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PART II.

On *Laminaria* of Japan.

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With Pl. VII.¹⁾

The algal flora, especially *Laminariaceæ*, of the Upper Northern Pacific has been so often and so carefully investigated by many eminent botanists, among whom I especially mention KJELLMAN, that hardly any new species remains to be detected. Yet when I recently took up the study of our *Laminaria* group having simple lamina, I found a new species, besides observing several minute points in already known species which had been either overlooked or neglected by predecessors. Amongst others I found the existence of muciferous lacunæ in some species in which they have been hitherto considered as wanting. As a result of my investigation I propose to classify our *Laminaria* species as in the following synopsis:

¹⁾ The plate will appear in the next number.

- A. Muciferous lacunæ present in root, stipe and lamina.
 - L. japonica Aresch.
 - L. longipedalis sp. nov.
 - L. gyrata Kjellm.
 - L. radicata Kjellm.
- B. Muciferous lacunæ present in root and lamina, but not in stem.
 - L. angusta Kjellm.
- C. Muciferous lacunæ none at all.
 - L. peterseniana.

Laminaria japonica Aresch.

Many authors have frequently described this species and much has been written about this plant in particular. Notwithstanding, I am here to add some remarks on the variation of shape of frond and of the existence of lacunæ muciferae.

The present plant has a rather wider range of distribution within the compass of our empire. Its southern limit is Iwaki and its northern Etrofu, as far as is known to me. All the coast around the Hokkaido, that is the ancient Iesso, has more or less altered forms of this species. It attains its maximum size and its luxuriant growth in the locality surrounding Hakodate. The western coast of Hokkaido, that is the coast extending from Cape Sōya down to Otaru is fringed with one and the same variety. Its range of distribution being rather wide, it, as a consequence, varies somewhat in its form and structure.

Generally we may distinguish two forms in this species, viz. *f. typica* and *f. angusta*. Between these two forms there are gradual transitions from one to the other.

f. typica. This is the larger one which has been several times collected and so fully described by many authors that no further description is needed. It has larger and broader lamina and firmer and longer stipe than *f. angusta*. Muciferous lacunæ are present in root, stem and lamina. The substance varies somewhat in consistence.

f. angusta. This is shorter and narrower than *f. typica*. Stipe is slender and short. Lamina is linear-lanceolate slightly undulated at margin with cuneate or ovato-cuneate base and with more or less distinct

median fascia. The base of broader forms is more ovate than that of the narrower ones. Lacunæ are always present in root and stem; but those in lamina are sometimes absent or very difficult to detect. It is more especially so in southern forms such as are found along the coast of Iwaki and Iwashiro.

f. angusta is more widely distributed than *f. typica*, mainly along the coast of the Hokkaido. Almost all *Laminaria japonica* found along the western coast of the Hokkaido consists of plants of this form.

Great many examples of *L. japonica* has been brought to me from several localities, but none from any point beyond the south-west extremity of the province Iwaki. Notwithstanding, we find mention of collections of this species in other parts, e.g. DICKIE¹⁾ found it at Oshima harbour, southern coast of Japan. Such a plant may perhaps be a different species. Again HARIOT²⁾ mentions *L. flexicaulis* as has been collected at Yokosuka. It may be said with certainty, that it is a different species.

Laminaria longipedalis Okam. mscr. Pl. VII. Fig. 1—3.

Root consists of several-times dichotomously branched clasping fibres, extending from the lower end of stem in a conical form and attenuated toward the extremity. In a cross-section we find a ring of muciferous lacunæ situated just beneath the cortex.

Stem is almost cylindrical below, compressed and becoming flattish upwards where it expands into the base of a terminal simple lamina. In drying, stem becomes much flattened, but reassumes its original form on reimmersion in water. In a cross-section of stem the medullary layer is transversely elliptical, becoming more and more linear as the stem increases in diameter. In the cortical layer a more or less close ring of small roundish muciferous lacunæ is detected (Fig. 3). Lacunæ are situated so near the periphery that they are separated by the thickness of only 4—5 cells from the periphery. The plant seems to be perennial, as, in a cross-section of stem which has a length of 50 cm,

¹⁾ **Dickie**—Notes on Algae collected by Moseley of Challenger, &c.—Journ. Lin. Soc. Vol. XV, No. 87.

²⁾ **Harriot**—List. d. Algues Marines p. 217.

I find an annual ring corresponding to the growth of the former year. The stem of the first year has a length of 22—27 cm with a diameter of ca. 10 mm, while the dimensions of that of the second year are 40—50 cm by ca. 15 mm.

