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Nr. 98

THE BARNACLE BALANUS BALANOIDES (LINNÉ, 1766) IN SPITSBERGEN

BY

ROLF W. FEYLING-HANSSEN

WITH 15 TEXT FIGURES AND 9 PLATES

I KOMMISJON HOS
BRØGGERS BOKTRYKKERIS FORLAG
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A. W. BRØGGERS BOKTRYKKERI A/S

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Introduction.

Only two original items of information about the occurrence of *Balanus balanoides* in Spitsbergen are found in the literature. Birula in 1906 states that *B. balanoides* occurs to the south (Gurjanova, Sachs, and Uschakov, 1925; Madsen, 1936; Tarasov, 1937). Broch (1924) mentions a sample in the Zoological Museum of Oslo labelled "Kapp Bruun, on the beach", collected by E. Hansen in 1921 (Stephensen, 1933, and Madsen, 1936). According to "The Place Names of Svalbard", 1942, this locality is identical with Kapp Klaveness on the coast between Hornsund and Bellsund, 77° 10′ N. lat., 14° E. long.

During my visit to Spitsbergen in the year of 1948 I found the species living in several places, and in the years of 1950 and 1952 I undertook an investigation of the occurrence and living conditions of *Balanus balanoides* in these northernmost localities of its habitat. The results of this study have been laid down in the present paper.

For their interest and expert help in the reading of the text and in the framing of the manuscript, I wish to render grateful acknowledgment to Dr. Hj. Broch, professor of Zoology at the University of Oslo, and to Dr. H. U. Sverdrup, professor of Geophysics and director of Norsk Polarinstitutt. Their criticism and advice were of the greatest service. I am indebted to Stud. real. Natascha Heintz who translated the Russian literature referred to in the present paper, to Miss Bergliot Mauritz who prepared the photographs, and to Miss Randi Gulliksen, Miss Spange and Mr. Evensen who prepared some of the drawings. Cand. mag. H. Skålvoll measured the specimens collected in 1952. The field work in Vestspitsbergen was greatly facilitated through the help of my companions there: M. Sc. J. S. Adams, Cand. philol. O. Chr. Feyling-Hanssen, Stud. real. P. Svendsen, and Stud. real. H. Wang. Finally I thank Norsk Polarinstitutt for financial support in the preparation of this paper.

Paleontologisk Museum,
University of Oslo,
February 1953.

Rolf W. Feyling-Hanssen.

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Abstract.

Living specimens of *Balanus balanoides* (Linne, 1766) were found by the author in the summers of 1948, 1950, and 1952, at various localities on the west and north coast of Vestspitsbergen and in the fjords of the same region. The northernmost locality is situated at 80° 3,7′ N. lat. This is the highest latitude at wich *B. balanoides* has been recorded up to the present.

B. balanoides has been previously recorded twice in Spitsbergen, viz. by Birula in 1906 "to the south", and by Broch in 1924 from Kapp Klaveness (77° 10′ N. lat.).

The general distribution of this species is discussed, and a map of its total occurrence is given. Records of *B. balanoides* as a fossil in Arctic and Subarctic Pleistocene deposits are considered.

The morphology of the Spitsbergen specimens is discussed. Some of them recall Darwin's variety *"a"*.

The occurrences of *B. balanoides* in Spitsbergen are almost exclusively associated with cracks and grooves in the substratum. The animal was found on hard rocks only. Specimens growing on a more or less subvertical substratum are usually orientated with their carina upwards and their rostra down. In none of the localities investigated *B. balanoides* was found living below low-water mark, and in many places it did not occur above mid-tide level.

B. balanoides penetrates far into the fjords of Vestspitsbergen, but it has not been observed close to the glaciers at the heads of the fjords. The limiting factor here is found to be the suspended minerogenic mud, which forms a slippery coating on the substratum in such localities.

B. balanoides can at least survive one winter in Spitsbergen, probably more. In this connection the relation of *B. balanoides* to the ice-foot is discussed. A few remarks have been inserted about breeding and reproduction. A brief survey is given of the localities in which *B. balanoides* was observed, and at the end of the paper measurements of carino-rostral basal diameters and heights will be found.

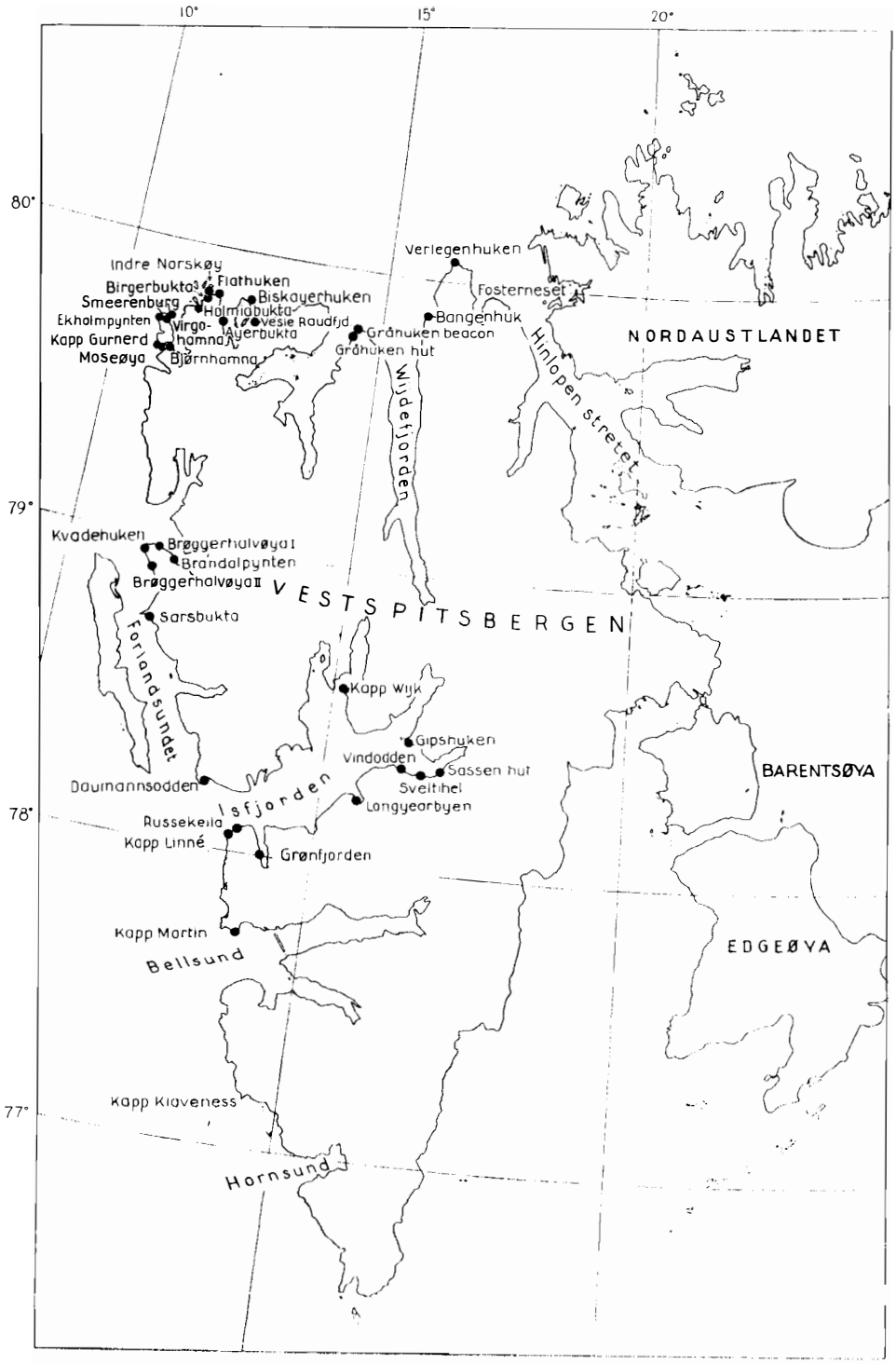

Fig. 1. The Vestspitsbergen localities in which *Balanus balanoides* was observed by the author.

DISTRIBUTION

Occurrence of *Balanus (Semibalanus) balanoides* (L) in Spitsbergen.

In the summer of 1948 living specimens of *Balanus balanoides* (L.) were observed in the littoral of 7 localities in Isfjorden, Vestspitsbergen, viz.:

Daumannsodden	observed	July	4th
Kapp Linné	»	»	5th
Longyearbyen	»	»	7th
Vindodden	»	»	8th
Sveltihel	»	»	11th
Sassen Hut	»	»	22nd
Gipshuken	»	August	8th

In the summer of 1950 the species was found thriving at the following 11 localities in Vestspitsbergen, and some samples were brought back:

Kapp Martin	observed	August	31st	sample
Kapp Linné	»	»	8th	sample
—»—	»	July	28th	sample
Russekeila	»	»	30th	sample
Grønfjorden	»	August	2nd	sample
Kapp Wijk	»	»	26th	
Sarsbukta "Balanuspynten"	»	»	17th	
Sarsbukta "Balanusvika"	»	»	21st	
Brandalpynten	»	»	15th	sample
Broggerhalvøya I	»	»	15th	
Broggerhalvøya II	»	»	16th	
Kvadehuken	»	»	16th	

In the summer of 1952 *B. balanoides* was again observed in Vestspitsbergen, and this time also some places along the north coast. The species was found living in the following 19 localities:

Kapp Linné	observed	June	28th	sample
—»—	»	August	29th	sample
Bjørnhamna	»	July	8th	sample
—»—	»	August	28th	sample

Moseøya	observed	July	9th	
Kapp Gurnerd	»	»	9th	
Virgohamna	»	»	10th	
—»—	»	»	20th	
Ekholmpynten	»	»	20th	
Smeerenburg	»	»	11th	
Fuglefjorden	»	»	13th	
—»—	»	August	25th	
Birgerbukta	»	July	13th	
—»—	»	August	23rd	sample
Kapp William	»	July	13th	
Indre Norskeøya	»	»	14th	
Flathuken	»	August	24th	
Ayerbukta in Raudfjorden	»	»	24th	
Biskayerhuken	»	July	25th	
—»—	»	August	20th	sample
Vesle Raudfjorden	»	July	27th	sample
Gråhuken hut	»	»	31st	
Gråhuken beacon	»	»	31st	
Bangenhuk	»	August	3rd	
Verlegenhuken	»	»	10th	

Balanus balanoides has thus been observed living in the littoral of Spitsbergen at many localities along the west and north coast and also in the fjords of these regions, from Bellsund to Verlegenhuken. Verlegenhuken is located at 80° 3,7′ N.lat. This is the highest latitude at which *B. balanoides* has been recorded up to the present.

East of Verlegenhuken the species was searched for on the rocks of Lagunepynten, Eolusneset in Sorgfjorden, further south in Sorgfjorden, at Crozierpynten, and at Fosterneset. *B. balanoides* was not found in any of these localities. Verlegenhuken, therefore, on Vestspitsbergen represents the easternmost limit of distribution for this species along the north coast, and it most probably constitutes the northernmost limit of distribution in general for this species.

At Verlegenhuken, however, only two specimens were found, and of these, one was dead. The occurrence at Verlegenhuken, therefore, must be regarded as occasional. At Bangenhuk (79° 52,5′ N.lat.) on the south side of the entrance to Mosselbukta, some more specimens were observed. At Gråhuken (79° 48,2′ N.lat.) too, on the west side of the entrance to Wijdefjorden, the species was extremely rare. In general the occurrence of *B. balanoides* along the eastern parts of the north coast is more or less occasional. Vesle Raudfjorden and Biskayerhuken further to the west had fairly rich populations of *B. balanoides,* and the investigated localities still further to the west and south had even richer assemblages of the species.

Nothing is known about the occurrence of *B. balanoides* along the east coast of Vestspitsbergen or on Barentsøya, Edgeøya, or Nordaustlandet.

The possibility exists that the rather rich occurrence of this species in Vestspitsbergen is associated with the present improvement of the climates in the northern hemisphere. This, however, can hardly be judged from the sparce records at hand.

Further distribution.

Balanus balanoides has a very wide geographical distribution, it occurs both in Atlantic and Pacific boreal waters.

The map, fig. 2, gives the total distribution of this barnacle. Many details of information about its occurrence towards the Arctic have been quoted here from the paper by Madsen (1936), who (p. 67) has presented a map showing the distribution of *B. balanoides* and littoral molluscs (Madsen does not distinguish between *B. balanoides* and littoral molluscs on his map but treats them as one characteristic ecological assemblage). Hutchins (1947, p. 328) presented a map with some records of this barnacle.

According to Madsen (1. c. pp. 12 and 48) *B. balanoides* is »known with certainity to occur on the east coast of Greenland as far as, but not north of, about 66°—67° N.lat.« *i. e.* but slightly north of Angmagssalik. Berthelsen (1939, pp. 17—18) did not find it north of Angmassalik (Cf. also Stephensen, 1943, p. 20)[1]. On the west coast of Greenland the species, according to Madsen (1940, p. 3), has its northernmost limit at Prøven, *i. e.* about 72° 25′ N.lat. Vibe (1939, p. 29) has found a single specimen of *B. balanoides* at Upernivik, but Madsen (1940, p. 8) states that this is evidently occasional. In his paper on crustacea collected by the Godthaab Expedition 1928, Stephensen (1936, p. 25) writes that *B. balanoides* is, at any rate, found up to about 78° N.lat. at Port Foulke on the Greenland side of Smith Sound (see also Stephensen, 1913, p. 379, Steven, 1938, p. 67, and Hutchin, 1947, p. 328) The Godthaab Expedition 1928 found *B. balanoides* on the rocky coast of Egedesminde, approx. 68° 40′ N. lat., but has no record of the species further north; in spite of the expedition visiting several northern localities, also in the Port Foulke area. In his paper "Conspectus Crustaceorum et Pycnogonidorum Groenlandicia" Stephensen (1913) quotes some earlier records of *B. balanoides* in Greenland, *i. a.* at Port Foulke. This record dates from Stimpson (1864, p. 140), and is the only original record from such a high latitude in Greenland waters. (Stephensen, 1. c., mentiones verbal information from Ad. S. Jensen that the species is commonly met with everywhere in Greenland between low- and highwater mark. This is doubtless

[1] In the summer of 1951 I have searched in vain for this species along the east coast of Greenland from 72° to 74°′ N.lat.

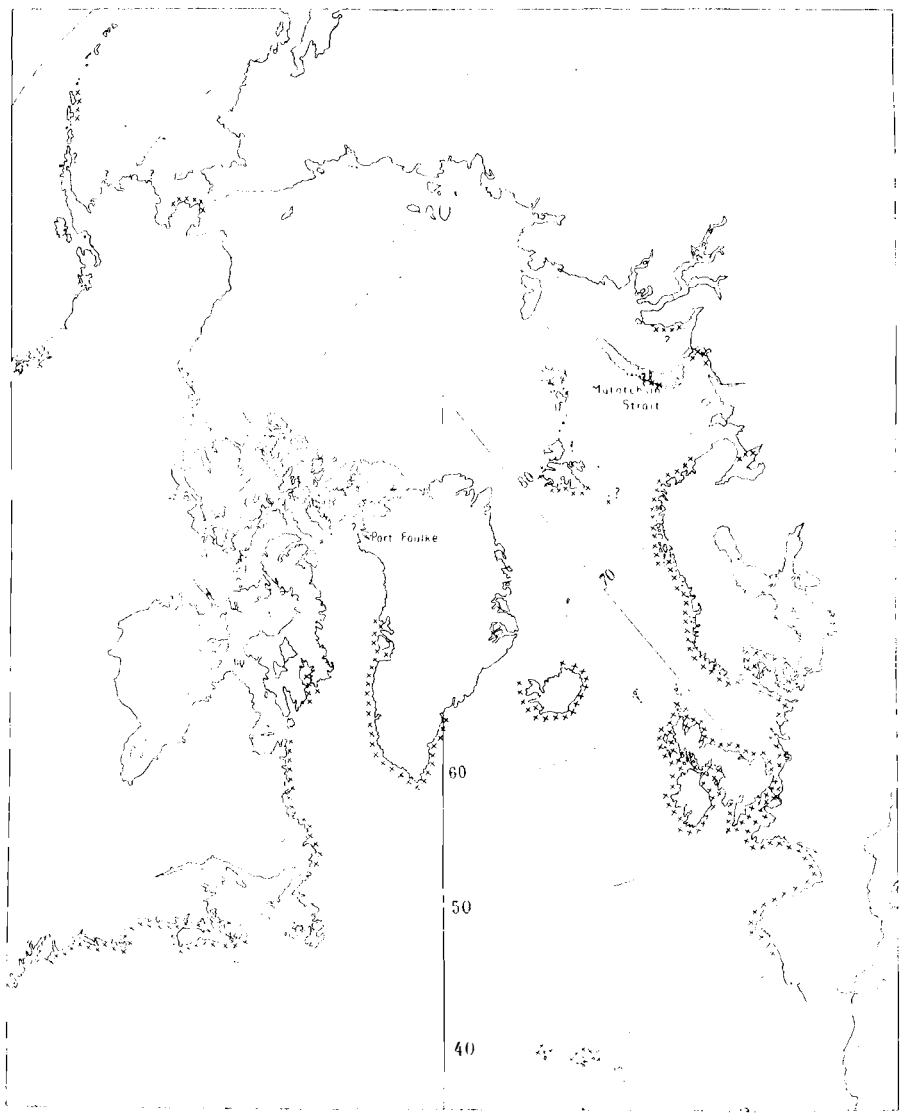

Fig. 2. The total distribution of *Balanus balanoides* (L.)

erroneous). The material of Stimpson was collected by the "Late Arctic Expedition, under Dr. I. I. Hayes" 1860—61. Stimpson (1864) states briefly: "*Balanus balanoides* Darwin. *Lepas balanoides* O. Fabr. Fauna Groenl. p. 422. Port Foulke." — Ortmann (1901, pp. 144—168) has quoted the record of *B. balanoides* at Port Foulke given by Stimpson. During the Princeton Expedition Ortmann found the species at Godhavn, Disco Island (69° 14′ N.lat.) "Between the tides (4, and several broken)" (1. c. p. 146). He also visited Port Foulke, but did not find *B. balanoides* there. He observes (1. c.): "I have seen also on the rocks of the shores of Foulke Fjord remains of a *Balanus* (bases only) which may belong to this species." — This assumption, however, seems unreasonable because of the lack of a calcified basis in *B. balanoides*. This species leaves no traces at all on the rock. The fact that Ortmann did not find *B. balanoides* in Foulke Fjord makes Stimpson's record rather questionable. — The Second Norwegian Arctic Expedition with the "Fram" visited Foulke Fjord in 1898 and brought back a sample of barnacles from Reindeer Point on the north side of Foulke Fjord (2—10 fathoms), all being *B. crenatus* Bruguiere (Cf. Broch, 1936, p. 4). Probably the records of Stimpson (1. c.) and Ortmann (1. c.) should be referred to this species.

