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Ultrastructure of the larval ventromental plates of *Chironomus balatonicus* DEVAI, WUELKER & SCHOLL (Diptera: Chironomidae)

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The micro-architecture of larval ventromental plates of *C. balatonicus* DEVAI, WUELKER & SCHOLL has been studied by scanning electron microscopy. The plates of this species are shown to have a number of ultrastructural features previously observed amongst European *Chironomus* only in *C. plumosus* L. and the closely related *C. muratensis* RYSER *et al.*, and *C. nudiventris* RYSER *et al.* The taxonomic implications of these findings are discussed.

INTRODUCTION

Chironomus balatonicus DEVAI *et al.* was described as a new species on the basis of chromosomal banding patterns which, together with biochemical genetic differences, distinguish it from the morphologically very similar species *C. plumosus* L. (DEVAI *et al.*, 1983). Larvae of *C. balatonicus* were assigned by DEVAI *et al.* (1983) to the *plumosus*-type, one of eight categories of *Chironomus* larvae initially recognized by LENZ (1954) and defined mainly on the condition of tubular appendages of the posterior abdominal segments. In addition to *C. plumosus*, LINDEBERG & WIEDERHOLM (1979) listed some 11 European species of *Chironomus* with larvae of the *plumosus*-type, several of which (e. g. *C. dorsalis* sensu KEYL & KEYL, *C. luridus* STRENZKE, *C. uliginosus* KEYL) are karyologically and enzymatically quite distinct from *C. plumosus* (e. g. MARTIN, 1979, SCHOLL *et al.*, 1980). In contrast, RYSER *et al.* (1983) described two species, *C. muratensis* RYSER *et al.* and *C. nudiventris* RYSER *et al.*, which are chromosomally and biochemically closely related to *C. plumosus*, while their larvae belong to different morphological types (SCHOLL *et al.*, 1980, RYSER *et al.*, 1983). RYSER *et al.* (1983) suggested that *C. plumosus*, *C. muratensis* and *C. nudiventris* should be included as the only *bona fide* members of a “*plumosus*-species group”.

A distinction of *C. plumosus*, *C. muratensis* and *C. nudiventris* from other European species of *Chironomus* has been supported by studies of one aspect of larval morphology, the ventromental plates which are structures involved in the processes of silk-spinning (WEBB *et al.*, 1981). The ventromental plates of *C. plumosus*, *C. muratensis* and *C. nudiventris* share a number of ultrastructural features which distinguish them from ventromental plates of all the other thirty-one species of European *Chironomus* examined to date, amongst which *C. balatonicus* is not included (WEBB 1980, WEBB *et al.*, 1981, 1985, 1987; WEBB & SCHOLL, 1985, 1987).

The possibility of including *C. balatonicus* in the *plumosus*-species group *sensu* RYSER *et al.* has not been directly addressed. The ultrastructure of the ven-

tromental plates of *C. balatonicus* is clearly of relevance to this question and forms the subject of the present communication.

MATERIALS AND METHODS

Head capsules from a total of sixteen fourth instar larvae were examined, including twelve specimens used in the original description of *C. balatonicus* by DEVAI *et al.* (1983). Larvae were identified on the basis of banding patterns of their polytene chromosomes and were all collected from the type locality of *C. balatonicus*, the Keszthely Basin of Lake Balaton, Hungary, by Gy. DEVAI and W. WUELKER.

Head capsules were fixed and preserved in 70% alcohol and dissected under a binocular microscope with a pair of fine tungsten needles sharpened electrolytically. Whole head capsules and dissected pieces were dehydrated to absolute alcohol, air dried and attached to stubs for examination in the scanning electron microscope (SEM). Specimens on stubs were coated with a thin layer of gold in a Balzers or Dynavac sputter coater and viewed with a Philips 500 or Jeol JSM-T330 SEM.

