; 1.7 times longer than greatest length of the femuroid. Chitinous lines distinct but incomplete at anterior end.

First dorsal plate a little wider than the basal plate; sides convex, converging caudad. Plates not sulcate.

Anterior ventral plates each with caudal border transversely conspicuously depressed or channelled and at middle with an angular process fitting into a corresponding process in the anterior border of the succeeding sternite.

Last ventral plate very broad; wider than the preceding one. Sides strongly converging caudad; caudal margin wide, weakly convex. Wider than long in about ratio 5:3.

Ventral pores numerous; arranged in a transverse band each side of the middle line and immediately in front of the caudal margin, the band on each side widest at ectal end.

Coxopleurae not large. Pores on each appearing as two pits near or partly beneath edge of sternite.

Spiracles all circular and small, scarcely differing in anterior and posterior regions; the first one not at all enlarged.

Anal legs distad of coxopleurae a little shorter than the penult pair. In the male strongly crassate; thickest at femur; ultimate article short, conically rounded distad. Clawless. Densely finely pubescent.

Legs of first pair a little shorter and more slender than those succeeding. Anterior pairs a little more robust than the posterior ones.

Pairs of legs 43 (♂).

Length 24 mm.

LOCALITY.— Mexico: Hidalgo; Guerrero Mill (W. M. Mann). TYPE, M. C. Z. 1715; one specimen.

CHILENOPHILIDAE.

NESIDIPHILUS, gen. nov.

Head with frontal plate usually not set off by distinct suture but this sometimes present or indicated by a pale line. Basal plate wide; trapeziform; overlapped by the cephalic plate. Dorsal plates bisulcate.

Antennae filiform, short.

Labrum free; tripartite. The median piece large; bearing along the caudal margin a series of long stout teeth of which the median ones are largest. Lateral pieces fringed with paler, distally more slender, spinescent processes.

Second maxillae with coxae completely united at middle, the isthmus moderately wide cephalocaudally and as well chitinized as the more lateral portions. Pleurosternal sutures strongly developed. The sclerite ordinarily appearing at caudal angles of inconspicuous size is in this genus large and extended cephalomesad parallel with suture, being separated caudally by a narrow slit but elsewhere united with portion of plate adjoining the suture. From between the anterior ends of these inner sclerites extends cephalad a median tongue-like chitinous process (Plate **5**, fig. 3). Palpus triarticulate, terminating in a simple claw of moderate size. None of articles with a process. First maxillae with two long membranous lappets on each side. Inner division set off by a distinct suture. Coxae completely fused.

Prehensors large; conspicuously exposed from above and extending much beyond front margin of head. Claw commonly serrulate proximally within; always armed at base with a stout black conical tooth. Femuroid armed within near distal end with a larger distally rounded process which is paler and less strongly chitinized than the tooth of claw, of about same color as rest of article. Other articles unarmed.

No chitinous lines on prosternum.

Ventral pores numerous; arranged in four areas, one on each quarter of plate toward anterior or caudal margin as case may be.

Spiracles circular excepting the first one which is vertically more or less elongate and of large size.

Last ventral plate narrow; its sides strongly converging caudad.

Tergite of last pediferous segment broad, being anteriorly as wide as the preceding tergite; sides convex; largely concealing the coxopleurae from above (Plate **5**, fig. 3).

Coxopleurae moderately inflated but not unusually elongate and not at all exposed at sides of last prescutum. Pores small and very numerous; most abundant dorsally and ventrally along and beneath edges of dorsal and ventral plate, fewer laterally and caudal end.

Anal leg with six joints distad of the coxopleurae. Unarmed or with obscure trace of claw. Not long.

GENOTYPE.— *M. latus*, sp. nov.

This genus corresponds in part to Polycricus as used by Cook but does not embrace the type of that genus (*P. toltecus*) as given by its authors, Humbert and Saussure. In addition to the genotype, *Nesidiphilus* includes *N. montis*, sp. nov., *N. nicaraguae*, sp. nov. and *N. marginalis* (Meinert), *Polycricus floridanus* Cook being a synonym of the last mentioned species.

NESIDIPHILUS LATUS, sp. nov.

Dorsum rather dark brown with anteriorly a black median stripe which posteriorly becomes geminate and may be there indistinct; margins of plates and pleural sclerites may be mottled with purplish much as in *marginalis*. Head typically of a chestnut cast. Antennae brown, somewhat paler at tips. Prosternum and prehensors like head. Venter a lighter brown than the dorsum. Legs testaceous.

Body broad, robust; strongly narrowed from the middle caudad but only moderately narrowing cephalad to the head.

Head with place of suture taken by a pale line from the level of which cephalad the head is somewhat constricted. Anterior margin convex, the part between bases of antennae straight or a little concave. Head distinctly narrowing from near frontal region caudad to caudal region where the sides convexly round in and converge to the straight caudal margin. Nearly two thirds as wide as long (ratio in type 60:97). Basal plate 3.45 times wider than long; coarsely punctate.

Antennae short being only about 2.33 times longer than the head. Ultimate article scarcely narrowed distad, apically well rounded; three fourths as long as the two preceding ones taken together.

Claws of prehensors when closed reaching to between proximal and distal ends of second article of antennae. Claws stout, proximally serrulate or finely crenulate on mesal side; armed at base with a stout conical black tooth and distad of this showing a dark low eminence. Femuroid distally with a stout well-rounded nodular process which is pale. Other articles unarmed.

Sinus of prosternum semicircular, shallow; a low dark nodular eminence or tooth on each side of it. Sides a little converging caudad, at middle of length very slightly incurved. Free portion nearly 1.2 times longer than greatest length; 1.7 times longer than greatest length of femuroid. Subdensely punctate.

Dorsal plates deeply bisulcate; the anterior ones showing also a deep median longitudinal sulcus extending caudad to a sharply impressed transverse sulcus extending across the plate caudad of the middle; farther caudad this median sulcus tends to be replaced by a pair of sulci.

Last ventral plate narrow but as wide across anterior end as its length. Sides straight, strongly converging caudad. Width across anterior end nearly twice as great as that across the caudal. Anterior margin convex, the caudal weakly incurved. A median longitudinal sulcus more or less evident.

Posterior prescuta short, the anterior ones very short.

Ventral plates with a median longitudinal furrow which is very deep at middle but on some anterior plates may not attain the margins; crossed near its middle by a weak transverse furrow.

Anal tergite broad. Wider than long in ratio 8:7. Sides only weakly convex, more abruptly bending in caudad. Caudal margin nearly straight.

Ventral pores in an area on each anterior quarter of sternite and in a transverse band across caudal border this band being more or less divided at median line by a poreless area.

Coxopleurae moderate. Pores small and numerous; most dense dorsally and ventrally along tergite and sternite, fewer laterally and absent from most caudal portion.

First spiracle much the largest, subcircular or vertically a little elongate; all others strictly circular; the second intermediate in size, the others decreasing caudad and in the caudal region becoming small or very small.

Anal legs exceeding the penult in length though not greatly so. In the female slender, the distal articles more slender than the proximal. Second tarsal article with a minute vague rudiment of claw. Anal legs in male more crassate than in female though not strongly so.

First legs shorter and much more slender than the second which are as large as those immediately succeeding. Posterior pairs longer than the anterior ones.

Pairs of legs 7 (♂)-49 (♀).

Length 24–40 mm. but mostly 30–40 mm.

LOCALITY.— Jamaica: Blue Mountain Peak. TYPE, M. C. Z. 1725; six specimens, Type and Paratypes, M. C. Z. 1749.

NESIDIPHILUS MONTIS, sp. nov.

Dusky brown. Head with prosternum and prehensors clearer brown of faint reddish cast. Antennae light brown. Legs brownish yellow.

Body narrowing conspicuously caudad.

Head and anterior portion of body broad. Head anteriorly semicircularly rounded. Widest near caudal end of frontal region from where the sides are straight and converge very slightly caudad to the oblique caudal corners. Caudal margin straight. Frontal suture not present; 1.45 times longer than wide. Basal plate 3.4 times wider than long.

Antennae very short, pointed; only about 2.2 times longer than the head. The ultimate article moderately short, distally rounded, only three fourths as long as the two preceding articles taken together.

Claws of prehensors when closed reaching or nearly reaching the distal end of the second antennal article. Claw at base with a stout, conical, black tooth. Intermediate articles unarmed. Femuroid near distal end with a stout rounded pale process of the usual type.

Anterior margin of prosternum with a median sinus which is shallow and semicircular; on each side of sinus an obscure low nodule or tooth. Sides nearly straight back to the rounded caudal corners; a little converging caudad. Exposed part of prosternum 1.24 times wider than median length; 1.64 times as long as the greatest length of femuroid. Densely and rather coarsely punctate.

Dorsal plates deeply bisulcate, with a mostly equally well-impressed median longitudinal sulcus; a sharply impressed transverse sulcus across plate a little caudad of its middle.

Last dorsal plate broader, largely concealing the coxopleurae in dorsal view; shield shaped with the caudal end truncate and the anterior margin also straight. Wider than long in ratio 5:4.

All prescuta short, those of anterior region extremely so.

Ventral plates with a deep median longitudinal sulcus which is deepest at middle of its length; this crossed behind middle by a weaker transverse sulcus.

Last ventral plate narrow and long; its sides straight, strongly converging caudad; anterior margin convex; caudal margin also, but weakly, convex. Anteriorly the plate is twice as wide as across caudal end or nearly so; about three fourths as wide as long.

Ventral pores numerous; chiefly in a transverse caudal band more or less clearly divided at middle line; a smaller area toward each anterior corner.

Coxopleurae moderately inflated; not unusually elongate. Densely porose as usual.

First spiracle much the largest, vertically elongate, subelliptic; others circular, decreasing caudad.

Anal legs much longer than the penult; slender. Last tarsal article long and slender.

Pairs of legs 55.

Length near 26 mm.

LOCALITY.— Cuba: Monte Verde. TYPE, M. C. Z. 1726; one specimen.

NESIDIPHILUS NICARAGUAE, sp. nov.

Dorsum light brown, becoming lighter, yellowish, caudad. Head and antennae dilute chestnut of weak ferruginous tinge. Prosternum and prehensors like the head. Venter yellow to testaceous. Legs testaceous to clear yellow.

Body moderately robust, conspicuously narrowing caudad from middle but only very gradually and moderately narrowed cephalad.

Cephalic plate about two thirds as wide as long. Sides back of suture nearly straight, slightly converging caudad and rounding in more strongly to a short strongly narrowed caudal portion of head. Frontal suture present. Punctae caudad of suture moderately coarse, not dense. Hairs sparse. Basal plate 3 times wider than long.

Antennae thick and moderately long. Ultimate article clearly shorter than the two preceding ones taken together.

Claws of prehensors when closed extending much beyond front margin of head and reaching to near distal end of second article. Claw armed at base with a stout, distally rounded black tooth. Femuroid with a more robust, distally rounded dark process or tooth projecting cephalomesad, this darker and more strongly chitinized than in the other known species of the genus.