Vanhöffen (1897) reports *B. balanoides* from the Umanak district (70° 20′ N. lat.) (Cf. also Weltner, 1898, p. 269, and 1900, p. 302). Broch (1924, p. 86) reports it from Egedesminde (where it was also found by the Godthaab Exp.). This record probably alludes to the specimens mentioned by Sars (1909, 1. c. p. 41): "On small stones, from 2 different places." The Second Norwegian Exp. with the "Fram" visited Egedesminde and crustacea were collected there in 1898 (Cf. Sars, 1909, 1. c. p. 3, where a list is given of the localities visited in 1898; the date is July 29th, which by a slip of the pen, Broch writes as 19th). Stephensen (1936, p. 25) erroneously assumes that this record by Sars may apply to Arctic America.

In "Fauna Groenlandica" (1780) Fabritius has mentioned *B. balanoides*. According to Madsen (1936, p. 52) these records concern the Fredrikshaab district. Stephensen (1917, p. 308) reports 2 specimens from Bredefjord (approx. 61° N. lat.). Stimpson's record from Port Foulke, more than 78° N. lat., thus seems to be very questionable (see also Madsen, 1940, p. 8).

At the west side of Davis Strait *B. balanoides* has been found in two places, viz. Cumberland Sound and Arctic Island, approx. 66° N. lat. (Cf. Pilsbry, 1916, p. 188; and also Stephensen, 1936, p. 25; Tarasov, 1937, p. 53; Madsen, 1940, p. 13). Darwin (1854, pp. 267—272) reports it from North America in lat. 66° 34′, and from Labrador, Nova Scotia southward to Delaware (Bay) (approx. 39° N. lat.). Pilsbry (1916,

pp. 183 and 188) has not found it south of Ocean City, New Jersey, but Richards, (1930, 1931) has recorded it from Cape Charles, Virginia. From Labrador Pilsbry (l. c. p. 188) gives three localities: Rigolet, Nain, and one only named Labrador. (Madsen, 1940, p. 13, erroneously writes that Pilsbry, 1916, mentions Nain — approx. 56° N. ast he northernmost known locality of *B. balanoides*.) Packard (1865) has reported *B. balanoides* from Labrador, and so has Tanner (1944, p. 240).

Madsen (1936, p. 68) suggests that the entire northern coast of the North American continent should probably be referred to his subarctic province which is thus suited to support a littoral fauna including *B. balanoides*. No record, however, of this species is available from these coasts, or from other parts of Arctic America. Weltner (1900, p. 302) has quoted a report of *B. balanoides* in Arctic America from Kumlien (1879). The latter, however, only mentions a locality in Cumberland Sound, southern Baffin Land (Cf. Smith in Kumlien, 1879, p. 139).

In the Pacific, *B. balanoides* has been recorded by Pilsbry (1916, p. 188) from three localities in Alaska, viz. Unalaska, Cold Bay, and Sitka. He finds, however, that only the specimens from Unalaska (approx. 53°—54° N. lat.) are referable to the Atlantic form of *B. balanoides,* "Other Alaskan forms seen may be segregated as a subspecies" (1. c. p. 187). According to Shelford (1930) *B. balanoides* thrives on the eastern side of the Bering Strait. Henry (1942, pp. 100 and 126) has observed it at Captains Harbor (Unalaska Island) and at Ketchikan (Alaska), its northern limit on the western coast of North America being Sitka (approx. 57° N. lat.) and its southern limit Unalaska (approx. 53,5° N. lat.). (The record of *B. balanoides* from Monterey, California, by Ricketts and Calvin, 1939, is queried by Henry.)

On the western side of the Pacific *B. balanoides* has been recorded in Japan (Hiro, 1935; cf. Henry, 1942, p. 126, Hutchin, 1947, p. 328). Tarasov (1937, p. 53) has found it in the Amur Bay (at the mouth of the Amur river and in the Ochotsk Sea.

As far as is known the species has not been recorded on the Arctic coast of Sibiria between the Bering Strait and the Kara Sea. From the Kara Sea, however, it has been reported by Baino-Rodzevich (1923, in the Baidarata Bay), and by Gurjanova (1932, p. 182, locality not given). Tarasov (1937, p. 53) presumes that the specimens found in the Baidarata Bay do not breed there, but have drifted in as larvae. This point of view is also held by Madsen (1940, p. 13) because of the constant easterly current through the Yugor Strait.

Strelnikov (1929, p. 932) has reported *B. balanoides* from Varnek Bay on the southern side of Vaigatsh Island. Tarasov (1937, p. 53) has recorded it at the same locality "on stones in the littoral". Hoek (1882,

p. 66) reports *B. balanoides* from Matotchkin Strait, Novaya Zemlya (approx. 73° 20′ N. lat.), at 2—11 fathoms (August 21—25th, 1878), again quoted by Schaper (1922, p. 239), Stephensen (1913, p. 379), and Weltner (1900, p. 302).[1] (See also Uschakov, 1931).

Westwards from Novaya Zemlya, *B. balanoides* has been reported from Cheshskaya Guba by Gurjanova (1929) and by Brotzky and Zenke-

[1] Broch (1924), pp. 9 and 114) believes that Hoek's record is based on specimens of *Balanus crenatus* Bruguiere, which is common at all depths around Novaya Zemlya. Considering, however, the description of the specimens given by Hoek, this does not seem so certain. Hoek (1882, p. 66) writes: "Die lang-cylindrische Form der W. Barents-Exemplare macht es schwer diese Art von dem nah verwandten *Balanus crenatus* Brug. zu unterscheiden. Nach dem Fehlen der kalkigen Basis, nach der Structur der Mundtheile und dem Fehlen des kleinen Dorns an der Basis des Penis zu urtheilen, gehören die mir vorliegenden Exemplare zu *B. balanoides*, Linn. Spec."

The lack of a calcified basis points to the subgenus *Semibalanus* Pilsbry, 1916, within which, *B. balanoides* seems to be the only species consistent with the description by Hoek. The posibility of Hoek's species being *B. crenatus* seems to be precluded also by the lack of a dorsal point at the basis of the penis. This characteristic is stressed both by Darwin (1854, p. 270) and Broch (1924, p. 85). Thus, even if some *B. crenatus* from the Barents Sea have been without a so called "inteapicale Area" (Broch, l. c. p. 81), and even if the calcified basis should have been sufficiently delicate to be overlooked by Hoek, the lack of a point at the basis of the penis precludes the specimens from Matotchkin Strait from belonging to *B. crenatus*.

B. balanoides should after all be able to thrive at the southwestern parts of Novaya Zemlya. According to Grieg (1924, p. 5), Strelnikov (1922), and Messjatzew (1931), *Mytilus edulis* L. occurs there, indicating more favourable ecological conditions than in Spitsbergen, where *Mytilus edulis* is only found as a fossil in Pleistocene deposits (Cf. *i. a.* Odhner, 1915).

The reason, however, why Broch (1924, p. 114) doubts the occurrence of *B. balanoides* in Novaya Zmelya is not only the northerly position of this locality, but also the information from Hoek (1882, p. 66) that the specimens were caught inbetween depths of 2 and 11 fathoms (3,6—20 m, according to Weltner, 1900, p. 302). This does not conform to the view that *B. balanoides* exclusively belongs to the tidal zone and that it is an essential condition for the animal to be sometimes exposed at ebb tide. Broch (l. c. p. 113) writes: "Überhaupt muss man jede Angabe über tiefere Fundorte mit grösstem Misstrauen behandeln." — Tarasov (1937, p. 54), however, holds the view that, as a rule *B. balanoides* is at littoral form but that under extraordinary environmental conditions it may be found submerged into the sublittoral. Shaper (1922 pp. 244—246) reports *B. balanoides* from 0 m to 45 m. Krüger (1927, p. 14) reports that the species has been taken in the Kattegat at depths of 8 and 35 m. Antevs (1928, p. 490) states that *B. balanoides* has been recorded at depths from 0 to 90 m (Cf. also Stephensen, 1933, p. 121, and Gurjanova, 1929).

witsch (1932).[1] Further, it is reported from the White Sea (Weltner, 1898, p. 269, and 1900, p. 302; Stephensen, 1913, p. 379; Derjugin, 1928) and from the Murman coast (Stephensen, 1936, and Derjugin, 1928).

From Bjørnøya (Bear Island, approx. 74° 30′ N. lat.) this species has been recorded only once, viz.: by Urban (1880) who reports having caught it at a depth of 45 m. This record has been quoted by several authors. Broch (1924, p. 114) presumes that the species taken by Urban at Bjørnøya has probably been *B. balanus* (L.), as this species is common in the area and at the depth indicated. On the other hand, *B. balanoides* may be expected at Bjørnøya.

B. balanoides occurs on the coasts of Iceland (Cf. Weltner, 1898, p. 269, and Ortmann, 1901, p. 146). From Jan Mayen no record seems to be at hand (Parat and Devillers, 1936).

In Norway the species occurs all along the coast. As to details the reader is referred to Broch (1924).

Further south *B. balanoides* is recorded from the European coasts to Portugal and the Azores, about 39° N. lat. (Weltner, 1900, p. 302; Schaper, 1922, p. 239; Stepensen, 1933 and 1936). Darwin (1854, p. 272) does not believe that *B. balanoides* extends its habitat into the Mediterranean, and Schaper (l. c.) writes: "Der als Litoralform eurytherme *B. balanoides* scheint gegen Änderungen im Salzgehalt sehr empfindlich zu sein, denn weder lebt er im salzigen Mittelmeer,[2] noch auch in der salzarmen Ostsee oder in brachischen Fluss-mündungen." The view, that *B. balanoides* is unable to withstand low salinities, is held also by Prennant and Teissier (1929). At la Rance, however, it has been found in water of only 0,45 ‰ (Fischer—Piette, 1929). — Concerning its occurrence towards the entrance of the Baltic see Aurivillius (1895 and 1898), Nilsson—Cantell (1921), Stephensen and Ussing (1918), Krüger (1927 and 1927 a, the latter with a map, p. 18).

According to this review the habitat of *Balanus balanoides* on both sides of the Atlantic Ocean extends southwards to about 39° N. lat. Its

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[1] Broch (1936, p. 5) has reexamined a sample of specimens from Cheshskaya Guba; they proved to be *B. crenatus*. Broch (1924 and 1936) assumes that *B. balanoides* has its eastern limit towards the Arctic somewhere along the Murman coast. According to the records cited above this limit ought to be moved estwards to Baidarata Bay, or to the entrance of the Kara Sea.

[2] In his paper "Studien an adriatischen Balanen" Kolosvary (1937, pp. 553—555) has dealt with the shape of specimens of *B. balanoides* taken in the Adriatic by the Hungarian "Najade" Expedition (1913—14). His drawings, however, do not resemble this species at all, and from his rather indistinct text it seems obvious that his specimens do not belong to *B. balanoides*. In a later paper on the total distribution of Adriatic cirripedes (Kolosvary, 1939, pp. 161—172) *B. balanoides* has been omitted.

northernmost finding place today is Verlegenhuken, Vestspitsbergen, at 80° 3,7′ N. lat.

The discontinous amphiboreal distribution of this species, viz. its occurrence in the northern Atlantic and the northern Pacific, and its absence along the Siberian and North American Arctic coast, is explained by Broch (1924, 1926, 1927, and 1937) by the occurrence of the Post Glacial warmer period. Broch presumes that during this warmer period *B. balanoides* had a continuous distribution along the Arctic coasts, and that it disappeared there, when the climate again became less favourable.

Occurrence in the Arctic Pleistocene.

Balanus balanoides is recorded as a fossil from a terrace at Lamposchnja some 20 km from the town of Mesenj (approx. 66° N. lat.) south of the Kanin Peninsula (Knipowitsch, 1904, p. 191, with a "?"). It has once been recorded from West Greenland where it was found in a terrace between 16,6 and 20 m above sea level, Lerbugten at Claushavn (approx. 69° N. lat.) (Harder, Jensen, and Laursen, 1949, p. 78). In Spitsbergen it has been found as a fossil in a raised beach 16,3 m above sea level in Sassenfjorden, the inner part of Isfjorden (78° 25′ N. lat.) (Feyling-Hanssen and Jørstad, 1950, p. 25)[1].

Thus records of *B. balanoides* from Pleistocene deposits along arctic and subarctic coastal areas are extraordinarily rare. The reason is that this species, partly owing to its lack of calcified basis, generally occurs in the deposits as single compartments and operculars, or fragments of compartments. These are small and may easily be overlooked, or if considered, recorded only as 'fragments of *Balanus*', or '*Balanus* sp.'. Probably also some of the recorded *B. crenatus* may have been *B. balanoides*. Old shell of *B. balanoides* are not easily distiguished from old *B. crenatus*, especially when the parietal tubes of *B. balanoides* are not secondarily filled up with calcareous material.

From Spitsbergen Knipowitsch (1900) mentions *B. porcatus* (= *B. balanus*) as a fossil from many localities; from Grønnfjorden he only records *Balanus*. Elton and Baden-Powell (1931) and Baden-Powell (1939) only report *B. balanus*. This species is recorded by most investigators of the Pleistocene of Spitsbergen, some of them have also mentioned *B. crenatus* (Cf. Blomstrand, 1864, Cöster, 1925, Heer, 1870, Hoel, 1914, Lamplugh, 1911, Nordmann, 1912, Hägg, 1950, 1951 and others).

[1] Hoel (1914, p. 35) recorded from the head of Woodfjorden 2—3 m above the sea "des restes d'un *Balanus*; mais à défaut de la plaque de base, je ne puis décider si l'on a à faire au *Balanus crenatus* — — ou au *Balanus balanoides*".

From Bjørnøya (Bear Island) no record of fossil *B. balanoides* has come to my knowlege.

From Iceland only *B. porcatus, B. crenatus,* and *Balanus* sp. are recorded as fossils (Cf. Bárdarson, 1921).

Even from the thoroughly investigated Greenland the find at Claushavn, quoted above, seems to be the only record of Pleistocene *B. balanoides.* Dan Laursen (1944 and 1950), who has reviewed the previous literature about the Greenland Pleistocene, mentions *B. balanus, B. crenatus,* and *B. hameri,* but not *B. balanoides.*

Also the Fifth Thule Expedition to Arctic North America (Fox Basin area — Southampton Island to Cockburn Land) did not obtain this species from Pleistocene deposits (Cf. Dan Laursen, 1946).

From the Ellesmere Land area no record of fossil *B. balanoides* seems to be available. Holtedahl (1917) mentions *Balanus* sp. at Pim Island, Moskusfjord, and from Jones Sound.

From Novaya Zemlya no record of this species as a fossil is at hand; Grønlie (1924) does not mention it from the Pleistocene of that region.

V. Tanner (1907, 1907 a, 1930) has no record of *B. balanoides* as a fossil from the Pleistocene of Northern Finland and Finnmark, but mentions 'fragments of Balanids', and *Balanus* sp. from several localities.

This brief account, in which only some of the numerous papers dealing with Pleistocene fossils from arctic and subarctic regions have been considered, shows 1) that *Balanus balanoides* occurs as a Pleistocene fossil in the Kanin Peninsula, in Spitsbergen, and in Greenland. 2) that many authors have not identified all Balanids present in their material. 3) that, accordingly, *B. balanoides* presumably occurs in the Pleistocene deposits of a great many more localities than those stated. Probably the species may be found in any deposit from the Post Glacial warm period within the region, containing littoral forms. The finds of the species in Greenland and Spitsbergen were made in deposits dating from that period.

MORPHOLOGY

Description.

The shape of *Balanus balanoides* varies from a low cone with more or less ribbed or folded walls, usually with a small orifice, to cylindric or clubshaped with an orifice larger than the basis (cf. *i. a.* Schäfer, 1952, and Caspers, 1949).

In Spitsbergen almost exclusively conical or patelliform individuals have been found. They vary in height, apparently according to local conditions. Most adult specimens have settled in cracks and grooves. The specimens growing in deeper fissures tend to be taller than specimens from shallower ones.

Only in one locality, viz. Birgerbukta (Cf. p. 45) obviously crowded populations were observed. Accordingly the only clearly elongated forms were found there. In the other localities the specimens were growing solitary or in small clusters seldom containing more than some 50 individuals.

Most of the Spitsbergen specimens are moderately folded (Cf. Pl. I and II). Taller forms are generally more smooth, whereas especially low-conical specimens may be strongly ribbed, *e. g.* those from Brandalpynten (Pl. III). Dons (1946) mentions the assumption that specimens growing in localities exposed to heavy wave action should develop a strongly ribbed surface, the less ribbed individuals living under quieter conditions. He has, however, (1946, p. 200) found both variants in sheltered localities with quiet water. This also holds good in Spitsbergen. Brandalpynten is evidently a quiet and protected locality, whereas Kapp Linné, even at the anchorage, is far more exposed to heavy seas; nevertheless, feebly folded forms were rather common there.

The size of *B. balanoides* seems to increase towards the north in Spitsbergen. At Kapp Martin (77° 43,2′ N. lat.) the largest specimen found had a carino-rostral basis diameter of 11,4 mm, the largest specimen from Kapp Linné (78° 3,8′) 11,9 mm, Brandalpynten (78° 56,4′) 13,6 mm, Bjørnhamna (79° 38,6′) 14,8 mm, and Biskayerhuken 79° 52,5′ 16,1 mm (Cf. fig. 13, p. 40).

The tubes of the parietes in the Spitsbergen specimens are in most cases not secondarily filled up (Fig. 3). The tubes are either small and

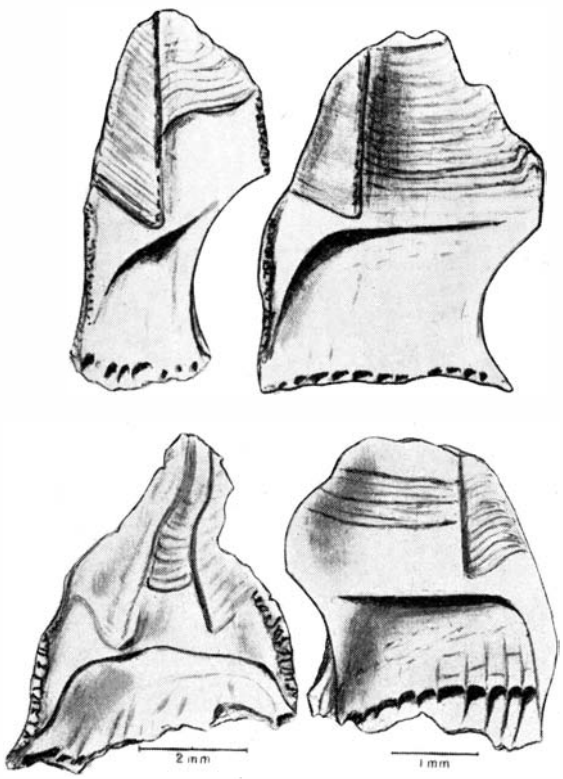

Fig. 3. Some compartments of *Balanus balanoides* (L.) Above: Carinolaterale (left) and Laterale of a specimen from Kapp Martin. × 17. Coll. Nr. 162. — Below, left: Rostrum of a specimen from Kapp Linné. Coll. Nr. 151. Below right: Lataerale of another specimen from Kapp Linne. Coll. Nr. 150. Author del.

irregularly rounded, or regular square tubes. All transitions are found. They intermingle in the different localities, and even within the same specimen. Often the lateralia have developed regular tubes, whereas the carino-lateralia and rostrum of the same specimen have only narrow pores.

In Spitsbergen specimens I have never observed the corrosion of the outer lamina elsewhere so common, and therefore neither the longitudinal tubes nor their transverse septa can be observed externally. On the inner surface of the plates, however, the septa in many specimens appear as dark lines shining faintly through the thin inner lamina.

