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PELECYPODA

WITH A DISCUSSION OF POSSIBLE MIGRATIONS OF ARCTIC PELECYPODS IN TERTIARY TIMES

BY

T SOOT-RYEN
TROMSØ MUSEUM

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Preface.

The material worked out in this paper is collected during the drift of "Maud" from 1922 to 1924 in the Chukotsk and the East Siberian Seas. One sample was also taken near Cape Chelyuskin 1919. The positions of the various stations are found in the list of the dredgings.

I have used the term "true circumarctic" or "circumarctic" to design such species as are really found almost continuously along the coasts of the Polar Ocean. The term "circumpolar" is commonly used by students for species occurring in the Northern Pacific and the Northern Atlantic, even if they are lacking on the arctic coasts of Eurasia or America. As no list exists of the Pelecypods found in the seas to the North of the Bering Strait, I have tried to compile available data in the second part of this paper. In the third part I have taken the opportunity of trying to follow the migrations of a part of the older species in the Northern Pelecypod fauna. The idea is chiefly based upon the somewhat great resemblance between the Pelecypod fauna of North Western America and our own seas and the recent distribution of the species. In the attempt to date the extended wanderings, it has been necessary to deal rather broadly with the history and fauna of the later Tertiary deposits.

To Mr. Olonkin, who has collected the material, Prof. dr. H. U. Sverdrup, who has given me much good advice, and Mr. Løyning, the curator of Invertebrates, University Museum, Oslo, who has placed the material in my hands for identification, I beg to tender my best thanks. The material including the types are to be found in the collections of the University Museum, Oslo.

Tromsø, March 1931.

List of the dredging stations of the "Maud"-Expedition where Pelecypods were obtained.

St. No.	N	E	Date	Depth
2	72° 06′	186° 27′	28 VIII 22	53 m.
3	72° 10′	188° 25′	4 IX 22	56 „
4	72° 24′	188° 59′	11 IX 22	60 „
5	72° 37′	188° 03′	18 IX 22	60 „
6	72° 56′	183° 41′	2 X 22	88 „
7	72° 44′	180° 13′	9 X 22	58 „
8	73° 05′	176° 37′	23 X 22	42 „
9	73° 15′	175° 30′	30 X 22	44 „
10	74° 41′	166° 10′	14 V 23	57 „
11	74° 39′	166° 15′	23 V 23	57 „
16	75° 30′	166° 14′	16 VII 23	68 „
17	75° 23′	167° 27′	23 VII 23	73 „
19	75° 51′	165° 10′	14 VIII 23	68 „
20	76° 07′	163° 59′	27 VIII 23	66 „
21	76° 07′	163° 25′	11 IX 23	62 „
28	76° 00′	150° 49′	2 VI 24	32.5 „
29	76° 05′	150° 32′	3 VI 24	34 „
30	76° 34′	139° 00′	16 VIII 24	20 „
	77° 33′	105° 40′	July 1919	30 „

Systematic Part.

Genus Nucula Lamarck 1799.

Nucula tenuis (Montagu 1808).

Pl. I, Fig. 1–6.

Supplement to Testacea Britannica, London 1808. Pg. 56. Pl. 29, Fig. 1.

This species occurs in two forms, one flat with light yellowish periostracum—*forma typica* with the *var. expansa* Reeve (cfr. Posselt (1898), Sparre Schneider (1885), and others), and one swollen with darker brown periostracum—*var. inflata* Hancock (*var. expansa* G. O. Sars (1878), W. H. Dall (1921), Leche (1883) and others).

Some specimens in the material are much thicker than any form of *inflata* hitherto observed. The two varieties are in the Siberian Sea of such a considerable difference that one has difficulty in considering them as belonging to only one species. I am inclined to think that this species with its wide distribution in the seas of the Northern Hemisphere, will after a close study of a large material be found to consist of several distinct forms or species.

6 specimens represent the *forma typica*, including some extremely flat specimens that ought to be referred to *var. expansa* Reeve. Between *forma typica* and *var. expansa* there are transitional forms (Pl. I, fig. 3, 4, 6). Of these 6 specimens the measurements with their ratios are given below.

L	H	$\frac{H}{L}$	D	$\frac{D}{L}$
13.9	11.0	79.2	7.5	53.9
13.7	10.1	73.8	7.0	51.0
10.2	7.8	76.4	5.0	49.0
9.5	7.2	75.8	4.0	42.1
8.0	6.5	81.3	4.3	53.7
7.5	6.1	81.3	4.1	54.7

The ratios $\frac{H}{L}$ lie between the extremes 73.8 % and 81.3 %, the highest value for the smallest specimens. The ratios $\frac{D}{L}$ are 42.1—54.7 %.

The other form, *var. inflata,* is represented by 5 living specimens and two valves, besides 5 defect ones. (Pl. I, fig. 1, 2, 5). All are thick, swollen and of a dark brown colour. Their measurements are:

L	H	$\frac{H}{L}$	D	$\frac{D}{L}$
9.7	9.0	92.8	6.9	71.1
9.1	9.1	100.0	7.0	77.0
8.9	8.3	93.4	7.2	81.0
8.8	9.0	102.2	7.0	79.6
8.5	9.1	107.0	7.9	93.0
8.5	8.7	103.4	6.7	74.8
8.0	8.9	111.1	8.0	100.0

The last specimen differs a good deal from the other specimens, the margin forming a circle, and the umbones being extremely large (Pl. 1, fig. 2).

All specimens of this variety have the ratios $\frac{H}{L}$ and $\frac{D}{L}$ lying between 92.8—111.1 % and 71.1—100 % respectively. The ratio $\frac{H}{L}$ also here increases for smaller specimens.

In the ratios there is a difference between the two varieties of 20—30 % for the height and 20 to about 50 % for the diameter.

Forma typica and *var. expansa* are obtained only from the Chukotsk Sea, and *var. inflata* from the East Siberian Sea.

Occurrence: Forma typica and *var. expansa* Reeve: 2 sp. St. 3, 1 sp. St. 4, and 3 sp. St. 7, all living. *Var. inflata* Hancock: 5/2 sp. St. 28, 2/2 and 5 living specimens St. 29.

Distribution: Circumarctic. Pacific: south to Coronado Island, Japan. Atlantic: south to Cape Hatteras and the Mediterranean.

Genus **Leda** Schumacher 1817.

Leda radiata Krause 1885.

Pl. I. Fig. 7—8.

Syn. *Leda pernula var. radiata* Krause. Archiv für Naturgeschichte. Bd. 51, Heft I, Pg. 23. Pl. III, Fig. 2 a—c.

This form from Emmahafen, that has been described by Krause as a variety of *L. pernula,* W. H. Dall considered as a valid species, an opinion that I, after a close examination of the periostracum of the "Maud"-specimens and the rather comprehensive collection of northern *Leda* in Tromsø Museum, fully confirm.

The outer form of the species of *Leda* more or less related to *pernula* is very variable and has caused the description of many new species. These new species from Northern Regions are generally referred to as the two well known species *pernula* (Müll.) and *minuta* (Müll.), partly as varieties. Some authors have also tried to join all into only one valid species. The concentric as well as the radial sculpture is, however, always different in *pernula* and *minuta,* and I think the sculpture must be of as great significance as a specific character as the outer form.

No other *Leda* has the same curious radiating sculpture consisting of fine elevated ridges of the periostracum, especially distinct along the rostrum. The concentric striae vary somewhat. Sometimes there are fewer and larger concentric striae on the anterior part than on the rest of the surface as in *pernula*, but never so conspicuous. On the rostrum the concentric striae are numerous and of the same form as the radiating ridges. Even on small individuals, 4,75 mm. long, the radiating sculpture was easily seen under a compound lens. The smaller specimens have the concentric striation more regular and distinct than the older ones.

The outer form of the specimens at hand vary somewhat, as will be seen from the measurements given below. They are rather short and high, with a broad rostrum, and bear some resemblance to *buccata* Steenstrup, as also mentioned by Krause. The faint sinuation on the ventral side of rostrum is, however, absent. The inner posterior carina is distinct, weakest in individuals with the broadest rostrum. The teeth vary from 15 ant. and 18 post. to 19 ant. and 24 post. Periostracum of the larger specimens is dark, of smaller light yellow.

L	H	$\frac{H}{L}$	D	$\frac{D}{L}$
29.8	14.5	48.6	9.0	30.2
26.0	13.9	53.5	7.8	30.0
21.5	14.0	57.2	8.4	34.3
23.0	12 6	54.8	7.0	30.4
22.7	12.0	52.8	7.6	33.5
16.0	8.8	55.0	5.6	35.0
15.8	8.7	55.0	5.0	31.6
13.9	7.7	55.4	4.2	30.2
8.9	5.2	58.4	3.2	36.0
4.75	3 0	63.2	1.85	39.0

Both ratios increasing with diminishing length.

If the true *L. pernula* is found in the Pacific is doubtful. *L. buccata* however is recorded from the northern Bering Sea, and *costigera* Leche and *pernula* from the Siberian Sea. Further Dall (1919) mentions *L. pernula* from off Sea House Island, Alaska, and from Union and Dolphin Strait.

Occurrence: 3/2 sp. St. 2, 4/2 sp. St. 3, these 7 valves are the largest in the collection. 1 yong sp. St. 4, living; 1 sp. St. 5, living, and 1 living and 1 dead specimen from St. 6. Depth 53 – 88 m.

Distribution: Arctic Pacific: Chukotsk and Beaufort Seas, Bering Strait and Sea, and Okhotsk Sea.

Leda lamellosa Leche 1883.

Pl. I, Fig. 9, 10, 11.

Syn. *Leda pernula var. lamellosa* Leche. Vega-Expeditionens Vetenskapliga Iakttagelser. Bd. III. Pg. 448. Tab. 33, fig. 26. *Leda minuta* (Müll.) Odhner. K. Svenska Vetensk. akad. Handl. Bd. 54. No. 1, Pg. 57.

Leche describes this form from 3 specimens from the Blischni Island. He remarks himself that this form diverges from all known species of *Leda* and that he has never found transitional forms between *lamellosa* and *pernula*. To judge from the specimens from the "Maud"-collection and the types of Leche, which I have through the kindness of dr. N. Hj. Odhner been able to examine, I am convinced that they represent a good species, probably more nearly related to *minuta* than to *pernula*.

The number of the lamellated concentric folds vary from 30 to 35. The interspaces between the lammels are much broader than the lamel. Though the specimens agree with the figure of Leche, I have photographed two specimens to show the well developed lamellae, especially in the largest one. The rostrum is obliquely cut. Periostracum light yellow, somewhat darker on the anterior area. The inner posterior carina is distinct. The teeth occur in the same number on both sides of umbo, in the largest specimen 18 on each side.

The measurements are:

L	H	$\frac{H}{L}$	D	$\frac{D}{L}$
24.0	13.4	55.8	7.5	31.3
14.8	8.2	55.4	4.8	32.4
11.0	6.5	59.1	4.3	39.0
10.9	6.6	60.5	4.2	38.5
and for the three type specimens:				
27.0	14.5	53.6	8.0	29.6
20.0	10.8	54.0	5.8	29.0
20.0	10.7	53.5	5.8	29.0

Occurrence: 1 sp. St. 8; 3 sp. St. 29, all living. Depth 34—42 m.
Distribution: East Siberian Sea.

Genus **Portlandia** Mørch 1853.

Portlandia arctica (Gray 1824).

Supplement to the Appendix to Parry's first Voyage; Shells, Pg. 241. 1824.

Only dead specimens found. All belong to the *var. siliqua* Reeve. Largest specimen has a length of 16,7 mm.

Occurrence: 7/2 sp. St. 30.

Distribution: Circumarctic. Pacific: south to Bering Strait. Atlantic: south to the White Sea, Spitzbergen, Greenland, Hudson Bay.

Genus **Arca** Linné 1758.

Arca (Bathyarca) glacialis Gray 1824.

Pl. I, Fig 12.

Supplement to the Appendix to Parry's first Voyage; Shells, Pg. 244. 1824.

Only one specimen in the collection. It is rhomboidical and differs somehwat from the usual form, as the posterior ventral margin is drawn out to a rounded corner. The specimen measures: length 20.7 mm., height 15.4 mm. and diameter 13.2 mm. Largest antero-posterior line 21.5 mm.

Occurrence: 1 living specimen St. 10.

Distribution: Siberian Sea from 166° E to East Finmark, Shetland Islands, Mediterranean(?). Gulf of St. Lawrence to Dolphin and Union Strait.

Arca (Bathyarca) pectunculoides Scacchi **var. grandis** Leche 1878.

Kungeliga Svenska Vetenskapsakademiens Handlingar. Bd. 16, Pg. 30. Syn. ***Arca glacialis pectunculoides & var. septentrionalis*** Leche. Expeditionens Vetenskapliga Iakttagelser. Bd. III. Pg. 449 1883.

Also of this species only one specimen was collected. Measurements: length 12 mm., height 9 mm., diam. 6 mm.

Occurrence: 1 living specimen St. 11.

Distribution: Var. grandis: Siberian Sea from 166° to 115° 30′ E. Kara Sea, New England(?) *A. pectunculoides* Scacchi + varieties: Siberian Sea. From 166° E along the northern and western coasts of Eurasia, from Western Greenland and Davis Strait along the eastern coasts of North America, Atlantic Ocean, south to the West Indies, and off Sudan. The Mediterranean.

