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Observations on the girdle of the genus *Amphora* (Diatoms)

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Although the girdle with numerous divisions of *Amphora* has been termed intercalary bands, it is a problem whether it has a set of numerous same single bands or a set of different elements. SEM investigation has been done in order to answer this question. As a result it became clear that the girdle is composed of numerous same single bands, therefore we should term it correctly connecting bands (pleurae). Further, concerning to the connection between a valve mantle and a connecting band, it became evident that the margin of the valve mantle overlaps the one side of the connecting band.

Key Index Words: Amphora, *Bacillariophyceae, connecting band, diatom, girdle structure, intercalary band.*

During the last several years, the taxonomical criteria of diatoms have become evident by using electron microscope. However, there are few reports on the structure of the girdle of the genus *Amphora*, which has been adopted as one of the taxonomical criteria observed by using light microscope. According to the past descriptions, the girdle of some of the genus *Amphora*, for instance *Amphora coffeaeformis* (AGARDH) KÜTZING which has numerous divisions, were termed only intercalary bands (cf. KARSTEN 1899, p. 104; HUSTEDT 1930, p. 345; PATRICK & REIMER 1975, p. 78 as *A. coffeiformis*). If we follow in MÜLLER's definition concerning to the girdle elements (MÜLLER 1886, 1895; cf VON STOSCH 1975), an intercalary band is not exist without a connecting band by reason that the intercalary band is an element which is inserted between a valve and a connecting band. On the girdle with numerous divisions of the genus *Amphora*, it is a problem whether it has a set of numerous same single bands or a set of different elements. If the girdle is a set of numerous same single bands, we should term it correctly connecting bands. The purpose of this study is to clarify this problem by the observation using scanning electron microscope.

Materials and Methods

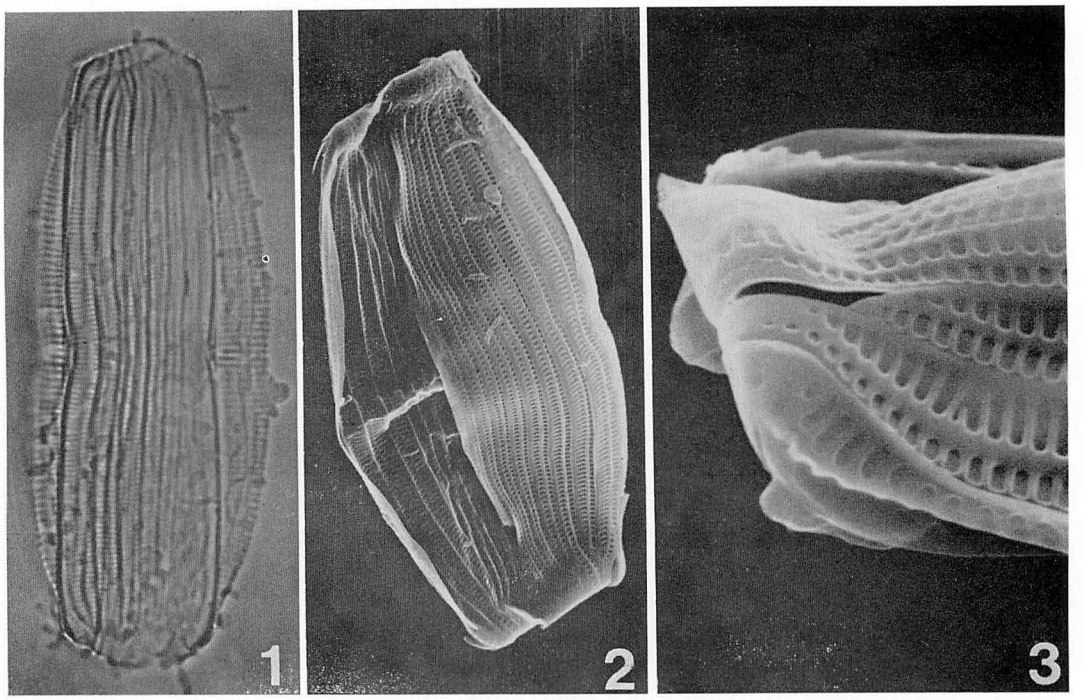
A species of the genus *Amphora* having numerous girdle elements was obtained from the film-like diatom assemblages which developed in one of the culture tanks of the rotifer *Brachionus plicatilis*. The diatom materials were collected from there and then cleaned by heating in concentrated sulphric acid, and adequate amounts of KNO_3 were added, then they were washed by distilled water until the supernatant became neutral. Preparations mounted in Pleurax were examined by using a Nikon Apophot microscope. For the scanning electron microscope examination, the material was cleaned as above and dehydrated in ethanol or iso-amyl acetate, and a drop of the suspension was dried by natural drying method or by critical point