Prosternum wider than long in the ratio 5:4. Anterior margin between prehensors widely concave; a slight pale tooth on each side. Sides of prosternum parallel between anterior end and the convex caudal corners; 1.76 times longer than greater length of femuroid.

Prescuta in anterior region short, becoming of moderate length in median region and then again decreasing in caudal region.

Ventral plates with a distinct transverse sulcus crossed by a median longitudinal one, the impressions deepest at the point of crossing, there being a pit-like depression on this part of anterior plates.

Last ventral plate narrow; its sides only slightly converging caudad, straight; caudal margin straight.

Ventral pores numerous; chiefly in two large areas in front of caudal margin and separated by a poreless area along the sulcus; a smaller porose area on each anterior quarter as usual.

First pair of legs shorter and much more slender than the second, the latter being intermediate in size between the first and the third. Anterior and posterior pairs in general scarcely differing in length or thickness.

Coxopleurae moderately enlarged; surface densely perforated with very numerous small pores.

Spiracles all circular; the first one much larger than the third with the second one intermediate in size; the others gradually decreasing caudad as usual.

Anal legs only slightly exceeding the penult ones in length. Slender. The distal article slender, distally rounded, with no trace of claw. Hairs sparse.

Pairs of legs, 79.

Length about 54 mm.

LOCALITY.— Nicaragua: Escondido River about 50 miles from Bluefields, September, 1892 (C. W. Richmond). TYPE, M. C. Z. 1731; one specimen.

TELOCRICUS, gen. nov.

Head without frontal suture. Basal plate trapeziform, wide, overlapped by the head. Dorsal plates bisulcate.

Antennae filiform, long.

Labrum and first and second maxillae essentially as described for Nesophilus.

Prehensors large, much exposed from above, projecting widely beyond front margin of head. Claw armed at base with a stout conical black tooth. Femuroid armed toward distal end with a similar stout black conical tooth equally as well chitinized as that of the claw.

Prosternum without chitinous lines.

Prescutum also long and narrow, the coxopleurae in dorsal view being much exposed each side of it.

Ventral pores arranged as in Nesidiphilus but usually fewer and less obvious.

Last ventral plate very narrow, typically much longer than wide; sides converging caudad.

Tergite of last pediferous segment unusually narrow, conspicuously narrower than the penult plate, clearly and considerably longer than wide; leaving coxopleurae much exposed from above.

Coxopleurae strongly inflated and unusually elongate in correspondence with the long tergite and prescutum, more or less encroaching cephalad. Pores very small and very numerous, densest dorsally and ventrally near plates.

Anal legs with six large joints distad of coxopleurae and in addition with a minute membranous but clearly defined terminal appendage replacing the claw.

GENOTYPE.— *T. cubae,* sp. nov.

Very close to Nesidiphilus from which it is most readily distinguished by the long and very narrow last tergite and the narrow prescutum which leave the elongate coxopleurae much exposed in dorsal view (Plate **4**, fig. 5) as well as by the narrow elongate sternite. The greater proportionate length of antennae and anal legs is readily noted in most cases.

TELOCRICUS CUBAE, sp. nov.

Anteriorly ochraceous, becoming clearer yellow caudad. Head darker, of very dilute chestnut cast. Antennae yellow. Prosternum and prehensors like head.

Body of nearly uniform width from middle forwards to head but conspicuously narrowing caudad.

Cephalic plate with anterior margin subtruncate; caudal margin straight. Head of nearly uniform width from frontal region to rounded caudal corners, the sides being straight. Frontal plate coalesced but line of union indicated by a faint pale line. Head 1.67 times longer than wide (ratio cir. 92:55). Basal plate three times wider than length at middle.

Antennae long, 3.25 times longer than the head. Rather thick. Articles long; the ultimate only about two thirds as long as the two preceding ones taken together.

Claws of prehensors when closed reaching to distal end of second antennal article. Claw armed at base with a stout black tooth. Intermediate articles unarmed. Femuroid with a stout, distally truncate black tooth toward distal end, the tooth larger than that of the claw; femuroid somewhat protruding midway between tooth and proximal end.

Prosternum with two short, bluntly rounded, well-chitinized teeth on anterior margin, one each side of the narrow, shallow, median sinus. Sides nearly straight, very slightly converging caudad. A little wider than long, the ratio being about 19:18; 1.63 times longer than the greatest length of femuroid. No trace of chitinous lines.

Dorsal plates deeply bisulcate. A conspicuously impressed median longitudinal sulcus also evident on the anterior plates especially. On most plates a strongly impressed transverse sulcus a little in front of the caudal margin. Hairs very short, sparse.

Anterior prescuta very short, gradually increasing caudad, but still short in caudal region.

Anterior spiracles very large, vertically subovate, gradually assuming the circular form caudad. First spiracle much the largest, the others gradually decreasing in size caudad, the most posterior ones being very small.

Ventral plates marked with a strong median longitudinal sulcus which is crossed between middle and caudal margin by a weaker transverse sulcus, impression deepest at point of crossing. On the anterior plates the median sulcus bifurcates widely cephalad, in a somewhat Y form. Last ventral plate very narrow; its anterior border triangular; caudal margin straight or nearly so; sides moderately converging caudad, straight; plate 2.33+ times longer than greatest width.

Tergite of last pediferous segment with sides substraight and only slightly converging caudad; caudal margin weakly convex. Plate only two thirds as wide as long. Last prescutum long and rather narrow.

Coxopleurae inflated and much elongate, crowding cephalad toward bases of penult legs. Densely porose with numerous small pores as shown in the figures.

Anal legs very much longer and more robust than the penult; proportionately slender, the articles decreasing regularly in diameter from the femur distad. Articles from the prefemur to the first tarsal inclusive somewhat clavately enlarging distad; second tarsal article of nearly uniform diameter or a little decreasing in width distad. At end of second tarsal, joint a minute, membranous but clearly separated, appendage or article bearing short hairs.

Anterior legs more robust than those of the posterior region.

Pairs of legs 79.

Length 52–58 mm.

LOCALITY.— Cuba: Soledad, near Cienfuegos (Thomas Barbour). TYPE, M. C. Z. 1757; two specimens, Type and Paratypes, M. C. Z. 1756.

TELOCRICUS FRATER, sp. nov.

Dorsum ochraceous, the head nearly of same color. Antennae and legs yellow.

Head 1.55 times longer than wide. A little widest near caudal end of the frontal region, though only slightly narrowing caudad. Sides straight or nearly so back to the rounded caudal corners. Anterior margin substraight. Caudal margin straight. Basal plate much covered by the head and the first dorsal plate, the exposed portion being fully six times as wide as long.

Antennae rather thick, a little attenuated distad; three times longer than the head. Ultimate article much shorter than the two preceding articles taken together, being only about three fourths as long.

Claws of prehensors stout; when closed extending widely beyond front margin of the head as usual. Claw armed at base with the usual stout, conical black tooth. Femuroid bearing at its distal end a black tooth somewhat stouter than that of the claw, the tooth conical, distally rounded and projecting cephalad of directly mesad; femuroid only vaguely bulging proximad of the tooth.

Anterior margin of prosternum armed with two pale nodular teeth, one each side of the narrow and shallow sinus, these much closer to each other than either is to the corresponding prehensor. Sides nearly straight, only very slightly converging caudad. Wider than long in ratio 21:19. Nearly 1.4 times longer than greatest length of femuroid.

Dorsal plates as usual showing in part a median sulcus in addition to the paired ones.

Prescuta short to very short.

Anterior spiracles large, vertically subelliptic, somewhat narrower ventrally than dorsally. Decreasing in size caudad and gradually becoming circular, those of the caudal region small as usual.

Ventral plates with the usual deep median longitudinal sulcus which is deepest when crossed by the weaker transverse sulcus behind middle.

Last tergite with sides straight, distinctly and considerably converging caudad. Caudal margin straight. Plate much longer than wide (ratio about 19:15).

Last ventral plate narrow. Sides conspicuously converging caudad, somewhat incurved toward anterior end and excurved toward the caudal.

Coxopleurae much enlarged and elongate, densely finely porose as usual.

Anal legs much longer than the penult; nearly as in *cubae.*

Pairs of legs 65.

Length near 26 mm.

LOCALITY.— Cuba: Monte Verde (Charles Wright). TYPE, M. C. Z. 1727; one specimen.

TELOCRICUS MAJOR, sp. nov.

Head and anterior portion of dorsum dark ochraceous, with a paler median longitudinal line; becoming yellow caudad. Antennae ochraceous. Prosternum chestnut, the prehensors paler, more ochraceous. Venter anteriorly dark ochraceous, caudally becoming yellow like the dorsum.

Body gradually and conspicuously narrowed caudad from the middle but scarcely at all narrowing cephalad. Body and legs in caudal region densely clothed with fine short hairs, these becoming more and more sparse cephalad.

Head anteriorly semicircularly rounded; caudal margin wide, straight; very slightly wider just in front of caudal corners than anteriorly; sides straight between rounded anterior and posterior corners. Frontal suture not evident. Plate 1.6+ times longer than wide. Basal plate considerably overlapped the exposed portion in type being five times wider than long, but the shortness may have been caused in part by shrinkage of full dorsal plate over the basal in the alcohol; but measuring entire length of plate caudad of head gives a ratio of width to length of 4:1.

Antennae robust, short, only 2+ times longer than the head. Articles moderate; the ultimate only three fifths as long as the two preceding ones taken together.

Claws of prehensors when closed extending to distal end of the second antennal article. Claw armed at base with the usual stout, subconical, distally rounded black tooth. Tooth near distal end of femuroid of about same size and form as that of claw; femuroid broadly bulging between tooth and proximal end.

Anterior margin of the prosternum bearing the usual two teeth; these distally well rounded and somewhat nodular, not so close together as in the preceding species, the distance between them nearly equalling that between each one and base of corresponding femuroid. Sides straight, only very slightly converging from anterior end to caudal corners. Exposed portion nearly of same length as breadth, total length of median portion when all is measured being greater than the width.

Anterior prescuta very short, the prescuta becoming of moderate length in caudal region.

Anterior spiracles very large, vertically subovate, gradually decreasing in size caudad and becoming circular, those of the caudal region very small.

Anterior sternites with the median longitudinal sulcus deeply impressed, crossed at or a little behind middle by a wider transverse sulcus, the impression deepest at place of crossing, sulci weaker on caudal plates.

Last ventral plate very narrow and long, sides incurved, more strongly converging than in *cubae;* caudal corners obliquely truncate; caudal margin straight; anterior margin strongly convex. Anterior portion of plate densely clothed with fine very short hairs which are more sparse on other parts of plate.

Coxopleurae large, elongate as usual. Densely finely porose. Densely clothed between pores with fine and very short hairs.

Last dorsal plate proportionately narrow and long; twice as long as its greatest width; almost as wide caudad as cephalad; sides a little incurved between ends; caudal corners oblique; caudal margin weakly incurved.