Genus **Modiolaria** Beck 1846.

Syn. *Musculus* Bolten 1798, not Martyn 1787.

Modiolaria nigra (Gray 1824).

Supplement to the Appendix to Parry's first Voyage; Shells. Pg. 244. 1824.

All specimens are rather inflated and can be regarded as belonging to the variety *obesus* Dall. Largest specimen has a length of 51 mm.

Occurrence: 1/2 sp. St. 7, 1/2 sp. St. 29, 2/2 sp. St. 30. All dead.

Distribution: Circumarctic. Pacific: south to the Tatar Strait and Oregon. Atlantic: south to Cape Hatteras and Holland.

Modiolaria discors (Linné 1767).

Systema Naturae edit. XII. 1767.

As regards the synonymy of this species I follow the opinion of Ad. S. Jensen (1912). There are however some peculiarities, which make it rather possible, that the various varieties and forms must be considered as belonging to more than one valid species.

In the "Maud" material two forms were represented, viz. *var. laevigata* Gray and *var. substriata* Gray *forma laevis* Beck.

Var. laevigata Gray 1824. One living specimen with the byssal nest adhering. Length 23.7 mm., height 16 mm., diam. 11.4 mm. The specimen belongs to the typical *laevigata* as figured by Jensen (1912) Pl. III, Fig. 4 a—b.

Var. substriata Gray 1824 *forma laevis* Beck 1851. The three other specimens must be regarded as belonging to this form. After the typical outer form they are the *substriata* of Gray, but as they wholly lack the radiating striae on the posterior area with the exception of a part near the umbones, they may, as Jensen indicates, be given the name of *laevis* Beck, as a special form of *substriata*. This form has the periostracum darker black-brown, while *laevigata* has a delicate pure brown colour. The measurements are:

L	H	$\frac{H}{L}$	D	$\frac{D}{L}$
32.0	20.0	62.5	15.5	48.5
31.0	20.0	64,5	16.0	51.6
26.5	17.4	65.6	14.0	52.9
var. laevigata				
23.7	16.0	67.5	11.4	48.1

Occurrence: Var. laevigata: 1 sp. St. 29. *Var. substriata forma laevis:* 2 sp. St. 29, 1/2 sp. St. 30.

Distribution: Circumarctic. Pacific: south to Puget Sound, Japan. Atlantic: south to St. Georges Bank, Kieler Bay.

Genus Palliolum Monterosato 1884.

Palliolum groenlandicum (Sowerby) 1845.

Thesaurus Conchyliorum vol. I, p. 57.

Altogether 19 specimens are collected. There is but little variation. The ratios $\frac{L}{H}$ and $\frac{D}{H}$ varies from 102 to 108.5 % and from 21.6 to 29 % respectively. Largest specimen, St. 20, was 26 mm. high. Dall (1919) describes *Pseudamusium Andersoni* from Dolphin and Union Strait. It seems to be nearly related to *P. groenlandicum* and is perhaps only a variety of this specimen.

Occurrence; 1 sp. St. 16, 1 sp. St. 17, 4 sp. St. 19, 12 sp. St. 20, 1 sp. St. 21.

Distribution: Not found in the Pacific, the Chukotsk and the Beaufort Sea. Occurring along the Eurasian shelf from 167° 30′ E. and in the Atlantic south to off Sudan and to the Gulf of St. Lawrence. Also found to the north of America.

Genus Periploma Schumacher 1817.

Periploma abyssorum Verrill 1893.

Pl. II, Fig. 10—12.

In Bush, K.: Report on the Mollusca dredged by the "Blake" in 1880, including descriptions of several new species. Bulletin of the Museum of Comparative Zoology. Vol. XXIII, No. 6. Pg. 227—228 Pl. II, Fig. 12, 13. 1893.

One broken right valve of this very interesting East American species was found at a depth of 60 m. east of Wrangell Island. Of the fragile valve only the anterior dorsal portion was lost, the rest of the valve was divided in two parts. Verrill's description agrees point to point with the valve, with the only exception that the two radial furrows, that border the posterior narrow, shallow depression, are not so distinct as he mentions. The valve is, however, broken just along this depression, and, as this is the only differing character, I do not hesitate to identify it with Verrill's species.

From the West coast of North and Middle America there are as yet known 5 or 6 species of *Periploma*. One species, *planiuscula* Sowb., has 4 or 5 synonyms. Of these synonyms *alta* C. B. Adams, not the fossil *alta* Conr. = *peralta* Conr., seems to be rather different from the other forms. The species, which all are found south of California from San Diego southwards, are: *discus* Stearns, *Carpenteri* Dall, *Stearnsii* Dall, *planiuscula* Sowb., *papyracea* Carp. (not *papyratia* Say 1822), and *obtusa* Hanley. The last one is probably a synonym of *planiuscula*. *P. papyracea* Carp. is with doubt regarded as a separate species by Stearns, but by Dall included as a synonym of *planiuscula*. The three first mentioned species belong to the *discus*-group with rounded outer form. Dall in his list of the West American Molluscs (1921) mentions only two species *planiuscula* and *discus*, regarding all other forms as synonymous.

On the East North American coast there are known 8 species, viz. *inaeqvivalvis* Schum., *angulifera* Philippi, *papyracea* (Say) Conrad (originally *papyratia* Say), all known from the Mexican Gulf and southwards, *tenera* Jeffreys from Cape Hatteras, *undulata* Verrill (not *undulata* Clark 1918 = *binominata* Hanna 1924) from off Delaware Bay, *fragilis* Totten from Labrador to the West Indies, *affinis* Verrill from off Marthas Vineyard, and *abyssorum* Verrill from Chesapeake Bay to Cape Hatteras. The last species in depths from 101 to 1255 fathoms, living only from 906 fathoms downwards.

No true *Periploma* has been observed in the European Seas. Only one related species is found, viz. *praetenue* (Pultney), belonging to the genus or subgenus *Cochlodesma* Couthouy, which is also represented on the East American coast.

P. abyssorum is related to *fragilis* Totten and *papyracea* Say, and probably connected with the East American species through the fossil *peralta* Conr., which seems to be the precursor of the *discus*-group. In a very valuable work on "The Molluscan Fauna of the Alum Bluff Group of Florida", Miss Gardner describes a new species of *Periploma* under the name of *discus*. As *discus* is preoccupied by Stearns, I propose the name *P. Gardneri nov. nom.* for this miocene species. She considers this species as a probable precursor of *peralta*, and thus connects the early east and west American species.

P. abyssorum is easily distinguishable from the other species of *Periploma* by its large rib-like projektion below the chondrophore. This internal rib is directed towards the ventral margin and only a little bent backwards. Usually the rib is weaker or more or less parallel with the posterior dorsal margin. Its shallow pallial sinus resembles that of the *discus*-group.

The find of this species in comparatively shallow water in the Polar Ocean is very remarkable, as hitherto no species of *Periploma* is found farther north than Labrador.

The only record of an allied species is found in Krause (1885), where on Pg. 38 he mentions *Anatina? aleutica n. sp.* Only one left juvenile valve was dredged at 70 fathoms north of the Akutan-Pass. The drawing (Tab. III, Fig. 7), surely represents the young of a *Periploma.*

Whether *abyssorum* still lives in the Polar Ocean, or the valve is a very well preserved Tertiary or Quaternary fossil, is at present an insolvable question. I am inclined to think the latter opinion is more probable.

Occurrence: One left, defect valve St. 5. Depth 60 m.

Distribution: Western Atlantic from Chesapeake Bay to Cape Hatteras. Depth 906 to 1255 fathoms. Dead valves from 101 fathoms.

Genus Pandora Hwass 1795.

Pandora (Kennerlia) glacialis (Leach 1819).

Journal de Physique, de Chimie, d'Histoire Naturelle et des Arts. Vol. 88. Pg. 465. 1819.

One dead specimen, which measures 24.6 mm. in length, 14.2 mm. in height, and 4 mm. in diameter, was found. It is somewhat longer and less high than specimens from Spitzbergen. The ratio $\frac{H}{L}$ is 57.8 %, while the same ratio in Spitzbergen specimens varies from 63—65 %. Perhaps the specimen may be referred to *var. eutaenia* Dall.

Occurrence: 1 dead sp. St. 5.

Distribution: Pacific: south to Fuca Straits. Atlantic: the Murman coast, Spitzbergen, Greenland, Gulf of St. Lawrence, Jones Sound. Not recorded from the western part of the arctic seas of North America. Dall (1919) mentions *Pandora sp.* from off Collinson Point. Not recorded from the Kara Sea to 170° E.

Genus Lyonsia Turton 1822.

Lyonsia Olonkini nov. sp.

Pl. I, Fig. 13.

Shell rather large and thick, nearly parallel sided, much twisted. Surface in three parts, the anterior part separated from the middle area by a slight groove or fold from umbo to a faint sinuation on the ventral margin, the middle area separated from the posterior by its distinct convexity and different sculpture, the posterior part somewhat flattened, reaching from the middle of the posterior curve of the ventral margin. Periostracum distinct, rather strong, grayish, ornamented with wrinkled radial lines, about 13 on the anterior and middle part, and 19 on the posterior, most distant on the middle area. Beak rather prominent, placed one third of the length from the anterior end. Anterior dorsal margin straight, descending to an angle and continuing In the rounded anterior ventral margin, which has a faint sinuation opposite the beak. it is evenly rounded and proceeds in the posterior margin, which in an obtuse angle bends towards the beak. Dorsal posterior margin nearly straight, angle obtuse. A faint ridge runs from the beak to the posterior angle.

Interior nacreous, pallial sinus indistinct, shallow. Lunula long, fusiform, eschutcheon rather large and broad, both distinct. Hing line feeble, the chondrophoric ridge somewhat descending, corresponding to the posterior outer ridge, which is also distinctly seen on the interior.

Length 30 mm., height 17 mm., diameter, left valve, 7.5 mm., beak behind the anterior end 10 mm.

Type one left valve St. 28.

I take the liberty to name this species in honour of Mr. Olonkin, who during the expedition has collected and preserved all the marine material.

This species is easily distinguishable by its outer form from the other known species of *Lyonsia*. Its nearest relatives are perhaps to be found among the Pacific species as e. g. *L. pugetensis* Dall.

Occurrence: 1 left valve St. 28.

Distribution: East Siberian Sea.

Genus Astarte Sowerby 1816.

No other genus of arctic Pelecypods is so polymorph as *Astarte*. A lot of species are described and a large mass of varieties are known. The various forms are, however, still so confluent and imperfectly circumscribed that the drawing together of the various North Atlantic forms to 5 species, as done by Ad. S. Jensen, seems to be the only way to clear up the systematics. The question, if the North Pacific species may find their natural place in these collective species, can only by a close comparison of extensive collections from the circumarctic and boreal localities be settled. Of the species mentioned by Dall (1921), *polaris* Dall, *compacta* Carp., and probably *Willetti* Dall seem to belong to the *crenata*-group; *fabula* Reeve, *Bennettii* Dall, *vernicosa* Dall, and *globosa* Mørch to the *Montagui*-group, while *Rollandi* Bernardi perhaps may be referred to the *borealis*-group together with *arctica* Gray. *Alaskensis* Dall resembles *elliptica* Brown. The occurrence of transitional forms especially in arctic Pacific species makes the grouping difficult.

The creation of species is hardly more pronounced in any other genus of arctic Pelecypods. Its wide distribution and the diversity of physical conditions during the Tertiary and Quaternary time, together with its ability to form local races and its faculty of adaption are surely some of the chief causes of this. But concerning the question as to why *Astarte* has these abilities, we do not know more than the fact itself,

In the following discussion of the "Maud" specimens I follow the view of Ad. S. Jensen. To facilitate the recognition of the varieties I give figures of some of them.

Astarte borealis (Chemnitz 1784).

Neues Systematisches Conchylien-Cabinet. Nürnberg 1784.

One living specimen, rather elongated, without distinct concentric lines, with thick fibrous periostracum may perhaps be referred to *var. Withami* Wood. Length 38.5 mm., height 28 mm., diam. 13.5 mm. One valve with abnormal shell, the ventral margin consists only of periostracum, resembles somewhat *var. placenta* Mørch. Length 34.5 mm., height 26.7 mm., diam. 15.5 mm.

Occurrence: One valve St. 7, one living sp. St. 8.

Distribution: Circumarctic. Pacific: south to North Japan and the Aleutian Islands. Atlantic: south to Nova Scotia and Denmark.

Astarte Montagui (Dillwyn 1817).

Pl. I, Fig. 14.

A Descriptive Catalogue of recent shells arranged according to the Linnean Method, I & II, London 1817.

The specimens of the *Montagui*-group belong to two forms. Below are tabulated some measurements of the specimens at hand, together with those of the types of *vernicosa* Dall and *Bennetti* Dall. P. indicates the measurement from the posterior end to umbo.

