Helgoländer wiss. Meeresunters. 29, 311–314 (1977)

Growth performance of *Alaria esculenta* off Helgoland

I. M. MUNDA[1, 2] & K. LÜNING[2]

[1] *Biological Institute, Slovene Academy of Science; Ljubljana, Jugoslavia*
and
[2] *Biologische Anstalt Helgoland (Meeresstation); Helgoland, Federal Republic of Germany*

ABSTRACT: *Alaria esculenta* (L.) Grev. sporophytes, raised in culture and originating from the North of Iceland were immersed in the sea near Helgoland (North Sea) for the period from February to August. Notable growth of the thalli was found between February and May, when the water temperature was similar to that of their original habitat in Iceland. Less conspicuous growth but development of sporophylls took place between May and July. The temperature rose to 16.8° C during the first half of July and remained on the same level during August, when the plants deteriorated. The present experiments yield additional evidence that the regional distribution of *A. esculenta* is temperature controlled.

INTRODUCTION

The genus *Alaria* has a northerly distribution pattern and its southern limit is close to the 20° C isotherm of maximum sea temperature (Widdowson, 1971). The type species of this genus, *Alaria esculenta* (L.) Grev. is common in the North Atlantic north of the 16° C isotherm (Sundene, 1962). This species is common and abundant in the Faeröes (Börgesen, 1902), Greenland (Lund, 1959), Iceland (Jónsson, 1903; Munda, 1972) and the British Isles. Its absence in the whole North Sea and the greater part of the English Channel obviously relates to elevations in the average sea temperature (Southward, 1960). It is common along the Norwegian coast (Jaasund, 1965; Printz, 1926; Jorde, 1966) with Mandal as its southern limit (Wille, 1897; Sundene, 1953). Its southernmost habitat in Europe is Brittany, France (Fischer-Piette, 1936; Dizerboe, 1947). The distribution pattern of *A. esculenta* around Iceland is not uniform and seems related to the hydrographic conditions. Its maximum abundance was found along the eastern coast which is influenced by arctic water, whereas it is sparse in the South, where the influence of Atlantic water masses is strongest (Munda, 1975).

Field and laboratory experiments, carried out by Sundene (1962) in Norway gave support to his hypothesis that the distribution of *Alaria esculenta* is temperature controlled. In the present experiment a further step is taken to prove the temperature tolerance of *A. esculenta* sporophytes and thus one of the causal factors affecting its distribution. For this purpose, sporophytes raised from zoospores from material

originating from the North of Iceland were kept in the sea off Helgoland where *A. esculenta* does not occur.

MATERIAL AND METHODS

Thalli of *Alaria esculenta* with mature sporophylls were obtained from Tjörnes, North Iceland. The sporophylls were rinsed with filtered seawater and kept dry for 6 hours. Sporophylls were immersed in sterile seawater containing Provasoli ES enrichment. The released zoospores were allowed to settle on white plastic plates (PVC; 3 × 5 cm, 6 mm thick) which were transferred to plexiglass chambers (50 × 50 cm) for three months. Temperature was 12° C and illuminance 1500–2000 lux (white fluorescent lamps Osram 40 W/19, continuous illumination). The cultures were aerated and the medium was changed every week. The small sporophytes were then transferred into a seawater shower (Chapman, 1973), where they were immersed 2 cm below the water and kept at the same conditions of temperature and illumination as stated above. In the middle of February 1976 the 5 months old sporophytes were, on the average, 10 cm long and 0.8 cm broad. 50 plants were transferred into the sea at 2 m below MLWS. For this purpose the plastic plates with the attached experimental plants were fastened to metal frames. Temperature data were provided by Treutner (personal communication).

RESULTS AND DISCUSSION

Growth of the sporophytes was vigorous as long as the seawater temperatures remained within the range of the limits of the regional distribution of this species. In February and March, the average water temperature was 3.3° C. In April the temperature rose to 5.2° C and in the middle of May to 8.5° C. The first check was made on May 19, when the plants had reached an average length of 40 cm and a width of 5 cm (Fig. 1). During June the water temperature rose to 14.6° C and to 16.8° C during the first half of July. Fronds of sporophytes observed on July 10 were 30–50 cm long and 6 cm wide. The length of the stipes was between 5 and 8 cm (Fig. 1). They had immature sporophylls. The water temperature was 16.9° C during the second part of July and the same average was found during the first half of August. At the August 13 observation the plants were strongly reduced. The laminae as well as their intercalary meristems were wasted away. Only haptera with stipes of 1–4 cm in length with immature sporophylls remained. At this stage all experimental plants were removed from the sea.

This field experiment indicates that temperatures of 16–17° C of a few weeks duration are lethal for the sporophytes of *Alaria esculenta*. At Tjörnes, from where the experimental material was taken, the yearly temperature means are 4.8° C and the summer maxima in July and August 8.9° C, while the winter minimum of 1.7° C is in March (Stefánsson, 1962). The summer temperature of the original habitat corresponds to May temperatures in Helgoland, when the growth rate of the experi-

mental material was maximal. A somewhat decreased growth intensity, but with fructification, was found at temperatures of 11–15° C in June. It seems likely that plants are able to tolerate a temperature elevation over 16° C for some days, but that a longer exposure becomes lethal.