In some specimens the parietal tubes are closed along the entire basal edge (Pl. VIII, fig. 2), or only along some parts of it.

Most specimens with secondarily solid parietes occurred at Brandalpynten.

These features of *Balanus balanoides* in Spitsbergen deviate to some degree from those of Norwegian specimens. According to Broch (1924, pp. 84—87) Norwegian specimens generally have solid compartments, the parietal tubes secondarily being filled up. He regards this as a significant feature which, in many cases, distinguishes this species from *B. crenatus*. Broch points to this (l. c. p. 71) as being especially important in Pleistocene geology when isolated compartments or frag-

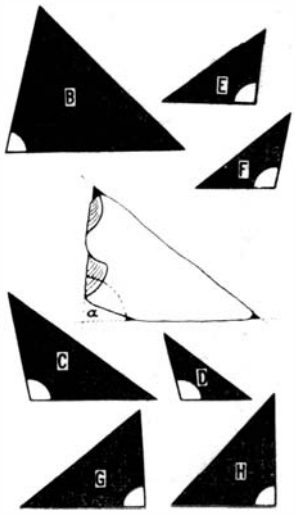

Fig. 4.

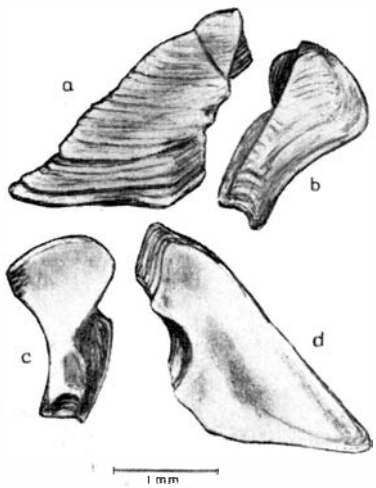

Fig. 5.

Fig. 4. Circumscribed scutal triangles showing differences in the basai-tergal angles. A and B scuta from a Norwegian specimen (A: Broch, 1924, Pl. III fig. 17 d. B· Broch, 1924, Pl. III fig. 17 c). C and D, Spitsbergen specimens (C from Brandalpynten, D from Russekeila). E and F specimens from Nahant, Massachusetts (E: Pilsbry, 1916, Pl. 45, fig. 2 a, F: Pl. 45, fig 1 a). G from a specimen from New Haven, Connecticut (Pilsbry, l.c. Pl. 44, fig. 5 a). H from a specimen of *B. balanoides calcaratus* Pilsbry, 1916 (Pilsbry, l. c. Pl. 45, fig. 3 a).

Fig. 5. Two Opercular valves of a specimen of *B. balanoides* from Kapp Linné, coll. July 28th 1950 (Nr. 75).

a. Scutum, external view, b. tergum, external view, c and d internal view of the same valves (author del).

ments of compartments, require specific identification. The character should, however, be of dubious value in Spitsbergen. — Only from one of his 17 Norwegian localities, viz. Jeitingen, does Broch (l. c. p. 87) mention some specimens with open parietal tubes.

With respect to the presence of well-developed regular tubes most of the Spitsbergen specimens resemble Darwin's variety "a".

There is a remarkable difference in the shape of the scuta of Spitsbergen specimens as compared with the scuta of the Norwegian specimen figured by Broch (1924, Pl. III, figs. 17c, d). This difference is most plainly seen when the scutum is circumscribed by a triangle (fig. 4). The angle between the basal and tergal line in this triangle seems to be larger in the Spitsbergen specimens than in the specimen figured by Broch. This basi-tergal angle is in all observed scuta of Spitsbergen specimens larger than 90° (360 grading), in most of them even more than 100°. Two specimens from Russekeila have basi-tergal angles measuring 101° and 109° (fig. 4d), and a scutum from Brandalpynten has $\alpha = 101°$

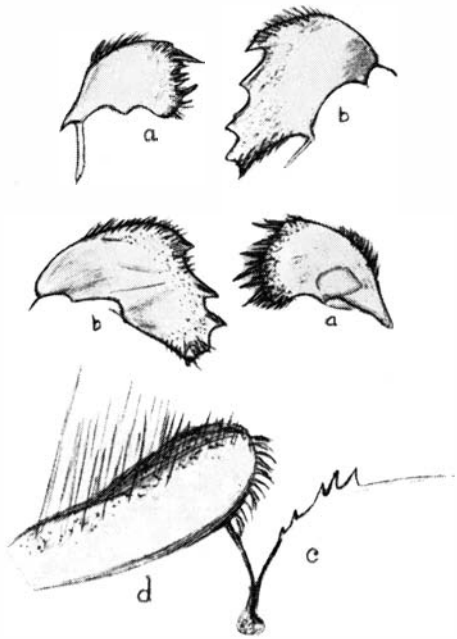

Fig. 6. *Balanus balanoides* (L.) from Spitsbergen. a. Maxillæ. b. Mandibles. c. Labrum. d. Palpus.

(fig. 4c). In the two scuta of *B. balanoides* figured by Broch the basi-tergal angles are approx. 85° and 76° (fig. 4a, b). When scuta from Spitsbergen specimens are compared with the scuta figured by Pilsbry (1916, Pl. 44—45) it appears that they resemble Pilsbry's figs. 1a and 1b Pl. 45, more than any others of his figures (fig. 4f). Pilsbry's figs. 1a and 1b (Pl. 45) represent the two scuta of a specimen of the "var. (a)" from Nahant, Massachusetts. Taken together the figures of scuta in the literature (*e. g.* Darwin, Pilsbry, Broch) display a great variation in this character, the taxonomic value of which cannot be judged at present.

The tergum is usually narrow with a very strong triangular articular ridge, and with the inflection of the scutal margin remarkably deep and broad. In the present Spitsbergen specimens the spur is generally pointed and more or less narrow (Pl.V and VI). It is very seldom rounded to a degree comparable with the spur of *B. crenatus*. In some specimens from Brandalpynten (Pl. V, b) the tergum has a decidedly narrow, tapering, and rather long spur recalling *B. balanoides calcaratus* Pilsbry, 1916 (Pl. 45, figs. 3 and 4b). In other specimens from the same locality, the spur is of a more ordinary shape, shorter and broader. On the whole, all transitions in shape of the tergal spur may be traced among Spitsbergen specimens of *B. balanoides,* although a really rounded spur is very seldom. Crests for the depressor muscle are well developed in all specimens (Pl. V, m).

Labrum usually has a variable number of teeth on each side of the central notch. A specimen from Brandalpynten had 5 teeth on each side, those nearest to the central notch being the smallest (fig. 6c). Mandibles with the fourth teeth small, or even rudimentary (fig. 6 b). In a specimen from Brandalpynten one mandible shows a slight bifurcation of the third tooth (fig. 6b upper right), another specimen had quite ordinary mandibles. Broch (1924, p. 86) mentions that in some Norwegian specimens the second tooth shows a tendency towards bifurcation. Maxillae with about 8 larger spines and numerous smaller ones.

The cirri do not seem to differ from those of *B. balanoides* from other regions. The sixth cirrus of a specimen from Brandalpynten had 30 segments, each segment supporting six pairs of distinct spines, in some segments only five pairs could be observed, and in some others there was an extra pair of very tiny spines, these segments thus carrying seven pairs. This same specimen, which generally had six pairs of spines on each segment of the sixth cirrus, had terga with rather narrow and tapering spurs.

Discussion.

In many respects the specimens of *Balanus balanoides* from Spitsbergen approach more the var. *(a)* Darwin, 1854, than the ordinary type, owing to the general shape of the tergal spur, which is pointed and only very seldom rounded. Furthermore, the existence of regular, open parietal tubes, and to some extent the outline of the scuta coincide with var. (a). Nearly all transitions, however, in these characters from one extreme to another, seem to exist among the specimens from Spitsbergen. The var. (a) is characterized also by numerous segments on the sixth cirrus, and especially in the great numbers of spines on each segment — usually 7 or 8 pairs. This character too is variable in Spitsbergen specimens, and does not seem necessarily to be associated with terga having long, narrow, and pointed spurs.

Some specimens, especially some of those from Brandalpynten, show affinities to the subspecies *Balanus balanoides calcaratus* Pilsbry, 1916. These affinities are most plainly observed in the opercular valves Pl. V, figs. a, b, c); the extremely narrow spur of the tergum especially points towards this subspecies. This character, however, varies greatly in specimens from this same locality.

Summing up the characters found in specimens of *Balanus balanoides* from Spitsbergen it should, in spite of the variability, be emphasized that 1) clearly elongated forms have been observed only in one locality, 2) regular, open parietal tubes are commonly met with, 3) the spur of the tergum is generally more or less pointed, and 4) the basitergal angle of the scutum is usually obtuse, generally about 100° (360-graduation).

RELATION TO ENVIRONMENTAL CONDITIONS

Relation to substratum and tide.

The populations of *Balanus balanoides* in Spitsbergen are poor. I have nowhere observed in Spitsbergen waters the continuous white lining of the littoral of rocky coasts so commonly met with in more southerly regions. The occurrence of *B. balanoides* in Spitsbergen is almost exclusively associated with cracks and grooves in the substratum. Thus the rock within the littoral of a coast in Spitsbergen may appear to be quite devoid of *B. balanoides* when observed at a distance of some few meters, a closer examination, however, usually reveals small assemblies in fissures and depressions. In such places the animal seems to grow under good conditions, well protected against heavy waves and drifting ice. The frequency of individuals along a coast in Spitsbergen is therefore closely related to the frequency of suitable clefts and depressions in the littoral of the rock surface.

It seems as if cypris larvæ of *B. balanoides* are provided with the ability to select the most suitable place for settling, as also juvenile individuals evidently occur exclusively in more protected spots. The explanation, however, may be that the young balanids which may have settled on more exposed parts of the rock had already vanished before observations were made in the locality. On the other hand, Vischer (1928, p. 330) has described how the cypris larvæ move about the surface on which they are going to settle, apparently testing it until they find a suitable place. (For further account regarding this question the reader is referred to Vischer, 1928; Vischer and Luce, 1928; Neu, 1933, Moore, 1935 b; Fischer—Piette, 1932, and Schäfer, 1952).

Specimens growing on more or less subvertical substratum are usually orientated with the carinas upwards and the rostra downwards. This orientation is most probably caused by the light conditions; the carina and terga being turned towards the light (Cf. Schwarz, 1932, p. 438). This orientation was very distinct at Brandalpynten and at Kapp Martin. Moore (1935 b, p. 295) has described how barnacles, if there is a continuous flow of water over the surface of attachment, tend to attach themselves with their axis along the direction of the current, and that barnacles which have settled closely along cracks and grooves in the rocks are frequently orientated with their long axis along the

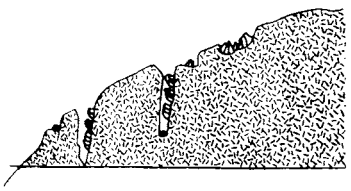

Fig. 7. *Balanus balanoides* in Spitsbergen keeps to cracks and grooves in the substratum. Schematic section from Brandalpynten, Ny Ålesund, at low water tide. August 15th 1950.

groove. Such orientations probably occur with *B. balanoides* also in Spitsbergen, but they have not been noticed.

Balanus balanoides seems to prefer harder rocks as supporting substratum. All specimens from Spitsbergen were collected from hard rocks, and no individual was observed growing on looser shales or rocks easily affected by weathering. Moore (1939, p. 531) points out that only harder rocks form substrata suitable for barnacles. (For details about substrata for the Spitsbergen samples see p. 39 and following.) *B. balanoides* furthermore requires a rigid substratum, *i. e.* it is usually found on bedrock, or on blocks and boulders large enough to withstand the forces of waves and currents without being set in motion.[1]

Balanus balanoides in Spitsbergen generally occurs about mid-tide level. Only in a few localities it was observed up to high-water level, but on the whole its upper limit seems to be decidedly lower than in more southerly localities. Its lower limit is low-water mark. It was never observed below that level.

Distribution within the fjords.

Balanus balanoides penetrates far into the fjords of Vestspitsbergen, but it does not occur close to the glaciers at the heads of the fjords. In general the innermost parts of the fjords do not seem to be populated by this species. The limiting factor is most likely the suspended minerogenic mud, probably in connection with low salinity.

Observations made in Isfjorden in July 1901 by Johan Hjort, and quoted by Nansen (1912, p. 56), show decreasing salinity on the surface towards the inner end of the fjord.[2] This decrease in salinity, at least during summer months, is closely related to the glaciers which are

[1] On the shore in Grønfjorden specimens were found growing on a stone of diabase lying loosely on the shore and being of quite a moderate size. This locality was very sheltered.

[2] The conditions found in Lilliehöökfjord (in Krossfjorden) are not normal. Nansen (1920, p. 256) mentions that strong north winds, which had blown for several successive days, might partly have swept the surface layer out of the fjord (Lilliehöökfjorden extends N—S).

usually found at the heads of the fjords. Just outside the glaciers, and also at the river mouths, the surface layer may sometimes be nearly fresh, and is very often brackish (Cf. Nansen, 1922, p. 30). This surface layer is usually rather thin (a few centimetres) and it is generally saturated with mud. This mud is composed of clayey material, partly in collodial suspension, washed out of the glacial moraines by melt-water. The mud seems to remain in the melt-water for a long time while this is floating out from the glacier. Due to its lower density, the melt-water keeps to the surface and does not mingle easily with the water of the fjord. Thus in such places, the surface layer forms an opaque, light cover over the dark fjord water, this latter appearing when an oar or a boat's propeller, for a moment splits the cover. These conditions are so conspicuous that they may easily be observed at a long distance from a plane (Pl. IX). The border between the mud-bearing melt-water and the water of the fjord may appear remarkably well defined.

It is certain that this mud is more active as a limiting factor, regarding the distribution of *B. balanoides,* than the low salinity.

It is an often quoted opinion that *B. balanoides* is unable to withstand low salinities (*i. a.* Schaper, 1922; Broch, 1924; Prennant and Teissier, 1929). Fischer—Piette (1929), however, found it at la Rance in water with a salinity as low as 0,45 ‰ (see p. 16). Generally, however, it prefers the rather high salinities of the open coasts.

Balanus balanoides, like other barnacles, can close its aperture and so protect itself from a temporary lowering of the salinity of the surrounding water (Cf. Moore, 1939, p. 530). If low salinity is a more permanent condition, but associated with a rather thin surface layer of the water, as is the case in the inner fjord regions, the animal will suffer least from the harmful effect of this surface water by settling in the lower part of the tidal zone. In this position the animal spends the greater part of the time in water with a comparatively high salinity. About low-water tide, when reached by the disadvantageous surface layer, the animal can close its aperture. *B. balanoides* should therefore be able to spread to the innermost parts of the Spitsbergen fjords and maintain its population there. Since, however, it is generally absent from those parts of the fjords, the most likely limiting factor is the mud.

Most of the mud is continuously deposited at the bottom of the fjord from the glaciers front and some thousand meters outwards. Some of the mud, however, settles within the tidal zone. Due to the motion of the water the deposition of mud in this zone is, in general, scanty but a small amount of clay particles adheres to stones and rock surfaces on the beach, enough to form a coating of the substratum rendering it impossible for the cypris larvæ to settle on it. The larvæ of *B. balanoides* usually require a clean substratum for attachment.

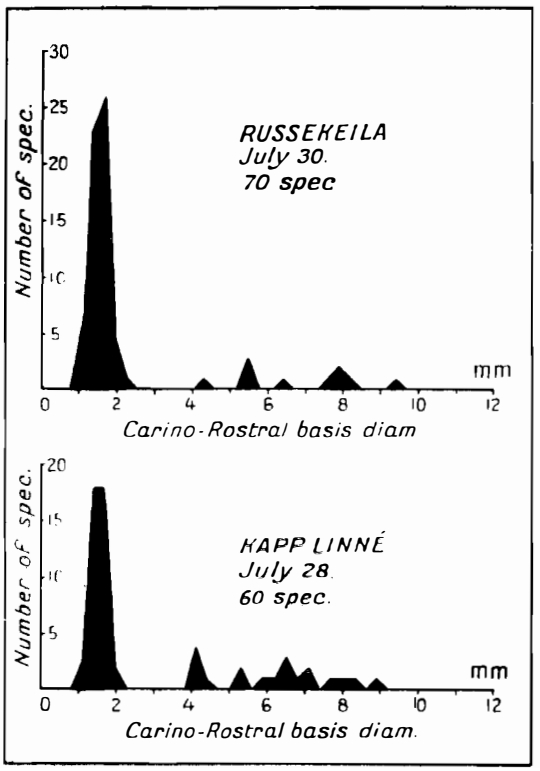

Fig. 8.
Size distribution diagrams for specimens of *Balanus balanoides* in Spitsbergen, 1950.

Such a coating of the beach material is most likely formed during the summer months when the flow of melt-water from the glaciers is considerable. In favourable years, when the larvæ of *B. balanoides* settle rather early in the summer, they will find the mud content of the water lower than it is later in the summer, and this may account for some discoveries of the barnacle in rather muddy water.

Specimens of *B. balanoides* observed in Adventfjorden in 1948, at the quay of Longyearbyen, were growing in fairly muddy water. They were few and scattered. Neither in the summer of 1950 nor in 1952 the species was observed in this locality. On the north side of Coraholmen (Cora Island) in Ekmanfjorden, *B. balanoides* was thoroughly searched for but in vain; the water was very muddy there and the beach very slippery.

Length of life.

From measurements of carino-rostral basal diameters of specimens from Spitsbergen and from the general appearance of the colonies, it seems evident that *Balanus balanoides* in Spitsbergen is, at least biennial.

Measurements have been made from the different collecting localities. In many specimens both diameter and height have been measured

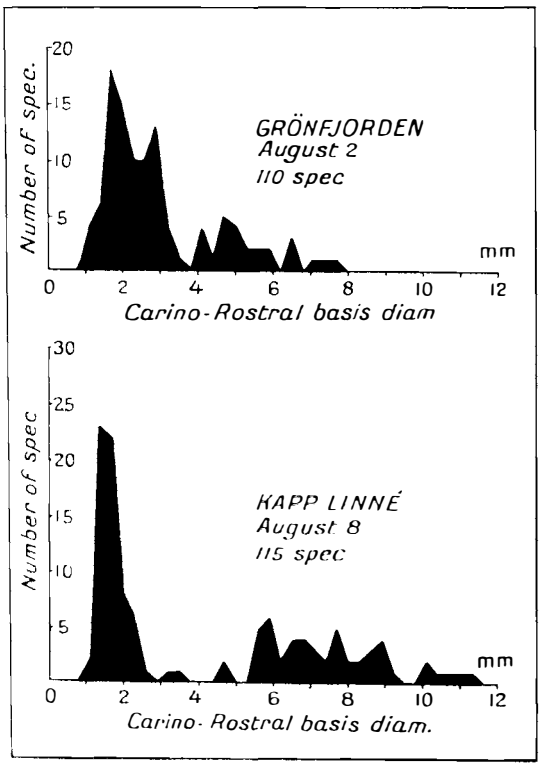

Fig. 9.
Size distribution diagrams for specimens of *Balanus balanoides* in Spitsbergen, 1950.

but, as the height is to a certain degree dependant on the character of the substratum (Cf. p. 19), the carino-rostral basal diameter has been taken as representative of the size of the barnacle, as *i. a.* by Runnström (1925, p. 37). Volumes have not been calculated (Cf. Moore, 1934, pp. 852—861). The measurements are found in the tables at the end of this paper; the results of the measurements from three localities are also given in the diagrams (figs. 8—9).