Anal legs greatly exceeding the penult in length. Slender, the tarsal articles especially so. Terminal membranous article minute, bearing very short hairs. Hairs short, dense, evenly distributed, like those of other parts of caudal portion of body.

Pairs of legs 89 (♀).

Length near 80 mm.

LOCALITY.— Cuba: San Diego de los Baños. TYPE, M. C. Z. 1728; one specimen.

TELOCRICUS MULTIPES, sp. nov.

Body light lemon-yellow anteriorly, paler yellow posteriorly. Head and prosternum darker. Antennae yellow. Legs yellow with the posterior pairs very pale.

Body very slender, gradually narrowing to the caudal end.

Frontal plate not discrete. Head widest anteriorly; sides nearly straight, considerably converging caudad. Anterior margin semicircularly rounded, indented as usual between the antennae. Caudal margin straight; 1.45 times longer than wide. Basal plate largely overlapped by the head, the exposed portion being in the type eight times wider than long.

Antennae moderate, in type being 2.6 times longer than the head. Ultimate article pointed, a little shorter than the two preceding ones taken together. Other articles mostly short. The distal seven or eight articles subdensely clothed with fine short hairs, the others with sparse long bristles arranged chiefly about proximal ends.

Claws of prehensors when closed attaining or a little exceeding the distal end of the first antennal article. Claw at base with a black, acutely conical tooth and a small protuberance distad of this as usual. Femuroid with a stouter subconical black tooth at distal end, with no protuberance proximad of it.

Median sinus of prosternum narrow, semicircular at bottom, sides vertical. A relatively broad nodular elevation each side of sinus. Sides straight and parallel or nearly so. Exposed portion wider than long in ratio 11:10; 1.6 times longer than greatest height of femuroid.

Prescuta very short in anterior region, gradually increasing and becoming moderately long caudad.

First spiracle large, very much exceeding the second in size; subcircular or vertically a little elongate. Others strictly circular, decreasing caudad and in posterior region becoming minute.

Median longitudinal sulcus of sternites very deep, crossing entire length of plate, transverse sulcus more or less vague.

Last ventral plate very narrow, longer than wide, strongly narrowed caudad, sides incurved.

Tergite of last pediferous segment with caudal margin strongly rounded; sides but slightly converging caudad; narrower than the penult tergite.

Coxopleurae strongly enlarged but less elongate than usual. Densely, finely porose as usual.

Anal leg much exceeding the penult, moderately thickened in the male. Second tarsal article slender, with the usual minute membranous appendage at its end.

First legs considerably shorter and more slender than the second which are of full size. Anterior legs clearly shorter and stouter than the posterior ones.

Pairs of legs 113 (♂).

Length about 35 mm.

Locality.— Haiti: Mannville, December, 1912 (W. M. Mann).

Type. M. C. Z. 1717; one male.

This is the most aberrant species of the genus.

Lestophilus, gen. nov.

Head without evident frontal suture. Basal plate wide, largely overlapped by the cephalic plate, the exposed portion being very short. Dorsal plates bisulcate.

Antennae short, filiform.

Labrum free, tripartite. The median piece of good size, not at all overlapped by the lateral; its free margin with a series of stout conical teeth which are much less slender and spiniform than in Taiyuna (six in genotype). Lateral pieces fringed with many slender spinescent processes which are more numerous than in Taiyuna.

Outer process of first maxillae distinctly biarticulate, bearing two very long membranous lappets. Inner process set off by a distinct suture. Coxae completely coalesced. Second maxillae with coxae almost completely separated at middle, there being but a pale membranous connective or isthmus. The entire anteromesal border, or all excepting most mesal end, more strongly chitinous and at times appearing almost as a separate sclerite (Plate **5**, fig. 4). Pleurosternal suture strongly marked; pore situated mesad of the suture a little in front of middle of its length and opening through the mesal margin. The sclerite at angle small, not at all enlarged or extended cephalad as in Teloericus and Nesidiphilus and no median chitinous process present (Plate **5**, fig. 5). Palpus triarticulate; terminating in a large simple claw; none of the joints with processes.

Prehensors large, conspicuously exposed at the sides and projecting much beyond front margin of the head. Claw armed at base with a stout conical black tooth. Femuroid armed toward distal end with a larger stout, distally rounded process or tooth which is less strongly chitinized than that of the claw and is pale like that of Nesidiphilus.

Prosternum without chitinous lines. Anterior margin with two teeth.

Ventral pores few; present on the anterior plates in a narrow transverse band in front of the caudal margin.

Spiracles all circular or the first one a little vertically elongate and much larger than the third one.

Last ventral plate intermediate in size, varying across the anterior end from slightly wider than long to a little longer than wide; sides strongly converging caudad.

Tergite of last pediferous segment mostly very broad and almost wholly, concealing the coxopleurae in dorsal view. Not strongly narrowing caudad. As wide as penult tergite to a little narrower with sides more converging; equal in length and breadth to wider than long.

Coxopleurae moderately inflated, not unusually elongate, not at all exposed at sides of last prescutum. Pores small and numerous; most dense on ventral surface; absent from caudal end and above excepting proximally where they open near and beneath the edge of the tergite and beneath border of prescutum.

Anal pores present but small.

Anal legs with six articles distad of coxopleurae. Clawless.

GENOTYPE.— *L. paucipes*, sp. nov.

LESTOPHILUS PAUCIPES, sp. nov.

Ochraceous or in some clear yellow caudally. Head darker, of dilute chestnut tinge, darker along sides and in region of the frontal suture. Legs yellow. Prosternum and prehensors dilute chestnut like the head. Venter pale ochraceous to clear yellow.

Body moderately robust. From the middle region conspicuously narrowing to the caudal end but only very slightly narrowing cephalad.

Cephalic plate widest at junction of frontal and caudal divisions; semicircularly rounded cephalad and the sides converging caudad; the caudal corners rounded as usual; caudal margin straight or weakly widely incurved. Longer than wide in ratio 7:5. Place of frontal suture taken by a vague, incomplete pale line. Hairs short and very sparse. Basal plate largely overlapped by the cephalic plate; the exposed portion very short, in type being 6.44 times wider than its median length but in some specimens even as much as 13 times wider.

Antennae short and thick, near 2.5 times longer than the head. Ultimate article distally obliquely truncate; shorter than the two preceding articles taken together.

Claws of prehensors when closed extending much beyond anterior margin of head, attaining distal end of second antennal article. Claw at base with a stout conical black tooth just distad of which is a pale protuberance. Femuroid at distal end with a much thicker, paler, distally rounded process or tooth extending in a distomesal direction; near middle of length showing also a slight rounded protuberance.

Prosternum with anterior margin bearing two acute teeth close together, the sinus between them being narrow and not deep, its bottom straight. Sides subparallel from anterior end to rounded caudal corners. Wider than long in about ratio 7:6; 1.54 times longer than ectal height of femuroid.

Dorsal plates deeply bisulcate; a pair of weaker intermediate sulci more or less developed on some of the plates or in place of these a single median sulcus on most anterior plates. A transverse sulcus, angulate at middle, evident on some of anterior plates.

Anterior prescuta very short; the others increasing in length caudad and becoming long in the middle and posterior regions.

Spiracles all circular; the anterior one much larger than the third with the second intermediate; others of moderate size and not much varying from anterior to posterior regions.

Ventral plates with a distinctly impressed median longitudinal furrow which is deepest at middle of length, in some plates with a vague transverse furrow crossing this at middle.

Ventral pores free; present on anterior plates in a narrow transverse band across caudal border. Last ventral plate with sides conspicuously converging caudad; straight or a little incurved. Width across anterior end to width across caudal as 9:5; length to greatest width as 10:9, twice the width at caudal end.

For dorsal plate see Plate **5**, fig. 6.

Coxopleurae of anal legs moderately enlarged. Pores small and numerous both below and above but not present on most caudal portion ventrally and on a still larger caudal area dorsally.

Anal legs much longer than the penult. Slender; the last article slender and moderately narrowing distad. Hairs moderately long, sparse. Clawless.

Pairs of legs in most cases 45; rarely 43 or 47.

Length 23 to 35 mm.

LOCALITY.— Mexico: Hidalgo, Guerrero Mills (W. M. Mann). TYPE, M. C. Z. 1730; many specimens, Type and Paratypes, M. C. Z. 1750.

LESTOPHILUS DIDYMUS, sp. nov.

Dorsum yellowish, pale ochraceous anteriorly. Head darker, of a dilute chestnut cast. Legs yellow, the antennae a little darker. Prosternum and prehensors dilute chestnut. Venter yellow.

Body conspicuously narrowed caudad but as usual only slightly narrowed cephalad.

Head anteriorly subsemicircularly rounded but anterior corners somewhat angular. Narrowed from frontal region caudad, caudally abruptly rounding in mesocaudad with a very short caudal part having sides again subparallel. Caudal margin straight. 1.45+ times longer than wide. Basal plate 2.6− times wider than long; as long mesally as at sides; its width anteriorly equalling the width of the narrowed caudal division of the cephalic plate.

Antennae short and proportionately thick; 2.2 times longer than the head plate. Ultimate article distally conically rounded, about equal in length to the two preceding articles taken together.

Claws of prehensors when closed extending a little beyond distal end of the first antennal article. Claw armed at base with a conical subacute black tooth. Femuroid with a paler, distally rounded stout process or tooth of usual type and a small, rather vague protuberance proximad of this.

Prosternum with two small, well-chitinized conical teeth close together, one at each edge of the narrow, shallow median sinus. Prosternum a little widest across anterior end. Exposed portion wider than long in ratio 47:43; 1.65 times longer than greatest length of femuroid.

Anterior prescuta very short; the others gradually increasing in length toward the caudal end where they are of moderate size. Each prescutum with a single transverse row of short straight hairs, each scutum having a transverse row of fewer similar hairs across caudal border and another one across the anterior border.

Spiracles all circular. The anterior one much the largest with the second intermediate in size, the others decreasing caudad, mostly small.

Sternites with the usual median longitudinal sulcus which is deepest at or a little caudad of its middle where crossed by a weaker and often indistinct transverse impression.

Ventral pores few; as usual in a narrow transverse band in front of the caudal margin.

Coxopleurae of last pediferous segment moderate in size. Pores small, numerous, not dense; occurring above and below, but above confined to proximal end where in part covered as usual.

Anal legs much longer than the penult; slender; clawless as always. Bristles sparse, moderate, chiefly at distal ends of articles.

Pairs of legs 47.
Length 22 mm.

LOCALITY.— Mexico: Hidalgo, Pachuca (W. M. Mann). TYPE, M. C. Z. 1729; one specimen.

LESTOPHILUS HAITIENSIS, sp. nov.

Ochraceous, clearer yellow caudad. Head darker, of somewhat chestnut cast. Antennae ochraceous. Prosternum and prehensors like head. Venter like dorsum or but little paler. Legs yellow.

Body slender, a little narrowed cephalad; gradually and conspicuously narrowed caudad.