Station	L	$\frac{H}{L}$	H	$\frac{D}{L}$	D	$\frac{P}{L}$	P
Maudhavn 1....	17.0	79.0	13.4	41.1	7.0	58.8	10.0
— 2....	16.8	76.4	12.8	35.7	6.0	53.5	9.0
— 3....	16.0	81.4	13.0	38.7	6.2	56.2	9.0
— 4....	14.9	77.8	11.6	38.9	5.8	55.0	8.2
— 5....	11.5	78.2	9.0	36.5	4.2	56.5	6.5
St. 30 6....	17.0	87.0	14.8	47.0	8.0	55.8	9.5
— 7....	11.0	83.6	9.2	50.0	5.5	50.0	5.5
— 8....	10.0	88.0	8.8	46.0	c. 4.6	50.0	5.0
vernicosa	17.0	88.4	15.0	39.4	6.7	55.0	—
Bennetti	15.0	96.8	14.5	46.7	7.0	47.5	—
—	11.5	91.4	10.5	43.5	5.0		—

From the Siberian Sea, the Chukotsk Sea and the Beaufort Sea Dall mentions *fabula, vernicosa* and *Bennetti*. *A. fabula* Reeve is characterized by the umbonal region being "peculiarly, squarely, concentrically sulcate, and the basal portion striated", usually with contrast between the sulcated and striated part of the shell. Further it is slightly inequilateral, the posterior part largest, colour usually dark brown. *A vernicosa* Dall has a polished shining periostracum, and is sculptured with even and regular sulcations less pronounced on the ventral third. The shell is subequilateral, though the figure shows that the posterior portion is the largest. The height is somewhat larger than in *fabula*. *A. Bennetti* Dall has also a polished periostracum, nearly smooth or with fine concentric striations, shell inequilateral, the anterior part the longest, and rather inflated.

2 living and 8 partly defect valves No. 1—5 all from the "Maudhavn", must be referred to *var. fabula* Reeve. The lunula is rather long and well defined, oblique, as the left valve forms the largest part of it, especially in dried specimens. Escutcheon longer with rather short ligament, also oblique, the right valve forming the largest part.

One dead specimen, No. 6, probably represents an inflated form of *vernicosa*. The lunula is very large and broad, not pronounced oblique. The sculpture consists of faint sulcations and striations, colour dark brown, periostracum somewhat shining. One living specimen, No. 7, must also be referred to the same variety, though the sculpture only consists of faint, low, irregular striae. One somewhat defect valve surely belongs to the same form. All specimens rather thick.

Occurrence: 2 living sp. and 8 valves *var. fabula* Reeve from the "Maudhavn", 1 living, 1 dead, and one valve an *var. vernicosa* Dall, St. 30.

Distribution: Circumarctic. Pacific: south to British Columbia. Atlantic: south to Nova Scotia and France.

Astarte crenata (Gray 1824).

Pl. I, Fig. 15–18.

Supplement to the Appendix to Parry's first Voyage; Shells. London 1824.

All specimens at hand have one common character in the sculpture of the surface. The sculpture of the dorsal and anterior part consists of numerous rather regular concentric ridges with somewhat broader interspaces. On the ventral and posterior part these sulcations are gradually replaced by irregular wrinkles of the periostracum. This character makes it rather probable that they must be referred to *polaris* Dall, in spite of the more oblique and variable outer form.

One dead specimen and a right valve are rather large and have a darker yellow colour. The other specimens are of a light yellow colour and more inflated. These have a plain inner ventral margin, while the larger ones have fine indistinct crenulations, chiefly observable on the incurvate part of the periostracum. The outer form of the shells is seen on the figures on plate I, and forms 4 types. The measurements of the specimens are given below.

Station	L	$\frac{H}{L}$	H	$\frac{D}{L}$	D	$\frac{P}{L}$	P
17	24 0	80.0	19.2	50.0	12.0	64.2	15.4
17	21.6	83.4	18.0	48.6	10.5	72.2	15.6
16	15.5	84.0	13.0	52.8	8.2	64.5	10.0
16	15.0	80.0	12.0	53.3	8.0	60.0	9.0
16	14.9	86.0	12.8	53.6	8.0	67.1	10.0
16	12.0	83.4	10.0	50.0	6.0	65.0	7.8
16	11.8	81.3	9.6	57.6	6.8	63.5	7.5
16	9.8	81.7	8.0	53.1	5.2	65.3	6.4
polaris	28.0	89.3	25.0	53.5	15.0	59.4	—

The chief difference between the specimens from the two stations is that the smaller specimens have a distinct angle on the posterior dorsal slope, while the larger ones are more evenly rounded. The measurements as well as the figure of the type show that the form described by Dall is more equilateral and higher than the "Maud" specimens.

Occurrence: 5 living sp. and one valve St. 16; one dead sp. and one valve St. 17.

Distribution: Circumarctic? Pacific: south to Shumagin Islands. Atlantic: south to Maine, and Bergen (?) Norway.

Genus Serripes Beck 1841.

Serripes groenlandicus (Chemnitz 1782).

Neues systematisches Conchylien-Cabinet, VI. Nürnberg 1782.

Only 4 subfossil valves found. Largest valve has a length of 53.5 mm.

Occurrence: 4/2 sp. St. 30.

Distribution: Circumarctic. Pacific: south to Hakodadi and Puget Sound. Atlantic: south to Stonington, Iceland and East Finmark.

Genus **Thyasira** (Leach) Lamarck 1818.

Thyasira arctica nov. sp.

Pl. II, Fig. 8, 9.

Shell white, large, rather solid; general outer form rounded triangular. Periostracum rather thick, light grayish yellow with darker concentric growth lines. Beak prominent, lunule large, escutcheon long, bounded by a sharp keel. The posterior margin slightly convex. The depressed posterior area about 1/6 of the breadth of the shell; the radial fold rather deep and the distance from the curve of the posterior area to the curve of the ventral margin about 1/7 the breadth of shell. The anterior dorsal margin nearly straight with a sinuation on its lower part. The posterior hinge broad, inner margin straight. Length 28 mm., height 29 mm., diameter, left valve only, 9.5 mm.

Type one nearly complete left valve St. 20.

This species resembles much *cygnus* Dall from Cygnet Inlet from a depth of 160 fathoms, so far as may be seen from his short description. *Th. arctica*, however, is twice as large as *cygnus* and the outer form is rounded triangular as also indicated by the different ratios between height and length and diameter and length.

	L	H	$\frac{H}{L}$	D	$\frac{D}{L}$
Th. arctica	28	29	103.5	19	67.8
Th. cygnus	14	13.5	96.5	8.5	60.6

With the exception of *bisecta* Conrad and some fossil forms as *quadrata* and *inflata* Yabe and Nomura this species belongs to the largest forms of *Thyasira*. The younger stages of *bisacta var. nipponica* Yabe and Nomura somewhat resemble *arctica*.

Occurrence: 1/2 sp. St. 20.

Distribution: East Siberian Sea.

Thyasira flexuosa Gouldi (Phillippi 1845).

Zeitschrift für Malakozoologie. Vol. 2, Pg. 74.

Pl. II, Fig. 7.

One small dead *Thyasira* surely belongs to this arctic form of *flexuosa* Gould. Length 3.85 mm., height 3.85 mm., diameter 2.7 mm.

Occurrence: 1 sp. St. 6.

Distribution: Th. flexuosa incl. *Gouldi* and *polygona* is widely distributed. Pacific: south to San Diego, Corea, New South Wales. Atlantic: south to the Canaries and south of Cape Cod. Mediterranean.

Genus **Macoma** Leach 1819.

Macoma calcarea (Chemnitz 1782).

Pl. II, Fig. 1—6.

Neues systematisches Conchylien-Cabinet, VI. Nürnberg 1782.

Only two large dead specimens and one defect valve were obtained. The specimens at hand are all very different from the typical form of *calcarea*, and it is with doubt that I refer them to this species.

In the Bering Strait 9 species of *Macoma* are as yet known, of which 7 also live farther north in the Chukotsk and the Beaufort Sea. From the East Siberian Sea only *calcarea* and *moesta* Desh. are known living, and *baltica* is found in a subfossil state. Farther south in the Bering Sea, the Okhotsk Sea, and along the northern part of the west coast of America, many additional species occur. Also from the arctic coasts of Canada and the American Archipelago a few species are described. Further some arctic species occur in the Atlantic, at Greenland, North-Eastern American coasts, and at Spitzbergen. Of all these species we have a lot of forms and varieties, partly interpreted as valid species. The huge mass of names and forms, and the difference in the interpretation of the specific names, make it a difficult task to clear up the systematic value of the species in this genus.

The following taxonomic characters are generally used to separate the various species: the general outer appearance, the form of the posterior part, the position and development of the beaks, the extension of the ligament, and especially the form and extension of the pallial sinus in both valves. All characters seem, however, to be rather variable. As typical characters in *calcarea* must be mentioned the ovate-triangular outer form with somewhat pointed and truncated posterior part, which has a distinct radial fold; rather long ligament, and conspicuous beaks situated on the posterior 1/3—1/2, and the deep pallial sinus in the left valve, reaching nearly to the anterior muscular scar, and the shorter sinus in the right valve.

I have been able to compare some specimens of *calcarea* from various parts of the circumarctic and boreal area and have compiled a table of the ratios of the various measurements. P. is the length of the posterior part, S. the distance between the innermost part of the pallial sinus in the right valve and the posterior border of the anterior muscular scar. The lengths of the measured specimens are 17 to 46.5 mm.

Locality	$\frac{H}{L}$	$\frac{D}{L}$	$\frac{P}{L}$	$\frac{S}{L}$
New York..........	68—69	c. 28	38 —43.2	18—22
Pitlekaj............	65—71.2	28.8—34.4	32.5—39	20—25
Spitzbergen........	70—73	30 —34	32.5—35	20—25
White Sea.........	c. 71	30 —31	30 —31	c. 21
Tromsø............	70—74	30 —32	42.2—47.8	22—26
"Maud" sp. I.......	71	32.9	31.2	21.5
"Maud" sp. II......	68.6	28.3	40.4	11.2

According to the measurements the specimens from New York are elongated, rather thin and equilateral with long pallial sinus; from Pitlekaj high, thick, more inequilateral and with intermediate sinus; from Spitzbergen and the White Sea high, thick and with still shorter posterior part, sinus intermediate, and specimens from Tromsø are high, thick, nearly equilateral, and have a short sinus. The posterior fold is conspicuous on specimens from the Eastern Atlantic, more indistinct from Eastern America and Pitlekaj. The distance in the left valve from the innermost part of the sinus to the muscular scar varies between 7 and 10 %, rarely to 14 %, but in one case I found a specimen from Tromsø with equal sinus in both valves, and an other specimen with a sinus like that of *baltica* in the right valve. The outline of the sinus varies a good deal.

The two "Maud" specimens, whose ratios are given above, belong to two very different forms. The first specimen ("Maud" sp. I) is large, inequilateral, the hingline oblique, forming a direct continuation of the posterior dorsal margin. The anterior dorsal margin expanded and convex, anterior margin evenly rounded, ventral margin with a faint concavity opposite the beaks, posterior margin rounded. Posterior muscular scar very large. The expanded dorsal margin and oblique hingline give this form a very uncommon appearance (Pl. II, Fig. 4—6). Length 46.5 mm., height 33 mm., diameter 15.3 mm. I name this form *obliqua*. One sample from the "Vega"-Expedition St. 1068 contains some small specimens of the same form.

The other specimen (sp. II) is smaller, evenly rounded, oval, rather equilateral, with small beaks, posterior part truncated, and the fold very indistinct. The pallial sinus in the right valve is very deep and its innermost part tapering and angulated, the distance to the muscular scar is only 11.2 % of the length. The last character easily separates this form from the other forms of *calcarea,* and might perhaps be of specific value. I give this form the varietal name of *longisinuata* (Pl. II, Fig. 1—3). Its outer form closely resembles specimens from the East American coast, and also in some degree some of the specimens collected by "Vega". Length 33.5 mm., height 23 mm., diameter 9.5 mm.

The defect valve has an unusually low pallial sinus and might perhaps be referred to one of the known forms from the arctic Pacific.

Occurrence: *Var. obliqua* one dead sp. St. 9?, *var. longisinuata* one dead sp. St. 30, and one defect valve St. 7.

Distribution: Circumarctic. Pacific: south to Oregon and North Japan. Atlantic: south to Long Island Sound and Denmark.

Genus **Saxicava** Fleuriau de Bellevue 1802.

Saxicava arctica (Linné 1767).

Systema naturae, edit. XII, pg. 1113.

All specimens are large, thick and have heavy shells. The form is nearly rectangular. All but one with sinuous ventral margin. They belong to *var. pholadis* Linné. Measurements:

L	H	$\frac{H}{L}$	D	$\frac{D}{L}$
43.5	27.0	62.0	21.0	48.3
40.0	23.0	57.5	22.5	56.2
36.4	17 8	48.9	16.3	44.8
35.0	18.5	52.8	18.0	51.5
34.4	20.5	59.5	22.0	64.0

One specimen has well defined posterior carina and nearly straight ventral margin.

Occurrence: 5 sp. Cape Chelyuskin, Lat. 77° 33′ N, Long. 105° 40 E, Depth 30 m.

Distribution: Nearly cosmopolitic.