The diagrams (from 1950) show two clearly defined groups in each sample: one group containing only small individuals with basal diameters about 1—2 mm, the other consisting of individuals with diameters up to about 11 mm.

The individuals of the first group are the newly-settled spat, animals which attached themselves in the early summer of the same year. Their size and development stage compared with Norwegian specimens indicate an age of approximately one month. They are also easily distinguished from older individuals by their general appearance; their shells are partly translucent due to their being only feebly calcified, and accordingly, also very fragile. Their opercular valves are the primordial ones with only a few lines of growth at their basal parts (fig. 10). Many of these young individuals have as yet only 4 compartments in their wall;

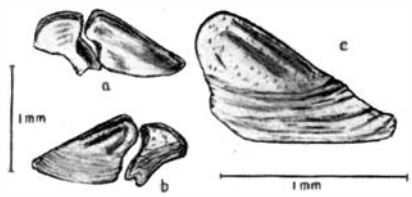

Fig. 10. Pimordial operculars of *Balanus balanoides* from Kapp Linne, coll July 28th. 1950. (Nr. 149). a, tergum and scutum, internal view; b, scutum and tergum, external view; c, scutum, showing newly added lines of growth. Author del.

the carinolateralia not being separated. In the lot from Grønfjorden (collected August 2nd) 20 of the 82 measured young individuals, or 24,4 per cent, had no carinolateralia (Cf. fig 12).

The individuals of the second group are adults, all probably more than one year old, and thus they all have wintered in Spitsbergen. Madsen (1940) has arrived at a parallel result in West Greenland. He found two distinct size groups of *B. balanoides,* and concludes that the species is able to winter on West Greenland coasts.

The barnacles of this second group settled as cypris larvæ probably some 13 months ago, many of them, however, may be older. A subdivision of the adults does not show clearly up in the diagrams.

Thus it seems evident that *B. balanoides* in Spitsbergen has a span of life of at least one year, *i. e.* this species is at any rate able to survive one winter in Spitsbergen, most probably more.

Runnström (1925) found that the span of life of the species at Herdla in Norway is generally two years and that some specimens may attain an age of a little more than three years. Moore (1934, p. 857) states that at Port Erin, Isle of Man, *B. balanoides* can live for more than six years.

Balanus balanoides in relation to the ice-foot.

Neither from Spitsbergen nor from Greenland are any direct observations available concerning the wintering conditions of littoral marine animals, but it is at once clear that the ice-foot probably represents the most decisive ecological factor for these animals during the wintertime.

Observations from Europe (Cf. Madsen, 1936, p. 50, who refers to Aurivillius, 1895, Blegvad, 1929, and Gurjanova, Sachs, and Uschakov, 1930), show that mobile species spend the winter in the sublittoral. Similar conditions prevail in the southern parts of East Greenland, where *Littorina saxatilis groenlandica* Menke, 1842, were taken at depths of 3—5 fathoms and 6—30 fathoms respectively immediately before the winter, and at the end of it (Madsen, l. c.). Such is, no doubt, the behaviour of *Littorina saxatilis groenlandica* (which occurred together with *B. balanoides* at most localities) also in Spitsbergen.

B. balanoides is not able to move, after having once settled. Concerning its fate in high latitudes during the winter, Madsen (l. c. p. 51) writes: "*Balanus balanoides* has no possibility of passing into the sublittoral zone, but is decidedly and exclusively associated with the tidal zone, so that there is hardly any doubt that it is frozen up in the ice-foot in the winter. But is *Balanus balanoides* on the east coast (and on the west coast) of Greenland annual or biennial?" —

In the previous chapter it has been pointed out that *B. balanoides* in Spitsbergen is at least biennial. This is also the case in the localities in Greenland discussed by Madsen (1940, pp. 15—16). For these reasons the following account of the ice-foot (Cf. Feyling-Hanssen, 1953) may contribute to the understanding of the influence of this phenomenon on *B. balanoides*.[1]

A definition of the term is given *i. a.* by Bentham (1937, p. 328): "The ice-foot is that part of the sea-ice which is frozen to the shore and is therefore unaffected by tidal movements. It is separated from the sea-ice proper which moves up and down with the tide, by the tidal crack." Bentham (l. c. pp. 328—29) states that the following two conditions are essential to the formation of an ice-foot: sufficiently low temperatures and a considerable difference in the level of the high- and low-tide marks. When the water under such conditions, recedes at ebb, "the cliffs or shore become covered with a layer of ice. This process is repeated at every tide until ultimately a continuous rim of ice is formed all along the coast". — According to this view snow has no part in the formation of the ice-foot. After its formation, however, falling and drifting snow may lodge thereon and by melting and freezing add to its apparent bulk (Cf. MacMillan, 1925, p. 154).

Concerning the influence of an ice-foot on *B. balanoides,* it is important to known something about the the duration of the ice-foot in the regions dealt with. Unfortunately, no observations about the dates of appearance and disappearance of the ice-foot in Svalbard are available in the literature. When summer expeditions enter Spitsbergen waters at the end of June or the beginning of July, they usually find

[1] Few direct observations, and hardly any systematic measurements concerning the ice-foot are available. This despite the fact that nearly every arctic expedition has given some record of the phenomenon. Most of these brief records are from West Greenland and adjacent areas of Arctic America due to so many sledge journeys in these regions at some time or another having been forced to keep to the ice-foot as the only possible way for further progress with the sledges. Such notes are found *i. a.* in Bentham (1937, Appendix III in Schackleton, 1937, pp. 328—332), Koch (1927, pp. 50, 51, and 1945, p. 20), MacMillan (1925, p. 154), Maurstad (1935, p. 10), Rasmussen (1919, p. 183), Shackleton (1937, for pages see his index). Papers by Smith (1931, and also 1932), Transehe (1928), and Zukriegel (1935) contain comprehensive information about the literature regarding sea-ice.

remnants of the ice-foot in different places. On sand- and gravel beaches the ice-foot remains more or less buried in the beach material. In 1950 such remnants were observed in the shore gravel at Russekeila (outer part of Isfjorden) as late as the beginning of August.[1] On rocky coasts remnants of the ice-foot are found as a more or less fragmentary ledge clinging to the cliff with its even under surface rather high above high-water level. In favourable localities, as for instance, fjords protected from heavy seas, the ice-foot does not fully disappear before the middle of July. But long before that date the ice-foot has ceased to affect the life functions of *B. balanoides* (see below).

From Northwest Greenland Bentham (1937, pp. 328 and 332) mentions that at Eath (78° 19′ N. lat.) the ice-foot begins to form at the end of September or at the beginning of October and has attained its maximum development by December. Furthermore, he writes that the ice-foot at that same locality remains unchanged, "apart from a slight increase in height due to snow being converted into ice, until the middle of June". Bentham (l. c.) presumes that the decisive factor determining the date at which the ice-foot disappears is the presence or absence of sea-ice.

Although the latitude of Etah is about the same as that of the Isfjord area in Vestspitsbergen, the climatic conditions of Vestspitsbergen are decidedly more favourable than those of West Greenland at the corresponding latitude. The northernmost branch of the Gulf Stream sweeps the western coast of Spitsbergen, whereas the cold Polar Current runs south through Kane Basin and Smith Sound at the northern coasts of West Greenland.

Steenstrup (1907) has presented some photographs of the ice-foot at Egedesminde, Southwest Greenland (approx. 60° 40′ N. lat.), showing that it was still under formation there as late as December 22nd, and that it had been dissolved up to high-water level by May 13th. (Cf. Feyling-Hanssen, 1953.)

These conditions are probably more in keeping with those in Spitsbergen. In 1950 the ice-foot at Kapp Linné did not begin to form until the beginning of December (telegraphic information from the chief operator, L. Bye, at Isfjord Radio). There was no continuous ice-cover in Isfjorden that winter, but sometimes the fjord was entirely blocked by drift ice. In general it is assumed that the ice-foot in the Isfjord area forms about November and breaks down about May. The dates of formation and disappearance are, no doubt, subject to great variations.

Concerning the relation of *Balanus balanoides* to the ice-foot another question is even more important than the duration of the ice-foot,

[1] This kind of an ice-foot is described from Graham Land by Joyce, 1950, pp. 646—49.

namely: How far down does the under surface of the ice-foot reach? — According to its mode of formation, the ice-foot should cover the shore from high-water level down to low-water level. This may be the case during the coldest parts of the winter in localities which are not exposed to frequent heavy seas and where therefore the sea-ice is not so often broken up and swept away. During the greater part of the winter in Spitsbergen, however, it must be assumed that the under surface of the ice-foot does not reach low-water level.

Engell (1910, p. 194) stated that the ice-foot begins to form before any sea-ice is formed (observations made at Ritenbenk, West Greenland, 69° 44′ N. lat.). It starts as a thin congealed cover on the shore when the water recedes at ebb tide, and when the water again rises the lower part of this cover is dissolved. In this way the ice-foot will grow faster in its upper parts than in its lower. Steenstrup (1907, p. 7) favours the opinion that the ice-foot does not have any destructive effect on the *Fucus* vegetation, because the ice-foot is, in general, attached to the cliff *above* the upper limit of this vegetation.

Considering these conditions it seems reasonable to assume that, the under surface of the ice-foot, within the Spitsbergen waters dealt with here, is situated about high-water level during the greater part of the winter. In a telegram from Isfjord Radio, Kapp Linné, March 3rd, 1951, the chief operator, Bye, reported that the under surface of the ice-foot in that locality and on that date was situated at mid-tide level. This was the deepest position of the under surface of the ice-foot at Kapp Linné that winter.

The disintegrating power of the ice-foot does not necessarily affect bodies frozen in the ice-foot at its basis. Engell (1910, p. 195) in Jakobshavn, Greenland, observed that *Fucus* which was frozen in the ice-foot, was entirely freed from is, without loosing a single flap, when it melted away. The dark body of the plant absorbs heat, and water is formed around it. Engell (l. c. p. 194) further reports, that he has never observed that the ice-foot was broken off from the rock; but he often noticed that the outer edge of it was broken off. He concludes that the ice-foot has probably no destructive effect on the algæ vegetation within the tidal zone.[1]

[1] This does not cantradict the erosive power of the ice-foot by frost-wedging, A body *e. g.* a plant of *Fucus* or a barnacle, which is frozen in the ice-foot will be subjected to pressure caused by the expansion of the surrounding water by freezing. This outer pressure, however, is counterbalanced by the freezing of the liquid within the plant or the water contained in the barnacle. A bottle filled with water will burst when the water freezes in it. But if the filled bottle is immersed in water and then exposed to frost so that the water freezes both inside and outside the bottle, the destruction will generally not take place.

Thus, the ice-foot most probably does not in general affect the lower part of the tidal zone during any considerable part of the winter. For shorter periods, however, the tidal zone may be frozen up in its entire vertical extension.

The bathymetrical habitat of *Balanus balanoides,* its occurrence within the tidal zone in connection with its wide distribution shows that, it is very resistant to adverse external conditions.

B. balanoides has to endure a periodical stay on dry land as it is generally exposed with every receding tide. That the animal is able to avoid dessication for some shorter time is explained because a small amount of water is kept within the pallial cavity of the animal when the operculum is shut. But Runnström (1925, pp. 14—15) has shown that larvæ (within the mantle cavity) and adults were still alive when returned to the water after at least one months stay on land. When removed from the sea the shells keep closely shut, so that the water can remain within it for a long time. But it is very remarkable that the animal within can live in such a small amount of water for more than one month. Runnström (l.c.) says that the consumption of oxygen during this period must be very small. Uschakov (1925) supposes that this species spends the winter in an anabiotic condition on the Murman coast. This contributes to the explanation of its adaptability to dessication as well as to frost. Under extreme conditions the life functions of *B. balanoides* are most likely in a latent state.

Aurivillius (1895, 1898) has shown that *B. balanoides* can endure severe frost on the southwestern coast of Sweden. On the 21st of January, when the ice had begun to form in some places, specimens of *B. balanoides,* located above the sea-ice, were investigated. The temperature of the air was — 8° C. All specimens were covered by a layer of ice. The animals inside the shells were frozen and quite stiff. On attempting to open the operculum the adductor muscle offered no resistance and, on the whole, no sign of life could be observed. However, after being placed for some hours in water of a temperature of + 0,5° C, the animals livened up again and shed numerous nauplii (Aurivillius, 1895, pp. 142—43).

On the 20th of February Aurivillius (l. c. p. 143), at approximately the same locality, collected a large number of *B. balanoides,* the greater part of wich were frozen up in spray from the sea and, during four weeks, had been exposed to an air temperature varying between —8° C and —15° C. None of them showed any sign of life. They were taken to the biological station; some specimens were carried dry and exposed to the air, the rest in water of + 0,5° C. The transport lasted 1 hour, and on his return to the station the specimens carried in water had already livened up again and shed thousands of nauplii. The specimens carried in the air livened up when they afterwards were placed in water, but much lesser numbers of nauplii were spawned from these.

These observations show that *B. balanoides* is able to survive freezing perhaps even for a considerable part of the winter.

The risk exists that the animal is scraped off its substratum by the ice. Records of such ice destructions of *B. balanoides* are given *i. a.* by Aurivillius (1895, p. 143) and Broch (1924, p. 113). Aurivillius (l. c.) writes that the destruction is caused by the ice moving up and down with the tides and also due to the ice being pressed towards the beach by winds. Broch (l. c.) reports that the rocks along the beaches at Drøbak, Oslofjorden, were cleaned of *B. balanoides* by the scouring of ice in the early part of 1922. Similar cases are mentioned by Dons (1946, p. 197).

A typical ice-foot is not formed either on the west coast of Sweden or in Oslofjorden. Therefore the beaches in these southern localities are exposed to a casual pressure from the sea-ice and the scouring of moving and drifting ice.

In areas where an ice-foot is present, this ice-foot protects the beaches against attacks from the sea-ice. Terefore the risk of *B. balanoides* being scoured off its substratum is lesser in arctic regions than in boreal ones, where an ice-foot is not formed but where drifting ice may occur more or less by accident. From the areas around Northwest Greenland Shackleton (1937, p. 214) writes: "For some huge boulder-shaped pieces of ice had been piled up here and there on the seaward edge of the ice-foot, an indication of tremendous pressure during the previous open season." (Cf. l. c. p. 175). Steenstrup (1907, p. 7) presumes that the ice-foot has a protecting influence on the *Fucus*-vegetation within the littoral. In the summer, when the ice-foot has perished from the beaches of Spitsbergen, drifting calf-ice from the glaciers may cause some destruction of *B. balanoides,* but the majority of these floats run aground before they can do any harm.

The ice-foot and the drift ice are not so serious factors as it has generally been assumed. Evidently the animal can endure to be frozen in the ice-foot for some time. It can also be protected by the ice-foot from being removed by drift ice, and thus, *B. balanoides* can, after all, survive the winter in Spitsbergen.

When the barncale is frozen, the life functions come to a standstill. If the period, or periods, of freezing are extended, the time left may be too short for the development of the brood. In this way the ice-foot represents a decisive factor in limiting the distribution of the species.

Breeding and reproduction.

The dates of impregnation, hatching, and settling of *Balanus balanoides* in Spitsbergen and other arctic regions depend on the severeness of the winter and also on local conditions. In favourable years the spawning takes place probably about June and the settling about July in the Isfjord

area. In less favourable years the spawning is delayed until the later part of August or later, and if delayed too much there will be no spawning at all. This happens especially when an unfavourable spring is met by a cold autumn with early formation of the ice-foot.

In the summer of 1950 first-year specimens of *B. balanoides* were observed at several localities at the end of July and beginning of August. At Kapp Linné (78° 3,8′ N. lat.) newly settled spat was observed July 28th. Only at Brandalpynten, the northernmost locality visited that year, the barnacles contained brood as late as August 15th.

In the summer of 1952 no first-year specimens were observed. Most specimens examined contained brood even at the end of August. At Kapp Linné, the southernmost locality investigated that year, all specimens examined contained brood having not yet reached their first nauplius stage June 28th. August 29th the larvæ had hatched from all specimens examined in this locality. At Biskayerhuken (79° 50,5′ N. lat.) the barnacles were observed during the period of spawning; on August the 20th most of the investigated specimens from this locality contained larvæ in their first nauplius stage, whereas some specimens had shed their larvæ. At Bjørnhamna (79° 38,6′ N. lat.) there was brood in all investigated specimens on July the 8th. On August the 28th, however, some specimens contained larvæ in their first nauplius stage, whereas others had shed their nauplii.[1] These observations show that the larvæ of *B. balanoides* hatch in their first nauplius stage also in Spitsbergen.

Thus, in the year of 1952 the hatching was delayed to the later part of August in the northerly localities, probably it took place somewhat earlier at Kapp Linné. At Birgerbukta (79° 49,2′ N. lat.), which is a sheltered locality, all examined specimens contained brood having not yet reached their first nauplius stage. This being on August 23rd there would probably be no hatching at all that year in this locality. The animals must have been frozen for such a long time during the winter that the development had been much delayed.

Samples of first-year specimens were taken at four localities in the summer of 1950. In the following table three of these localities are given[2] together with date of collecting, number of young barnacles in the sample, mean basal diameter, and the extremes.

In fig. 11 these mean diameters have been plotted together with the measurements presented by Dons (1946, p. 198) and also two of the mean values given by Runnström (1925, pp. 37 38). The points

[1] Bjørnhamna is a very sheltered locality where an ice-foot can remain for a longer time than at Biskayerhuken which is an exposed point on the north coast.

[2] Grønfjorden has not been considered, because the animals there that settled on a rather small stone lying loose on the beach, thus constituting a substratum somewhat different to that generally met with.

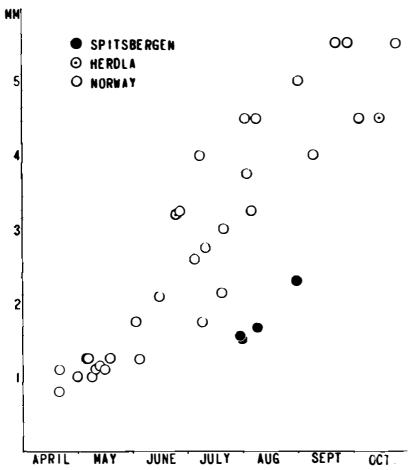

Fig. 11. The size of first-year specimens of *Balanus balanoides* from Spitsbergen compared with the size of first-year specimens from Norway (cf. text).

Locality	Date	Mean diam.	Smallest	Greatest	Number
Kapp Linné	VII. 28.	1.53 mm	1.2	2.0	41
Russekeila	VII. 30.	1.57 »	1.1	2.3	59
Kapp Linné	VIII. 8.	1.68 »	1.2	2.5	61
Kapp Martin	VIII. 31.	2.33 »	1.8	3.2	9

representing the diameters of the Spitsbergen specimens fall to the right of the diagram, indicating that they are smaller than specimens from Norway measured at about the same dates.