RESULTS

The ventromental plates of *C. balatonicus* appear as approximately fan-shaped structures lying lateral to, and partly behind the toothed mentum (Fig. 1a, b). The range of plate size, as indexed by peripheral length, overlaps size ranges of plates of *C. plumosus*, *C. muratensis* and *C. nudiventris*, although mean size is smaller than in these three species (Tab. 1; WEBB *et al.*, 1985).

In common with other species of *Chironomus*, the inner (dorsal) surface of the plates of *C. balatonicus* bears a series of lamella-like striae which originate posteriorly from an elliptical area of unstriated cuticle occupying the extreme rear section of plates (Fig. 1c, d; WEBB *et al.*, 1981, 1987; WEBB & SCHOLL, 1987). This rear section bears some small, irregular folds which are prominent distally (Fig. 1e), an arrangement that has been recorded in several *Chironomus* species (WEBB *et al.*, 1985, 1987; WEBB & SCHOLL, 1987). However in specimens of *C. balatonicus* examined the unstriated rear section of plates also has a ridge running just behind its anterior boundary (Fig. 1f), a structure previously ob-

Tab. 1: Quantitative variation in ventromental plates of *Chironomus balatonicus*.

Plate feature	n	range	\bar{x}	S.E.
size* (μm)	11	300.0-373.0	327.64	7.45
number of striae	13	75-91	83.85	1.37
total number of inner spines	8	365-428	397.13	7.01
group size of inner spines+	158	3-6	4.73	0.06
total number of outer spines	10	68-95	82.22	2.78

* peripheral length; + over middle section of plate; n, number of observations; \bar{x} , mean value; S. E., standard error of mean.

served only in members of the *plumosus*-group *sensu* RYSER *et al.* (WEBB *et al.*, 1985).

Features of strial organization observed in *C. balatonicus* and shared by other *Chironomus* species are the progressive shallowing and broadening of striae as they run anteriorly and the apparent subdivision through folding of striae occupying the extreme distal and proximal portion of plates (Fig. 2a–f; WEBB *et al.*, 1985, 1987; WEBB & SCHOLL, 1987). However striae of *C. balatonicus* appear narrower and are certainly more numerous than those of all other European *Chironomus* examined, apart from species of the *plumosus*-group *sensu* RYSER *et al.* (WEBB *et al.*, 1985, 1987; WEBB & SCHOLL, 1985, 1987). The range of strial numbers encountered in *C. balatonicus* overlaps that of *C. plumosus* and mean values of striae in the two species are similar (Tab. 1; WEBB *et al.*, 1985). In