The Pelecypod fauna of the vast shallow continental slope to the north of Eastern Asia and Western America is still very unsatisfactorily investigated. From the East Siberian Sea only the collections of "Vega" are worked out, while the mollusca of the expeditions of Baron Toll have not yet been published. Further Dall (1903) has given a list of the few molluscs saved from the unfortunate Jeanette-expedition. From the Chukotsk and the Beaufort Sea Dall (1919 & 1921) has mentioned some species.

The Pelecypods of the "Maud"-Expedition give us some new information regarding the distribution of the Pelecypods in these regions. Though no more than 20 species were found, most of them dead and in single valves, the collection brings several interesting facts. New to the East Siberian Sea are *Arca glacialis* Gray whose eastern limit is changed from 116° to 166° 11′ E. *Arca pectunculoides* Sc., whose eastern limit is changed from 116° to 166° E, and *Palliolum groenlandicum* Sow., whose eastern limit is changed from 116° to 167° 30′ E. All having a pronounced, western or Atlantic distribution. Further *Astarte crenata* Gray and the two new species, *Lyonsia Olonkini* and *Thyasira arctica*. The last two have Pacific affinities. New to the fauna of the Chukotsk Sea are *Thyasira flexuosa Gouldi* Phil. and the valve of *Peripioma abyssorum* Verrill.

On the various stations only few species are found. The stations near the New Siberian Islands are the richest, St. 29 with 5 species, 4 living, and St. 30 with 6, only 1 living. The most frequent species is *Palliolum groenlandicum* Sow., as usual in the arctic seas, found in 19 living specimens at 5 stations, further *Leda radiata* Krause, also found at 5 stations. The other species are usually found only at one station. The material is, however, too scarce to draw any conclusions concerning the true frequency of the various species. The bottom generally consists of mud, where life was very scarce. Sometimes the dredge came up wholly filled with mud but without any living creature, Sverdrup (1926).

In the following list the occurrence of the species on the various stations is tabulated. The dead specimens are marked with +, the living with the actual number in which they occurred. The St. 2—7 lie in the Chukotsk Sea, St. 8—30 in the East Siberian Sea, and St. M indicates "Maudhavn" near Cape Chelyuskin.

	2	3	4	5	6	7	8	9	10	11	16	17	19	20	21	28	29	30	M
Nucula tenuis Mont. *v. expansa* Reeve		2	1			3													
v. inflata Hancock																+	5 (+)		
Leda radiata Krause	+	+	1	1	1 (+)														
Leda lamellosa Leche							1										3		
Portlandia arctica Gray																		+	
Arca glacialis Gray									1										
Arca pectunculoides Sc.																			
v. grandis Leche										1									
Modiolaria nigra Gray						+											+	+	
Modiolaria discors Lin.																			
v. laevigata Gray																	1		
v. substriata laevis Beck ...																	2	+	
Palliolum groenlandicum Sow.											1	1	4	12	1				
Periploma abyssorum Verr....				+															
Pandora glacialis Leach......				+															
Lyonsia Olonkini n. sp.																+			
Astarte borealis Chemn.......						+	1												
Astarte Montagui Dillw.																			
v. fabula Reeve............																			2 (+)
v. vernicosa Dall...........																		1 (+)	
Astarte crenata Gray																			
v. polaris Dall											5 (+)	+							
Serripes groenlandicus Gml...																		+	
Thyasira arctica n. sp.														+					
Thyasira flexuosa Gouldi Phil.					1														
Macoma calcarea Gml........						+?													
v. obliqua n. var...........								+?											
v. longisinuata n. var........																		+	
Saxicava arctica Lin..........																			5

The Pelecypod fauna of the arctic regions to the north of the Bering Sea.

To be able to find the affinities of the Pelecypod fauna of the East Siberian Sea, the Chukotsk Sea, and the Beaufort Sea, and, as no list exists of the Pelecypods from this region, I have compiled in the table below available data regarding the Pelecypods of the said regions and of the Bering Strait. The list contains only the species, not the various varieties and forms. As many forms of the Northern Pacific, though nearly related to Atlantic arctic or boreal species, are regarded as valid species, especially by American malacologists, I have tried to join these into one species as per to the following list. Perhaps more species might be drawn together than I have done, e. g. *Axinopsis viridis* Dall with *orbiculata* G. O. Sars, and some of the species of *Macoma* with *calcarea* and *moesta*.

Nucula tenuis incl. *var. inflata* Hanc., *Leda pernula* incl. *var. buccata* Steenstr. & *var. costigera* Leche, *Portlandia arctica* incl. *var. glacialis* Gray, *var. siliqua* Reeve, *var. inflata* Leche, and *L. Collinsoni* Dall, *P. lenticula* as *abyssorum* Torell (Dall 1903), *Yoldia limatula* incl. *hyperborea* Lov., *Arca pectunculoides* as *var. grandis* Leche, *Crenella decussata* as *Cr. aff. rotundata* Dall, *Astarte elliptica* as *alaskensis* Dall, *A. crenata* as *polaris* Dall, *Venericardia borealis* as *var. Novangliae* Morse, *paucicostata* Krause & *crebricostata* Krause, *Thyasira flexuosa* as *var. Gouldi* Phil., *Diplodonta Torelli* as *aleutica* Dall, *Liocyma fluctuosa* incl. *Beckii* Dall & *viridis* Dall, *Macoma calcarea* incl. *inconspicua* Brod. & Sow., *Siliqua patula* as *var. alta* Brod. & Sow.

I am aware of the fact that this drawing together is a difficult task, and may be critizised. Only a thorough study of a large material will justify it.

In the following table the first three columns comprise the East Siberian Sea, the Chukotsk Sea and the Beaufort Sea to Cape Bathurst, and the Bering Strait from Cape Serdze Kamen and Cape Espenberg, to Cape Chukotskoi, St. Lorenz Island, and Cape Rodney. Species found both in the Bering Sea and the Chukotsk Sea are also referred to the Bering Strait. An attempt to list the Pelecypods from the Chukotsk Sea and the Beaufort Sea separately must unfortunately be abandoned on account of the difficulties in obtaining the proper localities.

The next three columns comprise species found in the Northern Pacific including the Bering Sea, true circumarctic species, and species occurring in the Atlantic. In the last three columns is indicated if the species is distributed in arctic, boreal or subtropic regions, both in the Pacific and in the Atlantic Oceans. Where the species are found living, they are marked with ×, the dead with †, and the doubtful with? Species from the East Siberian Sea found only in the extreme eastern part, to the West to 170° E, are marked also with (E). The term true circumarctic is used as before to designate species really found all round the coasts of the Polar Sea. The scarcity of material from high arctic regions makes it difficult to decide if a species occurs e. g. in the Siberian Sea, and I am inclined to think that the material from the Toll-expeditions, when published, and future investigations, will show that more species than listed by me, are true circumarctic.

Species not found between the Taimur peninsula and the extreme eastern part of the East Siberian Sea, are either not regarded as circumarctic or at least with doubt.

	East Siberian Sea	Chukotsk and Beaufort Sea	Bering Strait	Occurring in the Pacific	True Circum-arctic	Occurring in the Atlantic	Occurring in the		
							Arctic region	Boreal region	Subtropic region
Nucula tenuis Mont.	×	×	×	×	×	×	×	×	×
Leda pernula Müll.	× (E)	×	×	×	?	×	×	×	?
„ *minuta* Fabr.		×	×	×		×	×	×	×
„ *lamellosa* Leche	×						×		
„ *radiata* Krause		×	×	×			×	×	
„ *fossa* Baird		×	×	×			×	×	
Portlandia arctica Gray	×	×	×		×	×	×		
„ *intermedia* Sars			×	×		×	×	×	
„ *oleacina* Dall		×					×		
„ *lenticula* Møll.	×					×	×	×	
Yoldia thraciaeformis Storer		×	×	×		×	×	×	
„ *myalis* Couth.		×	×	×		×	×	×	
„ *limatula* Say	× (E)	×	×	×		×	×	×	×
„ *scissurata* Dall		×	×	×			×	×	×
Arca glacialis Gray	×					×	×	×	×
„ *pectunculoides* Sc.	×					×	×	×	×
Chlamys islandica Müll.		×	×	×		×	×	×	
Palliolum groenlandicum Sow.	×					×	×	×	×
Mytilus edulis L.		×	×	×		×	×	×	×
Modiolus modiolus L.		×	×	×		×	×	×	×
Modiolaria nigra Gray	×	×	×	×	×	×	×	×	×
„ *discors* L.	×	×	×	×	×	×	×	×	
„ *corrugata* Stimps.	×	×	×	×	×	×	×	×	
Crenella decussata Mont.		?	×	×		×	×	×	×
Periploma abyssorum Verrill		†				×	†	×	
Thracia curta Conr.		×	×	×			×	×	×
Pandora glacialis Leach	× (E)	×	×	×		×	×	×	
Lyonsia arenosa Møll.	× (E)	×	×	×		×	×	×	
„ *Olonkini* n. sp.	†						†		
Astarte borealis Chemn.	×	×	×	×	×	×	×	×	
„ *elliptica* Brown.		×	×	×		×	×	×	×
„ *Montagui* Dillw	×	×	×	×	×	×	×	×	×
„ *crenata* Gray	×	×	×	×	?	×	×	×	
Venericardia borealis Conr.	× (E)	×	×	×		×	×	×	×
„ *crassidens* Brod. & Sow.		×	×	×			×	×	
Thyasira flexuosa Gould.		×	×	×		×	×	×	×
„ *arctica* n. sp.	†						†		
Axinopsis viridis Dall		×	×	×			×	×	×
Diplodonta Torelli Jeffr.		×	×	×		×	×	×	
Rochefortia planata Dall		×	×	×			×	×	
Pseudopythina compressa Dall		×	×	×			×	×	×
Turtonia minuta Fabr.			×	×		×	×	×	×
„ *occidentalis* Dall			×	×			×		
Cardium corbis Martyn		×	×	×			×	×	×
„ *ciliatum* Fabr.		×	×	×		×	×	×	
„ *californiense* Desh.		×	×	×			×	×	×
Serripes groenlandicus Gml.	×	×	×	×	×	×	×	×	
„ *Laperousii* Desh.		×	×	×			×	×	
Saxidomus giganteus Desh.		×	×	×			×	×	×
Paphia staminea Conr.		×	×	×			×	×	×
Liocyma fluctuosa Gould	† (E)	×	×	×		×	×	×	
Tellina lutea Gray		×	×	×			×	×	

Continued from pag. 20.

	East Siberian Sea	Chukotsk and Beaufort Sea	Bering Strait	Occurring in the Pacific	True Circum-arctic	Occurring in the Atlantic	Occurring in the Arctic region	Boreal region	Subtropic region
Macoma calcarea Gml.	×	×	×	×	×	×	×	×	×
„ *balthica* L.		×	×	×		×	×	×	×
„ *moesta* Desh,	× (E)	×	×	×	?	×	×	×	
„ *truncaria* Dall		×					×		
„ *charlottensis* Whit.		×	×	×			×	×	
„ *inflatula* Dall		×	×	×			×	×	×
„ *inquinata* Desh.		×	×	×			×	×	×
„ *brota* Dall		×	×	×			×	×	
„ *incongrua* Martens		×	×	×			×	×	×
„ *Middendorffii* Dall			×	×			×	×	
Siliqua media Gray		×	×	×			×	×	
„ *patula* Dixon			×	×			×	×	×
Spisula polynyma Stimps.		×	×	×			×	×	
Mya truncata L.		×	×	×		×	×	×	
„ *intermedia* Dall		×	×	×			×	×	×
Panomya ampla Dall		×	×	×			×	×	
Cyrtodaria Kurriana Dunker	†	×	×	×	?	×	×		
Saxicava arctica L.		×	×	×		×	×	×	×
Zirphaea Gabbi Tryon		×	×	×			×	×	×

From the above list I have compiled some data in the following table. The same 9 columns are used as before. Species, which are probably or only found dead, are mentioned separately and not used in the calculations in the various rubrics. As high arctic species only those are considered as are found to the north of the Bering Strait.

There is an astonishing difference in the Pelecypodfauna of the two seas to both sides of Wrangell Island. The East Siberian Sea has only 21 living species, while not less than 57 are found in the Chukotsk and Beaufort Seas. The East Siberian Sea and the Chukotsk Sea are, however, rather different in their physical conditions. According to Sverdrup (1929) the bottom of the East Siberian Sea "is covered with a very thin layer of heavy salty water". The temperature is nearly constant c. — 1.5° C. The salinity is on the inner western part to the New Siberian Islands less than 32 ‰. In the area where most dredgings were made, the salinity is somewhat higher, 33 ‰, upwards to 34 ‰. The oxygen content is very small sinking even to a saturation of 18 % on the eastern part of the shelf. On the western part, however, it varies from 40—50 % and in the somewhat deeper middle part it rises to about 80 %. The renewal of oxygen comes from water to the north of the shelf, which at times overflow the shelf bottom forming the thin layer.

The Chukotsk Sea, however, shows quite a different picture. The physical conditions in the various parts and at the various seasons are rather varying. The bottom layer has a temperature between — 0.1 and — 1.1° C., and a salinity, which, however, seems to be very constant, 32.8 ‰. The saturations of oxygen is rather high, varying from somewhat less than 80 % to 100 %. These variegated conditions in the Chukotsk Sea are due to the complicated currents and the exchange of water through the Bering Strait.