The intepretation of this might be that specimens from Spitsbergen, on the whole, are smaller than Norwegian ones and that they never attain the size of Norwegian specimens. The greatest Spitsbergen specimen, however, had a carino-rostral basal diameter of 16,1 mm (Biskayerhuken August 20th, 1952), whereas the two greatest animals measured by Runnstrøm (Herdla, April 4th) had diameters of 14 mm. At Port Erin *B. balanoides* at the end of its second year attains a length of 8,1 mm (B 3-group) and at St. Malo 5,5 mm (Moore, 1934, p. 857). On the other hand, Dons (l. c. p. 199) gives a maximum size for Norwegian specimens 22 mm (measured at Storfosen, approx. 63°40′ N. lat.). The largest specimens collected by the Godthaab expedition at Egedesminde (August 10th, 1928) measured 23 and 24 mm (Madsen, 1940, p. 15), and Vanhöffen (1897, p. 210) gives the size of 23 mm for specimens from the Umanak area. These lager individuals are growing in more favourable places and are probably several years old (Madsen, l. c.). There is little reason to believe that Spitsbergen specimens of *B. balanoides* are smaller than corresponding specimens from other regions.

Therefore, as the first-year specimens from Spitsbergen are smaller than first-year specimens from Norway, measured at about the same

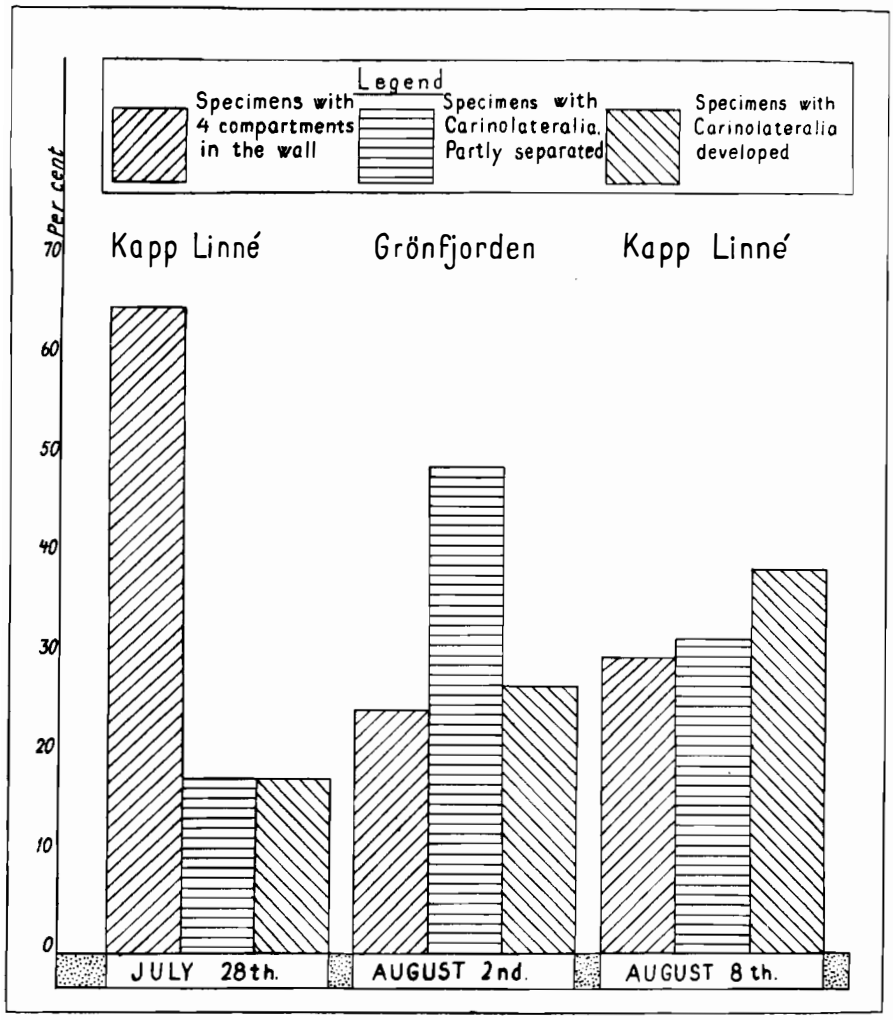

Fig. 12 The separation of carinolateralia in some specimens of *Balanus balanoides* collected from three localities in Spitsbergen, 1950.

dates, this, as we have seen, makes it resonable to assume that the Spitsbergen specimens settle later in the spring, than specimens from Norway. In addition the rate of growth is probably higher in Norwegian localities.

In Spitsbergen there was a frequent occurrence of young specimens with only 4 compartments in the wall (1950). Hitherto there has never been recorded in Norway finds of *B. balanoides* which had not developed carinolateralia at the end of July or beginning of August.

In the summer of 1950 ripening gonads were observed in all adult specimens collected at Kapp Martin on August 31st. The ovaries seemed already to be mature. The penis had reached a high degree of extension with spiral structure (Pl. VIII, fig. 1). The vesiculæ seminales were

large and swollen and the testicular cæcæ seemed already to be full of sperm. First-year specimens showed no trace of gonads.

It seems reasonable to assume that in this locality in Vestspitsbergen impregnation would take place earlier than in localities in lower latitudes, probably already in September.

In the summer of 1952 ripening gonads were observed in several localities, but not in such an advanced stage of maturity as at Kapp Martin 1950. At Biskayerhuken an extended penis was seen in one specimen on August the 20th. At Bjørnhamna several specimens had their penis extended, even if the specimens still contained nauplii. At Kapp Linné the animals had extended penis and slightly swollen ovaries.

Madsen (1940, p. 15) supposes that *B. balanoides* in the southern part of West Greenland is sexually ripe in August, "since in this month the penis is well developed, whereas this is not the case in July and September, judging from the somewhat sparse material in the Zoological Museum" (Copenhagen). Runnström (1952, p. 5) states that impregnation at Herdla in Norway takes place about the end of October or the begynning of November. Moore (1935, p. 269) found that at Port Erin, Isle of Man, shedding of the ova and impregnation take place in November. At den Helder in the Netherlands Hoek (1876) found the first impregnated eggs in the pallial cavity of *B. balanoides* by the middle of November (Cf. Delsman, 1917).

LOCALITIES

Kapp Martin (77° 43,2′ N. lat. 13° 57′ E. long.) *B. balanoides* observed and collected on August 31st, 1950. Substratum: Pressed conglomerat of the Heklahuk formation. The locality is the point north of the entrance to Bellsund. It is exposed to the open sea. All specimens were growing in cracks. Three generations were probably distinguishable (Pl. II). The first-year specimens were rather large. 45 specimens were measured. Largest individual: D = 11.4 mm, H = 5.8 mm. Smallest: D = 1.8 mm, H = 1 mm. The gonads of the second-year and older, specimens were in an advanced stage of development. The water was clear.

Kapp Linné (78° 3,8′ N. lat. 13° 38′ E. long.) *B. balanoides* observed on July 5th, 1948; observed and collected on July 28th and August 8th, 1950; observed and collected on June 28th and August 29th, 1952. Substratum: Mica-schist of the Heklahuk formation. The locality is the point on the south side of the entrance to Isfjorden. It is exposed to the open sea. The samples were taken close to the small quay in the bay Ranviken, thus being a somewhat sheltered place. The species was observed also beneath the light house and on rocks on the west side of the point. The barnacles were quite frequent, especially in the bay. They were growing in rather crowded patches between the tides. Numerous specimens of *Littorina saxatilis groenlandica* occurred together with the barnacles.[1] The water was clear.

In the year of 1950 175 specimens of *B. balanoides* were measured (p. 48, 50; figs. 8—9), the greater part of these were first-year specimens (collected at the end of July and beginning of August). In 1952 662 specimens of the samples taken at the end of June, were measured (fig. 13). No subdivision in first-year specimens and adults shows up in the diagram, and a closer examination revealed that the specimens contained brood having not yet reached their first nauplius stage. All specimens

[1] Elmhirst (1922) states that in the upper levels the newly settled barnacles are eaten by *Littorina saxatilis* (= *L. rudis*). Moore (1935 b) could not verify this (Cf. also p. 43 of the present paper).

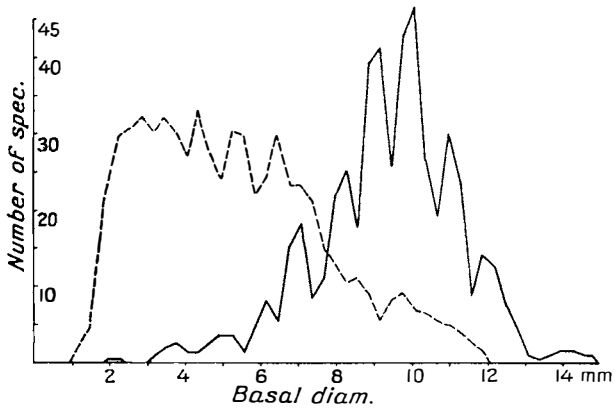

Fig. 13. Size distribution of 500 specimens of *Balanus balanoides* from Bjørnhamna (—) measured on July 8th—10th, 1952, and of 662 specimens from Kapp Linné (- - - -) measured on June 28th, 1952.

collected on August 29th had shed their nauplii. They had now ripening gonads, the extended penis with spiral structure being easily observable.

The largest measured specimen from Kapp Linné had a carino-rostral basal diameter of 11.9 mm. Some specimens of the lot from August 8th 1950, are reprodused on Pl. I.

Russekeila (78° 5,2′ N. lat. 13° 46′ E. long.) *B. balanoides* observed and collected on July 30th, 1950. Substratum: Carboniferous sandstone. The locality is an exposed point just northeast of the outlet of the river from Linnévatnet (Lake Linné) on the south side of the Isfjord gap. The animals were few and concentrated only in cracks and narrow grooves about mid-tide level. 70 specimens were measured of which first-year individuals made up a large per cent (Cf. fig. 8 and p. 48). The largest specimen had a diameter of 9.5 mm, with a height of 7.6 mm. The water was clear.

Grønfjorden (78° 0,5′ N. lat. 14° 12′ E. long.) *B. balanoides* observed and collected on August 2nd, 1950. Substratum: Diabase. The locality is situated on the west side of Grønnfjorden on the northern beach of a delta, rather far into the fjord, and is therefore sheltered. The barnacles were found on a few stones on the beach about mid-tide level. One of these stones, a block of diabase measuring 17×8×6 cm (Pl. IV), was taken. This was one of the bigger stones.

The species was thoroughly searched for also on the rock wall north of the delta, but was not observed there, the reason being that the rock consists of a soft shale easily affected by weathering.

120 individuals were growing on the diabase block. Only two were on the upper surface of the stone, about 110 on the vertical side facing the sea, very few on the short sides, and only one on the under surface. All

of them were growing in cracks and grooves on the stone. 110 specimens were measured (Cf. fig. 9, and p. 49). The greatest one had a carino-rostral basal diameter of 7.6 mm, and a height of 3.6 mm. First-year specimens could be distinguished from older ones.

Longyearbyen (78° 13.6′ N. lat. 15° 38.5′ E. long.) *B. balanoides* observed on July 7th, 1948. The locality is sheltered. The barnacles were sparsely represented, most of them growing on stones on the beach close to the quay in muddy water. Some occurred in small patches, but most of them were scattered. They all had a greenish coating of algal vegetation. They were of regular shape and slightly, if at all, folded on the external. Carino-rostral basal diameters from 8 to 10 mm, heights about 4 mm. This locality was visited again in 1950 and also in 1952, but these years *B. balanoides* was not observed.

Vindodden (78° 20,2′ N. lat. 16° 32′ E. long.) *B. balanoides* observed on August 8th, 1948. Substratum: Diabase. The locality is situated at the south side of Sassenfjorden west of Sveltihel and is rather exposed. The barnacles were growing in small but rather crowded patches on larger stones and boulders about mid-tide level and lower. They were white and of irregular shape, mostly flattened; basal diameter 7 to 10 mm, height 2—4 mm.

Sveltihel (78° 20.2′ N. lat. 16° 44′ E. long.) *B. balanoides* observed on July 11th, 1948. Substratum: Spirifer limestone. The locality is on the south side of Sassenfjorden west of the mouth of Sassenelva and is rather exposed. The barnacles were quite numerous, growing in rather crowded patches from above mid-tide level down to low-water level, on bedrock. They were of a dirty-white colour, strongly folded externally. The carino-rostral basal diameter varied from 8 to 11 mm, the height from 5 to 7 mm. The water was quite clear.

Sassen Hut (78° 21.3′ N. lat. 16° 57′ E. long.) *B. balanoides* observed on July 22nd, 1948. Substratum: Limestone. The locality is at the south side of the entrance to Tempelfjorden, east of the mouth of Sassenelva (Sassen River), and is rather sheltered. The barnacles were growing on bedrock, partly scattered, and partly in small crowded patches, prefering fissures and depressions which afford some shelter. Some of them were growing on small stones which stuck in cracks in the bedrock. Carino-rostral basal diameter varying between 11 and 5 mm, height about 4 and 3 mm. The water was somewhat muddy.

Gipshuken (78° 26.5′ N. lat. 16° 24′ E. long.) *B. balanoides* observed on August 8th, 1948. Substratum: Diabase. The locality is the rather straight coast of the inner part of Isfjorden between Anservika (Anser Bay) and Gipsvika. This coast is frequently exposed to heavy seas runing in from the Isfjord gap. The barnacles were quite numerous,

growing in cracks and grooves on the bedrock all along this coast, occurring also above mid-tide level. Different generations were observed. The water was clear.

Kapp Wijk (78° 36.2′ N. lat. 15° 9.5′ E. long.) *B. balanoides* observed on August 26th, 1950. Substratum: Spirifer limestone. The locality is the cape on the west coast of the peninsula between Dicksonfjorden and Billefjorden. The animals were growing between mid- and low-tide level on bedrock at the end of the long sand bar. Some specimens of *Littorina saxatilis groenlandica* were observed together with the barnacles. The locality is sheltered and the water was clear.

Daumannsodden (78° 12.8′ N. lat. 13° 5′ E. long.) *B. balanoides* observed on July 4th, 1948. Substratum not noted, probably a metamorphic rock of the Heklahuk formation. The animals occurred in somewhat crowded patches on bedrock and larger boulders about mid-tide level. The locality is a little bay just east of Daumannsodden at the north side of the entrance to Isfjorden. The water was very clear, but probably much diluted with fresh-water from melting snow and ice. *L. saxatilis groenlandica* occured together with the barnacles.

Sarsbukta, "Balanuspynten" (78° 43.2′ N. lat. 11° 43′ E. long.) *B. balanoides* observed on August 17th, 1950. Substratum: Big quartzite boulder from the Heklahuk formation. The locality is a point midway between the northern lateral moraine of Aavatsmarkbreen and the southern root of Sarstangen. The species was scarce, growing just above low-water level.

Sarsbukta, "Balanusvika" (78° 43.5′ N. lat. 11° 40.1′ E. long.) *B. balanoides* observed on August 21st, 1950. Substratum and growth conditions as in the previous locality.

Brøggerhalvøya II (78° 54.1′ N. lat. 11° 30′ E. long.) *B. balanoides* observed on August 16th, 1950. Substratum: Carboniferous limestone. Locality exposed to Forlandsundet. The species was very sparsely represented.

Kvadehuken (78° 56.2′ N. lat. 11° 22′ E. long.) *B. balanoides* observed on August 16th, 1950. Substratum: Carboniferous limestone. Locality exposed to the open sea, and the species very sparsely represented.

Brøggerhalvøya I (78° 58.2′ N. lat. 11° 33.5′ E. long.) *B. balanoides* observed on August 15th, 1950. Substratum: Carboniferous limestone. The locality is rather exposed, facing Kongsfjorden to the north. The animals were growing in fissures and small cavities, none of them directly on the exposed rock surface. The water was clear.

Brandalpynten (78° 56.4′ N. lat. 11° 54′ E. long.) *B. balanoides* observed and collected on August 15th, 1950. Substratum: Carboniferous limestone. Point north-west of Ny-Ålesund on the south side of Kongsfjorden (Kings Bay). The coast runs NE-SW, facing Kolhamna bay to the south, thus being a sheltered locality. The salinity of the water must be rather low due to the discharge from Bayelva (Bay River) just south of the locality. For the same reason the water was rather muddy.

The specimens were found just beneath the little hunters hut at the south corner of the lagoon. They occured just above low-water level, most of them growing in cracks and grooves. They were large externally strongly folded, or ribbed (Cf. Pl. III and measurements p. 51). All of them carried a brownish coating of algal vegetation. Many specimens had much in common with Darwin's var. (a). First-year specimens were not observed, and all examined animals carried brood. The largest specimen had a carino-rostral basal diameter of 13.6 mm. and a height of 6.3 mm.

Bjørnhamna (79° 38.6′ N. lat. 11° 2′ E. long.) *B. balanoides* observed from the 5th to the 24th of July and on August 28th 1952. Substratum: Foliated granite. Bjørnhamna is a small well sheltered bay on the south side of Sørgattet between the mainland (Reuschhalvøya) and Danskøya. Its rocky shores were richly populated by *B. balanoides* and *L. saxatilis groenlandica*. On July 6th, 8th, and 10th 500 specimens of *B. balanoides* were measured *in situ*. The result is given in fig. 13, p. 40, where, for comparison, the size distribution curve has been drawn within the same diagram as the curve from Kapp Linné (June 28th 1952). The bulk of the specimens from Bjørnhamna were larger than the bulk of the Kapp Linne specimens. The largest specimen measured at Bjørnhamna had a basal diameter of 14.8 mm. The highest specimen measured 9.1 mm.

The barnacles were mostly growing in small clusters in cracks and grooves on the rocks. They were generally associated with a rich *Fucus*-vegetation (Pl. VII, fig. 2). Some clusters made up of older individuals had so thick a cover of some algal vegetation that only the orificium of the specimens were visible.

It was often observed that a specimen of *Littorina saxatilis* had taken up its position within the shell of a *B. balanoides*. On various occasions, when a *Littorina* was removed from the shell of a barnacle there was found remnants of the barnacle's soft parts in the shell. Several times *Littorina* was sitting on the opercular of *Balanus,* generally at the basis of the scuta, apparently forcing the barnacle to open. It seems to be beyond doubt that *Littorina saxatilis* were feeding on *Balanus balano-*

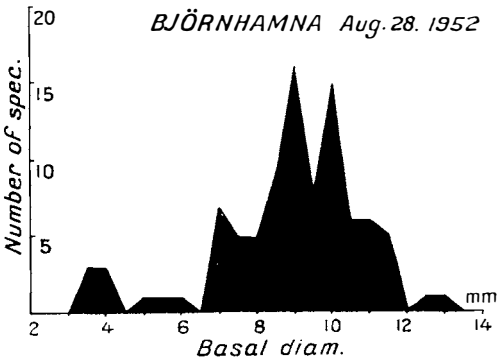

Fig. 14. The size distribution of 89 specimens og *Balanus balanoides* from Bjørnhamna.

ides. Littorina saxatilis, being present in large quantities, seemed to cause considerable waste in the population of *B. balanoides* in this locality. It seemed to be particularly the younger specimens of *Littorina* which were feding on barnacles (cf. p. 39).