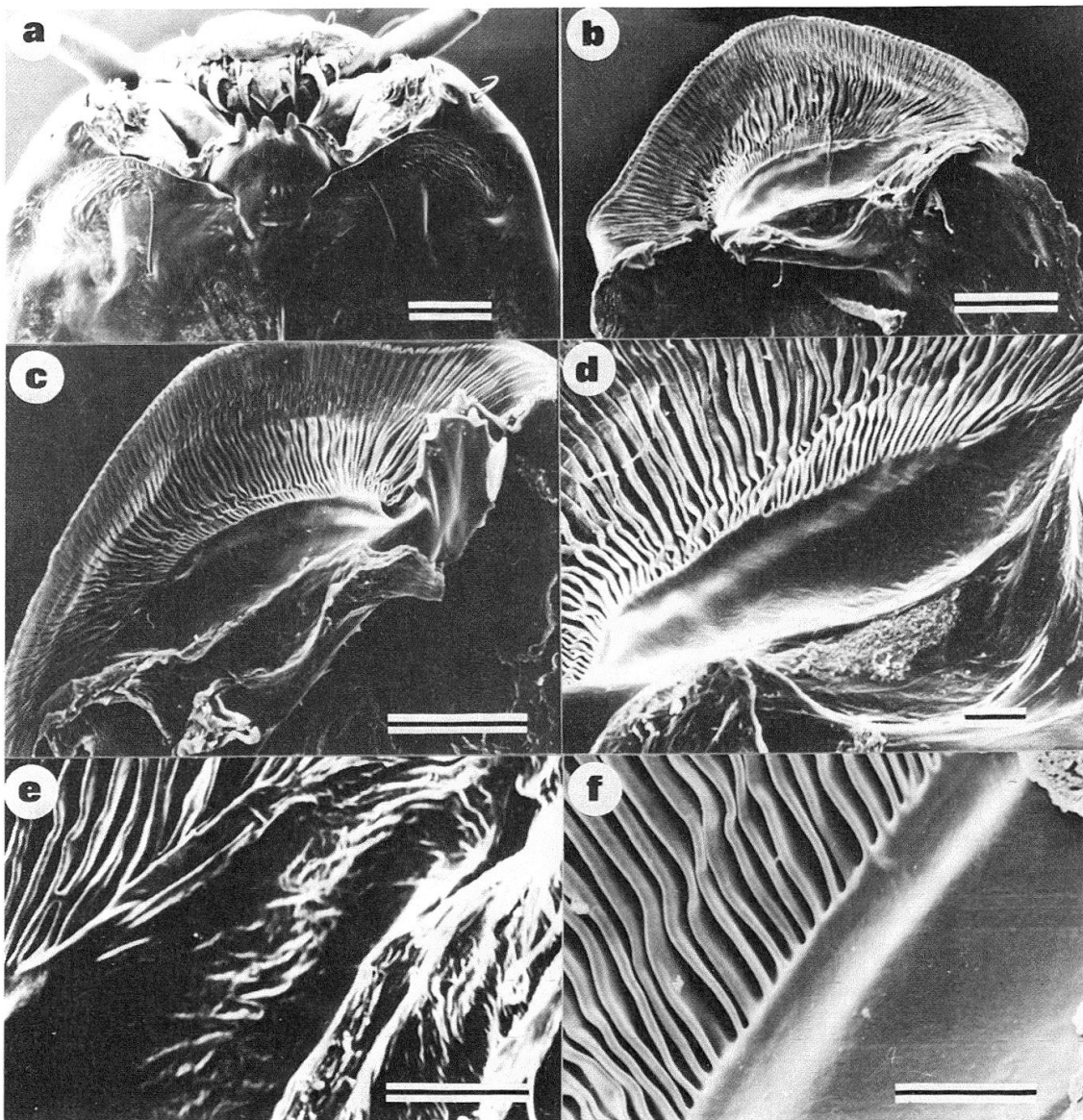


Fig. 1. Views of ventromental plates of *C. balatonicus*. (a) Outer (ventral) surface, (b) and (c) inner (dorsal) surface, (d) rear section of inner surface, (e) rear-lateral section of inner surface, (f) rear-mid section of inner surface. —b & c: mentum removed. Scales a 100 μm , b & c 50 μm , d–f 10 μm .