drying method on stubs, and coated with gold (roughly 200 Å in thickness) by using a GIKO IB 3 ion coater. These were examined by using a HITACHI S-450 unit in the Institute of Life Science, Kinki University, at an accelerating voltage of 20 kV, and photographed on Kodak Tri-X pan film.

Observations

This taxon is nearly akin to *Amphora castellata* GIFFEN and *A. turgida* var. *africana* CHOLNOKY. But it differs from those taxa in several characters. In this report, therefore, the author deals with it as *Amphora* sp. The valve structure and taxonomical considerations of this diatom will be reported in another place.

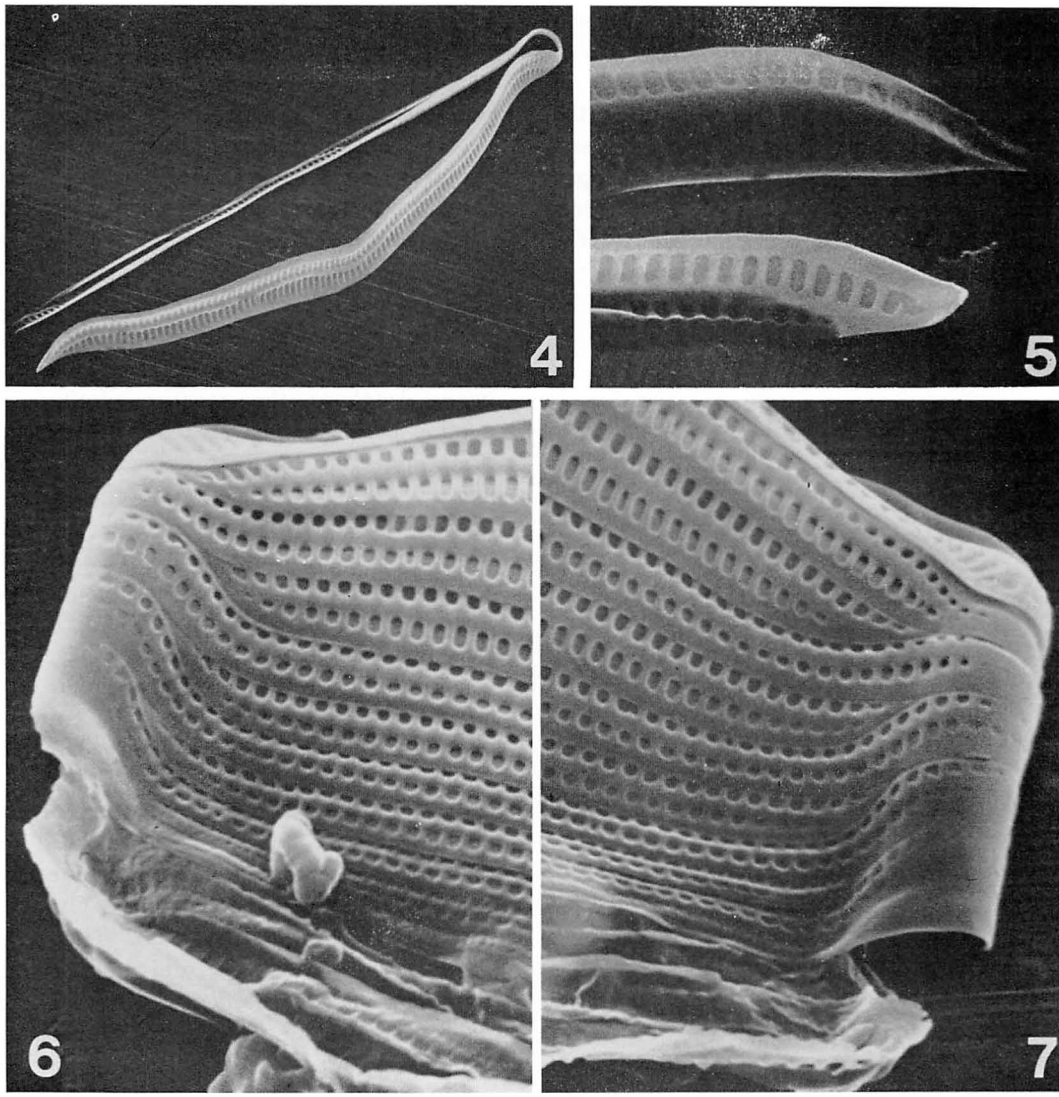
Light microscope observations: In this specimen, several linear series of short dashes are observed at the ventral and the dorsal part of the frustule (Fig. 1).