Lamina is lanceolate rising from broadly ovate or slightly cuneate base with undulated margin. Median portion does not much differ in thickness from the remaining. The shape of lamina does not vary according to its ages, but the size is very different. The lamina of the first year is 40—70 cm long and 15—20 cm broad, while that of the second year is 170—220 cm by 30—40 cm. These measurements have been taken from dried specimens the exact length being unknown, on account of the loss of the terminal portion by erosion. In a cross-section of lamina we find the intermediate layer consisting of several layers of roundish-angular cells, whose diameter gradually diminishes towards the periphery. Muciferous lacunæ are present beneath the cortex a little to the outward of half the thickness of the middle layer.

Sori are produced on both surfaces, forming large and irregular cloud-like patches which are equally spread all over the surface, leaving a narrow intra marginal portion naked. They seem to be produced at first in median portion and gradually to extend afterward toward the margin. Sometimes they are formed far above the base of the frond or in others in the basal portion. In several specimens, however, the basal portion is left naked for a more or less wider range. In marginal portion of the frond sori are formed in roundish spot-like patches and those becoming confluent with each other form larger patches.

It seems rather peculiar that such a larger plant as the present remained undescribed up to this day, in spite of earnest and diligent searches of many eminent European botanists who took home huge mass of collections from the Upper Northern Pacific. It is doubtful whether the present plant has hitherto been not taken for *Laminaria japonica* or *L. saccharina*, instead of being established as a distinct species.

The present plant is closely related with *Laminaria japonica* Aresch. from which however it differs in the length of stem, position of lacunæ in stem, and the indistinct median fascia. Moreover, *L. japonica* is an annual plant, while the present is perennial,—or at least biennial. It is difficult to distinguish the present species from *L. japonica* by the structure of lamina, its cross-section being pretty much the same in both.

The middle layer, however, is composed in *L. japonica* of larger cells than in the present. The position and form of lacunæ in the stem distinctly separates the one from the other. In *L. japonica* they are larger than in *L. longipedalis* and are situated beneath cortical portion (Fig. 4.), while in the latter they are within cortical range.

From *L. saccharina* which has a longer stem and a frond of similar shape, the present species differs in the indistinctness of fascia and in the presence of muciferous lacunæ in the stem.

Laminaria longipedalis—Perennial; Root branched, conical, with a ring of muciferous lacunæ beneath the cortex; Stipe long, subterete, complanated toward the base of a simple lamina, with a close ring of small lacunæ very near the periphery, and with an annual ring; lamina broadly lanceolate, $\pm$ broadly ovate at base, undulated at margin, with indistinct median fascia and provided with muciferous lacunæ. Sori spread over the frond on both surfaces, forming cloud like patches.

***Laminaria gyrata* Kjellm.**

*Laminaria gyrata*¹⁾ has been described from the materials collected at the Hokkaido by KJELLMAN who mentions that the stem has no muciferous lacunæ. My recent researches however prove that the absence of lacunæ in the stem of plants of this species is not a fixed character. In many specimens in my collection I studied the structure of stem and I found that in some examples lacunæ are entirely wanting, while in the other they are sparingly present. Even in one and the same plant, one cross-section may shew a few lacunæ, while another shews none. Those, when present, are roundish or longish, being smaller in size and situated just beneath the cortical layer (Fig. 7). They do not form a continuous ring in a cross-section, being separated by more or less wider patches of non-lacunose portion.

These researches have been conducted in order to settle doubts which arose in classifying the related plants collected in abundance in Urupp, Etrofu and in other places. They have all the other characters safely referable to *Laminaria gyrata*, except the presence of lacunæ in stem, which form a continuous ring beneath the cortex. At first, according to the diagnosis of *L. gyrata* given by KJELLMAN I took those plants for a new species, which differs from the former species only in the presence of lacunæ in

¹⁾ De Toni Syllog. Alg. III. p. 348.

the stem. But some hesitation still lingered in my mind in separating those plants from *L. gyrata*. I began to doubt whether in *L. gyrata* lacunæ were not present in the stem of some examples and whether my plants in question were not a form or variety of that species. Thereupon I studied several examples of *L. gyrata* and I was fortunate enough to discover the fact above referred to.

Based upon the fact that lacunæ are present in the stem of *L. gyrata* and are somewhat variable in their existence, I distinguish three forms of this species, viz. *f. linearis*, *f. latior*, and *f. obovata*.

Laminaria gyrata Kjellm.—“Rhizinis attenuatis, stipite brevi, inferne tereti, crassiuscule, superne compresso, attenuato, in laminam sensim abeunte, levi, lacunis muciferis nullis corticeque deciduo deficiente; lamina lineari-lanceolata, angusta, demum pergamea, fascia angusta, fere coske-formi percursa, marginibus planis vel subundulatis; soris in utraque superficie laminæ inferne evolutis, marginalibus fasciam medianam medam relinquentibus, numerosis, parvulis, elevatis, distincte circumscripti, vel subcircularibus vel secus directionem laminæ transversalem elongatis, plus minus ramosis, structura vulgari.—ad Hokkaido-Stipes 4-5 cm longus, lamina 7-8 cm latitudine metiens; consistentie ut in *Laminaria saccharina*.”—G. B. DE TORI Syllog. Alg. III. p. 348.

f. linearis. Characters same as above.