Of the 21 living species from the East Siberian Sea, 9 are true circumarctic, of which 8 species occur both in the Atlantic and the Pacific, and 1, ***Portlandia arctica***,

	East Siberian Sea	Chukotsk and Beaufort Sea	Bering Strait	Occurring in the Pacific	True Circum-arctic	Occurring in the Atlantic	Occurring in the		
							Arctic region	Boreal region	Subtropic region
Living	21	57	61	60	9	39	68	63	32
Dead	4	1	—	—	—	—	3	—	—
Doubtful	—	1	—	—	4	—	—	—	1
Living in % of total	30.9	83.8	89.7	88.2	13.2	57.4	100	92.6	47.1
Excl. arctic sp.	2 + 3 †	4	3	2	1	2	6 + 2 †	—	—
Excl. arctic boreal sp.[1]	10 + 1 †	27 + 1 †	29	29	4	19	31	31	—
Excl. arctic + boreal-subtropic sp.	9 + 1 †	26 + 1 ?	29	29	4	18	32	32	32
Excl. arctic sp. %	9.5	7.0	5.0	1.6	11.2	5.1	8.8	0	0
Excl. arctic-boreal sp. %	47.6	47.4	47.5	48.3	44.4	48.7	45.6	49.2	0
Excl. arctic-boreal-subtropic sp. %	42.9	45.6	47.5	48.3	44.4	46.2	47.1	50.8	100
Sp. occ. in Pacific	15 + 2 †	54	60	60	8	33	60	58	29
True circumarctic sp.	9	9	9	8	9	9	9	4	4
Sp. occ. in Atlantic	20 + 2 †	31	34	33	9	39	39	37	17
Sp. occ. in Pacific %	71.4	94.6	98.4	100	88.9	84.6	88.2	92.1	90 7
Circumarctic sp. %	42.9	15.7	14.8	13.3	100	23.1	13.3	6.3	12.5
Sp. occ. in Atlantic %	95.2	54.4	55.8	55.0	100	100	57.4	58.7	53.1
Excl. Atlantic sp.	5	1 + 1 †	1	—	1	6	5 + 1 †	5	3
Excl. Pacific sp.	0	24	27	27	—	—	27	27	15
Excl. high arctic sp.	1 + 2 †	2	—	—	—	—	3 + 2 †	—	—
Excl. Atlantic sp. %	23.9	1.8	1.7	0	11.2	15.4	7.4	7.9	9.4
Excl. Pacific sp.%	0	42.1	44.3	45.0	0	0	39.7	42.9	46.9
Excl. high arctic sp. %	4.8	3.5	0	0	0	0	4.4	0	0

[1]) Incl. *P. lenticula.*

is not found living to the south of Bering Strait. *Astarte crenata* is probably circumarctic too. Further 6 species are only found in the extreme eastern part, some of which, however, are perhaps circumarctic. Only one of these species, *Venericardia borealis,* is not found living in European waters. *Leda lamellosa* is the only endemic species. The four remaining species, *Portlandia lenticula, Arca glacialis, A. pectunculoides* and *Palliolum groenlandicum,* are not found either in the Pacific or in the Chukotsk or Beaufort Seas. They seem all to be of Atlantic origin, the two *Arcas* occurring in distinct varieties. Of the four species only found in valves, 2 are described as new and are probably extinct, *Cyrtodaria Kurriana* is probably circumarctic and *Liocyma fluctuosa* is only found in the eastern part.

The Chukotsk and Beaufort Seas as well as the Bering Strait are inhabited by the same species as the East Siberian Sea, with the exception of the endemic and the four Atlantic species. The larger amount of species is for the greater part due to the contribution of Pacific species, but also to some extent of species occurring both in the Pacific and the Atlantic. These are either wholly lacking or have a limited distribution only on the European and arctic Eurasian shores. In the Bering Strait, where even more variegated physical conditions may be supposed to prevail, only 5 species not occurring in the Chukotsk and Beaufort Seas are found.

It is interesting to note how many of the species living in these arctic regions are distributed in boreal and even subtropical seas too. From the table is seen that nearly half of the species live also in subtropic regions. Many of these are usually termed "arctic". Most of them have, however, developed arctic varieties.

The Pelecypod fauna of the said regions may from the distributions to day be separated in four distinct zoogeographical groups of which one may be divided in 3 subgroups:

1. Endemic species.
2. Exclusive Pacific species.
3. Exclusive Atlantic species.
4. Both Atlantic and Pacific species.
   a. True circumarctic species.
   b. Exclusive western Atlantic species.
   c. Both western and eastern Atlantic species.

The endemic species are *Leda lamellosa, Portlandia oleacina, Macoma truncaria* and the 2 new species.

The exclusive Pacific species number 27. They are chiefly arctic-boreal-subtropic species (55.5 %). Some are also found on the Asiatic coasts of the Pacific. The four exclusive Atlantic species are mentioned before, 50 % of which ranges to the subtropic regions. To this group may further be referred *Periploma abyssorum,* which is only found living on the north eastern coast of America, and perhaps the arctic and true circumarctic *Portlandia arctica.*

The last group is the largest, containing 33 species in all. Of these 8 are, as mentioned before, true circumarctic. 3 are in our days exclusive western Atlantic species, viz. *Yoldia thraciaeformis, Yoldia myalis* and *Venericardia borealis,* the last also found in the subtropic region. The last subgroup, 22 species, live also on the European or Eurasian coasts. They are distributed to the east either to Novaya Zemlja or to the Kara Sea or the Taimur peninsula. Four are probably circumarctic and some more will perhaps be found to be circumarctic also, when a larger material from the arctic coasts is obtained.

Migrations of arctic Pelecypods in Tertiary times.

If the present fauna of an area shall be compared to the fauna of other areas and the affinities between them be found, it is not sufficient to compare the lists of existing species to each other, but we must also try to find the relations in the Quaternary and Tertiary times. Natural phylogenetic pedigrees must be arranged for every species, and the distribution and wanderings of the progenitors of now existing species and varieties must be thoroughly studied.

No other group of animals is better fitted for this purpose than the molluscs and especially the Pelecypods, and no other region offers more interesting conditions than the northern circumpolar area. The Polar Ocean with its shallow coastal plains forms the only connection in the northern hemisphere between two large oceans after the elevation of Middle America in miocene time and the disappearance of the "Thetys". The rather shallow Bering Strait allows the exchange of litoral species only, and it seems impossible that the broad continental plateau connecting America with Asia since the Cretaceous has allowed an intermingling of the deeper water strata in the Polar Ocean with the deeps of the Pacific or the Bering Sea — if there ever has been such a communication at all.

I will, in the following pages, make an attempt to follow the wanderings of some of the Pelecypods now living in both the Pacific and the Atlantic Ocean, and whose first appearance was in the Tertiary of Western America. The recent distribution of the arctic Pelecypods points towards a wandering along the arctic American coasts, and, as it seems, chiefly from west to east. As many of the species are found in Tertiary deposits in the Pacific, one is inclined to think that they have migrated from the Pacific to the Atlantic. There are no signs of such a migration along Eurasian arctic coast neither in the recent nor in in the fossil distribution. The occurrence of the same species in Tertiary European deposits, especially British and Icelandic Crag, made me try to find the time in which the extending wanderings took place. From available literature I have compiled the scarce dates and found it of some importance to deal rather broadly with the history of later Tertiary epochs. Our knowledge of the older and newer fossiliferous sediments are still very incomplete and our understanding of the geographical changes the land masses have undergone during the long space of time in which life has existed on earth, is very little and unsatisfactory. From the Neogene, however, we may with more certainty be able to follow the migration of species and groups.

That varying physical conditions have a great influence on the variation of the species and their wanderings is a well known fact. It is thus interesting to note the physical similarities between the area of Northern Norway to Spitzbergen and Greenland, and the Bering Strait inclusive its southern and northern neighbourhood. In both areas there exists an exchange of polar water with southern warmer water, perhaps more intensive during some seasons, through the narrow Bering Strait. In both areas also an intermingling of southern and northern animals is found, further in the species, a pronounced tendency to be variable.

Also the, partly revolutionary, alterations in the physical conditions during the Tertiary and Quaternary times, great and repeated changes of the sea level, and in the climatic conditions, have caused extended wanderings of the animals and, as it seems, given rise to the creation of a lot of new forms and species. This fact is a striking contrast to the conditions in tropical seas, where the physical conditions have remained nearly unaltered during the last geological epochs. According to R. E. Dickerson (1921), the fauna of the Phillippine Islands is only little modified since the Lower Miocene and Oligocene times. The tendency towards the rise of new species is thus much less pronounced in seas with only slight changes in physical conditions.

The establishment of natural pedigrees are at present a very difficult task. The various fossil as well as recent species, are to be met with under different names, and especially the fossil forms are often found in few specimens and in a rather bad state of preservation. There must be made a great revising work before the history of every genus or species be written. A close study of the various varieties with regard to our present knowledge of the influence of the physical conditions on the species, are also of the highest importance. A very important fact that must not be neglected when the faunas of the Pacific and the Atlantic shall be compared, is the nearly related or corresponding species. Nordgård (1915, 1918) has in two interesting papers drawn attention to what he names pairs of species. Such pairs are also to be found on both sides of the Wyville-Thomson-ridge, on the eastern and western Atlantic coast etc.

The Pelecypod fauna of the western coasts of North America bear a close resemblance to that found on the coasts of Northern Norway. As will be seen from the foregoing table not less than 30 species are common to both areas. These are more or less arctic, but we also find some species only found in the boreal and subtropic regions on the western and eastern coast of America and in Europe, not able to succed in arctic waters. Many of these species are also familar to the later Pliocene and the Quaternary deposits in Northern Europe, some also found in earlier Pliocene deposits.

This fact has long been observed by malacologists as Conrad, Carpenter, Jeffreys and Dall. The latter writes (1921) "Of the fauna as now enumerated (Western America), 136 forms are common to the Atlantic waters, nearly all belonging to the Arctic Seas", and "The Tertiary and Pleistocene fossils of the shores of Bering Sea also bear evidence of a communication with Atlantic waters during the prevalence of more genial conditions. Several species now living in Bering Sea are found fossil in the late Pliocene of Sankoty Head, Nantucket, and the Pliocene of Iceland, and conversetly the common periwinkle of New England, *Littorina palliata* Say, is one of the species found in the elevated beaches of the Nome district, Alaska, and now extinct on the Pacific side" Various explanations of this fact have been given. Carpenter (1865) e. g. considers that both faunas "have emanated from the North, the one diverging eastward and the other westward" as several of these can scarcely have travelled through Behring Strait, not being Boreal forms" (Wood 1850–79). Regarding the American forms, especially eastern American, in Icelandic Pliocene, Jeffreys seeks to explain their occurrence in America as due to immigration of species in earlier times by the Great Arctic Current from Iceland to America (cfr. J. S. Gardner 1885, from Barðarson 1925). Hägg (1924) mentions some species first met with in the Miocene or lover Pliocene deposits in the Pacific region. As these are known only from the Quaternary or younger Pliocene deposits in the Atlantic, he considers that a part of the now living arctic molluscan fauna originated in the environments of Bering Strait in Miocene time under colder climatic circumstances than at that time, were found in the Northern Atlantic regions,

The Tertiary is generally considered as a time of warm and little varying climate, gradually cooling towards the end of Pliocene. The immense space of time from Cretaceous to the Quaternary period, has, however, not elapsed without great changes both in geographic as well as climatic conditions.

By the inspection of the literature on American Tertiary one obtains the view, that there in Tertiary times has been a multitude of both greater and minor climatic changes. Even glacial deposits are known from this period. Thus Atwood (1915) reports glacial Eocene deposits from Colorado and Miocene from Iceland, both perhaps also observed in Italy. Dall (1893) reports a subtropic Miocene fauna from Arctic Siberia and Yabe and Nomura (1925) mentions the wanderings of *Thyasira bisecta* Conr. in Japanese Seas in the Middle Tertiary, which are due to climatic changes. It seems as if the Miocene has been colder than Pliocene and Pleistocene, at least in California. Thus Stephens (1929) writes that only few of the true northern species are found in the Pleistocene deposits, and that such forms occurring in the Miocene must live farther to the north in this time. In Europe the conditions are rather different. The explanation may be as given by Wegener (1922), that the glacial epoch commenced in early Tertiary times in the vicinities of Bering Strait. This glaciation must however have been interrupted by "interglacial" times, with more genial or even warm climate.

The recent Pelecypod first met with in Miocene deposits on the western coast of North America are according to Hägg (1924), Dall (1896, 1909): *Nucula tenuis, Yoldia thraciaeformis, Mytilus edulis, Modiola modiolus* (?) *Modiolaria nigra, Astarte borealis, Venericardia borealis, Liocyma fluctuosa, Macoma calcarea, Cardium ciliatum, Serripes groenlandicus, Lyonsia arenosa, Mya truncata, Saxicava arctica,* perhaps also *Yoldia limatula*, and from lower Pliocene *Chlamys islandica* Arnold (1906) and *Thyasira Gouldi* Yabe and Nomura (1925), also from Japan. The above list is by no means complete, but contains the species now living also in the regions dealt with in this paper.