The specimens collected on July 8th contained brood. Up to August 28th the locality was repetedly investigated in order to discover first-year specimens, but in vain. On the latter date a part of the investigated specimens contained larvæ in their first nauplius stage whereas others had shed their nauplii. At the end of August all examined specimens had a more or less extended penis.

Some specimens were measured also on August 28th, the measurements will be found at the end of this paper. (Cf. fig. 14).

Moseøya (79° 38.5′ N. lat. 10° 56′ E. long.) *B. balanoides* observed on July 9th, 1952. Substratum: Foliated grantie (strike: NV-SE). The island is found in Sørgattet and the observation was made on its east side. The barnacles were mostly large and numerous, growing together with *Fucus*. The larger specimens were found in cracks and clefts. The animals were most crowded between high-water mark and mean-tide level. They were not growing quite down to low-water mark. There are strong currents running through Sørgattet. No first year specimen was found. Some measurements will be found at the end of the paper.

Kapp Gurnerd (79° 39′ N. lat. 10° 47′ E. long.) *B. balanoides* observed on July 9th, 1952. Substratum: Granite. Kapp Gurnerd is the SE point of Danskøya. The barnacles were growing mostly on the landward side of rocks and larger blocks.

Ekholmpynten (79° 43.6′ N. lat. 10° 54′ E. long.) *B. balanoides* observed on July 20th. Substratum: Gneis. The locality is on the north side of Danskøya west of Virgohamna. There was a rich population of *B. balanoides* on the subvertical rock walls together with *Fucus* and *Littorina saxatilis.*

Virgohamna (79° 43.4′ N. lat. 10° 56′ E. long.) *B. balanoides* observed on July 10th, 1952. Substratum: Granite. Numerous living specimens were present, mostly growing on the landward side of larger granite blocks in the beach. Many larger specimens were dead.

Smeerenburg (79° 44.1′ N. lat. 11° 1′ E. long.) *B. balanoides* observed on July 11th, 1952. Substratum: Foliated granite. The flat of Smeerenburg forms the southeast corner of Amsterdamøya (Amsterdam Island). *B. balanoides* was quite sparsely present on a rock (Pl. VIII, 5) by the third lagoon NE of the beacon (Cf. Chart 510 of Norsk Polarinstitutt). Some measurements were made (p. 53). Many specimens were just dead, operculars and soft parts still remaining. The species was found also west of the beacon.

Fuglefjorden (79° 47.2′ N. lat. 11° 30′ E. long.) *B. balanoides* observed on July 13th and August 25th, 1952. Substratum: Granite. Fuglefjorden (Fowl Bay) is a sheltered locality south of Fugløya. The barnacles were seen on the bedrock of the numerous islets in the fjord.

Birgerbukta (79° 49.2′ N. lat. 11° 36′ E. long.) *B. balanoides* observed on July 13th and 14th, and also on August 23rd, 1952. Substratum: Granite. The locality is situated at the east side of the entrance to Holmiabukta, south of Indre Norskøya. It is a very sheltered bay formed behind an old bar of morainic material. The barnacles were growing quite richly on blocks and boulders of granite, generally on the landward sides and often also on the under surface of blocks, if that was possible (Pl. VII, fig. 1). *Fucus* and *Littorina saxatilis* occurred together with the barnacles. The barnacles were mostly growing between low- and mid-tide level.

On the under surface of some blocks in the northern corner of the bay the *Balanus*-assemblages were crowded, the animals growing in clusters with approximately 200 individuals in each. In these clusters the shell of *B. balanoides* was cylindrical and elongated, (for measurements cf. p. 53). Some specimens were collected on August 23rd. They all contained brood having not yet reached the first nauplius stage. For some reason the development of the brood had been delayed, and, this being late in the autumn in Spitsbergen, there would probably not be any hatching at all that year. No first-year specimen was observed.

Kapp William (79° 49.8′ N. lat. 11° 37′ E. long.) *B. balanoides* observed on July 13th, 1952. Substratum: Granite. The locality is the cape north of Birgerbukta, on the south side of the entrance to Svenskegattet. The species was growing on larger blocks. It was also observed along the coast between Birgerbukta and Kapp William.

Indre Norskøya (79° 50.2′ N. lat. 11° 36′ E. long.) *B. balanoides* observed on July 14th, 1952. Substratum: Granite. The species

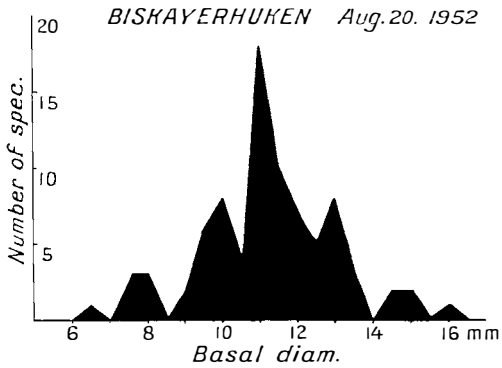

Fig. 15. The size distribution of 82 specimens of *Balanus balanoides* from Biskayerhuken.

was found on blocks and bedrock on the south side of the island. It occurred almost up to high-water mark, and was frequently found on the landward surface of larger blocks, and down between the blocks. No first-year specimen was found. Some measurements were made of specimens *in situ* (Cf. p. 53).

Flathuken (79° 50.6′ N. lat. 11° 50′ E. long.) *B. balanoides* observed on August 24th, 1952. Substratum: Granite. Flathuken is found on the west side of the entrance to Raudfjorden (Red Bay). The barnacles were growing on rounded blocks.

Ayerbukta (79° 47.7′ N. lat. 11° 52′ E. long.) *B. balanoides* observed on August 24th, 1952. Substratum: Granite. Ayerbukta is on the west side of Raudfjorden in front of Hamiltonbreen. The species was found on bedrock on one of the small islets.

Biskayerhuken (79° 50.5′ N. lat. 12° 24′ E. long.) *B. balanoides* observed on July 25th and August 20th, 1952. Substratum: Mica-schist (strike: N-S, dip: subvertical). The barnacles mostly large (Cf. measurements p. 53 and fig. 15) associated with a rich *Fucus*-vegetation A sample taken on August 20th showed that the specimens contained large quantities of larvæ in their first nauplius stage. One of the examined barnacles had shed its nauplii, its penis was extended and had spiral structure.

Vesle Raudfjorden (79° 46.1′ N. lat. 12° 33′ E. long.) *B. balanoides* observed on July 27th. Substratum: Mica-schist of the Heklahuk formation. The locality (Little Red Bay) is the innermost part of Breibogen (Broad Bay). The barnacles were found on bedrock at the north side of the entrance to the lagoon there. They were sparse with only few clusters in cracks. No first-year specimen was found, and the barnacles contained brood. *Littorina saxatilis* and *Fucus* were present.

Gråhuken hut (79° 47.3′ N. lat. 14° 29′ E. long.) *B. balanoides* observed on July 31st, 1952. Substratum: Devonian sandstone. The

locality is on the east side of the entrance to Woodfjorden. Only dead specimens were found.

Gråhuken beacon (79° 48.2′ N. lat. 14° 33′ E. long.) *B. balanoides* observed on July 31 st, 1952. Substratum: Devonian sandstone. Only two living specimens were found.

Bangenhuk (79° 52.5′ N. lat. 15° 44′ E. long.) *B. balanoides* observed on August 3rd, 1952. Substratum: Hornblende schist (strike: N-S). Bangenhuken is the point on the south side of the entrance to Mosselbukta on the east side of Wijdefjorden. The species occurred in few but large specimens, the largest found having a basal diameter of 16.0 mm. They were all firmly attached in grooves and cracks. No small individual was found.

Verlegenhuken (80° 3.7′ N. lat. 16° 6′ E. long.) *B. balanoides* observed on August 10th, 1952. Substratum: Grey phylite with quartz intrusions (strike: N-S, dip: subvertical). Verlegenhuken is the northernmost point of Vestspitsbergen. The coasts to the east of Verlegenhuken is more frequently blocked by drift ice than the coasts to the west of the point.

A survey of the tidal zone of the rocks in the neighbourhood of the beacon (Chart 510 of Norsk Polarinstitutt) revealed one living and one dead specimen of *B. balanoides*. The living specimen had a basal diameter of 3.0 mm. This occurence is evidently occasional.

Measurements.

Kapp Linné, July 28th, 1950.

D	H	Remarks
mm	mm	
1.2	< 1.0	4 compartments
1.2	1.0	»
1.6	1.0	»
1.6	1.0	»
1.5	1.0	»
1.7	1.0	»
1.7	1.0	»
1.4	1.0	»
1.6	1.0	»
1.7	1.0	»
1.4	1.0	»
1.4	1.0	»
1.4	1.0	»
1.3	1.0	»
1.2	1.0	»
1.3	1.0	»
1.3	1.0	»
1.3	1.0	»
1.4	1.0	»
1.6	1.0	»
1.6	1.0	»
1.6	1.0	»
1.5	1.0	»
1.2	1.0	»
1.4	1.0	»
1.4	1.0	»
1.5	1.0	»
1.5	1.0	»
1.4	1.0	»
1.4	1.0	»

D	H	Remarks
mm	mm	
1.7	< 1.0	partly developed c.-l.
1.7	1.0	»
1.8	1.0	»
1.9	1.0	»
1.7	1.0	»
1.7	1.0	»
1.7	1.0	»
1.7	1.0	6 compartments
1.8	1.0	»
1.8	1.0	»
2.0	1.0	»
4.0	= 2.3	»
4.2	1.5	»
4.2	2.7	»
4.2	2.8	»
4.4	2.2	»
5.3	1.8	»
5.3	2.5	»
6.0	5.4	»
6.1	4.4	»
6.4	4.0	»
6.5	3.7	»
6.6	2.6	»
6.7	3.3	»
7.0	4.4	»
7.0	5.2	»
7.6	4.6	»
8.0	8.0	»
8.2	4.2	»
8.8	5.5	»

Russekeila, July 30th, 1950.

D	H	Remarks
mm	mm	
1.5	< 1.0	4 compartments
1.3	1.0	»
1.4	1.0	»
1.3	1.0	»
1.4	1.0	»
1.2	1.0	»
1.1	1.0	»
1.3	1.0	»
1.4	1.0	»
1.2	1.0	»
1.2	1.0	»
1.4	1.0	»
1.5	1.0	»
1.3	1.0	»
1.5	1.0	»
1.4	1.0	»
1.3	1.0	»
1.4	1.0	»
1.3	1.0	»

D	H	Remarks
mm	mm	
1.7	1.0	partly developed c.-l.
1.5	1.0	»
1.7	1.0	»
1.5	1.0	»
1.6	1.0	»
1.7	1.0	»
1.6	1.0	»
1.7	1.0	»
1.5	1.0	»
1.6	1.0	»
1.6	1.0	»
1.5	1.0	»
1.6	1.0	»
1.8	1.0	»
1.5	1.0	»
1.5	1.0	»
1.6	1.0	»
1.7	1.0	»
1.6	1.0	»

Russekeila continued.

D	H	Remarks
mm	mm	
1.6	< 1.0	partly developed c.-l.
1.7	1.0	»
1.7	1.0	»
1.5	1.0	»
1.7	1.0	»
1.4	1.0	»
1.8	1.0	6 compartments
1.9	1.0	»
1.9	1.0	»
1.8	1.0	»
1.7	1.0	»
1.7	1.0	»
1.7	1.0	»
2.1	1.0	»
1.8	1.0	»
2.3	1.0	»

D	H	Remarks
mm	mm	
1.9	< 1.0	6 compartments
1.9	1.0	»
2.0	1.0	»
1.7	1.0	»
1.8	1.0	»
1.8	1.0	»
4.3	= 2.6	»
5.4	4.0	»
5.5	3.0	»
5.5	2.9	»
6.5	3.0	»
7.5	3.6	»
7.8	3.6	»
8.0	3.0	»
8.2	4.0	»
9.5	7.6	»

Gronfjorden, August 2nd, 1950.

D	H	Remarks
mm	mm	
1.1	< 1.0	4 compartments
1.2	1.0	»
1.2	1.0	»
1.2	1.0	»
1.3	1.0	»
1.3	1.0	»
1.3	1.0	»
1.4	1.0	»
1.4	1.0	»
1.4	1.0	»
1.4	1.0	»
1.5	1.0	»
1.6	1.0	»
1.6	1.0	»
1.6	1.0	»
1.6	1.0	»
1.6	1.0	»
1.8	1.0	»
1.8	1.0	»
1.6	1.0	partly developed c.-l.
1.7	1.0	»
1.7	1.0	»
1.7	1.0	»
1.8	1.0	»
1.8	1.0	»
1.8	1.0	»
1.8	1.0	»
1.8	1.0	»
1.8	1.0	»
1.8	1.0	»
1.8	1.0	»
1.9	1.0	»
1.9	1.0	»
1.9	1.0	»
1.9	1.0	»
1.9	1.0	»

D	H	Remarks
mm	mm	
2.0	< 1.0	partly developed c.-l.
2.0	1.0	»
2.0	1.0	»
2.0	1.0	»
2.0	1.0	»
2.0	1.0	»
2.0	1.0	»
2.0	1.0	»
2.1	1.0	»
2.2	1.0	»
2.2	1.0	»
2.2	1.0	»
2.1	1.0	6 compartments
2.2	1.0	»
2.2	1.0	»
2.3	1.0	»
2.3	1.0	»
2.4	1.0	»
2.4	1.0	»
2.4	1.0	»
2.4	1.0	
2.5	1.0	
2.5	1.0	
2.7	1.0	
2.7	1.0	
2.6	1.0	»
2.6	1.0	»
2.7	1.0	»
2.7	1.0	»
2.7	1.0	»
2.8	1.0	»
2.8	1.0	»
2.8	1.0	»
2.8	1.0	»
2.8	1.0	»
2.8	1.0	»

Grønfjorden continued.

D	H	Remarks
mm	mm	
2.8	1.0	6 compartments
2.9	1.0	»
2.9	1.0	»
2.9	1.0	»
3.0	1.0	»
3.0	1.0	»
3.0	1.0	»
3.1	1.0	»
3.1	1.0	»
3.2	1.0	»
3.3	= 1.0	»
3.6	1.2	»
4.0	2.0	»
4.0	1.7	»
4.0	1.7	»
4.1	1.2	»
4.4	1.3	»
4.6	1.8	»
4.7	1.3	»
4.8	1.4	6 compartments
4.8	1.7	»
4.8	1.7	»
5.0	2.2	»
5.0	1.5	»
5.0	2.2	»
5.1	2.0	»
5.2	2.0	»
5.4	2.2	»
5.6	2.0	»
5.6	2.0	»
6.0	1.9	»
6.0	2.1	»
6.4	3.0	»
6.6	1.7	»
6.6	1.3	»
7.3	2.0	»
7.6	3.6	»
7.0	3.3	»

Kapp Linné, August 8th, 1950.

D	H	Remarks
mm	mm	
1.2	< 1.0	4 compartments
1.3	1.0	»
1.3	1.0	»
1.3	1.0	»
1.3	1.0	»
1.3	1.0	»
1.4	1.0	»
1.4	1.0	»
1.4	1.0	»
1.4	1.0	»
1.4	1.0	»
1.4	1.0	»
1.4	1.0	»
1.4	1.0	»
1.3	1.0	»
1.5	1.0	»
1.5	1.0	»
1.5	1.0	»
1.4	1.0	partly developed c.-l.
1.4	1.0	»
1.4	1.0	»
1.5	1.0	»
1.5	1.0	»
1.6	1.0	»
1.6	1.0	»
1.6	1.0	»
1.6	1.0	»
1.7	1.0	»
1.7	1.0	»
1.7	1.0	»
1.7	1.0	»
1.7	< 1.0	partly developed c.-l.
1.7	1.0	»
1.7	1.0	»
1.8	1.0	»
1.8	1.0	»
1.8	1.0	»
1.9	1.0	»
1.7	1.0	6 compartments
1.7	1.0	»
1.8	1.0	»
1.8	1.0	»
1.8	1.0	»
1.8	1.0	»
1.8	1.0	»
1.9	1.0	»
1.9	1.0	»
1.9	1.0	»
2.0	1.0	»
2.0	1.0	»
2.0	1.0	»
2.0	1.0	»
2.1	1.0	»
2.2	1.0	»
2.2	1.0	»
2.2	1.0	»
2.2	1.0	»
2.3	1.0	»
2.4	1.0	»
2.5	1.0	»
3.2	= 2.0	»
3.6	3.5	»
4.6	4.3	»

Kapp Linné continued.

D	H	Remarks
mm	mm	
4.7	= 3.0	6 compartments
5.5	2.5	»
5.6	2.0	»
5.6	4.0	»
5.5	2.5	»
6.0	3.5	»
6.0	3.4	»
6.1	3.8	»
6.2	3.6	»
6.5	4.0	»
6.5	3.5	»
6.5	3.0	»
6.6	4.2	»
6.7	4.4	»
6.8	4.4	»
6.8	5.5	»
6.9	2.5	»
7.0	4.6	»
7.0	4.5	»
7.1	4.5	»
7.5	4.5	»
7.5	3.7	»
7.6	3.5	»
7.6	5.2	»
7.7	5.0	»

D	H	Remarks
mm	mm	
5.7	= 4.6	6 compartments
5.8	3.0	»
5.8	4.3	»
5.9	2.6	»
6.0	3.7	»
7.8	4.0	»
7.7	5.5	»
7.9	4.6	»
8.0	7.6	»
8.2	4.8	»
8.4	4.0	»
8.5	3.6	»
8.6	4.2	»
8.7	3.6	»
8.8	5.3	»
9.0	4.0	»
9.0	4.5	»
9.0	6.2	»
9.3	4.4	»
10.0	4.5	»
10.0	5.5	»
10.5	6.1	»
10.7	4.5	»
10.9	6.8	»
11.2	6.0	»

Brandalpynten, August 15th, 1950.

D	H	Remarks
mm	mm	
4.0	= 3.4	6 compartments
4.2	2.5	»
4.5	3.0	»
4.7	3.7	»
5.0	3.3	»
5.0	3.0	»
5.0	2.7	»
5.0	2.6	»
5.2	2.5	»
5.5	2.2	»
5.5	2.6	»
5.5	3.8	»
5.6	3.0	»
5.6	4.6	»
6.0	3.3	»
6.4	3.3	»
6.4	4.5	»
6.5	4.0	»
6.5	4.8	»
6.6	3.8	»
6.7	4.3	»
6.7	5.4	»
6.9	4.9	»
7.0	3.8	»
7.0	4.5	»

D	H	Remarks
mm	mm	
7.1	= 3.6	6 compartments
7.3	4.3	»
7.4	2.7	»
7.5	4.1	»
7.5	5.5	»
8.0	5.4	»
8.0	5.6	»
8.5	6.0	»
8.6	4.0	»
8.7	5.7	»
9.2	5.7	»
9.5	6.0	»
9.7	4.5	»
9.7	5.6	»
9.8	5.0	»
9.4	6.5	»
9.9	5.5	»
10.0	6.5	»
10.0	5.6	»
10.8	6.7	»
11.0	5.1	»
11.3	5.6	»
11.3	6.2	»
12.3	6.2	»
12.7	4.7	»
13.6	6.3	»

Kapp Martin, August 31st, 1950.