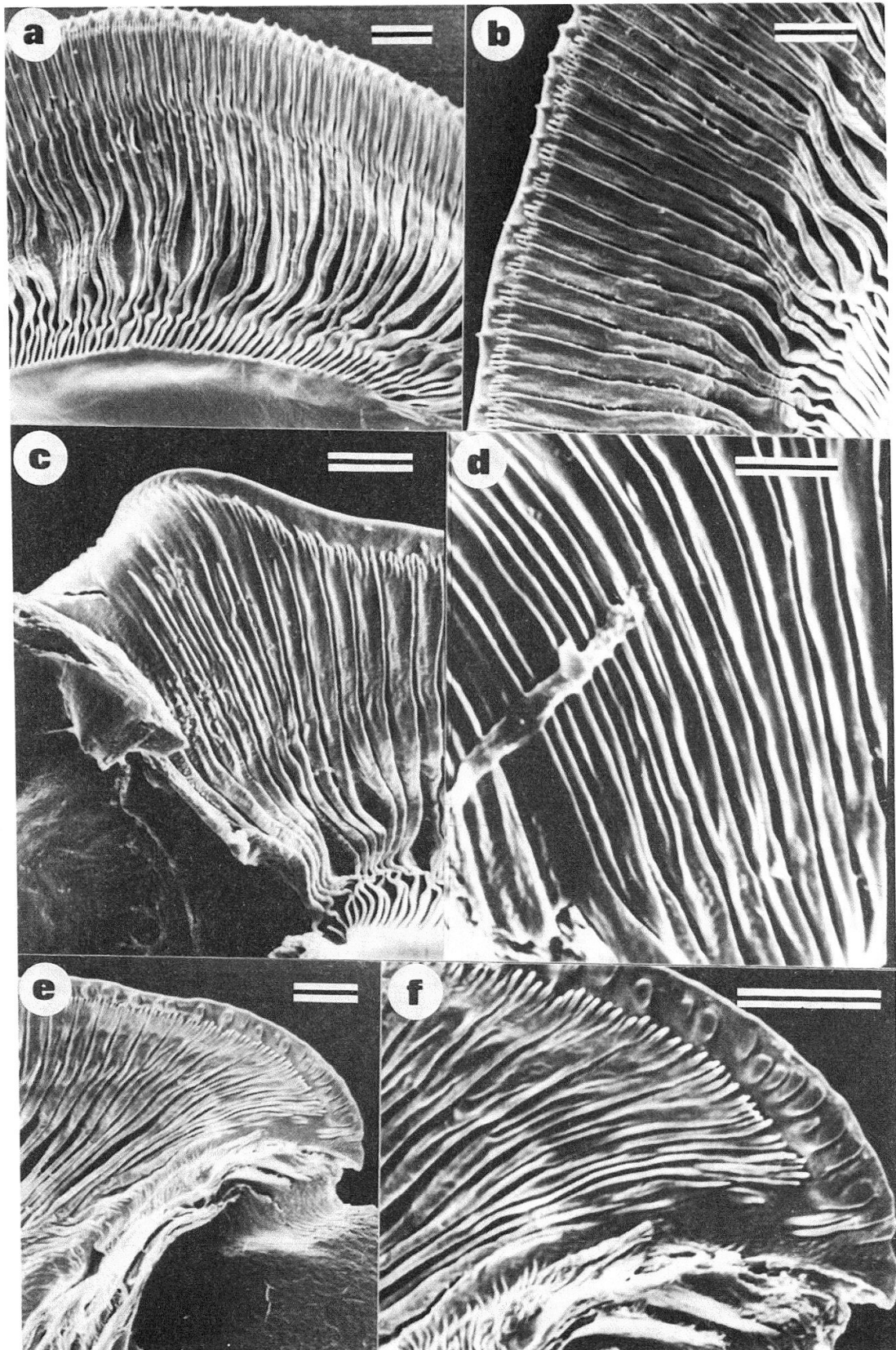


Fig. 2. Views of inner surface of ventromental plates of *C. balatonicus*. (a) and (b) mid section, (c) and (d) proximal section, (e) and (f) distal section. — c & d: mentum removed. Scales all 10 μm .

C. balatonicus striae run right up to a series of small, mainly pyriform spines, the inner of two rows of spinous projections found in the anterior section of plates of *C. balatonicus* (Fig. 3a, b) and all other *Chironomus* species examined to date (WEBB *et al.*, 1981, 1985, 1987; WEBB & SCHOLL, 1987). This type of strial termination, type IIIB in the terminology of WEBB *et al.* (1985), has been found previously only in *C. plumosus*, *C. muratensis* and *C. nudiventris* (WEBB, 1980; WEBB *et al.*, 1985).