These species have probably developed on the western coasts of America, where they are first found, often together with nearly related forms. Some of the early west American species entered the Japanese Tertiary Seas along the land bridge across the Bering Strait.

The migration to the Atlantic ocean during Miocene times took place either through the connection in Middle America or along the Asiatic coast through the Red Sea to the Mediterranean (Thetys). That a migration existed in Panama is proved, but there is no evidence that Pacific species along this route entered European waters. The Tertiary fauna of Florida (Dall 1895—1900, Gardner 1926—28) show few relations to the Pacific. Woodring (1926) has studied the living and fossil species of *Clementia*, and supposes that these species have migrated along the Asiatic coasts to the Mediterranean. Some other facts seem also to point in this direction. The barrier across the Bering Strait has probably, during the greatest part of Miocene not allowed marine animals to enter the now existing Polar Ocean or migrate this way to the Atlantic. However this connection may have been interrupted for shorter or longer periods and at least in the youngest Miocene allowed a migration along the northern coasts of America to Europe.

The Pliocene epoch is of far more interest for the wanderings and history of the recent Pelecypod fauna. Especially the Crag Sea and its inhabitants give us many very interesting facts and these may justify a somewhat long account of the Crag History.

The history of the upper Pliocene or Crag deposits of eastern Great Britain may, in the opinion of the eminent student of the Crag Mollusca, the late F. W. Harmer, be summarized as follows:

"As is well known, the general facies of the Coralline Crag fauna is distinctly southern. Of the species still living most are now found in the Mediterranean or along the western coasts of France and Portugal, while characteristically northern species are as a rule conspicuous by their absence. These facts point, I think, to the view, that free communication then existed between the Crag basin and the Atlantic, but not with northern seas". — "Since the lower Pliocene period the Anglo-Belgian basin has moved as on a pivot, rising in the south and sinking in the north ....." "As a result of the upheaval of the Lenham-Diestien area, communication between the Crag Sea and the Atlantic was interrupted, while by the Northerly subsidence connection with northern seas was established and many boreal and some arctic species were introduced apparently rather suddenly to the Crag basin".

This appeared in the Red Crag stage. The latest epoch of the Red Crag, the Butleyan, contains a more recent and northerly molluscan fauna with forms as:

Serripes groenlandicus, *Astarte compressa.*

The Icenian appears to have originated under different conditions from those in the Red Crag, in an open and shallow sea, possibly as the western edge of the great delta deposit of the Rhine ...

The Icenian Crag is increasingly poor in species, no more than 150 species in all have been found, of which only 40 are really abundant, most of them still living in British seas. Harmer explains this fact by the way that the great glacial ice little by little has closed the connection to the north. Fresh water from he south, especially in the summer, has made the water brackish. The mollusca are generally more fragile and the characteristic species of the older Crag desposits disappear. Among the typical Norwich fossils may be mentioned:

Nucula tenuis,
Astarte compressa,
Astarte borealis,
Macoma lata,
Mactra subtruncata,
Mactra elliptica

and as typical for the Chillesford beds

Macoma calcarea,
Serripes groenlandicus.

The Weybourne beds contain only 50 species of which 34 are common British shells and 21 arctic, but also 23 Mediterranean. *Macoma baltica* is the most typical species and made its first appearance in the Crag at this stage in great abundance. Though the communication with the Atlantic was reestablished by the cutting of the Dover Strait, the east Anglican Molluscfauna has never recovered the riches it had in the older Pliocene epochs.

Unfortunately the Crag Pelecypods are not dealt with since the great work of Searles V. Wood (1850—79) and the new results obtained during the last decennians are not published. The revision of this material will probably alter our knowledge regarding the various varying species to some degree. It is to be hoped that this revision will be made with the attention to the earlier Tertiary forms from the Pacific. From the corresponding deposits in Holland, Tesch (1912) has given a list of all molluscan remains, paralellized to the English and Belgian Crag fauna.

The highly interesting Crag deposits of Iceland have in the last years been described by Barðarson (1925) and Schlesch (1924). To the latter work Barðarson mentions that some of the determinations "are not sufficiently reliable" as several of the species "are not correctly named". Barðarson has examined these deposits during many years and has given a rather true picture of the various zones. He considers the sediments at Tjörnes to have a thickness of at least 450 m. They have all a dip towards N W somewhat irregular, apparently due to minor dislocations. The younger sediments at Breiðavik he says are at least 150 m. thick, the thickness of the entire Pliocene being at least c. 700 m. The deposits at Breiðavik are not concordant with the older strata on the western side of Tjörnes, as they dip roughly N E.

The basalt underlying the Crag deposits in the southern part dip far more to N or N W than the Crag sediments. Its surface has been eroded and deeply furrowed, showing that "some considerable time must have intervened between the formation of the basalt and the first deposits of the pliocene". Above the basalt lies conglomerate deposits, closely associated to the subsequent marine strata, and supposed to be of littoral origin. Barðarson divides the strata in the *Tapes* zone, the *Mactra* zone and the *Cardium groenlandicum* zone. In the *Tapes* zone the marine strata are repeatedly interrupted by fresh water deposits, as well as the first half of the *Mactra* zone. All these oldest marine strata are evidently formed in slight depths, and the molluscan remains consist of only a few species. The *Cardium groenlandicum* zone is in the first strata deposited in greater depths. The mollusc fauna is increasingly richer and contains more recent forms. The upper marine strata are interrupted by unquestionable land- and freshwater deposits.

As to the climatic conditions during the various zones, Barðarson supposes that none are deposited under more arctic conditions than that on the west coast of Iceland to-day. The *Mactra* zone is deposited during the warmest conditions, perhaps as on the British Isles. The Breiðavik sediments are formed during somewhat colder climatic conditions than the Tjörnes deposits, but not very different from that of the west coast of Iceland.

Of the 33 species found living in the Bering Strait and neighbouring arctic seas and common both to the Pacific and the Atlantic, and the circumarctic *P. arctica*, no less than 13 or probably 15 are found in Miocene deposits on the western coasts of North America and 2 in lower Pliocene deposits. This amounts to c. one half of all species, which unquestionably must have migrated from the Pacific to the Atlantic, as they are here met with in the younger Pliocene deposits for the first time. Of these 34 species, dealt with in the following pages, 7 species are not, as I have found from available literature, found in Tertiary deposits either in America or Europe, viz.: *Portlandia arctica*, *Portlandia intermedia*, *Modiolaria corrugata*, *Crenella decussata*, *Pandora glacialis*, *Diplodonta Torelli* and *Turtonia minuta*, further 2, *Liocyma fluctuosa* and *Lyonsia arenosa*, found in American miocene but not met with in European Tertiary.

If we try to follow the succession of the remaining 25 species in the Crag deposits of England, Belgium and Holland, we find that *M. edulis* is one of the oldest species.

In Coralline Crag we also meet

Mya truncata,
Cyrtodaria Kurriana (as *siliqua* (cfr. Knipowitch 1901)),
Saxicava arctica
and perhaps *Modiola modiolus*,
Thyasira flexuosa.

Of these 2 or 3 are found in West American Miocene and one in lower Pliocene. The three latter species have a rather wide distribution.

In the Red Crag deposits we find:

x *Nucula tenuis*,
Leda minuta,
x? *Yoldia limatula*,
Yoldia myalis,
Astarte Montagui,
Astarte elliptica?
Astarte crenata?
x *Serripes groenlandicus*,
x *Macoma calcarea*,
Macoma baltica.

Of these 3 or 4, marked with an x are met with in West American Miocene. Many of these species occur first in the later Red Crag stages.

In Icenian Crag we find:

Leda pernula,
x *Yoldia thraciaeformis?*
x *Modiolaria nigra*,
Modiolaria discors,
(x) *Chlamys islandica?*
x *Astarte borealis*,
x *Venericardia borealis?*
x *Cardium ciliatum*.

Further the two *Astarte* species probably found in Red Crag. Of these 5 are found in Miocene and one in lower Pliocene in West America. The three species marked with ? are probably from early Pleistocene deposits.

From the Icelandic Crag only 14 of these 34 (or 25) Pelecypods are mentioned by Barðarson. Schlesch mentions 23 species or all found in England, but *Yoldia myalis*, *Yoldia thraciaeformis* and *Thyasira flexuosa*, further *Macoma moesta* not recorded from England. As his references to various zones, however, are somewhat doubtful, I only discuss the Pelecypods listed by Barðarson.

In the lowest zone, the *Tapes*-zone we find only *Mytilus edulis*, as in England. In the *Mactra*-zone we have further

Modiola modiolus, *Cyrtodaria Kurriana* (as *siliqua*),
but also *Chlamys islandica*, *Cardium ciliatum* (?).

The last two are first found in England in Icenian.

From the *Cardium groenlandicum*-zone is known

Leda pernula,	x *Serripes groenlandicus,*
Modiolaria nigra,	x *Macoma calcarea,*
Astarte borealis,	*Mya truncata.*
Veneticardia borealis,	

The last one is found in the Coralline Crag, and the two marked with an x in Red Crag. The other four are first found in the Icenian.

In the younger deposits at Breiðavik we find *Nucula tenuis,* but *Nucula* sp. is recorded from the *Mactra*-zone. In England this species is found in the Butleyan Crag.

That the various species do not occur in the same succession in Iceland as in the more eastern Crag deposits may be due to various circumstances. The most important one is surely the depth in which the various layers have been sedimented. One may consider that the species are first to be met with in Iceland and that it took some time to enter the eastern Crag Sea. When the incompleteness of our knowledge of the faunas of the Pliocene seas are regarded, there is indeed rather good accordance.

It is seen that the three now exclusive Western Atlantic species in Pliocene time lived in European waters, but have not survived the Great Ice Age. Some of the other species have also in former days had a much greater distribution. So e. g. the northern species as *Chlamys islandica* etc. found in Pliocene or Pleistocene in Italy. In postglacial times many species lived in northerly habitats where they are now extinct. Of special interest is the find of *Chlamys islandica* in raised layers abt. 20 meter above the Sea level at the Chelyuskin peninsula. Grønlie (1929).

In a very interesting paper Jensen (1900) draws attention to the important fact that great quantities of valves of some littoral species are found at great depths to 1309 fathoms in the area between Greenland, Iceland and Jan Mayen. He explains this fact in the way that the sea bottom has lowered abt. 2500 meter in the glacial epoch, and maintains that the shells are not transported by ice. The question has been much discussed. According to Jensen and Brøgger (1901) who mentions some dead shells from the Norwegian North-Atlantic Expedition, the following Pelecypods are found dead in depths from abt. 500 to 1333 fathoms.

Leda pernula,	*Cardium ciliatum,*
Yoldia limatula,	*Serripes groenlandicus,*
Portlandia arctica,	*Liocyma fluctuosa,*
Chlamys islandica,	*Mya truncata,*
Lyonsia arenosa,	*Cyrtodaria Kurriana (siliqua),*
Astarte borealis,	*Saxicava artica*
Astarte Montagui,	

and from the Valorous-Expedition: *Diplodonta Torelli.*

from the sea west of Spitzbergen in 1450 fathoms.

The bathymetrical distribution of these species is maximal 677 meter, but they are only frequent in lesser depths. 9 of the species are found in Miocene or Lower Pliocene in West America and 10 in European Crag deposits. It seems most reasonable to consider these valves as Pliocene or perhaps partly Pleistocene fossils. There are known many examples on the capture of fossil forms now extinct in the respective area from the sea bottom with the dredge. e. g. along the Norwegian coast (Øyen 1915) in England etc. among the living species. That the continental mass once has lowered to a large extent is also shown by the occurrence of littoral water-worn pebbles along the Norwegian slope to the depths.

How can the Pacific species migrate to European seas? Are they able to cross the great ocean that now exists between America and Europe? The answer must undoubtedly be no. The Pelecypoda do not move much in the adult stage. They are either fixed by a byssus or burrowed in the sand or mud bottom. Only in the larval stage are they able to migrate to some extent. The larvae are pelagic in abt. 20 days, somewhat longer in lower temperature and unfavourable conditions, to 3 months uppwards? (Kändler 1927) and are transported by the prevailing currents to new habitats. If we now assume that abt. one month is the common maximal duration of the pelagic larval stage of the arctic species they may be transported by a current of one half meter pr. second abt. 1300 km.

No so exclusive migrations have, however, ever been observed even where the conditions are still more favourable. That Pelecypods spread rapidly along the shores is repeatedly remarked. Thus *Mya arenaria* implanted with seed-oysters on the west American coast has migrated towards the North and South and is now distributed from Victoria to Monterey, Oldroyd (1924). On the North Norwegian coast I have in latter years found *Modiolaria marmorata* very frequent, previously not observed to the North of the Trondhjem Fjord. It has surely invaded during the last years to Northern Norway together with some other southern animals. If there existed such a strong current as mentioned above from America to Greenland, Iceland, the Færøes and England, there seems to be no hindrance for the species to migrate along this route without geographical changes. But such a current can, however, never have existed without great alterations in the geographical features of this area and I suppose has never existed at all. A strong current would probably give an explanation to the migrations of American species to Europe but not the migration of European species to America. The facts seem to confirm that the more littoral Pelecypods migrate along coast lines only and very seldom happen to cross greater depths as larvae.