D	H	Remarks
mm	mm	
1.8	< 1.0	4 compartments
2.1	1.0	6 compartments
2.2	1.0	»
2.3	1.0	»
2.4	1.0	»
2.4	1.0	»
2.5	1.0	»
2.5	1.0	»
2.8	1.0	»
2.1	1.0	»
3.2	= 1.4	»
3.8	2.3	»
4.0	2.2	»
4.3	1.6	»
4.7	2.8	»
4.8	2.4	»
5.0	3.0	»
5.1	3.1	»
5.1	3.3	»
5.4	4.0	»
5.6	4.0	»
5.7	2.4	»

D	H	Remarks
mm	mm	
7.0	= 3.4	6 compartments
7.2	3.6	»
7.2	3.4	»
7.6	4.4	»
7.8	4.1	»
7.8	3.9	»
7.8	4.2	»
8.0	6.0	»
8.0	4.3	»
8.1	5.0	»
8.3	3.4	»
8.4	4.5	»
8.9	5.4	»
9.0	6.1	»
9.1	4.6	»
9.2	4.8	»
9.2	4.0	»
9.0	5.0	»
9.6	5.3	»
10.0	5.4	»
11.2	5.1	»
11.4	5.8	»

Bjørnhamna, July 8th, 1952.

D	D
mm	mm
4.2	11.3
6.9	11.5
7.1	11.5
8.1	11.7
9.7	12.6
9.9	12.7
10.4	13.7
11.2	

Moscoya, July 9th 1952.

D	H	D	H	D	H
mm	mm	mm	mm	mm	mm
8.6	3.8	13.1	7.0	13.1	6.8
9.3	4.2	8.8	3.2	13.8	7.0
9.9	3.8	9.4	4.5	13.9	7.2
10.9	5.9	10.2	6.0	14.0	4.4
11.0	3.0	10.9	11.1	14.1	5.0
11.7	5.7	11.1	5.0		

Smeerenburg, July 11th, 1952.

D	H	D	H	D	H
mm	mm	mm	mm	mm	mm
5.6	3.8	7.9	4.1	7.8	3.0
8.5	4.3	8.6	4.0	9.6	4.2
9.7	3.5	9.7	4.4	10.0	5.1
10.1	6.5	10.2	5.2	10.3	4.5
11.3	5.1	12.6	5.7		

Birgerbukta, August 23rd, 1952.

D	H	D	H	D	H	D	H
mm	mm	mm	mm	mm	mm	mm	mm
7.5	8.3	9.0	4.3	9.5	4.7	10.8	6.1
7.7	11.0	9.0	7.2	9.5	12.3	11.0	7.2
8.0	10.0	9.0	13.2	10.0	14.1	11.3	10.3
8.0	14.3	9.1	13.0	10.2	13.4	11.7	7.1
8.5	5.5	9.3	16.3	10.3	7.8	11.8	5.1
8.5	10.7	9.4	12.1	10.5	5.1	12.3	6.1
8.5	12.3	9.4	12.2	10.6	14.4	12.5	8.9
						12.5	11.5
						12.6	7.4

Indre Norskøya, July 14th, 1952.

D	H	D	H	D	H	D	H
mm	mm	mm	mm	mm	mm	mm	mm
4.1	2.5	7.4	4.1	9.1	6.6	10.2	5.2
5.9	4.0	8.1	4.3	9.8	6.2	10.8	6.5
6.6	2.9	8.7	4.1	9.9	5.0	13.0	6.0
7.4	4.0	9.0	2.8	9.9	5.2		

Biskayerhuken, August 20th, 1952.

D	H	D	H	D	H	D	H
mm	mm	mm	mm	mm	mm	mm	mm
6.7	4.0	10.2	6.0	11.4	7.5	12.7	6.8
7.3	4.4	10.5	7.0	11.5	4.8	12.8	5.8
7.6	3.5	10.6	8.0	11.5	6.0	12.8	6.6
7.6	5.0	10.8	4.5	11.5	6.2	12.9	5.0
8.0	4.0	10.8	6.5	11.6	6.0	12.9	7.2
8.0	6.0	10.8	7.7	11.6	4.4	13.0	7.5
8.1	5.8	10.9	6.0	11.6	6.7	13.0	8.9
9.1	4.0	10.9	6.0	11.7	4.3	13.4	5.8
9.3	4.6	9.2	7.0	11.7	6.1	13.7	8.5
9.5	5.0	11.0	4.3	11.8	6.5	13.0	7.3
9.5	5.5	11.0	4.5	11.8	8.0	13.3	5.0
9.5	7.6	11.0	6.0	11.8	7.7	14.3	7.0
9.7	4.8	11.0	7.5	11.9	6.7	14.3	8.1
9.7	6.2	11.1	4.0	12.0	8.3	15.1	5.6
9.8	6.0	11.1	5.0	12.1	7.0	15.2	9.2
10.0	7.0	11.1	5.4	12.2	5.2	16.1	9.2
10.0	7.2	11.0	9.0	12.2	6.0		
10.1	5.2	11.2	6.0	12.2	8.2		
10.1	6.2	11.2	6.0	12.4	4.6		
10.2	9.0	11.2	6.9	12.4	5.2		
10.3	5.0	11.0	8.1	12.5	7.0		
10.2	7.0	11.4	4.0	12.6	7.0		

Veste Raudfjord, July 27th, 1952.

D	D	D	D
mm	mm	mm	mm
8.1	9.8	11.2	11.9
8.2	10.5	11.4	12.4
9.3	11.1	11.8	12.8

Bjørnhamna, August 28th, 1952.

D	H	D	H
mm	mm	mm	mm
3.5	1.2	8.1	4.0
3.7	1.3	8.1	
3.8	1.2	8.1	
3.9		8.2	
3.9		8.3	
5.0		8.4	3.4
5.3		8.5	3.9
6.0		8.5	4.5
6.8		8.5	5.3
6.9		8.6	4.4
7.0	3.1	8.7	3.4
7.0		8.7	4.5
7.1		8.7	4.5
7.1		8.8	3.2
7.2		8.8	4.3
7.5		8.8	4.7
7.6		8.8	
7.6		9.0	
7.7	5.0	9.0	
7.7		9.0	
7.9	5.0	9.0	

D	H	D	H
mm	mm	mm	mm
9.0	4.8	10.1	
9.0	5.3	10.1	
9.2		10.1	
9.2		10.1	
9.1	4.8	10.2	6.1
9.2	6.3	10.2	6.1
9.3	4.7	10.2	8.6
9.3	5.9	10.3	5.8
9.3	6.2	10.4	5.0
9.4		10.4	6.7
9.5	5.5	10.5	6.1
9.6	5.1	10.6	4.5
9.6	5.2	10.7	
9.7	6.0	11.0	
9.8		11.0	8.0
9.8	3.7	11.0	8.2
9.8	6.1	11.1	
9.9	4.4	11.2	
9.9	7.6	11.2	5.7
10.0	3.5	11.4	6.0
10.0	5.8	11.5	3.8
		11.5	6.2
		11.5	7.7
		11.6	6.9
		12.5	4.3
		13.0	6.3

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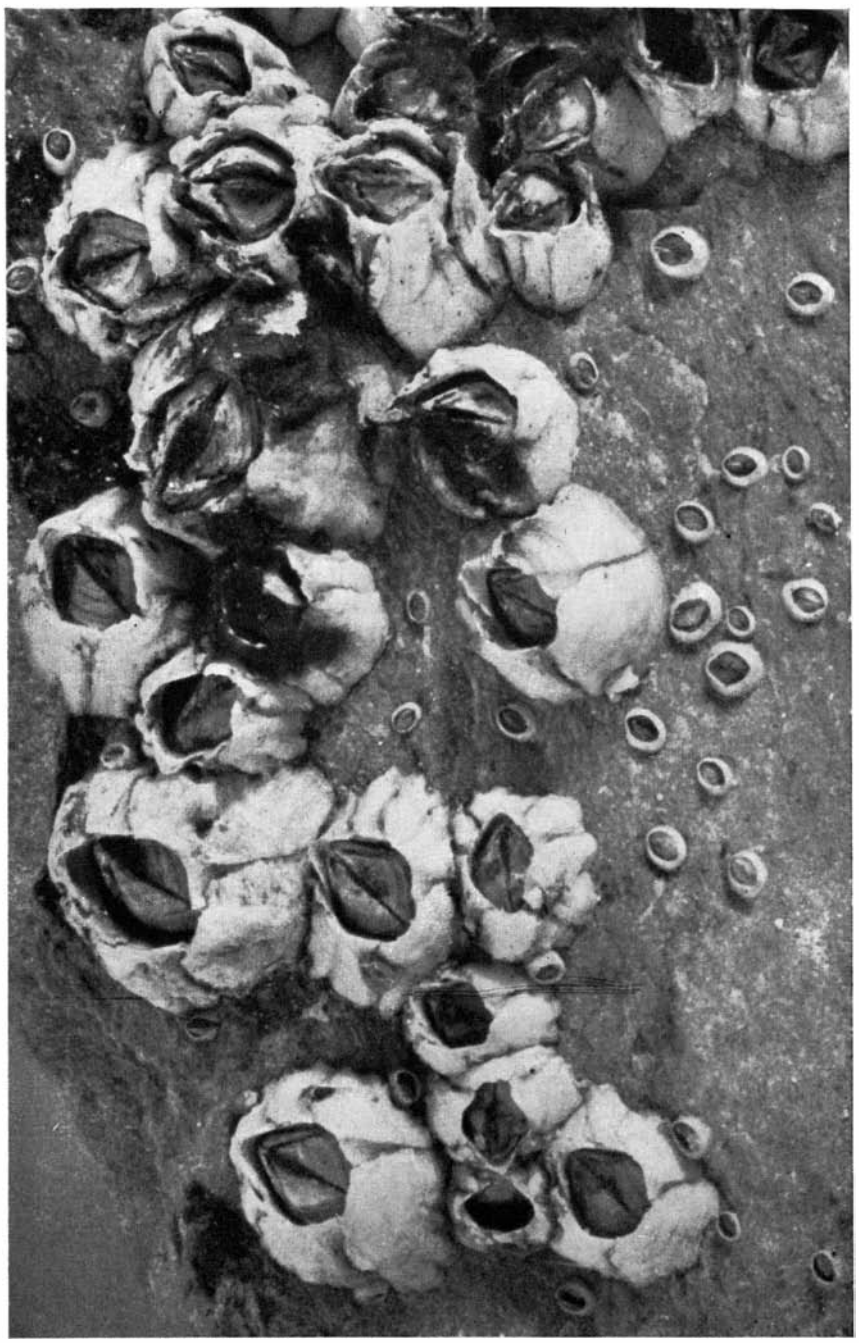
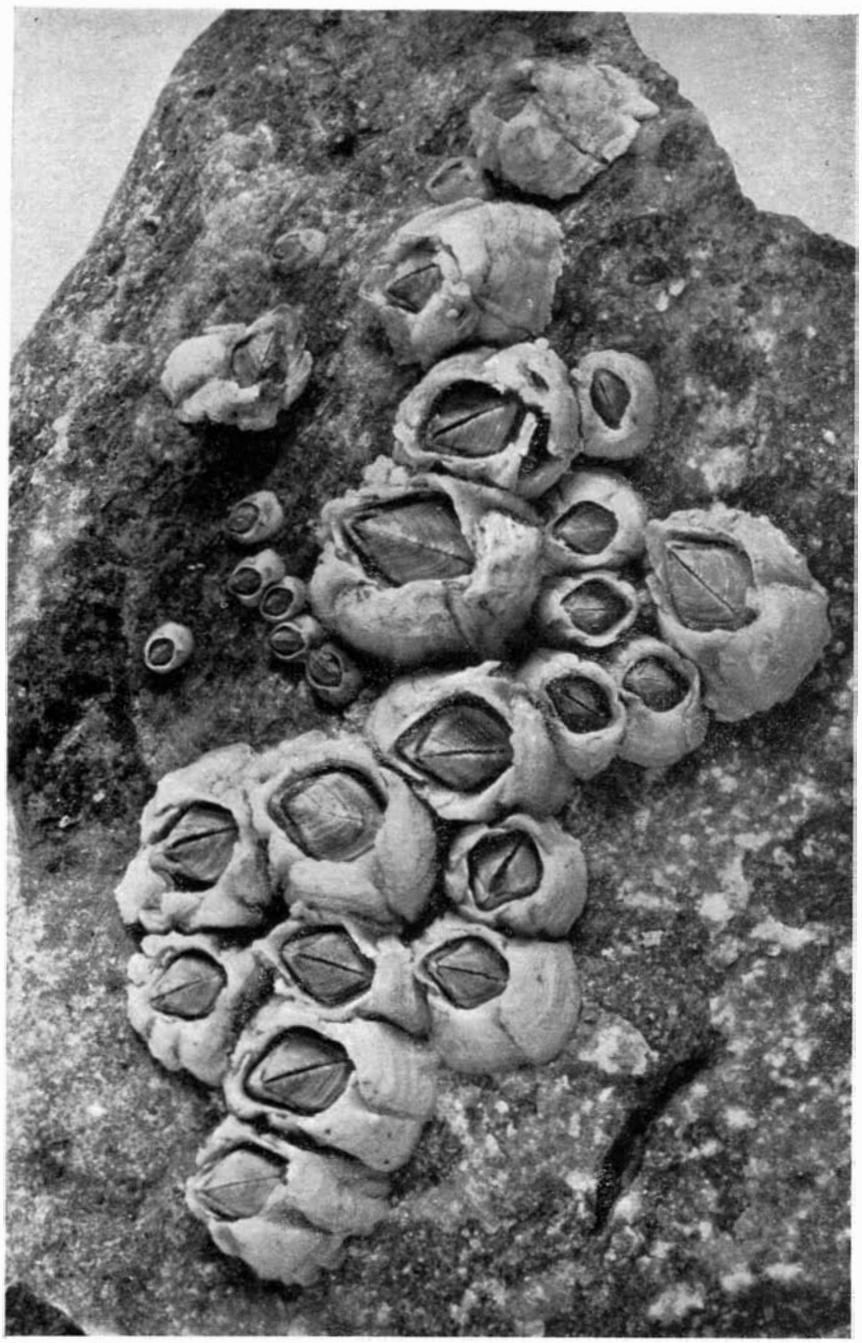
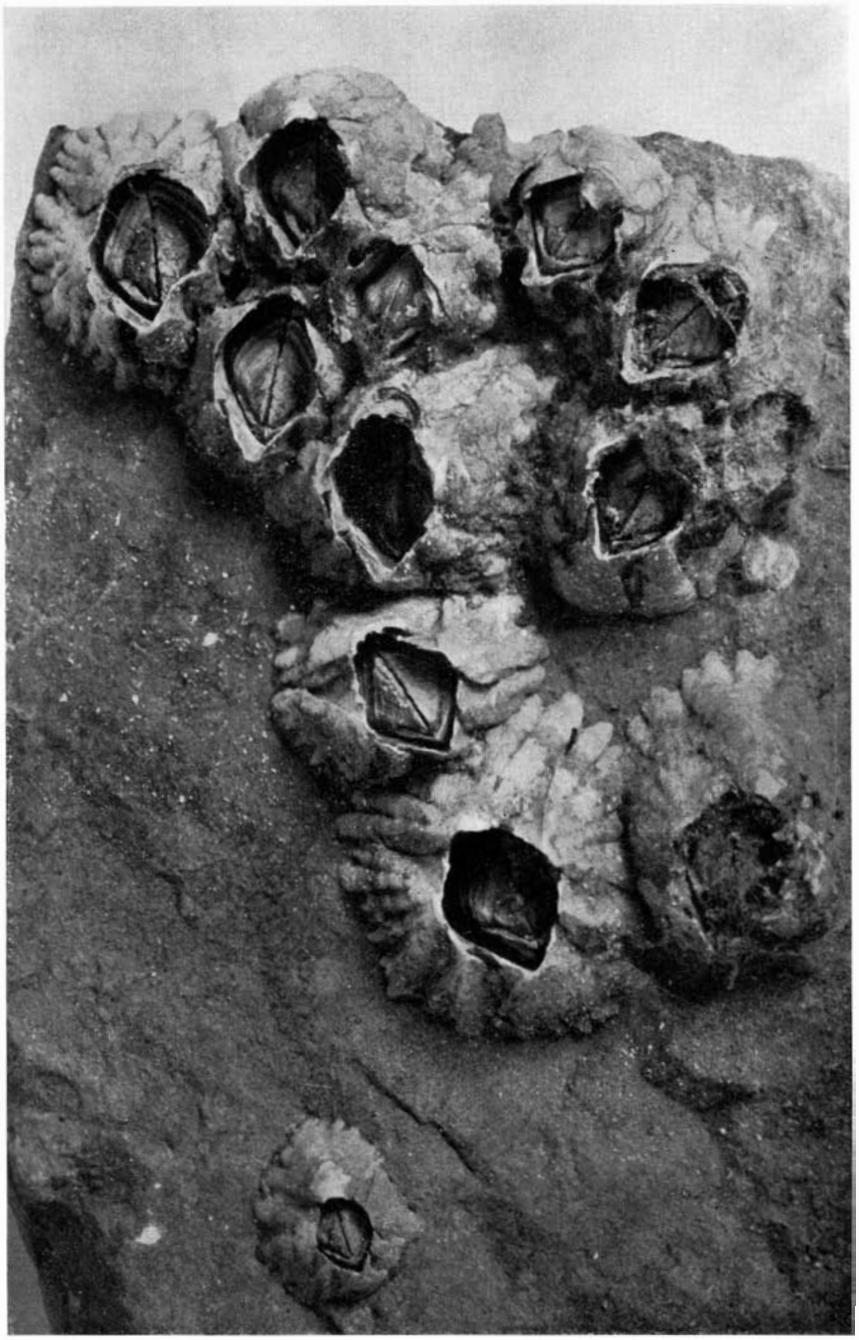
PLATES



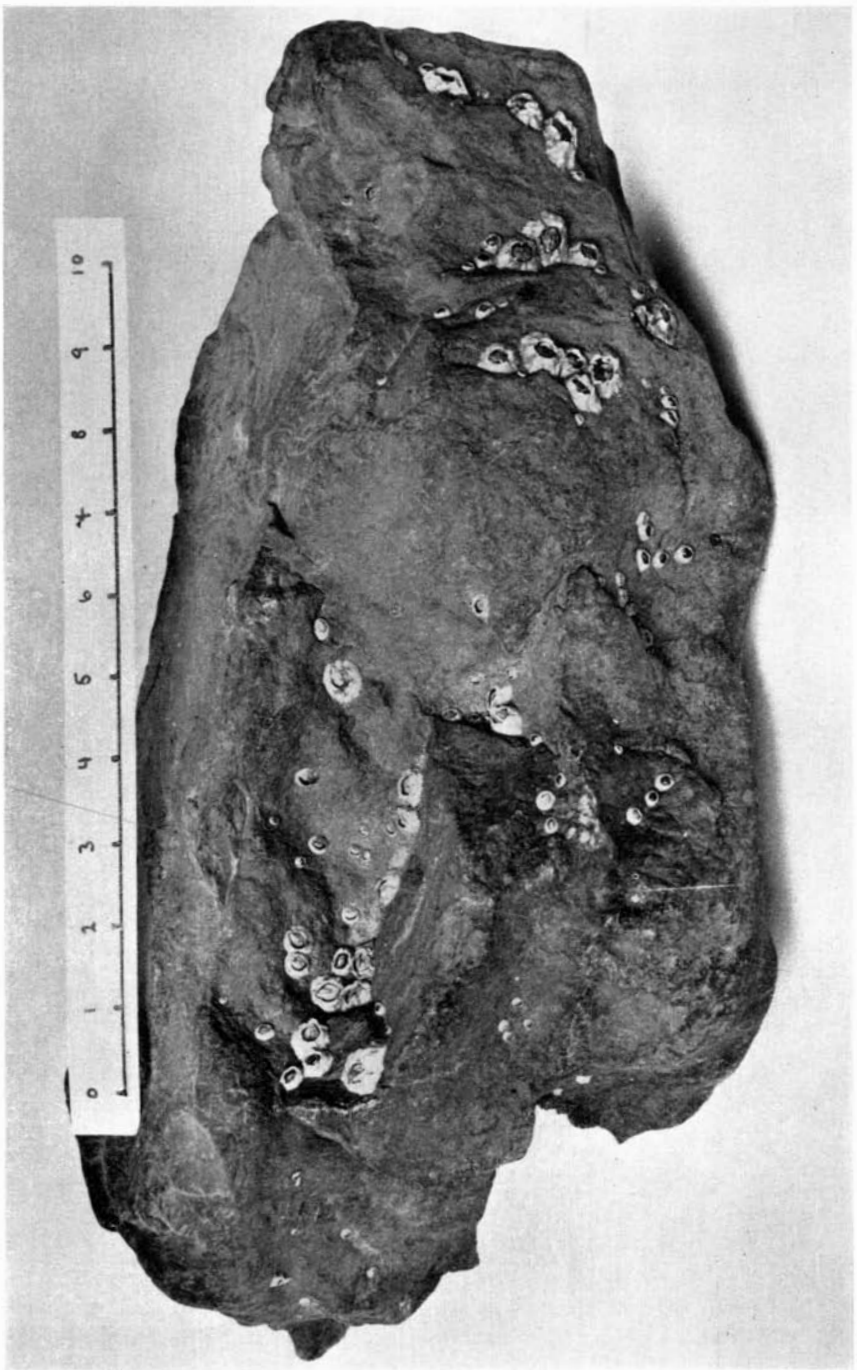
Balanus balanoides (L.) from Kapp Linné collected August 8th, 1950. Adults and first-year specimens. × 3.5. Coll. Nr. 183.