Anterior margin of head nearly straight or a little arcuate; anterior corners oblique. Caudal margin straight. Head widest just back of frontal region. Sides nearly straight, converging caudad to the widely rounded caudal corners. Head a little constricted at frontal region; 1.4 times longer than wide. Basal plate largely overlapped by the head, the exposed portion between 5 and 5.5 times wider than long.

Antennae nearly three times as long as the head plates; stout; moderately attenuated distad. Ultimate article not narrowed distad, apically rounded; about four fifths as long as the two preceding articles taken together.

Claws of prehensors stout, finely serrulate within proximally; when closed reaching to between proximal and distal end of the second article; armed at base with a stout subconical black tooth which is slightly bent caudad at tip; first distad of the tooth a small dark nodular eminence. Femuroid with a stout, subconical, distally blunt or truncate tooth as usual; also with a small dark protuberance immediately proximad of basal oblique suture.

Anterior border of prosternum with two distinct nodule-like teeth about as far from each other as each is from the femuroid of the same side. Sides straight, a little converging caudad. Wider than long in ratio 32:29.

Dorsal plates bisulcate as usual. The anterior ones, at least, also showing a distinct median longitudinal sulcus. A distinct transverse sulcus across plates a little in front of the caudal margin.

All prescuta short, those of the anterior region especially so.

First spiracle greatly exceeding the second one in size, subcircular or slightly vertically elongate. All others circular; gradually decreasing in size caudad and in the posterior region becoming very small.

Ventral plates with the usual median longitudinal sulcus and the weaker transverse one. Last ventral plate narrow, longer than the greatest width in about ratio 8:7. Sides concave, diverging more strongly near anterior end.

Coxopleurae strongly inflated. Pores small and numerous excepting for the usual pore-free areas above and less markedly below at caudal end.

Anal tergite broad; very slightly wider than long; sides convex, converging caudad; caudal margin rather wide, straight.

First legs a little shorter and considerably more slender than the second. Anterior legs more robust than the posterior ones.

Anal legs in the female considerably longer than the penult; slender. Distal article without membranous appendage. Short hairs uniformly distributed with much longer ones at or toward the distal ends of articles.

Pairs of legs 57.

Length about 29 mm.

LOCALITY.— Haiti: Furcy (W. M. Mann). TYPE, M. C. Z. 1713; one female.

LESTOPHILUS NESIOTES, sp. nov.

General color of body yellow. Head with basal plate, prosternum, and prehensors very dilute chestnut, antennae testaceous. Legs pale yellow.

Body conspicuously narrowed caudad as usual but of nearly uniform width over middle and anterior regions.

Head with sides between caudal corners and frontal region straight and only slightly converging caudad. Sides of frontal region convex, converging to ectal side of antennae. Anterior and posterior margins truncate; 1.46 times longer than wide. Hairs few, moderate in length. Basal plate with exposed portion 3.66+ times wider than long.

Antennae long, being in type about 3.77 times longer than the head plate. Articles long. Ultimate article much shorter than the two preceding ones taken together.

Claws of prehensors when closed extending a little beyond distal end of the first antennal article. Claw armed at base with a conical, distally rounded black tooth. Intermediate joints unarmed. Femuroid with a stout, subconical, distally truncate or bluntly rounded dark tooth.

Anterior margin of prosternum with a low dark nodular tooth each side of the narrow median sinus. Sides nearly straight, a little converging from the anterior ends. Caudad to the rounded posterior corners. Exposed portion equal in length and breadth.

Prescuta all short, those of the anterior region especially so.

Tergites with the paired sulci distinct as usual. A median sulcus also commonly clearly impressed.

Anterior spiracles large, vertically subelliptic. The first one largest. Others decreasing gradually caudad and beyond the first few becoming strictly circular.

Ventral plates with a median longitudinal sulcus which is deepest caudad.

Ventral pores more numerous than usual in the genus; arranged in a transverse band in front of the caudal margin, the band being widest at the middle when it is somewhat extended cephalad along the groove. Last ventral plate narrow. Sides a little concave cephalad but mesally straight, converging caudad, abruptly a little more strongly so toward caudal end. Caudal margin straight.

Coxopleurae considerably inflated. Pierced by numerous small pores above and below as usual, fewer on lateral surface and caudal end poreless as usual, the pore-free area largest above.

Last tergite somewhat narrower than the preceding one, leaving the coxopleurae more exposed above than usual in the genus. Sides straight, moderately converging caudad. Caudal margin straight. Nearly equal in length and breadth or but slightly longer.

Anal legs in the female longer than the penult, slender, the joints decreasing in diameter distad. Last tarsal joint especially slender, narrowing distad. Hairs mostly long, sparse.

Anal pores distinct.

Pairs of legs 77 (♀).

Length about 36 mm.

Locality.— Haiti: Petionville, November, 1912 (W. M. Mann). Type, M. C. Z. 1712; one female.

GEOPHILIDAE.

PIESTOPHILINAE.

LEPTOPHILUS, gen. nov.

Head without frontal suture. Basal plate very wide. Dorsal plates bisulcate.

Labrum free; tripartite. Median piece large, armed with a series of stout conical teeth (six or seven in genotype). Lateral pieces with a fringe of spinescent processes as in Geophilus.

Coxae of second maxillae united at middle only by a weak membranous isthmus. Palpus triarticulate, ending in a simple claw.

Palpus of first maxillae large; consisting of two distinctly separated joints, of which the distal one is large and subconical and the proximal one bears ectodistally a very short membranous appendage or dwarfed lappet. Inner branch rather large, not separated from coxa by a suture; a deep incision separating it from its mate. Coxae fused proximally.

Prehensors small; wholly unarmed. Claws slender; when closed not extending beyond front margin of head.

Prosternum unarmed. Chitinous lines strongly developed.

Ventral pores present in a transverse area a little caudad of middle, the band leading to be divided at middle on the more caudal sternites.

Last ventral plate wide.

Coxopleural pores small; few.

Anal legs consisting of six joints distad of the coxopleura, the last of which bears a well-developed claw. First tarsal joint abruptly smaller than the preceding one and the second tarsal joint abruptly much smaller than the first, the latter being somewhat intermediate in size.

GENOTYPE.— *L. carribeanus*, sp. nov.

Evidently closely related to Erithophilus but differing especially in the structure of the first maxillae in which the palpus is large with both joints distinctly separated and not reduced and fused at base with coxa and laterally with the inner process. In Erithophilus the two tarsal joints are equally slender whereas in the present genus the first joint is conspicuously thicker than the second (Plate **3**, fig. 6).

LEPTOPHILUS CARRIBEANUS, sp. nov.

Entire body with legs, antennae, and frontal region of head yellow. Head darker over posterior portion.

Body slender; of nearly uniform width throughout, being only slightly narrowed caudad.

Caudal margin of head widely incurved; anterior margin truncate or slightly angulate at middle. Head widest caudad, the sides being convex and moderately converging cephalad. Equal in length and breadth. Exposing prehensors at sides. Prebasal plate slightly exposed. Basal plate large; very wide; sides convex, moderately converging cephalad. Slightly more than twice as wide as long.

Antennae long and slender; filiform, scarcely narrowing distad; 4.5 times longer than the head.

Prehensors small. Claws small and slender, when closed not attaining the front margin of the head. Prehensors wholly unarmed.

Margin of prosternum between prehensors forming an obtuse reentrant angle; wholly unarmed. Sides convex, strongly converging caudad. Chitinous lines strongly developed, complete: 1.36 times wider than long.

Anterior prescuta short, the median and posterior ones becoming long.

Spiracles all circular or the first one a little vertically elongate. First larger than the second, the others gradually decreasing caudad and in the posterior region minute.

Anterior ventral plates with the caudal margin angularly produced and extending into a corresponding shallow excavation in anterior border of succeeding plate. The excavation expanding on sternites from twelfth to twentieth into a clearly limited, large, transversely elliptic depressed area which is strongly chitinized.

Last ventral plate wide; wider than long; sides convex, converging caudad; caudal margin weakly concave over entire length (Plate **4**, fig. 2).

Ventral pores present on anterior sternites in a transverse band a little caudad of middle. Pores also present on caudal plates but fewer the area showing a tendency to be divided at the middle. The pores detected on sternites of middle region of body.

Coxopleurae small, not inflated. Pores small, few; opening beneath edge of sternite.

Dorsal plates distinctly bisulcate.

Last dorsal plate very broad. As wide anteriorly as the penult tergite. Sides convex, strongly converging caudad, the caudal end being rather narrow, rounded.

First pair of legs a little shorter and more slender than the second which are nearly as large as the third. Anterior pairs of legs shorter and stouter than the posterior.

Anal legs very much longer and thicker than the penult. In the male much inflated, a little thicker dorsoventrally than laterally. Second tarsal article abruptly and greatly more slender and the first article intermediate but still much more slender than the proximal ones. Claw well developed. Hairs sparse, moderately long.

Pairs of legs 60 (♂).

Length near 30 mm.

LOCALITY.— Swan Island, April 13, 1913 (George Nelson). TYPE, M. C. Z. 1716; one male.

LITHOBIOMORPHA.

LITHOBIOIDEA, superfam. nov.

Proposed to embrace the Lithobiidae *sens. str.*, Ethopolidae, fam. nov. (Ethopolys, Bothropolys and allies), Watobiidae, and Gosibiidae, fam. nov. (Gosibius, Arenobius and allies) in contrast with the Henicopoidea, superfam. nov. (the Henicopidae).

GOSIBIIDAE, fam. nov.

All but one or two species of the known lithobioid fauna of Mexico belong to genera of this family, which ranges into the southern United States, extending in California as far northward as Oroville and northeastward to Tennessee and North Carolina.

ATETHOBIUS, gen. nov.

Head without distinct lateral marginal breaks much as in Bothropolys.

Antennae composed of numerous articles, numbering above forty.

Eyes composed of seriate ocelli.

Prosternal teeth 2 + 2. Spines ectal in position; stout and tooth like.

Posterior angles of the seventh, ninth, eleventh, and thirteenth dorsal plates, strongly produced, these plates appearing deeply mesally excavated posteriorly, processes broad and rounded. The fourteenth dorsal plate greatly enlarged, being distinctly wider than any of the more anterior plates and completely extending over and concealing the reduced fifteenth plate and the anal coxae.

Coxal pores uniseriate.

Claw of female gonopods large, strictly entire. Spines stout, conical.

Tarsi of all legs biarticulate. None of posterior coxae armed either laterally or dorsally.

Anal legs with two claws, dorsal spines 0, 0, 3, 2, 0. Dorsal spines of penult legs 0, 0, 3, 2, 2. The anal leg in the male bears a lobe at distal end of tibia on mesal side.

GENOTYPE.— *A. mirabilis*, sp. nov.

This genus is remarkable because of the greatly enlarged tergite of the fourteenth segment, a feature at once separating it from all others.

ATETHOBIUS MIRABILIS, sp. nov.