Sundene (1962) got similar results by transplantation of adult sporophytes of *Alaria esculenta* from western Norway (14° C summer isotherm) to the area of the Oslo Fjord (16° C summer isotherm) where this species is absent. His experimental

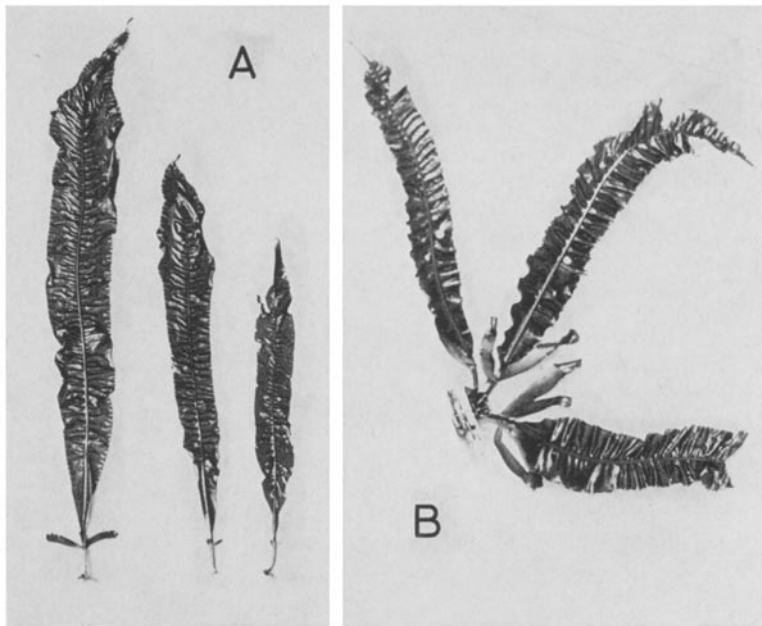

Fig. 1: *Alaria esculenta*. Photographs of test specimens. (A) May, (B) July (about 1/5th natural size)

plants had already exhibited a reduction of the thalli in June and a complete deterioration occurred during July and August. Our long-distance transplantation showed the same evidence as the short-distance transplantation, carried out by Sundene (1962). It seems likely that susceptibility to temperatures over 16° C is genetically fixed within this species and not modified by temperature conditions in its original habitat.

Around the British Isles the distribution of *Alaria esculenta* also seems to be determined by the 16° C isotherm, since this species is absent in the greater part of the English Channel, where the summer temperatures rise to 17–18° C. As suggested by Southward (1960) several organisms including *Alaria esculenta* disappeared from the western part of the Channel due to a rise of 0.5° C of mean annual temperature. A similar distribution pattern is evident around the Irish coast (Cotton, 1913).

Acknowledgement. The authors are greatly indebted to Mr. A. Egilsson, Mánarbakki, Tjörnes, North Iceland, for sending fertile material from this area.

LITERATURE CITED

Börgesen, F., 1902. The marine algae of the Faeröes. Bot. Faeröes. **2**, 339–532.
Chapman, A. R. O., 1973. Methods for macroscopic algae. In: Handbook of phycological methods. Ed. by J. R. Stein. Univ. Press, Cambridge, 87–104.
Cotton, A. D., 1913. Marine algae of the Saltnes. Ir. Nat. **22**, 195–198.
Dizerboe, A. H., 1947. La répartition et la zone de végétation dans le massif armoricain d'*Alaria esculenta* (L.) Grev. (Algues, Phéophycées). Bull. Sci. Bretagne **22**, 113–117.
Fischer-Piette, E., 1936. Etudes sur la biogéographie intercôtiale des deux rives de la Manche. J. Linn. Soc. **40**, 181–272.
Jaasund, E., 1965. Aspects of the marine algal vegetation of North Norway. Bot. Gothoburg. **4**, 1–174.
Jónsson, H., 1903. The marine algae of Iceland. II. Phaeophyceae. Bot. Tidskr. **25**, 141–195.
Jorde, I., 1966. Algal associations of a coastal area south of Bergen, Norway. Sarsia **23**, 1–52.
Lund, S., 1959. The marine algae of east Greenland. I. Taxonomical part. Meddr. Grønland **156** (1), 1–247.
Munda, I., 1972. On the chemical composition, distribution and ecology of some common marine algae from Iceland. Botanica mar. **15**, 1–45.
— 1975. Hydrographically conditioned floristic and vegetation limits in Icelandic coastal waters. Botanica mar. **18**, 223–235.
Printz, H., 1926. Die Algenvegetation des Trondheimfjordes. Norsk. Vidensk. Akad. Skr. (Mat.-Nat. Kl.) **5**, 1–274.
Southward, A. J., 1960. On changes of sea temperature in the English Channel. J. mar. biol. Ass. U.K. **39**, 449–458.
Stefánsson, U., 1962. North Icelandic waters. Rit. Fiskideild. **3** (3), 1–269.
Sundene, O., 1953. The algal vegetation of Oslofjord. Norsk. Vidensk. akad. Skr. (Mat.-Nat. Kl.) **2**, 1–244.
— 1962. The implications of transplant and culture experiments on the growth and distribution of *Alaria esculenta*. Nytt Mag. Bot. **9**, 155–174.
Widdowson, T. B., 1971. A taxonomic revision of the genus *Alaria* Greville. Syesis **4**, 11–49.
Wille, J. N. F., 1897. Beiträge zur physiologischen Anatomie der Laminariaceen. K. norske Fredriks Univ. Festskr. **4**, 1–70.

First author's address: Dr. I. M. Munda
Biological Institute
Slovene Academy of Science
Ljubljana
Jugoslavia