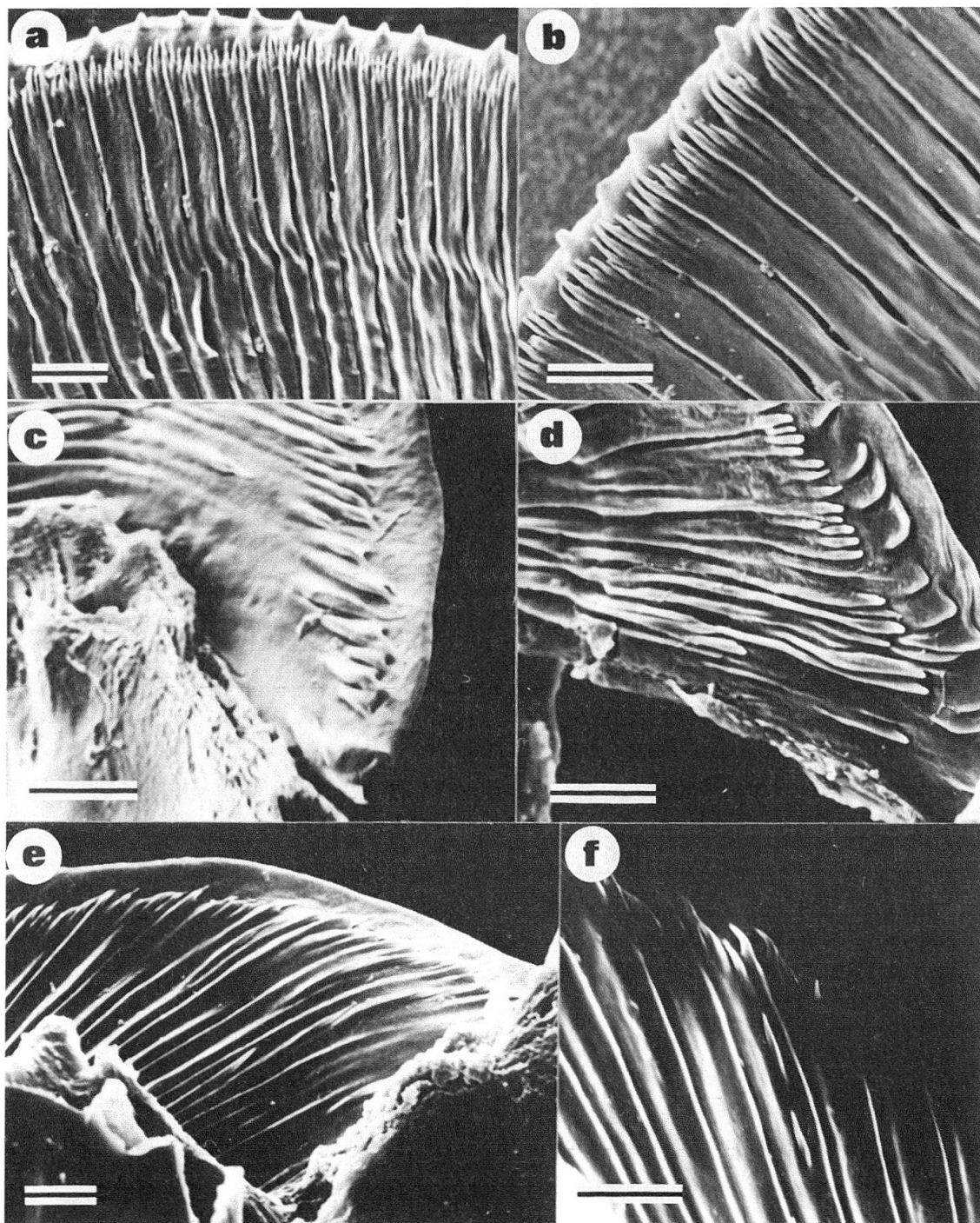


Fig. 3. Views of inner surface of ventromental plates of *C. balatonicus*. (a) and (b) anterior-mid section, (c) extreme anterior-proximal section, (d) extreme anterior-distal section, (e) and (f) anterior-proximal section. —c, e & f: mentum removed. Scales all 5 μ m.