Dorsum chestnut. Head back of the suture and the first dorsal plate a little darkest. Antennae typically darker distad than proximad.

Antennae reaching to middle of the fifth segment; articles above 40, in type being 43.

Eyes composed of about 13 ocelli in four series: *e. g.*, 1 + 3, 4, 4, 2. Single ocellus large, subcircular, pale. Most caudal ocellus of top series much larger than the others but smaller than the single one, often pale. Other ocelli black.

Prosternal teeth acute; well separated; the inner one on each side a little larger than the outer; line of apices distinctly recurved. Spines stout, more or less dentiform.

Posterior angles of seventh, ninth, eleventh, and thirteenth plates strongly produced; processes broad and long, distally more or less rounded. Fourteenth plate greatly enlarged, subcircular, covering the fifteenth.

Coxal pores large, circular, mostly 3, 4, 4, 3.

Claw of female gonopods entire as usual.

Spines of penult legs, $\frac{0,\,0,\,3,\,2,\,2}{0,\,1,\,3,\,3,\,2}$; of the anal $\frac{0,\,0,\,3,\,2,\,0}{0,\,1,\,3,\,2,\,0}$, with two claws. None of coxae armed.

Anal legs in male slender and short. The tibial process small, subcylindric, the article at its level being about 3.66 times as wide as the process is thick.

Length up to 24 mm., that of the type being 22.5 mm.

LOCALITY.— Mexico: Distrito Federal; Esclava (O. W. Barrett). TYPE, M. C. Z. 1733.

DELOBIUS, gen. nov.

Head with lateral marginal breaks small but distinct.

Antennae short or intermediate; composed of thirty-six or more articles.

Eyes composed of seriate ocelli; the ocelli few.

Prosternal teeth 3 + 3 (or 3 + 4). A sinus present, wide, and semicircularly rounded at bottom. Spines ectal in position, small and bristle like.

Posterior angles of ninth, eleventh, and thirteenth dorsal plates produced. Fourteenth plate normal.

Coxal pores circular; uniseriate.

Claw of female gonopods long and entire. Spines 2 + 2, stout, subconical.

Anal legs in male not specially modified but penult with fifth joint bearing at distal end on mesal or caudal surface a longitudinally placed swelling or crest suggesting that of species of Guanibius but proportionately larger and different in position.

Posterior coxae either wholly unarmed, or the last two or three armed dorsally while the anal pair may also be armed laterally. Dorsal spines of anal legs 1 (0), 0, 3, 2, 0; ventral, in genotype, 0, 1, 2, 2, 2; claws 2. Dorsal spines of penult legs 1, 0, 3, 2, 0 or 0, 0, 3, 2, 0. Ventral spines of first legs 0, 0, 0, 0, 1; dorsal 0, 0, 2, 1, 1. First nine to thirteen pairs of legs with but a single dorsal tibial spine.

Length averaging near 20 mm.

GENOTYPE.—*D. simplex*, sp. nov.

In lacking a median ventral spine on the third and fourth segments of all legs, this genus is unlike any other lithobioid known to the writer.

DELOBIUS SIMPLEX, sp. nov.

Dorsum chestnut or with some of middle plates deep brown, with no distinct chestnut tinge; with irregular dusky streaks. Head like dorsum or color slightly clearer. Antennae dark brown proximally, paler and somewhat rufous distad. Prosternum and prehensors dilute chestnut, the latter of pale ferruginous cast distad. Venter light brown, the caudal plates darker. Legs brown; the posterior pairs darker, the tarsi, excepting proximal portion of first article, dilute ferruginous.

Body in male type 8.5+ times longer than width of tenth plate Width of head and of first, third, eighth, tenth, and twelfth plates to each other as 53:47:49:56:55:52.

Head wider than long in about ratio 53:50. Head wider just back of eyes than at breaks. Caudal margin mesally weakly incurved. A longitudinal median sulcus which is deepest in front of frontal suture but which crosses the latter and is traceable to a transverse furrow some little distance in front of the caudal marginal thickening.

Antennae short, not very slender distad. Composed of 36–38 articles. First three articles moderate, the others short and very short. Ultimate article short, rounded, subequal to or a little shorter than the two preceding ones taken together.

Ocelli in type 8 to 11 arranged in 3 or 4 series: *e. g.*, 1 + 1, 3, 3; 1 + 1, 3, 3, 1; 1 + 3, 4, 3; 1 + 1, 3, 3, 2. Singles ocellus largest, separated. Others not very distinct. Organ of Tömösvary in outline smaller than the seriate ocelli.

Prosternum near 1.77 times wider than long. Distance between chitinous spots about 1.77+ times width at level of bottom of sinus; only 2.2 times the dental line. Teeth 3 + 3 or 3 + 4; not much differing in size; line of apices on each side a little convex with angle between lines at middle thus reentrant. Sinus shallow, broadly u-shaped or subsemicircular. Spine slender and short, on a tubercle just ectad of outer tooth. Margin evenly convexly rounding back from spine to prehensor on each side.

First dorsal plate in measured specimen 1.56 times wider than long. Sides between corners straight or toward middle of length a little incurved, only moderately converging. Posterior angles of ninth, eleventh, and thirteenth dorsal plates produced; the processes narrow and not long, those of ninth plate shortest.

Coxal pores moderately large, somewhat transversely elongate or subelliptic, decreasing on each coxa proximad: 5, 4, 4, 4; 5, 5, 5, 5.

Claw of female gonopods long, subacute, moderately curved. Spines 2 + 2, stout and rather short, of the usual subconical form. Mesal edge of first article sharp, strongly chitinized, conspicuously bending out ectad proximally.

Spines of first legs, $\frac{0,\,0,\,2,\,1,\,1}{0,\,0,\,0,\,0,\,1}$; of the second, $\frac{6,\,0,\,2,\,2,\,1}{6,\,0,\,0,\,0,\,1}$; of the third and fourth, $\frac{0,\,0,\,2,\,2,\,1}{0,\,0,\,0,\,1,\,2}$; of the fifth, $\frac{0,\,0,\,2,\,2,\,1}{0,\,0,\,0,\,2,\,2}$; of the sixth and seventh, $\frac{0,\,0,\,3,\,2,\,1}{0,\,0,\,0,\,2,\,2}$; of the eighth to twelfth, $\frac{0,\,0,\,3,\,2,\,1}{0,\,0,\,2,\,2,\,2}$; of the thirteenth, $\frac{1,\,0,\,3,\,2,\,1}{0,\,0,\,2,\,2,\,2}$; of the penult, $\frac{1,\,0,\,3,\,2,\,0}{0,\,1,\,2,\,2,\,2}$; of the anal, $\frac{1,\,0,\,3,\,2,\,0}{0,\,1,\,2,\,2,\,2}$, claws 2. Anal coxae laterally armed but the spine seemingly easily lost. The single dorsal tibial spine is in all cases on the anterior side.

Segments of legs longitudinally furrowed dorsally and ventrally, especially on the more posterior pairs.

Anal legs of male not specially modified. Penult legs with the fifth article at distal end on mesal surface presenting a longitudinally placed, pilose swelling or lobe somewhat similar to but proportionately larger than that borne on the corresponding article in males of Guambius.

Length 19–21 mm.; greatest width of tergites 2.25 to 2.6 mm.

LOCALITY.— Mexico: Hidalgo, Guerrero Mills (W. M. Mann). TYPE, M. C. Z., 1740; two specimens, Type and Paratype, M. C. Z. 1752.

DELOBIUS SPINIFER, sp. nov.

Dorsum brown, somewhat dusky; some plates with a paler median longitudinal stripe. Head concolorous with dorsum. Antennae dusky brown, at very tips paler, yellowish. Prosternum and prehensors brown of a somewhat lighter cast; prehensors rufous distally. Legs brown, the tarsi, of the posterior pairs in particular, brighter, yellowish.

Body slender, only very gradually narrowed cephalad to the third plate which is of same width as the first. Head wider than any of the plates. Width of head and of first, third, eighth, tenth, and twelfth plates to each other as 56 : 47 : 47 : 54 : 54 : 47. Head wider than long in ratio 14 : 13; widest at marginal breaks. Lateral marginal breaks small but distinct, much closer to eyes than to caudal corners. Strongly narrowed in front of eyes, the margin between which and antennae is somewhat concave; margin near mesal side of antennae on each side more strongly chitinous. The anterior median sulcus sharply impressed, not attaining the suture caudad.

Antennae of medium length. Articles 45–46 in type. Articles distad of the third short and very short. Ultimate article much longer than the two preceding ones taken together.

Ocelli 1 + 3, 3, 2; 1 + 3, 4, 2. Ocelli in type pale and indistinct. Single ocellus well separated, largest, but the first one of the upper series is nearly as large and is much larger than the others of series of which those in bottom row are especially small, smaller than the organ of Tömösvary in outline.

Prosternum 1.84 times wider than long. Distance between chitinous spots 1.84 times width at level of bottom of sinus; 2.2 times the dental line. Teeth 3 + 3, small, the most ectal on each side more remote from the median one than the latter is from the most mesal; line of apices on each side slightly convex, omitting the median tooth on each side the line of apices would be straight. Sinus very wide and very shallow, the distance between the teeth at its ends being much greater than between adjoining teeth on each side. Spine small and bristle like, inserted just ectad of ectal tooth. Margin slanting back directly from spine.

First dorsal plate in type 1.51 times wider than long; sides only gently converging caudad, nearly straight cephalad of the rounded caudal corners. Posterior angles of the ninth, eleventh, and thirteenth dorsal plates produced, the processes moderate.

Porigerous areas of coxae moderately depressed. Pores circular: 3, 3, 3, 3 or with a small additional pore at proximal end on some of the coxae.

Spines of first and second legs, $\frac{0,\ 0,\ 2,\ 1,\ 1}{0,\ 0,\ 0,\ 0,\ 1}$; of the third, $\frac{0,\ 0,\ 2,\ 2,\ 1}{0,\ 0,\ 0,\ 2,\ 2}$; of the fourth to seventh, $\frac{0,\,0,\,2,\,2,\,1}{0,\,0,\,1,\,2,\,2}$; of the eighth and ninth, $\frac{0,\,0,\,2,\,2,\,1}{0,\,0,\,2,\,2,\,2}$; of the tenth, $\frac{0,\,0,\,3,\,2,\,2}{0,\,0,\,2,\,2,\,2}$; of the eleventh, $\frac{0,\,0,\,3,\,2,\,1}{0,\,0,\,2,\,2,\,2}$; of the twelfth, $\frac{0,\,0,\,3,\,2,\,2}{0,\,0,\,2,\,2,\,2}$, the dorsal tibial spines equal; of the thirteenth, $\frac{0,\,0,\,3,\,2,\,2}{0,\,0,\,2,\,2,\,2}$, the caudal dorsal tibial spine small; of the penult, $\frac{0,\,0,\,3,\,2,\,0}{0,\,1,\,2,\,2,\,2}$, claws 3; (anal legs missing in type) none of the coxae at all armed.