Balanus balanoides (L.) from Kapp Martin, collected August 31st, 1950. Three generations distinguishable? × 3.3. Coll. Nr. 178.



Balanus balanoides (L.) from Brandalpynten, collected August 15th, 1950. Adults only. × 3.2. Coll. Nr. 180.



Balanus balanoides (L.) on a diabase block from Grønfjorden, collected August 2nd, 1950, adults and first-year specimens. Scale in cm. Coll. Nr. 179.

Plate V.

Opercular valves of a specimen of *B. balanoides* from Brandalpynten, Coll. Aug. 15th 1950. (Nr. 157.)

a. Scutum, external view (× 12).
b. Tergum, internal view (× 12).
c. Scutum, internal view (× 12).

Opercular valves of a first-year specimen from Kapp Linné, coll. July 28th 1950 (Nr. 149).

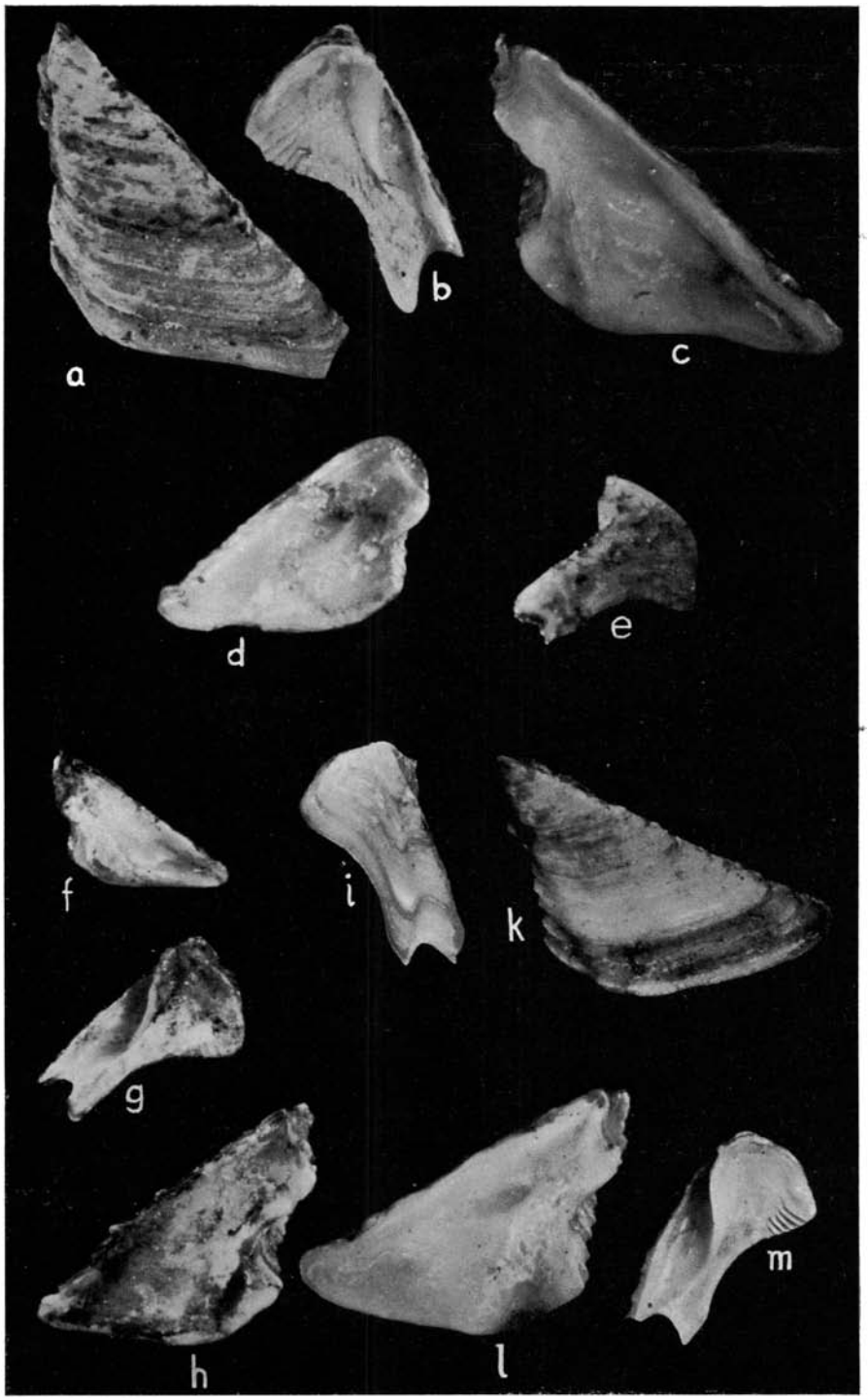
d. Scutum, internal view (× 40).
e. Tergum, external view (× 40).

Opercular valves of specimens from Kapp Linné, coll. July 28th 1950 (Nr. 161).

f. Scutum, internal view (× 15).
g. Tergum, internal view (× 15).
h. Scutum, internal view (× 15).

Opercular valves of a specimen from Kapp Linné, coll. Aug. 8th 1950 (Nr. 156).

i. Tergum, external view (× 11.5).
k. Scutum, external view (× 11.5).
l. and m, internal view of i and k.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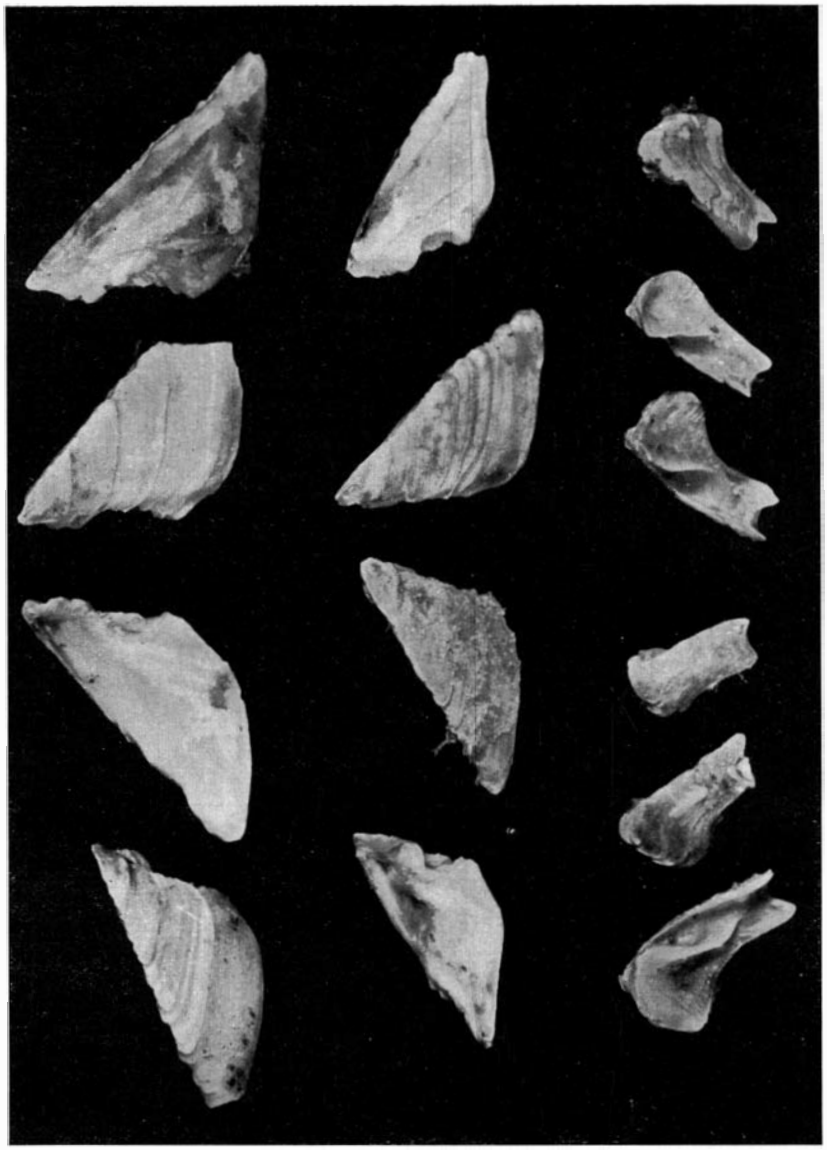


Opercular valves from specimens of *B. balanoides* from Russekeila, coll. July 30th 1950 (Nr. 152) × 13.

Fig. 1. *Balanus balanoides* from the under surface of a block at Birgerbukta.
Per Svendsen photo, Aug. 24th 1952.

Fig. 2. *Balanus balanoides* on bedrock at Bjørnhamna.
Per Svendsen photo, July 10th 1952.

Plate VIII.

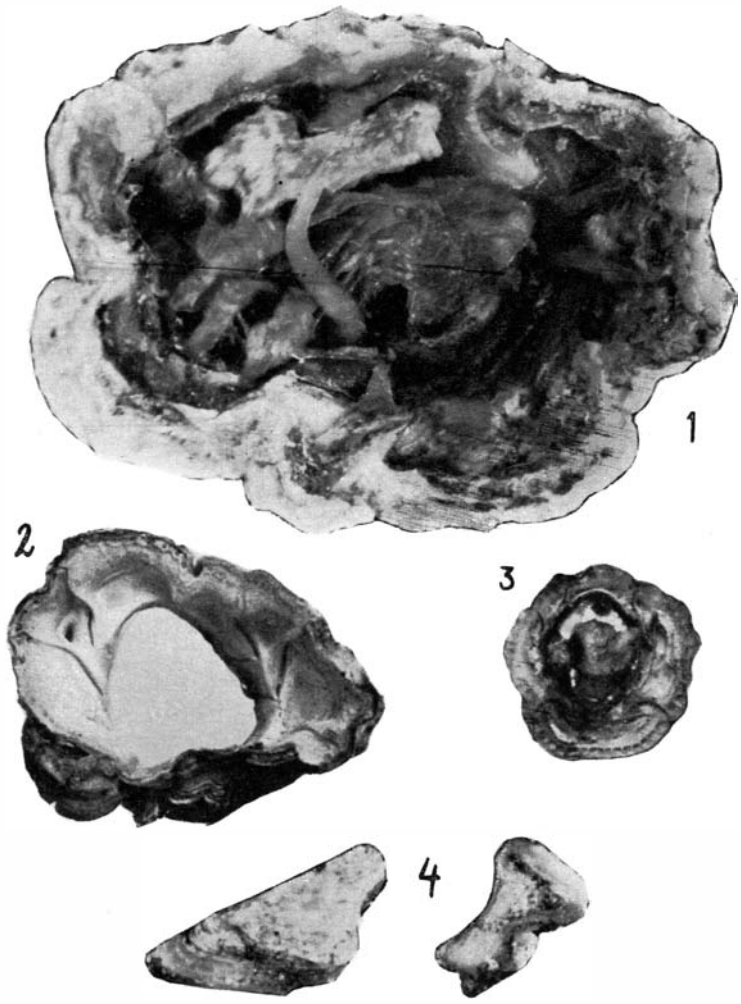
Fig. 1. Basal view of a specimen of *B. balanoides* from Kapp Martin, collected 31-8-50, Coll. Nr. 171, showing ripening gonads (Cf. p. 37) (Greater part of the ovary removed to show the penis) × 8.

Fig. 2. Basal view of the wall of a specimen from Russekeila, collected 30-7-50, Coll. Nr. 172. × 4. Showing obliteration of parietal tubes at the basal edge.

Fig. 3. Basal view of the wall of a specimen from Russekeila, collected 30-7-50, Coll. Nr. 172, × 4. Showing regular parietal tubes and lowest transverse septa.

Fig. 4. Scutum and tergum of a specimen from Kapp Linné, collected 28-7-50, Coll. Nr. 161, × 15.

Fig. 5. B. balanoides on bedrock at Smeerenburg.
Per Svendsen photo, July 11th 1952.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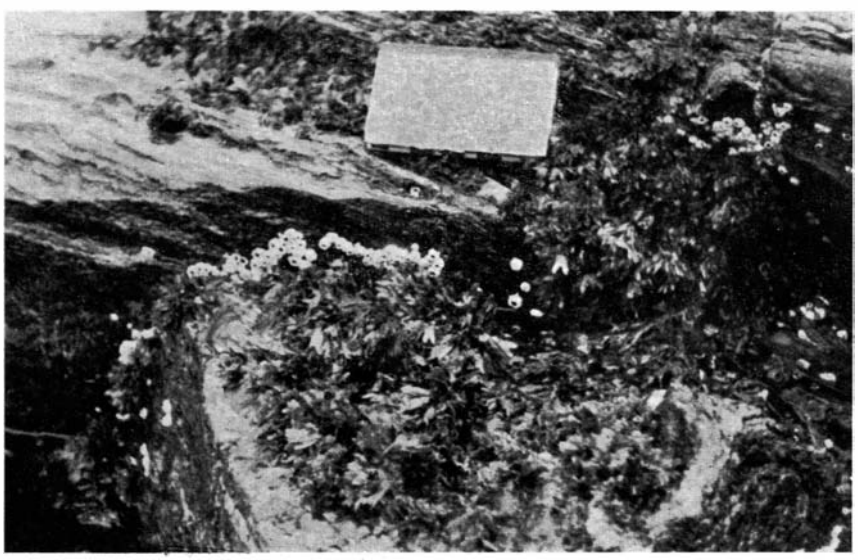

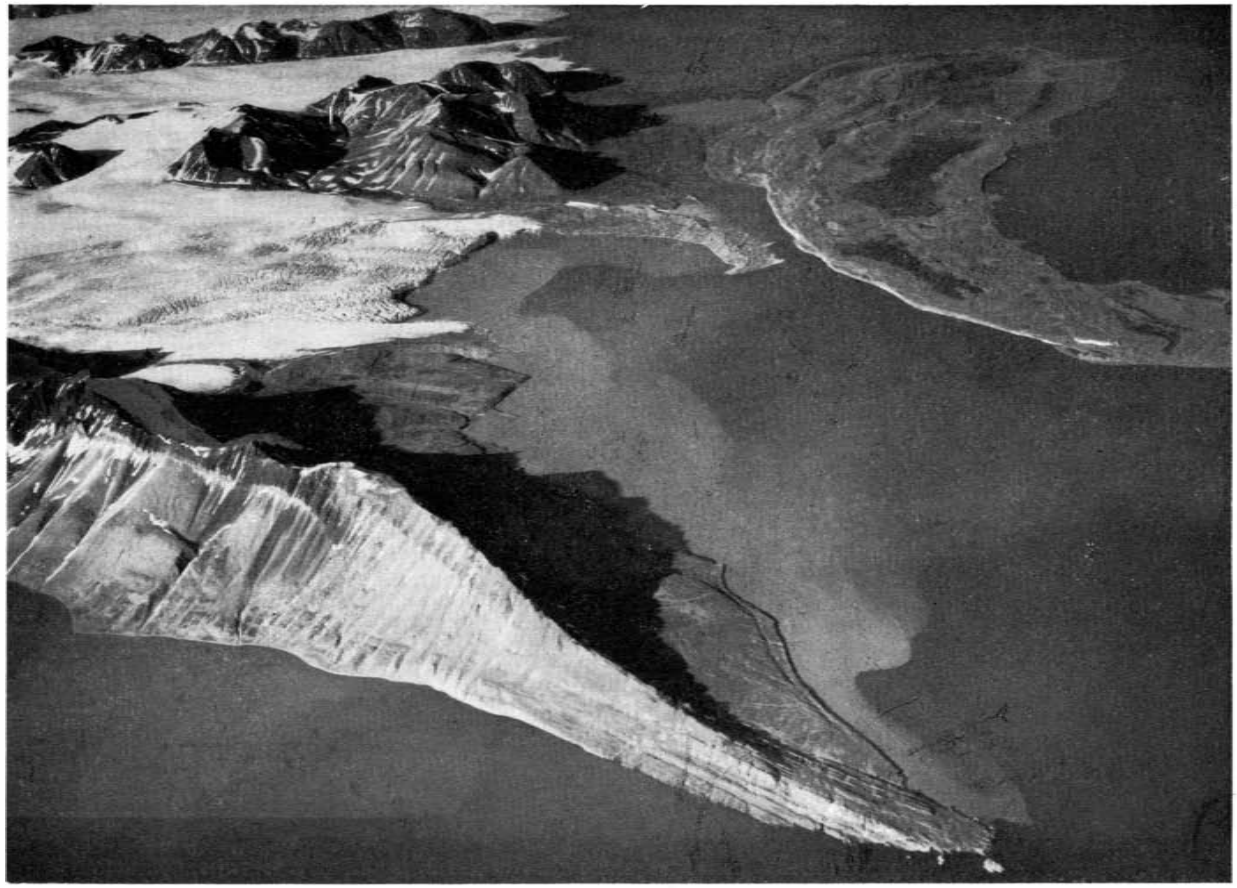

Mudbearing meltwater from Esmarkbreen in Ymerbukta, Isfjorden, Vestspitsbergen. (Photo: Luncke. 1936.)

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