Furrows between strial ridges delimit pyriform spines into groups (Fig. 3a, b). The range and mean number of spines in groups over the mid section of plates (Tab. 1) are very similar to those encountered in *C. plumosus* (WEBB *et al.*, 1985). The range and mean value of total number of inner spines in *C. balatonicus* (Tab. 1) are the highest recorded so far in *Chironomus* although information on this

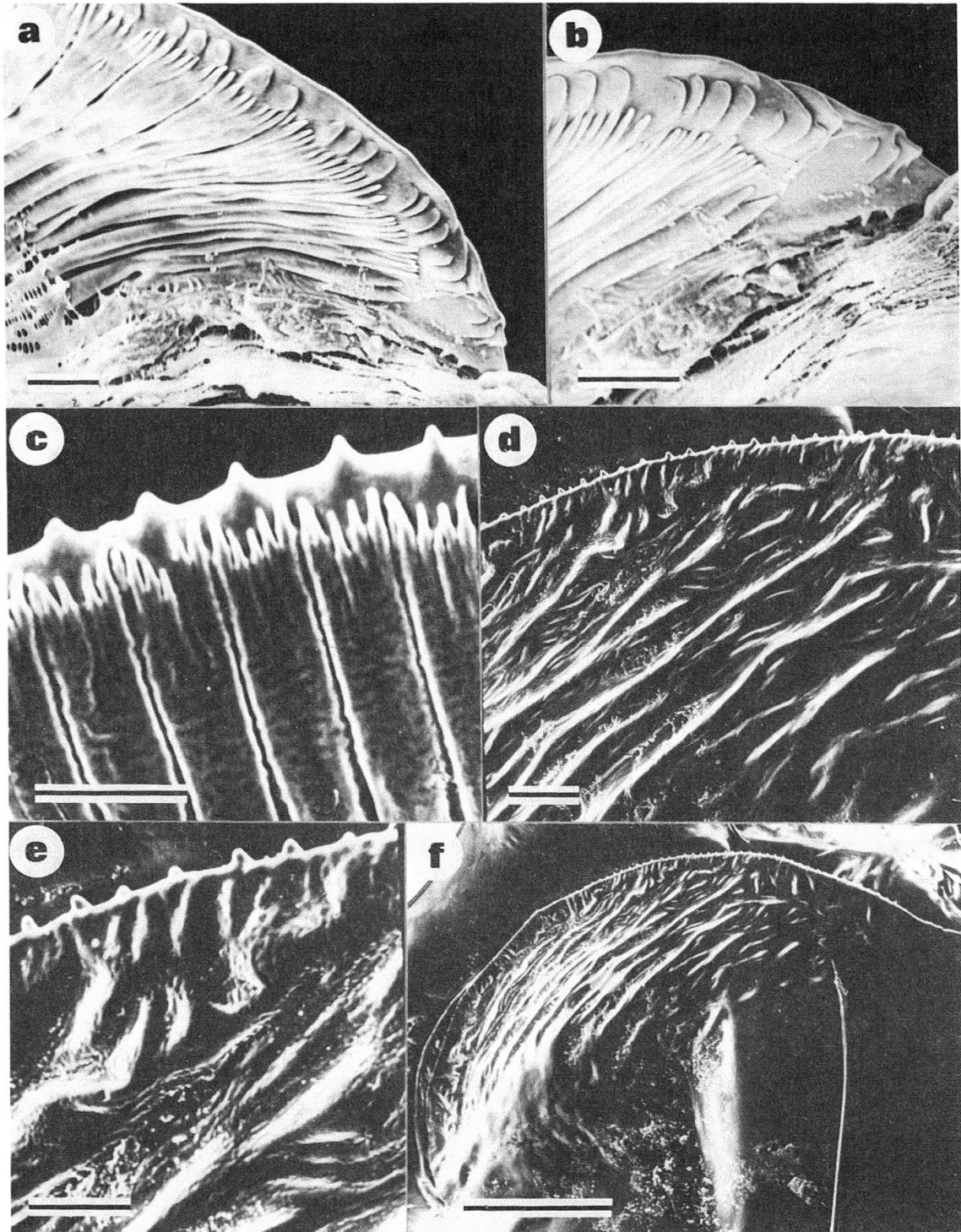


Fig. 4. Views of ventromental plates of *C. balatonicus*. (a) and (b) anterior-distal section of inner surface, (b) anterior-mid section of inner surface, (d) and (e) anterior-mid section of outer surface, (f) outer surface. Scales a, b, c & e 5 μm, f 50 μm.