Tibial process of penult legs of male dorsal in position; shorter and lower than in simplex, more crest like; not very conspicuous.

Length near 20 mm.

Locality.— Mexico: Distrito Federal; Esclava (O. W. Barrett). Type, M. C. Z. 1742; one male.

Closely allied with the preceding species but readily separated by differences in spining of legs (*e. g.* in total lack of coxal spines); clearly by differences in the position and form of the tibial lobe on penult legs of the male; and by differences in proportions, etc.

Labrobius, gen. nov.

Lateral marginal breaks of head very weak or obsolete.

Antennae short or intermediate; articles from 29 to 57.

Eyes composed of seriate ocelli. Single ocellus clearly differentiated.

Prosternal teeth 2 + 2; line of apices from straight to a little recurved. Spines slender, bristle like. Sinus distinct, more or less u-shaped.

Posterior angles of ninth, eleventh, and thirteenth or of seventh, ninth, eleventh, and thirteenth dorsal plates produced.

Coxal pores circular; uniseriate.

Claw of female gonopods strictly entire as usual, spines stout, subconical, 2 + 2.

Anal legs in male with fifth joint bearing at distal end on dorsal or dorsomesal surface a conspicuous, laterally compressed crest.

Posterior coxae dorsally armed or else wholly unarmed dorsally but armed laterally instead. Dorsal spines of anal legs 1, 0, 3, 1, 0 to 0, 0, 3, 2, 1; ventral 0, 1, 3, 2, 1; claws 2. Dorsal spines of penult legs 1, 0, 3, 2, 2 or 0, 0, 3, 2, 2; ventral 0, 1, 3, 3, 1. Dorsal spines of first legs 0, 0, 1, 1, 1 or 0, 0, 2, 1, 1; ventral, 0, 0, 0, 0, 0 to 0, 0, 1, 1, 1.

Length 10–13 mm.

Genotype.— *Labrobius minor,* sp. nov.

In addition to the genotype and *L. delus,* sp. nov., *L. sontus* (Chamberlin) and *L. vulcani* (Pocock) also belong in this genus.

LABROBIUS MINOR, sp. nov.

Dorsum light brown to very deep brown or dull brownish black in individuals in full color. Head concolorous with dorsum or nearly so. Antennae deep colored like the head and either uniform, or, more commonly paler, rufous distad. Prosternum and prehensors dark brown but paler than the dorsum. Legs brown with tarsi, especially in posterior pairs, lighter.

Body unusually broad, varying from only four to six times longer than width of the tenth dorsal plate. Body very strongly narrowed cephalad to the first plate. Widths of head and of first, third, eighth, tenth, and twelfth dorsal plates to each other as 79 : 65 : 77 : 116 : 127 : 112.

Head broad, laterally convex; widest at breaks which are weak; anteriorly widely rounded; caudal margin straight. Clearly wider than long, the ratio being close to 15:14. A distinct median longitudinal sulcus in front of the suture; head elsewhere smooth. Hairs in part short and in part long, straight.

Antennae of intermediate length; becoming very thin distad. Articles mostly 49 to 57 in number; of these the first three are moderately large and the others very short and closely compacted. Ultimate article clearly longer than the two preceding ones taken together.

Ocelli 1 + 2, 4, 5, 2; 1 + 3, 3, 5, 2; 1 + 3, 3, 3, 3; 1 + 3, 4, 4, 1; etc. The single ocellus distinctly largest, subcircular. Other ocelli small, distinct and regular, with the second ocellus of top series nearly always the largest.

Prosternum with teeth 2 + 2, relatively close together; the inner tooth of each pair larger than the outer one and the line of apices in adults straight or nearly so. Spine slender, distally extremely fine, inserted a little ectad of outer tooth on dorsal surface proximad of edge. Anterior margin extending a considerable distance ectad from outer tooth almost horizontally and then bending abruptly back and but little ectad of directly caudad, then curving out to prehensor: 1.57 times wider than long. Distance between chitinous spots 1.88 times width at level of sinus; and nearly four times the dental line.

First dorsal plate short, strongly narrowed caudad; varying from 1.8 to 2.16 times wider than long. Posterior angles of the seventh, ninth, eleventh, and thirteenth dorsal plates produced, the processes broad with mesal side long and oblique.

Coxal pores mostly 3, 4, 4, 3 or 3, 4, 4, 4, small. The porigerous area usually depressed with an elevated rim along each side.

Claw of female gonopods stout, relatively short, moderately curved, broadest a little distad of base. Spines 2 + 2; of the usual subconical form; the outer one of each pair a little longer than the inner. Inner edge of first article strongly chitinized, sharp, excavated proximally but excavation short and not deep and sometimes concealed; a narrow furrow across base of article. Excavation not always evident, especially in younger specimens.

Anal legs in male not especially crassate; fifth article at distal end on dorsal surface toward the mesal side with a conspicuous, laterally compressed and longitudinally placed crest which in side view is subtriangular, with dorsal surface convex and caudal end highest.

Spines of first legs, $\frac{0, 0, 1, 1, 1}{0, 0, 0, 0, 0}$; of the second the same as first or $\frac{0\ 0, 1, 2, 1}{0, 0, 0, 0, 0}$; of the third, $\frac{0, 0, 1, 2, 1}{0, 0, 0, 2, 1}$; of the fourth, $\frac{0, 0, 1, 2, 2}{0, 0, 0, 2, 1}$; of the fifth, $\frac{0, 0, 1, 2, 2}{0, 0, 0, 2, 2}$; of the sixth, $\frac{0, 0. 2, 2, 2}{0. 0, 0, 2, 2}$; of the seventh, $\frac{0, 0, 2, 2, 2}{0, 0, 0, 3, 2}$ or ventral spines, 0, 0, 0, 2, 2; of the eighth, $\frac{0, 0, 2, 2, 2}{0, 0, 1, 2, 2}$ or ventral spines 0, 0, 1, 3, 2; of the ninth, $\frac{0, 0, 2, 2, 2}{0, 0, 1, 3, 2}$ or ventral spines 0, 0, 2, 3, 2; of the tenth, $\frac{0, 0, 3, 2, 2}{0, 0, 2, 3, 2}$; of the eleventh and twelfth, $\frac{0, 0, 3, 2, 2}{0, 0, 3, 3, 2}$; of the thirteenth, $\frac{0, 0, 3, 2, 2}{0, 0, 1, 3, 3, 2}$; of the fourteenth, $\frac{0, 0, 3, 2, 2}{0, 1, 3, 3, 1}$, claws 3; of the anal, $\frac{0, 0, 3, 2, 1}{0, 1, 3, 2, 1}$ or $\frac{0, 0, 3, 4, 0}{0, 1, 3, 2, 1}$, claws 3, the inner accessory large, the outer one small but distinct. Last four pairs of coxae laterally armed, but none armed dorsally.

Length 10–13 mm.; width of tenth plate 1.9 to 2.5 mm.

LOCALITIES.— Mexico; Hidalgo; Guerrero Mills; San Miguel; Pachuca (W. M. Mann). TYPE, M. C. Z. 1737; eighteen specimens, Type, Paratypes, M. C. Z. 1751, and M. C. Z. 1738, 1739.

This species is notable for the relatively great width of the body in the posterior region.

LABROBIUS DELUS, sp. nov.

Dorsum from light to dark brown. Head of similar shade but color typically deeper. Antennae brown proximally, paler distad. Prosternum and prehensors clear brown. Venter paler brown, the caudal plates darker as usual. Legs light brown, the posterior pairs a little more brightly pigmented.

Body moderately narrowed cephalad to the first plate, which is clearly narrower than the plate and much narrower than the head. Widths of head and of first, third, eighth, tenth, and twelfth plates to each other as 74 : 63 : 67 : 80 : 80 : 74.

Head subcircular. Wider than long in ratio 37:35. Marginal breaks only obscurely indicated. Caudal margin nearly straight or very weakly incurved. The usual median sulcus in front of the suture and two longitudinal ones on caudal portion.

Antennae rather short. Composed of 29 to 36 articles. Articles distad of the third short and very short, varying irregularly in length, closely united. Ultimate article rather slender, as long as the two preceding articles taken together.

Ocelli mostly 1 + 1, 3, 3. Single ocellus vertically subelliptic, of almost same size as first one of top series, these two being conspicuously larger than the remaining ocelli. Ocelli distinct and regular, often not contiguous with each other. Organ of Tömösoary in outline of about same size as an average seriate ocellus.

Prosternum 1.48— times wider than long. Distance between chitinous spots 2.3 times width at level of bottom of sinus; 3.9 times the dental line. Prosternal teeth 2 + 2; line of apices a little recurved. Sinus between V- and U-shaped. Spine bristle like, inserted a little ectad of outer tooth on same level. Margin extending abruptly ectocaudad from spine.

First dorsal plate in the type 1.53 times wider than long; sides only moderately converging caudad; caudal corners widely rounded. Posterior angles of ninth, eleventh, and thirteenth dorsal plates produced.

Coxal pores small; mostly 3, 3, 3, 3.

Anal legs of male with the tibial process small, low and inconspicuous.

Spines of first legs, $\frac{0, 0, 2, 1, 1}{0, 0, 1, 1, 1}$; of the second, $\frac{0, 0, 2, 2, 1}{0, 0, 1, 2, 1}$; of the third, $\frac{0, 0, 2, 2, 1}{0, 0, 1, 2, 2}$; of the fourth, $\frac{0, 0, 2, 2, 2}{0, 0, 1, 2, 2}$; of the fifth, $\frac{0, 0, 2, 2, 2}{0, 0, 2, 2, 2}$; of the sixth to ninth, $\frac{0, 0, 2, 2, 2}{0, 0, 2, 3, 2}$; of the tenth and eleventh, $\frac{0, 0, 3, 2, 2}{0, 0, 2, 3, 2}$; of the twelfth and thirteenth, $\frac{1, 0, 3, 2, 2}{0, 1, 3, 3, 2}$; of the penult, $\frac{1, 0, 3, 2, 2}{0, 1, 3, 3, 1}$, the ectal accessory claw obsolescent; of the anal $\frac{1, 0, 3, 1, 0}{0, 1, 3, 2, 1}$, claws 2 or also a minute ectal accessory claw sometimes evident. No lateral spines on any of the coxae.

Length 10–12 mm.

LOCALITY.—Mexico: Hidalgo, Guerrero Mills (W. M. Mann). TYPE, M. C. Z. 1741; six males, Type and Paratypes, M. C. Z. 1753.

MEXICOBIUS, gen. nov.

Head with marginal breaks present but small.

Antennae very short; articles thirty-five or above.

Eyes consisting of seriate ocelli. Single ocellus clearly differentiated.

Prosternal teeth 2 + 2, small and nodular. Anterior edge of prosternum well chitinized, wholly without true sinus. Spines large and stout, much exceeding the teeth in size.

Posterior angles of ninth, eleventh, and thirteenth dorsal plates produced, those of ninth weakly so. Fourteenth tergite of normal form.