Figs. 1–3. *Amphora* sp.

1. The ventral part of the cell with several linear series of short dashes. LM. ×2000. 2. The dorsal part of the cell. Right: epitheca; left: hypotheca, with newly formed and weakly silicified hypocingulum. SEM. ×2300. 3. The incomplete dorsal apex of the epitheca showing a separate part and the connection between the valve mantle and the first connecting band. The valve mantle overlaps the first connecting band. SEM. ×10000.

Scanning electron microscope observations: The dorsal part of the girdle is divided by several longitudinal lines (Fig. 2). By observation of a separate part (Fig. 3) and of a single bobby-pin like open band (Fig. 4), it is understood that the cingula are composed of several open bands (7–9 per one cingulum). Each open bands has the pointed endings (Fig. 5) and two longitudinal rows of poroid areola, at the ventral and the dorsal part (Fig. 2). And the breadth of the open band in the dorsal part is somewhat broader than in the ventral part (Fig. 4). Externally, faintly raised axial ribs are laid at the portion of the both edges, respectively, and more silicified axial



Figs. 4–7. *Amphora* sp.

4. Single element of the cingulum, bobby-pin like open band. Upper: ventral side; lower: dorsal side. SEM. ×3000. 5. Showing the pointed endings and the ricae (or the vela) of a band. Upper: interior of the dorsal side; lower: exterior of the ventral side. SEM. ×10000. 6 and 7. The two apices of the dorsal part of the cell. Showing the position of the opening of open bands changed alternately, and the connections among the valve mantle and the first connecting band and each connecting band. SEM. ×9100.

ribs are raised in the center or in somewhat eccentric advalvar portion, and from which the transverse ribs are developed alternately to the advalver and abvalvar direction (Figs. 3, 4, 6, 7). Transverse ribs decrease their height gradually away from the axial rib (Figs. 3, 4). Internally, each ribs is slightly raised (Fig. 5). The rounded oblong to square portion, surrounded by the ribs is a rica (or a velum: not be observed in detail) (Figs. 3, 5, 6, 7). The rica (or the velum) is about 0.2–0.9 μm long and 0.2 μm wide in the dorsal part. These poroid areolae agree with the ornamenta-

tion of the valve. Connections of each open bands are as follows; the margin of the valve mantle overlaps the one side of the first band and the other side of the first band overlaps the margin of the second band, and in the same way each open bands is connected in the abvalvar direction (Figs. 2, 3, 6, 7). The position of the opening of the open bands changes in the pervalvar direction, alternately (Figs. 6, 7).