character is not available for any member of the *plumosus*-group *sensu* RYSER *et al.* In *C. balatonicus*, as in other *Chironomus* species, spines of the inner series extend around virtually the complete margin of plates, with some differentiation of their morphology in the extreme proximal and distal portions of the series where spines may be somewhat broader, longer or less regular in shape (Fig. 3a–d, 5; WEBB *et al.*, 1987; WEBB & SCHOLL, 1987). A small, additional group of pyriform spines situated behind the inner series on the anterior section of proximal striae running under the mentum was observed in *C. balatonicus* (Fig. 3e, f). Similar spines have been found in *C. pallidivittatus* (EDWARDS), *C. tentans* (FÄBRICIUS), *C. montuosus* RYSER *et al.* and *C. storai* GOETGHEBUER (WEBB & SCHOLL, 1987) but no information is available on their occurrence in members of the *plumosus*-group *sensu* RYSER *et al.*

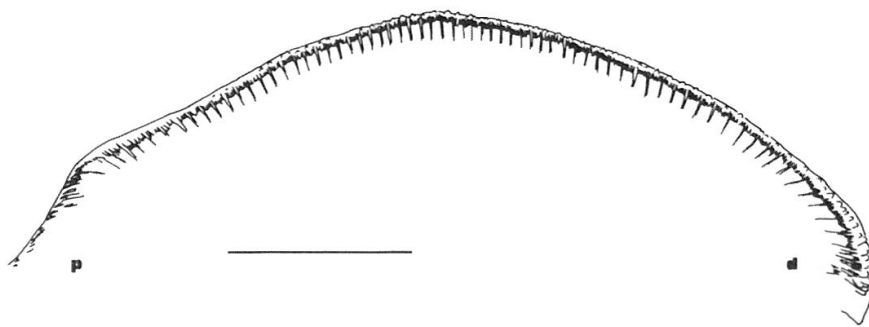


Fig. 5. Tracing of scanning electron micrographs of anterior inner surface of ventromental plate of *C. balatonicus*. Abbreviations: d, distal; p, proximal. Scale 50 μ m.

In *C. balatonicus*, as in other *Chironomus*, spines of the outer series are less numerous than those of the inner row and do not extend as far around the margin proximally (Fig. 3e, 5; WEBB *et al.*, 1985, 1987; WEBB & SCHOLL, 1987). The number of spines in the outer series is consistently higher in *C. balatonicus* than in all previously studied European species of *Chironomus* apart from members of the *plumosus*-group *sensu* RYSER *et al.* with the range and mean number of outer spines in *C. balatonicus* being similar to those of *C. plumosus* (Tab. 1, WEBB *et al.*, 1985, 1987; WEBB & SCHOLL, 1987). Outer series spines in *Chironomus* species studied to date are mainly conical in shape although distal members of the series are usually broader and less pointed than the rest (WEBB *et al.*, 1987; WEBB & SCHOLL, 1987). The situation is similar in *C. balatonicus* although this species is unusual in that spines of the inner and middle part of the outer row project beyond the anterior margin of the plate and can be seen from the outside of the plate (Fig. 4a–e). Amongst all the species of *Chironomus* examined previously, outer series spines overlapped the anterior margin of the plates of *C. plumosus*, *C. muratensis* and *C. nudiventris* only (WEBB *et al.*, 1985, 1987; WEBB & SCHOLL, 1987).