Coxal pores small, circular; uniseriate.

Claw of female gonopods strictly entire as always. Basal spines 2 + 2, conically acuminate. Inner edge of first article well chitinized; Article furrowed across base.

Posterior legs of male without special lobes or modifications.

Posterior coxae dorsally and laterally armed in type. Ventral spines of anal legs 0, 1, 3, 2, 0 or 0, 1, 3, 2, 1, rarely 0, 1, 3, 3, 1; dorsal, 1, 0, 3, 1, 0; claws 2, the accessory large and distinct. Ventral spines of penult legs 0, 1, 3, 3, 1; dorsal, 1, 0, 3, 2, 1, more rarely only 1, 0, 3, 1, 1. Dorsal and ventral spines of first legs 0, 0, 1, 2, 1. Legs from second to thirteenth with 2 dorsal tibial spines.

Length up to 18 mm.

GENOTYPE.— *M. hidalgoensis*, sp. nov.

This genus is close to Arenobius in its restricted sense with which it agrees in the unusual character of the prosternum. It is most readily distinguished by the large number of antennal articles, the number in Arenobius being fixed at 20. It also differs in wholly lacking the special lobes characterizing the anal and penult legs of males in Arenobius.

MEXICOBIUS HIDALGOENSIS, sp. nov.

Dorsum clear shining brown to dusky brown, the first plate typically somewhat darker than the others. Head brown of a dilute ferruginous tinge, dusky caudad of the suture. Antennae dusky or blackish brown, rufous at tips and also paler proximally. Prosternum brown, the prehensors similar but rufous distally. Venter light brown, the legs similar to venter, brighter distad; the caudal pairs not clearly differing in color from the others.

Body moderately attenuated cephalad. The widths of head and of first, third, eighth, tenth, and twelfth plates to each other as 72:70:74:83:85:80.

Head widest at level of marginal breaks; widely rounded anteriorly; caudal margin straight. Marginal breaks small but distinct. Weakly punctate. The usual median sulcus in front of the suture. Equal in length and breadth or very nearly so.

Antennae very short; strongly narrowed distad. Articles 35–41; the first two of moderate length, the third shorter and the remaining ones very short and closely crowded; the ultimate article shorter than the two preceding ones together.

Ocelli 14 to 26 in four or, less commonly, (pseudomaturus) in three series; *e. g.*, 1 + 3, 4, 4, 4; 1 + 4, 4, 4, 2; 1 + 4, 4, 3, 2; 1 + 4, 6, 6, 5, 4; 1 + 4, 4, 3. Single ocellus largest, contiguous with the others. First ocellus of uppermost series next in size to the single one; the others irregularly decreasing cephalad and ventrad. Ocelli deeply pigmented and commonly not clearly limited from each other, but those of the most ventral row sometimes pale.

Prosternal teeth small, nodular, inserted a little proximad of anterior edge, those of each side well separated. Anterior edge well chitinized, the two side portions meeting at middle in a very obtuse reentrant angle, the angle being but little less than 180°, with no true sinus. Spine on each side inserted at ectal end of anterior chitinous edge; large and stout, greatly exceeding the teeth in size. Edge outside each spine running at first but little caudad of directly ectad and then near middle of its length bending abruptly back more caudad to the prehensors; 1.7–1.77 times wider than long. Distance between chitinous spots 1.77–1.9 times greater than width at level of bottom of median reentrant angle; near 4.75 times the dental line.

First dorsal plate moderately narrowed caudad; 1.66 + times wider than long. Major dorsal plates with two submedian longitudinal furrows which are more deeply impressed on caudal plates. Posterior angles of eleventh and thirteenth dorsal plates strongly produced caudad, those of the ninth more weakly so.

Coxal pores small, circular, 3, 4, 4, 4; 3, 4, 4, 3; 4, 4, 4, 3; 4, 5, 4, 4.

Claw of female gonopods of moderate length; acute and well curved. Basal spines stout, conically acuminate, more strongly narrowing distally than proximally. Mesal edge of first article sharp, well chitinized, bending ectad proximally, constricted or furrowed across base.

Posterior legs of male without special lobes or modifications; slender, spines of first legs, $\frac{0,\,0\;\;1,\,2,\,1}{0,\,0,\,1,\,2,\,1}$; of the second to eleventh, $\frac{0,\,0,\,2,\,2,\,2}{0,\,0,\,2,\,3,\,2}$; of the twelfth, $\frac{0,\,0,\,3,\,2,\,2}{0,\,0,\,3,\,3,\,2}$; of the thirteenth, $\frac{1,\,0,\,3,\,2,\,2}{0,\,1,\,3,\,3,\,2}$; of the penult, $\frac{1,\,0,\,3,\,2,\,1}{0,\,1,\,3,\,3,\,1}$ or dorsal spines rarely 1, 0, 3, 1, 1, claws 3; of the anal, $\frac{1,\,0,\,3,\,1,\,0}{0,\,1,\,3,\,2,\,0}$ or the ventral spines 0, 1, 3, 2, 1, and in one specimen observed as 0, 1, 3, 3, 1, claws 2, the accessory one large and distinct. Last two pairs of coxae laterally armed.

Length 13–18 mm.

Localities.— Mexico: Hidalgo; Guerrero Mills (type locality); El Chico (W, M. Mann). Type, M. C. Z. 1736; three specimens, Type and Paratypes. M. C. Z. 1735, and M. C. Z. 1734.

PLATE 1.

PLATE 1.

Tidops simus Chamberlin.

Fig. 1.	Dorsal view of anterior portion.
Fig. 2.	Prosternum and prehensors.
Fig. 3.	Last dorsal plate.
Fig. 4.	Penult leg, mesal view.
Fig. 5.	Tarsus and portion of tibia of penult leg, ectoventral view.
Fig. 6.	Anal leg.

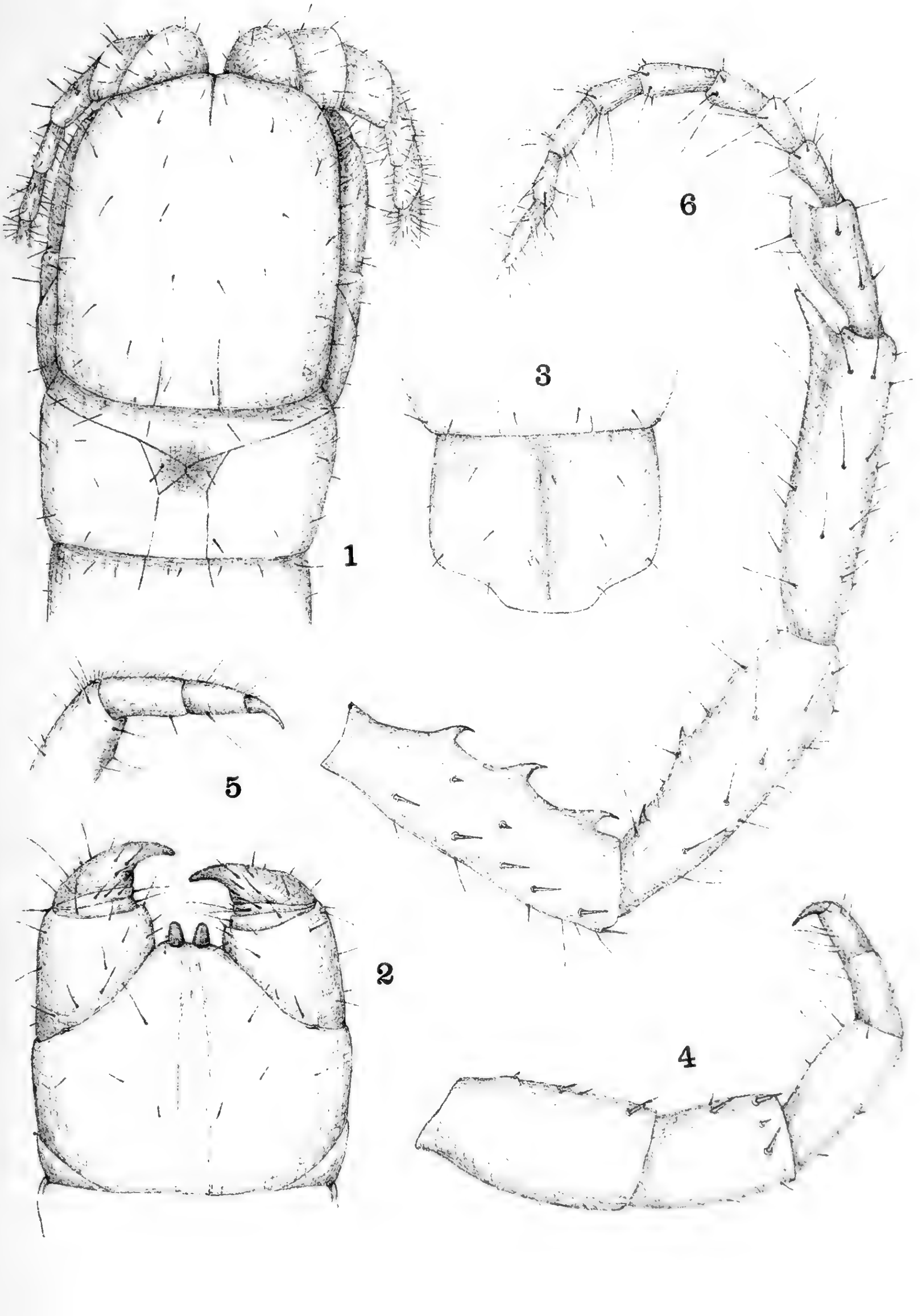
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PLATE 2.

PLATE 2.

Titanophilus maximus Chamberlin.

Fig. 1. Dorsal view of anterior portion.

Fig. 2. Ventral view of posterior portion of ♂.

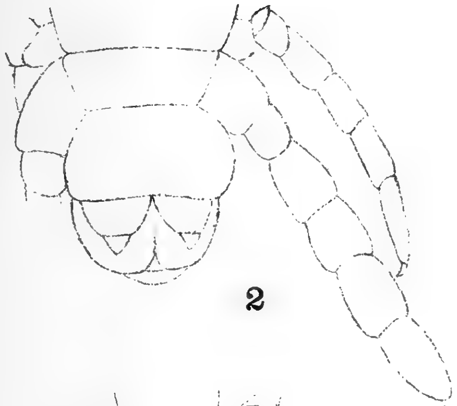
Fig. 3. Relations of spiraculiferous and prescutellar plates to tergites in eighth and ninth segments.

Fig. 4. Relations of spiraculiferous and prescutellar plates to suprascutella and tergites in 118th and 119th segments.

Titanophilus fratrellus Chamberlin.

Fig. 5. Dorsal view of anterior portion.