Discussion

The structure of the cingulum in this taxon seems to be a set of the single elements, although it is recognized that the breadth of the band and the size of the rica (or the velum) increase gradually from the opening of the cingulum to the advalvar direction, but is not divided clearly by their gradual changes. According to the terminology of the diatom girdle amended by VON STOSCH (1975), in this case, the first bands connected with the valve mantles are termed valvocopulae, and the other several bands are termed connecting bands (pleurae). However, in the terminology proposed by ANONYMOUS (1975) and ROSS *et al.* (1979), a term valvocopula is restricted to use for the special case. In this taxon, there is no reason to separate the first band by term from the others because of the each bands has no significant difference in structure. SCHOEMAN & ARCHIBALD (1978) showed the structure of the girdle of *Amphora veneta* var. *capitata* HAWORTH. This species has numerous bands, and is similar in the structure and the ornamentations to this taxon. KARSTEN (1899) gave many illustrations of *Amphora*, and showed that some of them had the girdle consisted of the numerous single elements. In these observations it is evident that the girdle of this taxon, probably of another species of *Amphora* having numerous girdle elements too, has been expressed as the intercalary bands, however we should term it correctly connecting bands.

Three types of connections between the valve mantle and the cingulum were shown by ROUND (1972 a, 1972 b) from a point of view of the relationship between the morphology of cell and the reduction of cell size during cell division. He showed that in the centric diatom *Stephanodiscus* the cingulum overlaps the margin of the mantle (ROUND 1971). However, VON STOSCH (1975) indicated the three possible interpretation on ROUND's SEM micrographs, and questioned whether the cingulum overlaps the margin of the valve mantle or not in *Stephanodiscus*. In the materials of the genus *Amphora*, the structure of the connection between the valve mantle and the first connecting band is same as the connecting band's juncture, i. e. the margin of the valve mantle overlaps the one side of the first connecting band. This type is similar to one of the three illustrations figured by ROUND (1972 a, fig. 1 C) and strictly speaking it agrees with the description and the illustration given by VON STOSCH (1975, fig. 12 c), but the structure so-called 'slit' edge is not observed in this taxon.

The alternate change of position of the opening of the open bands is observed not only in this taxon but also in connecting bands of *Chaetoceros septentrionale* OESTRUP (DUKE, LEWIN & REIMANN 1973). The structural pattern of the girdle elements is common between the pennate diatom *Amphora* and the centric diatom *Chaetoceros*. This is very interesting from a taxonomical point of view.

As one of the taxonomical criteria, the measurement of the number of the connecting bands (until now, they were termed intercalary bands) under light microscope has been done by some authors. In this case, it is out of the question whether the measuring of the numbers of the bands for unit is appropriate to the taxonomical criterion or not. It is neccessary to pay attention to the measurement because of its complexity. As the epicingulum and the hypocingulum overlap one another, it is a fact that the measurement is the sum of two numbers in the case which the overlapping can not be distinguished. Also

it must be designated clearly whether the numbers were measured by the numbers of the bands or by the numbers of rows of the areolae.

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後藤敏一：珪藻 *Amphora* 属の殻帯の観察

Amphora 属の中には殻帯 (girdle) が多くの縦線をもつものがある。従来の報告では上記のような殻帯は中間帯環 (intercalary band) と表記されているのみで接続帯環 (connecting band) の存在は明らかでない。上記のような構造をもつ *Amphora* sp. の殻帯の SEM による観察で次の3点が明らかになった。1) 殻帯は同一構造の開放帯環 (open band) の連なり〔半殻帯 (cingulum) あたり 7～9 本〕である。故に従来，中間帯環と表記されてきたのは誤りで，正しくは接続帯環と表記されるべきである。2) それぞれの開放帯環はその開口部を貫殻軸方向に交互に変換している。3) 殻套 (valve mantle) とそれに接続する接続帯環の結合部は前者が後者の端部を覆っている。接続帯環相互の結合も同様で殻 (valve) に近い方の端部はその前の接続帯環に覆われ，半殻帯の開口に近い端部は次の接続帯環の端部を覆っている。(術語訳は主に小林弘博士によるものである。)(577 大阪府東大阪市小若江 3-4-1，近畿大学教養部)