A SEM view of the outside of plates of *C. balatonicus* also reveals the existence of sculpturing on the anterior mid and lateral sections of their outer (ventral) surface (Fig. 4d–f). Similar sculpturing has been found on plates of *C. plumosus*, *C. muratensis* and *C. nudiventris* but none of the other European

species of *Chironomus* which have been investigated previously (WEBB *et al.*, 1985, 1987; WEBB & SCHOLL, 1987).

DISCUSSION

C. balatonicus shares with members of the *plumosus*-group *sensu* RYSER *et al.* several ventromental plate features which are unique amongst European species of *Chironomus*. These include the high number of striae, pattern of strial termination, size of inner spine groups, number and position of outer spine row and presence of sculpturing on the ventral surface of plates. The ventromental plates of *C. balatonicus* are clearly very similar to those of the *plumosus*-group *sensu* RYSER *et al.* and in terms of ventromental plate micro-architecture *C. balatonicus*, *C. plumosus*, *C. muratensis* and *C. nudiventris* form a clearly distinct grouping amongst the European species of *Chironomus*.

Although ventromental plate ultrastructure has proved of use in the systematics of larval chironomids (WEBB & SCHOLL, 1985, 1987; WEBB & MARTIN, 1987; WEBB *et al.*, 1985, 1987) it is not an infallible indicator of taxonomic relationship within *Chironomus* (WEBB *et al.*, 1985). As with other morphological characters, groups of species segregated on the basis of ventromental plate features do not invariably correspond with groupings based on karyology or biochemical genetics (LINDEBERG & WIEDERHOLM, 1979; SCHOLL *et al.*, 1980; WEBB & SCHOLL, 1985; WEBB *et al.*, 1985). One reason for this is that ventromental plates are functional features that may be subject to convergent evolution (WEBB, 1980; WEBB *et al.*, 1981). Within *Chironomus*, for example, *C. striatus* STRENZKE and *C. lacunarius* WUELKER & KLOETZLI, which are genetically very distinct species with a similar ecological niche, have plates that are ultrastructurally alike (WEBB *et al.*, 1985).

While *C. balatonicus* and *C. plumosus* are broadly sympatric, *C. balatonicus* appears to prefer habitats that are poorer in decomposing organic matter (DEVAI *et al.*, 1983) so may not occupy exactly the same ecological niche. There is also evidence independent of ventromental plate structure for a close relationship between *C. balatonicus* and members of the *plumosus*-group *sensu* RYSER *et al.* For example, electrophoretic investigations indicate that *C. balatonicus* has a Nei coefficient of genetic identity (\bar{I}) with *C. plumosus*, *C. muratensis* and *C. nudiventris* of 0.65 (DEVAI *et al.*, 1983). Although this is a lower value than the very high identities shared by members of the *plumosus*-group *sensu* RYSER *et al.*, where \bar{I} ranges from 0.81–0.85 (SCHOLL *et al.*, 1980), it exceeds identities recorded between *C. plumosus*, *C. muratensis* and *C. nudiventris* with other *Chironomus* species that have been examined (SCHOLL *et al.*, 1980; WUELKER *et al.*, 1981; RYSER *et al.*, 1983). Similarly, although there are karyological differences between *C. balatonicus* and members of the *plumosus*-group *sensu* RYSER *et al.*, particularly in arms A and F, *C. balatonicus* is still more similar karyologically to *C. plumosus*, *C. muratensis* and *C. nudiventris* than any other European species of *Chironomus* (MARTIN, 1979; WUELKER *et al.*, 1981, 1983; DEVAI *et al.*, 1983; RYSER *et al.*, 1983).

Amongst the European species of *Chironomus*, *C. balatonicus*, *C. plumosus*, *C. muratensis* and *C. nudiventris* are one of the few groups of species that can be associated together in terms of cytogenetics, biochemistry and larval morphology and their inclusion together in a "*plumosus*-group" does not seem unwarranted.

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