One is therefore inclined to think that there has existed a land connection between America and Europa in one way or other. Such a land connection is also very probable, if not proved by the former and present distribution of land and freshwater animals and plants. The theories of a land bridge or that of Wegener may both explain this, but it seems as the latter, to make the distance between the continents very small, is the more probable. In the latter years Gutenberg (1929) has combined both theories to a rather probable and interesting hypothesis, which will give the best explanations of the facts, that have hitherto existed.

The continents have not been lying close to each other but separated by an intermediate land, which has sunk more and more as the continents separated. One remnant of this connection may be the submarine bridge from the Færøes to Iceland not yet wholly interrupted. This hypothesis will give a good explanation of the find of littoral species at great depths, a fact that the Wegener theory alone can not explain.

If we now recapitulate the facts from early Pliocene we find that the Coralline Crag Sea was connected with the Atlantic but probably not with Northern waters. We may suppose that there was, in the place of the North Sea, a land connected with the rather short land-connection or land mass to Greenland. This "bridge" was probably lying somewhat to the north of Iceland allowing southern European species to reach the Icelandic Crag Sea in the *Tapes*-zone. In Red Crag the connection with the Atlantic was closed and a connection with northern waters established. The land to the north of the Coralline Crag sea slowly sinks, forming the North Sea and thus establishes a free passage for Northern species to enter the eastern Crag Sea. At this time the invasion of Pacific northern species began for some reason. Probably the Americo-Asiatic landbridge was interrupted and the northern parts of America sink, as is shown from Pleistocene also. Thus O'Neill (1924) mentions a submergence of at least 500 feet. This submergence will to a large extent facilitate the migrations of marine animals.

At this time also the littoral or sublittoral species now found extinct at great depths to the north of Iceland lived there in favourable depths or rather shallow water. Nearly the same conditions existed during the Icenian, but probably with the beginning of the great glaciation the westward movements of the American continent and also the lowering of the intermediate land was greater than before. The "Land bridge" sinks, the Pliocene layers, especially in Iceland dipped towards the North as well as those in England etc. The rather shallow seabottom to the north of Iceland sinks more and more and some of the animals living there perished. There is, however, some reason to think that the disappearance of the land connection was not definitive but that the smaller remains have taken part in the vertical movements of this region in Pleistocene and probably formed a real land connection in interglacial times.

As mentioned before not only American species migrated to Europe but also European species to America. None of these seems, however, to have reached the Pacific.

The hydrographical conditions must have been quite different to those of the day in the circumarctic and boreal regions. Nansen (1902) has discussed the influence that the alterations in the submarine ridges will have on the hydrographic and climatic conditions but it is easily seen how much greater differences a real land connection must cause.

The recent distribution of the Pelecypods in these regions agrees well with the migration of Pacific species along the coasts of arctic America to Europe. The 33 species common to both oceans may be divided in some faunal groups. 3 species are now exclusive western Atlantic, but have in Pliocene reached Europe. Of the other now living in European boreal and arctic waters, some are distributed to the Northeast to Novaya Zemlya, some enter the Kara Sea and some are found to the Taimur peninsula. 8 of the 33 species are circumarctic, but it seems that all these species have migrated the same route but have been able to go farther to the east than the rest of the species. There is also no reason to consider that the 16 species, not yet found fossil on the west coast of America but more or less distributed in the Pacific, should not have originated there and migrated the same way as the others. Most of these species have also wandered southwards on the East American coast. There is, as mentioned before, a great lot of more southern species common to both oceans too, and it is very probable that most of these species have migrated the same way as their more arctic relatives, with the exception of some old southern forms that have entered the Atlantic through the Mediterranean.

In the Pelecypodfauna of the East Siberian Sea we find a little faunal group of four species being exclusive Atlantic in their distribution. Of these at least one *Arca pectunculoides* is known from Pliocene, in England from Coralline Crag and it is probable that all four are old species. They have all reached the East American coast and penetrated to the west along the northern coasts, perhaps to Dolphin and Union Strait. They are not recorded either living or fossil farther to the west. All species have been able to spread along the Eurasiatic arctic coast, and as the two *Arcas* at least occur in distinct varieties, as also do many of the other species, we may suppose that they are old inhabitants in these waters. Contrary to the Pacific species their distribution in the Atlantic is very great, some reaching to West Africa.

There seems to be no immigration of Pacific species to the East Siberian Sea. Only in the extreme eastern part have some Pacific species been found. No other group of marine animals seem to point towards the immigration of Pacific species to the East Siberian Sea, at least of any importance. That some species, especially swimming forms, may enter the East Siberian Sea from the Chukotsk Sea is however probable, especially along the slope of the shelf as there exists a westerwardy current. No true Pacific species has been found to the west of the New Siberian Islands, which is not found on the Arctic coasts of America either, and being circumarctic.

For the eastward distribution of marine animals, both Pacific and Atlantic species, along the Eurasian arctic coast, we find some marked barriers, e. g. Novaya Zemlja and the Nordenskiöld Sea with large quantities of fresh water from the great arctic rivers. In former, not too remote days the New Siberian Islands have been connected with the Siberian coast, thus making the Nordenskiöld Sea an even better barrier than to-day.

The migration towards the east may pass on even in our days. Thus many of the animals obtained by the "Maud" have not been found by "Vega", e. g. *Palliolum groenlandicum*, which is the most frequent of all Pelecypods in the East Siberian Sea now. Perhaps the north going currents east of the Wrangell Island will serve as a barrier for the migration to the Chukotsk Sea.

Stuxberg (1880) considers that the Siberian Ice Sea has a faunal group with its western limit at Novaya Zemlja. His best proofs are *Bythocaris Payeri*, *Sclerocrangon salebrosus* and *Asterias panopla*. *Bythocaris Payeri* is found (Stephensen 1913) from Greenland to Franz Josephs Land and in the Kara Sea, not farther to the east. *Sclerocrangon salebrosus* is a Pacific species not occuring to the north of the Bering Sea and has been confounded with *Sclerograngon ferox*, which exist from Greenland to the East Siberian Sea (Sivertsen M. S.) *Asterias panopla* Stuxberg has also a conform distribution from Jones Sound to the Nordenskiöld Sea (Hofsten 1915). Stuxberg has, however, based his opinions on the rather scarce and unrevised material from the arctic regions then available.

Several plants and animals also indicate the same way of migration. At least many of our north Scandinavien species have a conform distribution with the marine fauna. Wille (1915) mentions the "Greenland element" in our arctic flora. It comprises species living in Greenland, Iceland, Arctic North America, Asiatic coasts of Bering Strait, and Scandinavia eastwards to Novaya Zemlja. such as *Campanula uniflora* and the curious *Carex scirpoidea.*

Holm (1922) has given a very interesting list of the arctic plants, a lot of which has the same distribution as the ones above named. Holm's interesting discussion on the migrations and origin of the various plants shows also that America to a large extent has been the original home of many of our plants. Perhaps some more plants may have migrated from America than he considers. Naturally also plants originated in Europe have migrated the opposite route to America as some of the eastern Atlantic Pelecypods.

I have in the foregoing pages tried to give a reasonable picture of the migration of the "circumpolar" part of the fauna of the regions listed in this paper. Though the facts and details are rather heterogenous, I hope that I have succeeded in the task and shown that a large part of our own arctic fauna has originated in the Pacific and migrated along the arctic coasts of Northern America, crossing the Northern Atlantic in one way or other to European coasts, and that the most extensive wanderings took place in Pliocene times. I am aware, however, of the incompleteness of the material used and that further investigations will alter the details, especially regarding the geological history. The question ought to have been worked out on a larger scale, considering all species common to both oceans now, or in former times, also the more southern ones.

LITTERATURE.

1906. Arnold, R.: The Tertiary and Quaternary Pectens of California. U. S. Geol. Surv. Prof. Paper No. 47. Washington.

1915. Atwood, Wallace W.: Eocene Glacial Deposits in Soutwestern Colorado. U. S. Geol. Surv. Prof. Paper No. 95 B. Washington.

1925. Barðarson, G. G.: A stratigraphical survey of the Pliocene deposits at Tjörnes, in Northern Iceland. Det Kgl. Danske Vid. Selsk. Biol. Medd. IV:5. København.

1901. Brøgger, W. C.: Om de senglaciale og postglaciale nivåforandringer i Kristianiafeltet. Norges geol. Unders. No. 31. Kristiania.

1898. Bush, K. J., see Verrill.

1885. Dall, W. H.: Report on the Mollusks. Report of the International Polar Expedition to Point Barrow, Alaska. Part IV. Washington.

1893. — A subtropic miocene fauna in Arctic Siberia. U. S. Nat. Mus. Proc. Vol. 16. Washington.

1895—1900. Contributions to the Tertiary fauna of Florida. Trans. Wagner Free Inst. of Sci. Vol. III, part III—V. Philadelphia.

1896 a. — Diagnoses of new species of Mollusks from the West coast of America. U. S. Nat. Mus. Proc. Vol. 18. Washington.

1896 b. — Report on Coal and Lignite of Alaska. 17th Ann. Rep. U. S. Geol. Surv. 1895—96. Washington.

1900. — Synopsis of the family Tellinidae and of the North American species. U. S. Nat. Mus. Proc. Vol. 23. Washington.

1901 a. — Synopsis of the Lucinacea and of the American species. U. S. Nat. Mus. Proc. Vol. 23. Washington.

1901 b. — Synopsis of the family Cardiidae and of the North American species. U. S. Nat. Mus. Proc. Vol. 23. Washington.

1902. — Synopsis of the Family Veneridae and of the North American Recent Species. U. S. Nat. Mus. Proc. Vol. 26. Washington.

1903. — Synopsis of the Family Astartidae, with a Review of the American Species. U. S. Nat. Mus. Proc. Vol. 26. Washington.

1909. — Contributions to the Tertiary Paleontology of the Pacific coast. I. The Miocene of Astoria and Coas Bay, Oregon. U. S. Geol. Surv. Prof. Paper. No. 59. Washington.

1913. — Diagnoses of new shells from the Pacific Ocean. U. S. Nat. Mus. Proc. Vol. 45. Washington.

1915. — A review of some bivalve shells of the group Anatinacea from the west coast of America. U. S. Nat. Mus. Proc. Vol. 49. Washington.

1916. — Diagnoses of new species of marine bivalve mollusks from the northwest coast of America in the collection of the United States National Museum. U. S. Nat. Mus. Proc. Vol. 52. Washington.

1919. — Report of the Canadian Arctic Expedition 1913—18. Vol. VIII, Part A. Mollusks, Recent and Pleistocene. Ottawa.

1921. — Summary of the marine shell bearing mollusks of the Northwest Coast of America. U. S. Nat. Mus. Bull. 112. Washington.

1921. Dickerson, Roy E.: Notes on a Fauna of the Vigo Group and its Bearing on the Evolution of Marine Molluscan Faunas. Proc. Calif. Acad. of Sci. Fourth Series. Vol. XI, no. 1. San Francisco.

1885. Gardner, J. S.: The Tertiary Basaltic Formation in Iceland. Quart. Journ. Geol. Soc. 41. London.

1926—28. Gardner, J.: The Molluscan fauna of the Alum. Bluff group of Florida. U. S. Geol. Surv. Prof. Paper. 142 A—E. Washington.

1870. Gould, A. A. & Binney, W. G.: Report on the Invertebrata of Massachusetts. Boston.

1824. Gray, J. E.: Supplement to the Appendix to Parry's first Voyage. Shells. London.

1909. Grieg, J. A.: Brachiopods and Molluscs, with a Supplement to the Echinoderms. Rep. Sci. Norwegian Arctic Exp. in the "Fram" 1898—1902. Vol. III, No. 20, Kristiania.

1928. Grønlie, O. T.: Fossil and Subfossil Shells from "Maud-Havn" and environs. The Norw. North Polar Exp. with the "Maud", Sci. Res. Vol. V, No. 20. Oslo.

1929. Gutenberg, B.: Veränderungen der Erdkruste. Natur und Museum, Bd. 59, H. 10. Frankfurt a. M.

1904. Hägg, R.: Mollusca und Brachiopoda gesammelt von der schwedischen zoologischen Polarexpedition nach Spitzbergen, den nordöstlichen Grönland und Jan Mayen im Jahre 1900. I. Brachiopoda und Lamellibranchiata. Arkiv för Zoologi. Bd. 2, no. 2. Stockholm.

1905. — 2. Scaphopoda, Gastropoda, Placophora und zwei vorher nicht erwähnte Lamellibranchiata. Arkiv för Zoologi. Bd. 2, no. 13. Stockholm.

1924. — Stångenäskraniets skalbank. Geol. Föreningens Förh. Bd. 46, H. 5. Stockholm.

1924. Hanna, G. Dallas: Rectifications of Nomenclature. Proc. Calif. Acad. Sci. Fourth Series. Vol. XIII, no. 10. San Francisco.

1914—20. Harmer, F. W.: The Pliocene Mollusca of Great Britain. Vol. I—II. Palæontographical Society, London.