Hab. Akkeshi in the Hokkaido.

It is to be added to the characters stated above, that lacunæ are more or less present in the stem. Of the existence of lacunæ in root fibres I can say nothing, for in my specimens roots are unfortunately wanting; but from their presence in other two forms it may be said that they are more probably present in root fibres.

f. latior. Stipe short, 4-7 cm long, ca. 5 mm in diameter, provided with a ring of muciferous lacunæ; lamina linear lanceolate, 50-100 cm long, 10-17 cm broad, oval or cuneate at base, slightly dilated above, with margins flat at base, more or less undulated above. —Fig. 6.

Hab. Urupu, Etrofu, Shikotan, Akkeshi.

Stipe is subcylindrical below, slightly compressed above, attenuated with a close ring of muciferous lacunæ, which assume an elongated angular chink-like appearance. Lamina is linear, with generally ovate base which is more roundish in some, more cuneate in others. Lamina has a tendency to dilate slightly above the middle point of the length of the specimen. Margin is flat in basal portion, $\pm$ undulated above, and especially so in broader or thinner lamina. The median fascia is

10—20 mm broad. Lacunæ muciferæ are present in root fibres forming a continuous ring beneath the cortical layer.

f. obovata. Stipe shortest, 1-2 cm long, Subcompressed, with a ring of muciferous lacunæ; lamina obovate or roundish, broadly oval or somewhat cordate at base, 25-55 cm long, 25-30 cm broad, with undulated margin.

Hab. Shikotan, Urupp.

Stipe is shortest, subcompressed, lamina is shortest and broadest, being obovate, roundish, or somewhat oblanceolate, more or less dilating upward; the base is broadly ovate or somewhat cordate; margin is very much undulated. Remaining characters are same as the other forms above described.

In instituting a comparison of these three forms we find a gradual transition of form from one to the other. Rugose surface of lamina, presence of lacunæ in stem, the median fascia, gyrate-appearance of sori,—all those characters remaining common, the lamina varies from linear to obovate. The length and breadth of lamina of those three forms taken in order read as follows: 170 + cm by 3—6 cm, 50—100 by 10—17, and 25—55 by 25—30. The true length of lamina of *f. linearis* is unfortunately unknown, the upper portion of specimens in my possession being cut off; and that of others is in some measure insufficient, owing to the erosion of the upper portion. Although the true length of lamina is insufficient, yet the increasing breadth of lamina will tell us the corresponding decrease in length. In company with the variation of form of lamina, the stem varies somewhat in length, the stem of *f. latior* being longer than that of the rest. From this reasoning, I think that *f. latior* should be considered the typical or original form of this species, from which the other two forms were derived.

Root-formation. In the course of my study, I have studied in *f. latior* the formation of root. Though not quite sure that the study of the same will add some novelty to the branch of science, yet as such a young plant as that may prove profitable to the study of root-formation can rarely be obtained, I should think it better to describe here than to pass it over in silence. Specimens which have been sought for, have been two in number (Fig. 8—9). The one has 2 mm long stipe which expands gradually into linear lamina at the upper portion.

Lamina has a length of 3 cm measuring 4 mm in the widest portion. The median fascia does not make its appearance in this stage and a longitudinal row of 3 or 4 roundish elevations of the surface occupies the median portions, the remaining part being flat. The lower end of stipe forms a primary holdfast which is a small disc, crenated into about 5 small lobes. Those lobes in the other specimen grow out into finger-like processes, which measure 1—2 mm in length.

In the next stage the secondary holdfasts make their appearance. They arise just above the primary one as a whorl of small protuberances (Fig. 9—10). These protuberances, 5—7 in number, extend at first in a nearly horizontal direction in finger-like processes and then more and more obliquely downwards. When they reach the substratum they flatten their tips against it and become attached to it. The specimen in this stage has a stipe of 3 mm long and has broader lamina whose apex is blunt and truncated from having lost the terminal portion. The lamina is 8 mm in breadth in the broadest portion and has somewhat cuneate base. The median fascia now makes its appearance like a fine costa, along both sides of which roundish angular elevations of surface are arranged alternately, reminding us with protovertebræ of chick's embryo.

About the formation of the next whorl and the persistence or disappearance of the two preceding holdfasts I can say nothing, on account of the want of suitable materials for investigation. But, we may guess that the next whorl above the second is formed in a manner essentially the same as that in which the second whorl has developed. Root-fibres coming forth more afterwards, at any rate, become longer and several times branch dichotomously and their tips are flattened against the substratum. As the plant grows more and more, roots are formed one after another and those formed previously are replaced by others. Finally in a fully grown fronds, root-fibres form a conical elevation.

(To be continued.)