Fig. 6. Ventral view of posterior portion.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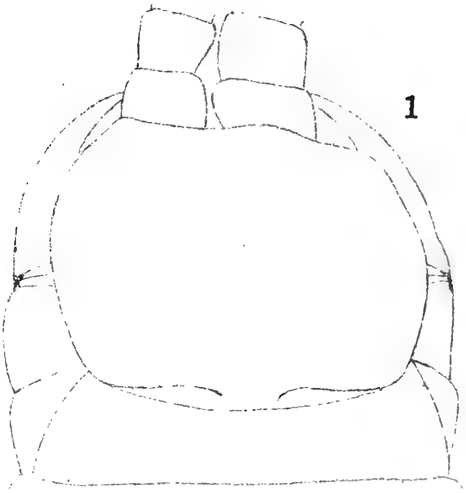
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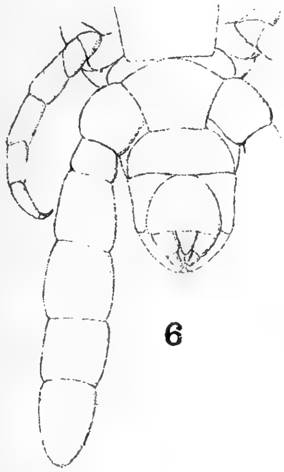
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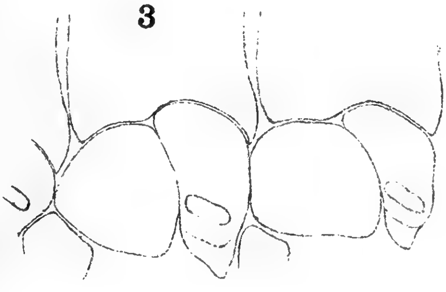
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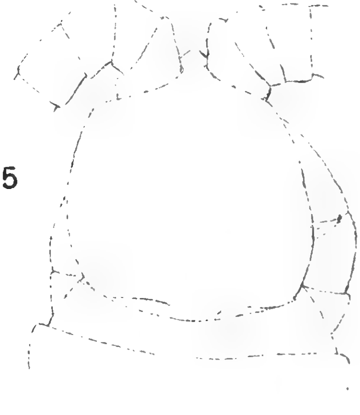
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PLATE 3.

PLATE **3**.

Garrina ochrus Chamberlin.

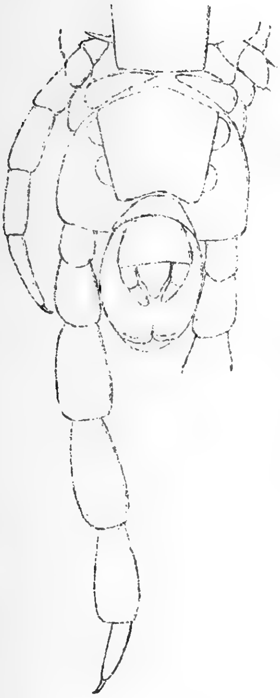
Fig. 1. Dorsal view of anterior portion.
Fig. 2. Prosternum and prehensors.
Fig. 3. Ventral view of posterior portion.

Pagotaenia lestes Chamberlin.

Fig. 4. Prosternum and prehensors.
Fig. 5. Ventral view of posterior portion more enlarged (♂).

Leptophilus carribeanus Chamberlin.

Fig. 6. First maxillae.



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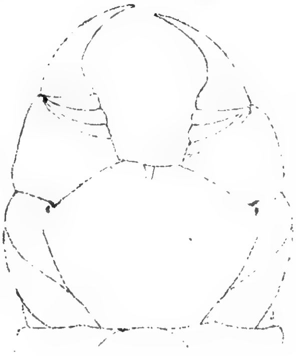

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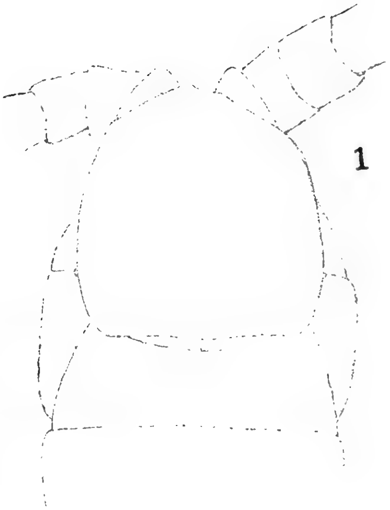

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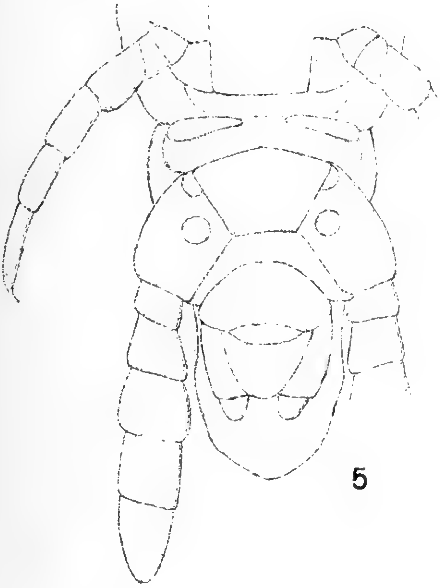

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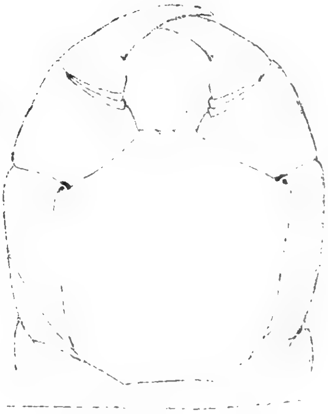

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PLATE 4.

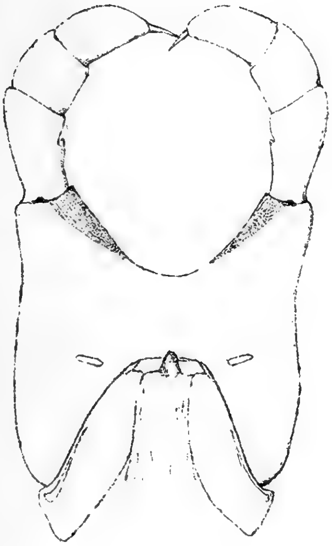
PLATE 4.

Leptophilus carribeanus Chamberlin.

Fig. 1. Prosternum and prehensors.
Fig. 2. Caudal portion, ventral view, ♂.

Telocricus cubae Chamberlin.

Fig. 3. Second maxillae.
Fig. 4. Prosternum and prehensors.
Fig. 5. Caudal portion, dorsal view (♂).
Fig. 6. Caudal portion, ventral view (♂).



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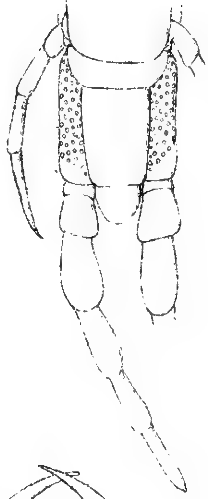

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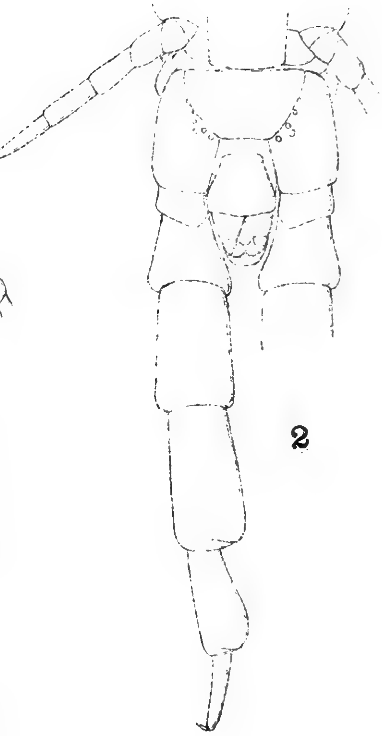

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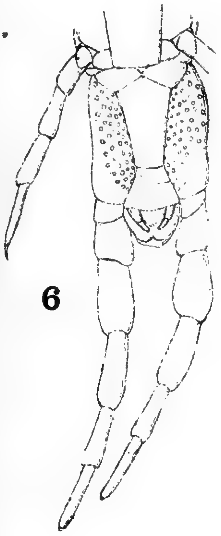

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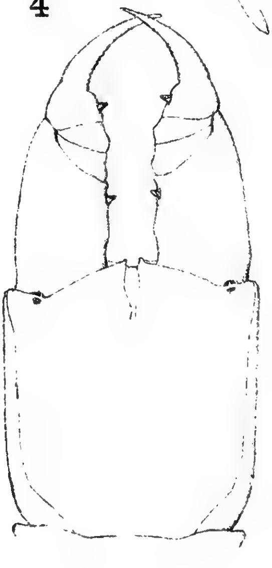

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PLATE 5.

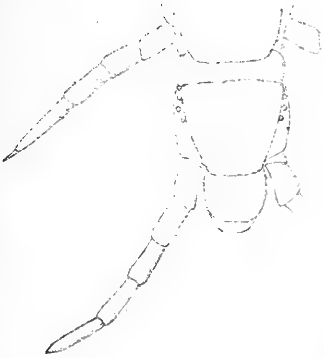
PLATE 5.

Nesidiphilus latus Chamberlin.

Fig. 1. Prosternum and prehensors.
Fig. 2. Caudal portion, dorsal view (♀).
Fig. 3. Caudal portion, ventral view (♀).

Lestophilus paucipes Chamberlin.

Fig. 4. Second maxillae.
Fig. 5. Prosternum and prehensors.
Fig. 6. Caudal portion, dorsal view.



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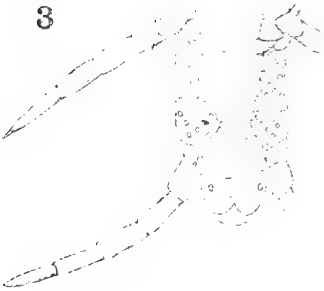

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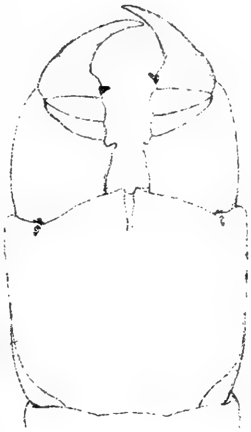

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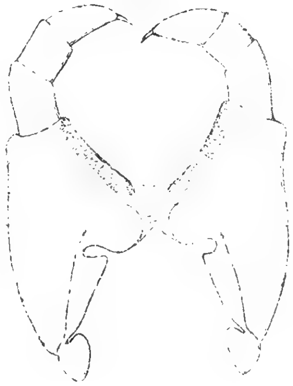

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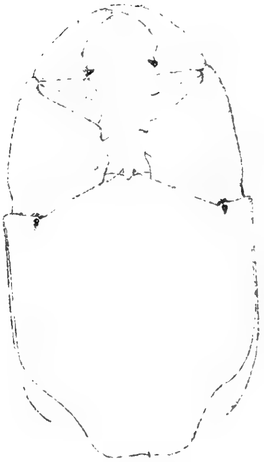

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