1915. Hofsten, U.: Die Echinodermen des Eisfjordes. Kungl. Sv. Vet. Akad. Handl. Bd. 54, no. 2. Stockholm.

1922. Holm, Th.: Contributions to the Morphology, synonymy and geographical distribution of arctic plants. Rep. Can. Arctic Exp. 1913—18. Vol. V. Botany, Part B. Ottawa.

1900. Jensen, Ad. S.: Om Levninger af Grundtvandsdyr på store Havdyb mellem Jan Mayen og Island. Vidensk. Medd. Naturhist. Forening. København.

1905 a. — Studier over nordiske mollusker. III. Tellina (Macoma). (1903). Vidensk. Medd. Naturhist. Forening. København.

1905 b. — On the Mollusca of East-Greenland. I. Lamellibranchiata. Medd. om Grønland. Vol. XXIX. København.

1912. — Lamellibranchiata. Part 1. The Danish Ingolf-Exp. Vol. II, part 5. København.

1927. Kändler, R.: Muschellarven aus dem Helgoländer Plankton. Wiss. Meeresuntersuch. Abt. Helgoland N. F. Bd. 16, No. 5. Kiel.

1901. Knipowitsch, N.: Mollusca und Brachiopoda. I. Zoologische Ergebnisse der Russischen Expeditionen nach Spitzbergen. Ann. Mus. Zool. Bd. 6. St. Petersbourg.

1885. Krause, Arth.: Ein Beitrag zur Kenntniss der Molluskenfauna des Beringsmeeres. Brachiopoda et Lamellibranchiata. Arch. f. Naturgeschichte. Bd. LI. H. 1.

1924. Köppen, W. & Wegener, A.: Die Klimate der geologischen Vorzeit. Berlin.

1878. Leche, W.: Öfversigt öfver de af svenske expeditionerna till Novaja Semlja och Jenissej 1875 och 1876 insamlade Hafsmollusker. Kgl. Sv. Vet. Akad. Handl. Bd. 16. Stockholm.

1883. — Öfversigt öfver de af Vega expeditionen insamlade Arktiska Hafsmollusker. 1. Lamellibranchiata. Vega-Expeditionens Vetenskapliga lagttagelser. Bd. III. Stockholm.

1851. Middendorff, A. Th. von: Reise in der äussersten Norden und Ostsibirien, während der Jahre 1843 und 1844. Mollusken. St. Petersbourg.

1902. Nansen, F.: The Oceanography of the North Polar Basin. The Norw. North Polar Exp. 1893—1896. Sci. Res. Vol. III. Kristiania.

1915. Nordgård, O.: Havstrømmene og den norske marine fauna. Kgl. Norske Vid. Selsk. Skrifter 1914, no. 5. Trondhjem.

1918. — Bryozoa from the Arctic regions. Tromsø Mus. Aarsh., vol. 40, nr. 1. Tromsø.

1915. Odhner, N. Hj.: Die Molluskenfauna des Eisfjordes. Zool. Ergebnisse der schwedischen Expedition nach Spitzbergen 1908. Kungl. Sv. Vet. Akad. Handl. Bd. 54, no. 1. Stockholm.

1924. Oldroyd, J. S.: Marine shells of Puget Sound and vicinity. Publ. Puget Sound Biol. St. Vol. 4. Seattle.

1924. O'Neill, J. J.: The Geology of the Arctic Coast of Canada, west of the Kent Peninsula. Rep. Canadian Arctic Exp. 1913—18. Vol. XI. Geol. and Geography. Part A. Ottawa.

1898. Posselt, H. J.: Conspectus Faunæ Grönlandicæ, Brachiopoda et Mollusca. Grønlands Brachiopoder og Bløddyr. Medd. om Grønland. Vol. XXIII. Kjøbenhavn.

1878. Sars, G. O.: Mollusca Regionis Arcticæ Norvegiæ. Univ. Progr. 1878. Christiania.

1924. Schlesch, H.: Zur Kenntnis der pliocänen Cragformation von Hallbjarnarstadur. Tjörnes, Nordisland und ihrer Molluskenfauna. Abh. Arch. f. Molluskenkunde. Bd. I, H. 3. Frankfurt a. Main.

1931. Sivertsen, E.: Crustacea Decapoda and Mysidacea from the East Siberian and the Chukotsk Seas. M. S.

1919. Smith, J. P.: Climatic Relations of the Tertiary and Quaternary Faunas of the Californian Region. Proc. Calif. Acad. Sci. Vol. IX, No. 4. San Fransisco.

1885. Sparre-Schneider, J.: Undersøgelser af dyrelivet i de arktiske fjorde. III. Tromsøsundets Molluskfauna. Tromsø Museums Aarshefter. Vol. VIII. Tromsø,

1891. Stearns, R. E. C.: Description of new west American Land, Freshwater, and Marine Shells, with notes and comments. U. S. Nat. Mus. Proc. Vol. XIII. Washington.

1929. Stephens, F.: Notes on the Marine Pleistocene deposits of San Diego County, California. Trans. San Diego Soc. Nat. Hist. Vol. V, No. 16. San Diego.

1913. Stephensen, K.: Grønlands Krebsdyr og Pycnogonider. Medd. om Grønland. XXII (1917) Kjøbenhavn.

1880. Stuxberg, A.: Evertebratfaunaen i Sibiriens Ishaf. Bih. till K. Sv. Vet. Akad. Handl. Bd. 5, no. 22. Stockholm.

1926. Sverdrup, H. U.: Tre aar i isen med "Maud". Oslo.

1929. — The Waters on the North Siberian Shelf. The Norw. North Polar Exp. with the "Maud" Sci. Res. Vol. IV, no. 2. Bergen.

1912. Tesch, P.: Beiträge zur Kenntnis der Marinen Mollusken im West-Europäischen Pliocänbecken. Mededeel. van de Rijksopsp. van Delfstoffen. No. 4. S. Gravenhage.

1884. Verrill, A. E.: Third Catalogue of Mollusca recently added to the Fauna of the New England Coast. Trans. Conn. Acad. Vol. VI. New Haven.

1898. — & Bush, K. J.: Revision of the Deep-water Mollusca of the Atlantic coast of North America, with descriptions of New Genera and Species. U. S. Nat. Mus. Proc. Vol. XX. Washington.

1922. Wegener, A.: Die Entstehung der Kontinente und Ozeane. Braunschweig.

1915. Wille, N.: The Flora of Norway and its Immigration. Ann. Missouri Bot. Garden. Vol. 2. St. Louis.

1850—79. Wood, S. V.: A Monograph of the Crag Mollusca. Vol. I—IV. Palæontographical Society. London.

1926. Woodring, W. P.: American Tertiary Mollusks of the Genus Clementia. U. S. Geol. Surv. Prof. Paper. No. 147 C. Washington.

1915. Øyen, P. A.: Kvartær-Studier i Trondhjemsfeltet. III. Kgl. Norske Vid. Selsk. Skrifter. 1914. No. 6. Trondhjem.

1925. Yabe, H. & Nomura, S.: Notes on the recent and tertiary species of Thyasira from Japan. Sc. Rep. Tohoku Imp. Univ. Sec. Series. Vol, VII, No. 4. Sendai.

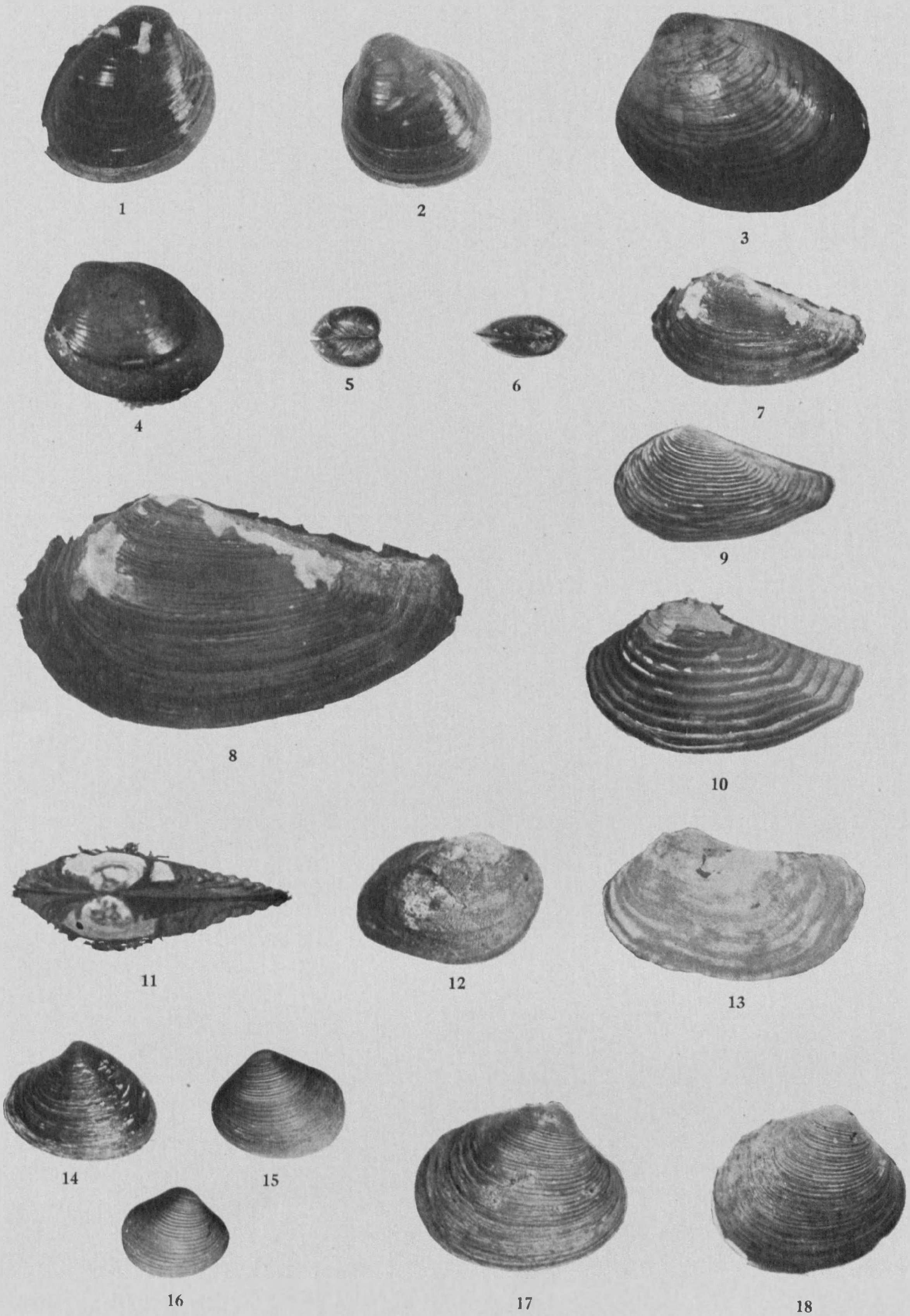
PLATE I.

Fig. 1, 2. *Nucula tenuis var. inflata* Hancock.
„ 3, 4. „ „ *an var. expansa* Reeve.
„ 5. „ „ *var. inflata* Hancock.
„ 6. „ „ *an var. expansa* Reeve.
„ 7, 8. *Leda radiata* Krause.
„ 9, 10, 11. *Leda lamellosa* Leche.
„ 12. *Arca (Bathyarca) glacialis* Gray.
„ 13. *Lyonsia Olonkini nov. sp.*
„ 14. *Astarte Montagui* (Dillwyn) *an var. vernicosa* Dall.
„ 15—18. *Astarte crenata* (Gray).

PLATE II.

Fig. 1, 2, 3. *Macoma calcarea forma longisinuata nov.*
„ 4, 5, 6. „ „ „ *obliqua nov.*
„ 7. *Thyasi'a flexuosa Gouldi* (Phil.).
„ 8, 9. *Thyasira arctica nov. sp.*
„ 10. *Periploma abyssorum* Verrill.
„ 11. „ „ „ posterior part.
„ 12. „ „ „ posterior part with the chondrophore and the rib-like projection.

All figures are enlarged.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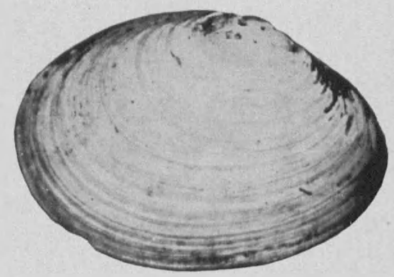
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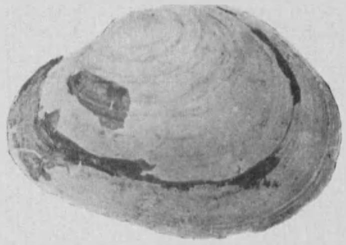
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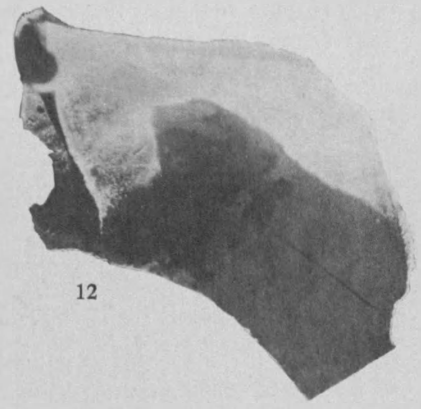
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